

Department of Computer Science & Engineering

Malaviya National Institute of Technology Jaipur (An Institute of National Importance)

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Department of Computer Science & Engineering came into existence in 1994. The first degree program offered by the Department was B.E. (Computer Engineering) in affiliation with the University of Rajasthan. The first batch graduated in 1998. Another degree programme B.E. (Information Technology) was initiated in 2001. In January 2004, first admissions to Ph.D. programme took place. In 2008, M.Tech. (Computer Science & Engineering) programme was initiated whereas, M.Tech. (Computer Science & Information Security) was started in 2016. At present, Computer Science & Engineering Department is offering following degree programmes: B.Tech. (Computer Science & Engineering) M.Tech. (Computer Science & Engineering) M.Tech. (Computer Science & Information Security) Ph.D. Faculty at Computer Science & Engineering believes in open interaction with students who are encouraged to participate in academic, research and extra-curricular activities. Students have never misplaced trust put in them by department and have done well in academic and industry alike. Vision To be a Centre of Excellence in Computer Science and Engineering domain and work with industry on cutting edge technology to address current and emerging challenges in global perspective for the development of society. Mission To impart quality engineering education, enhance problem solving skills, foster research and innovation, encourage entrepreneurship and mold students of integrity and ethics to provide leadership with social sensitivity for the betterment of the country and humanity as a whole. Contact Information Dr. Namita Mittal Head, Department of Computer Science & Engineering Malaviya National Institute of Technology JLN Marg, Jaipur-302017 0141-2713340 hod.cse@mnit.ac.in Related Links Malaviya National Institute of Technology Jaipur Jawahar Lal Nehru Marg, Jaipur-302017 (Rajasthan) INDIA webmaster[at]mnit.ac.in Disclaimer: Copyright © 2024 Malaviya National Institute of Technology Jaipur 18773518 Department of Computer Science & Engineering

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Units Media Centre Recruitment Facilities Cloud & Data Science Lab Details Of  
Equipment / Computer System:Dell OptiPlex 5040 Processor : - Intel(R) Core(TM) i7-  
6700 CPU @ 3.40GHz 3.41 GHz RAM :- 16.0 GB Hard Disk : - 500GB Network Card :  
- 10/10/1000 MbpsSoftware Installed:OS Ubuntu GCC, PythonNo. of System:54

NosProjector:1 Nos Computer Network Lab Details Of Equipment / Computer System:Processor Pentium Core i7 RAM 4GB 500 GB HDDSoftware Installed:OS Ubuntu Gcc Python, MatLABNo. of System:30 NosProjector:1 Nos Minsky Research Lab Details Of Equipment / Computer System:Workstation Supermicro Intel Xeon Silver 4110 CPU@2.10 GHz x32 , 96 GB RAM, 04 TB SSD DISK Graphics: GeForce RTX 2080/Ti/PCIe/SSE2, 27" MonitorSoftware Installed:OS UbuntuNo. of System:06 Nos Software Design Lab Details Of Equipment / Computer System:HP Elite Desktop 800 G1 SFF, I-7 (4770-3.4 GHz), 4 GB DDR3 RAM, 500 GB Sata HDD, with 18.5" ICD MonitorSoftware Installed:Ubuntu 20.04 LTSNo. of System:29 NosProjector:1 Nos10 KVA UPS:1 Nos Real Time Embedded System Lab Universal microcontroller Development (UMD) Board : 15Zig bee Technology Trainer Kit :5GSM development Board : 5SENSOR MODULES and Other Interfaces :5Bluetooth Trainer Kit : 2Smart Phone Trainer Kit : 2Object Detection and tracking using Tracked Robo Kit using Raspberry Pi / AVR / ARM/ Arduino : 1 Digital System Lab Digital Lab Trainer (Bread Board Model ME1154 With Complimentary Ready to Use Model) : 258085 Microprocessor Trainer - Micro 85EB-LCD - : 258086 Microprocessor Trainer - Micro 86 LCD – : 25Keyboard & Display Interface Board (VBMB 001)- : 102 Channel DAC Interface Board (VBMB-002) : 108 Channel ADC Interface Board (VBMB 003) : 108251 & 8253 Interface Board (VBMB 004) : 108259 Interface Board (VBMB - 007) : 108255 Interface Board (VBMB 008) : 10DC Motor Speed Measurement : 10Digital Storage Oscilloscope, High Performance With DVM &Wavegen; Agilent DSOx2014A with DSOX2000-DVM & DSO2000-001 all media & Manuals analog BW 100MHz, 4 Digital Channels , Built in Function generator 20 Mhz& Digital Volt Meter 3 Digit Enabled (30) & DSOX2MSO –MSO Upgrade -8 Channel for 2000 X-Series Oscilloscope (05) : 30Atlys Spartan 6 FPGA Development Kit : 18NetSim Academic version v12.2 perpetual and floating I : 30 users licenseNetSim Standard version and Emulator version v12.2 perpetual and floating : 05 users license IOT Lab Universal embedded mother board: 5Arduino YUN daughter boards: 5ARM 7 Daughter Board: 5Raspberry Pi development board: 5GSM Interfacing Module: 5Bluetooth Interfacing Module: 5RFID Interfacing Module: 5XBEE Interfacing Module: 5Temp. measurement sensor module: 5Tmote Sky Dev. Sensor Board: 5Wireless Modem: 5BeagalBone Black: 5Pressure measurement sensor module: 5Stepper motor interface module: 2IoT Training Kit: 2 ISEA Lab (Information Security Lab) Details Of Equipment / Computer System:Dell OptiPlex 7440 (AIO) Processor : - Intel(R) Core(TM) i5- 6500 @ 3.20GHz RAM :- 4.0 GB Hard Disk : - 500GB Network Card : - 10/10/1000 MbpsSoftware Installed:OS Ubuntu GCC, PythonNo. of System:20 Nos Details Of Equipment / Computer System:Dell OptiPlex 9020 Processor : - Intel(R) Core(TM) i5- 4590 @ 3.30GHz RAM :- 16.0 GB Hard Disk : - 500GB Network Card : - 10/10/1000 Mbps 19.5TFTSoftware Installed:OS Ubuntu GCC, PythonNo. of System:14 NosProjector (Casio XJ-V2):01 NosAPC-Smart UPS RT-5000, 5KVA:02 Nos Ramanujan Lab Details Of Equipment / Computer System:Wipro Pentium i3 RAM 4GB 500 GB HDDSoftware Installed:OS UbuntuNo. of System:35 Nos Kalam Research Lab Details Of Equipment / Computer System:Single Intel Xeon 16 Core, 2.10 GHz, 22 MB cache, 960 GB SSD, 2No NVIDIA Quadro RTX 6000 with 24GB DDR6, 2TB 7200 RPM Enterprise SATA Hard Drive.Software Installed:Ubuntu 18,

Python, tensor flow, PytorchNo. of System:01 Nos Details Of Equipment / Computer System: Intel Xeon, 2.10 GHz, 1 No NVIDIA Titan V with 12GB, 1TB Hard Drive Software Installed: Ubuntu 18, Python, tensor flow, PytorchNo. of System:01 Nos Miscellaneous Six UG/PG Labs; Six Research Labs; One Server room DFB room; office with reprographic facility, telephone and fax, printer available for students/faculty Individual faculty rooms with Computing, Internet, telephone Seminar hall – equipped with overhead LCD projector, computer, Internet connectivity Committee room – equipped with overhead LCD projector, computer, Internet connectivity Two Tutorial rooms Record room – Reports, Books Departmental Store room Related Links Malaviya National Institute of Technology Jaipur Jawahar Lal Nehru Marg, Jaipur-302017 (Rajasthan) INDIA webmaster[at]mnit.ac.in Disclaimer: Copyright © 2024 Malaviya National Institute of Technology Jaipur 18773525 Department of Computer Science & Engineering (Committee) ■■■■■■ ■■■■■■■■■■ ■■■■■■■■■■ ■■■■■■■■■■(■■■■■■■■■■ ■■■■■■■■■■ ■■■■■■■■■■) Malaviya National Institute of Technology Jaipur (An Institute of National Importance) About MNIT NIT Statutes & Act Reports MNIT Newsletters Administration Committees Minutes of Meetings Others Continuing Students Prospective Students Departments Centres Research @ MNIT Facilities Office of Deans Other Central Units Media Centre Recruitment Committee Department Under-Graduate Committee (DUGC) Department Post-Graduate Committee (DPGC) Related Links Malaviya National Institute of Technology Jaipur Jawahar Lal Nehru Marg, Jaipur-302017 (Rajasthan) INDIA webmaster[at]mnit.ac.in Disclaimer: Copyright © 2024 Malaviya National Institute of Technology Jaipur 18773527 Department of Computer Science & Engineering (Publications) ■■■■■■ ■■■■■■■■■■ ■■■■■■■■■■■■■■■■■■■ ■■■■■■■■■■ ■■■■■■■■■■(■■■■■■■■■■ ■■■■■■■■■■ ■■■■■■■■■■) Malaviya National Institute of Technology Jaipur (An Institute of National Importance) About MNIT NIT Statutes & Act Reports MNIT Newsletters Administration Committees Minutes of Meetings Others Continuing Students Prospective Students Departments Centres Research @ MNIT Facilities Office of Deans Other Central Units Media Centre Recruitment Publications Journal Publications (503) 2025 A. K. Prajapati, E. S. Pilli, R. B. Battula, V. Varadharajan, A. Verma, and R. C. Joshi, "A Comprehensive Survey on RPL Routing-based Attacks, Defences and Future Directions in Internet of Things", Computers and Electrical Engineering Volume :125 / / 2025 Anil Kumar Prajapati, Emmanuel S Pilli, Ramesh Babu Battula, Vijay Varadharajan, Abhishek Verma, RC Joshi, "A comprehensive survey on RPL routing-based attacks, defenses and future directions in Internet of Things", Computers and Electrical Engineering Volume :123 / / 2025 Akash Yadav, Mushtaq Ahmed, "A Framework for efficiently parallelizing loops for many core systems", SN Computer Science Volume :6 / / 2025 Idris Afzal Shah, Mushtaq Ahmed, "An Optimized Load Balancing Probabilistic Protocol for Delay Tolerant Networks accepted", SN Computer Science Volume :24 / 22 / 2025 ISBN: SNCS-D-24-04592R1 Kamakhya Bansal, Ashish Kumar Tripathi, "Automated floating debris monitoring using optical satellite imagery and artificial intelligence: Recent trends, challenges and opportunities", Remote Sensing Applications: Society and Environment Volume :37 / 101475 / 2025 Ravi Nahta, Ganpat Singh Chauhan,

Yogesh Kumar Meena, Dinesh Gopalani , "CF-MGAN: Collaborative filtering with metadata-aware generative adversarial networks for top-N recommendation" , Information Sciences Volume :689 / / 2025 Deepti Sharma, Ramesh Babu Battula, "CNN based Hybrid Precoding Framework using Dual-Phase Shifter in MIMO Systems" , International Journal of Ad Hoc and Ubiquitous Computing Volume :48 / / 2025 Abhishek Upadhyay, Yogesh Kumar Meena, Satyendra Singh Chouhan, "EJMACC: Emotion Aided a Joint Learning Approach for Multi-aspect Crisis Event Classification" , Expert System and Applications Volume :282 / 127597 / 2025 Monika Choudhary, Satyendra Singh Chouhan, "Enhancing credibility assessment in online social networks using multimodal deep learning" , Applied Soft Computing Volume :171 / 112796 / 2025 Sachin Gupta, Ashish Kumar Tripathi, "Flora-NET: Integrating dual coordinate attention with adaptive kernel based convolution network for medicinal flower identification" , Computers and Electronics in Agriculture Volume :230 / 109834 / 2025 Rohit Lohar, Meenakshi Tripathi, Hossein Shirazi, "Free-Phish: detecting phishing websites hosted on free web hosting domains." , International Journal of Computers and Applications Volume :47 (2) / 162-168 / 2025 Sachin Gupta, Ashish Kumar Tripathi, Nkenyereye Lewis, "Pre-trained noise based unsupervised GAN for fruit disease classification in imbalanced datasets" , Pattern Analysis and Applications Volume :28 / / 2025 Abhishek Narwaria, Arka Prokash Mazumdar, "SD-MoMa: ANN-based mobility prediction and adaptive handover management in SDWSN" , Cluster Computing Volume :Accepted / / 2025 Idris Afzal Shah, Mushtaq Ahmed, "Survey on Protocols in MANETs, WSNs and DTNs" , International Journal of System Engineering and Management Volume :31 / / 2025 Shreerudra Pratik, Pallabi Sharma, Deepak Ranjan Nayak, Bunil K Balabantaray, "WMCF-Net: Wavelet pooling-based multiscale contextual fusion network for polyp classification" , Biomedical Signal Processing and Control Volume :107 / / 2025 2024 Rukhsar Sultana, Jyoti Grover, Meenakshi Tripathi, Manhar Singh Sachdev, Sparsh Taneja , "Detecting Sybil Attacks in VANET: Exploring Feature Diversity and Deep Learning Algorithms with Insights into Sybil Node Associations." , Journal of Network and Systems Management Volume :32 / / 2024 Geetanjali Singh, Namita Mittal, and Satyendra Singh Chouhan, "A deep learning framework for multi-document summarization using LSTM with improved Dingo Optimizer (IDO)" , Multimedia Tools and Applications Volume :1 / 1-23 / 2024 Kamakhya Bansal, Ashish Kumar Tripathi, Varun G. Menon, Venki Balasubramanian, "A Federated Generative Adversarial Network With SSIM-PSNR Based Weight Aggregation for Consumer Electronics Waste" , IEEE Transactions on Consumer Electronics Volume :Early Acce / -- / 2024 Jyoti Nagpal, Lavika Goel, P.S. Shekhawat, "A hybrid deep learning neural network for early plant disease diagnosis using a real-world Wheat■Barley vision dataset: challenges and solutions" , International Journal of Data Science and Analytics Volume :0 / 1-22 / 2024 Mahipal Jadeja, Rahul Muthu and Ravi Goyal , "A New Characterisation of Total Graphs" , Palestine Journal of Mathematics Volume :13(4) / / 2024 Prem Shanker Yadav, Dinesh Kumar Tyagi, Santosh Kumar Vipparathi, "A Novel Approach for Image Retrieval in Remote Sensing Using Vision-Language-Based Image Caption Generation" , Multimedia Tools and Applications Volume :Xx / / 2024 Neeraj Garg, Sneha Garg, Mahipal Jadeja, Yogesh Kumar Meena, Dinesh Gopalani and Ganpat



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onRobotics and AI under aegis of E & ICT Academy at MNIT, Jaipur, India from 24-06-2019 to 28-06-2019 National Conference on Advanced Communication Technologies and Networks (ACTN) 2019 at MNIT Jaipur, Jaipur, India from 20-06-2019 to 21-06-2019 National Short Term Course on Introduction to Programming: A Pedagogical Approach at MNIT Jaipur, Jaipur, India from 17-06-2019 to 22-06-2019 National Short Term Course on Network Security (EICT Summer Global Course) at Malaviya National Institute of Technology, Jaipur, India from 20-05-2019 to 24-05-2019 National Workshop on Technical Writing With Advanced Computer Tools: Hands-On Training at Malaviya National Institute of Technology Jaipur, Jaipur, India from 14-05-2019 to 18-05-2019 International Conference on The Fourth International Conference on Internet of Things and Connected Technologies, IOTCT2019 at Malaviya National Institute of Technology Jaipur, Jaipur, India from 09-05-2019 to 10-05-2019 National Workshop on ATAL Workshop on Artificial Intelligence and Machine Learning at MNIT, Jaipur, India from 23-02-2019 to 26-02-2020 National Workshop on Artificial Intelligence and Machine Learning at MNIT, Jaipur, India from 22-02-2019 to 26-02-2019 International Workshop on The First International Workshop on Text Analytics and Retrieval (TexAR-2018), WI 2018 at University of Chile, Santiago, Chile from 03-12-2018 to 06-12-2018 International Short Term Course on Cyber Security Awareness and Cyber Security Challenge Competition at Malaviya National Institute of Technology Jaipur, Jaipur, India from 09-07-2018 to 13-07-2018 National Workshop on Internet of Things under aegis of E & ICT Academy at MNIT, Jaipur, India from 18-06-2018 to 22-06-2018 National Workshop on "ANN and Deep Learning" at MNIT, Jaipur, India from 11-06-2018 to 15-06-2018 National Short Term Course on Communication Skills at Malaviya National Institute of Technology Jaipur, Jaipur, India from 14-05-2018 to 18-05-2018 International Conference on Internet of Things and Connected Technologies at MNIT, Jaipur, India from 26-03-2018 to 27-03-2018 National Short Term Course on Big Data Analytics at LNM Institute of Information Technology, Jaipur, India from 17-03-2018 to 21-03-2018 International Conference on 10th International Conference on Internet of Things and Connected Technologies (ICIoTCT), 2018 at Malaviya National Institute of Technology JLN Marg Jaipur - 302017, Jaipur, India from 16-03-2018 to 18-03-2018 National Workshop on FDP on "Cyber Security and Its Challenges" at MNIT Jaipur, Jaipur, INDIA from 25-02-2018 to 01-03-2018 National Workshop on Latex and Technical Writing at Malaviya National Institute of Technology Jaipur, Jaipur, India from 24-01-2018 to 28-01-2018 International Short Term Course on GIAN: Advanced Data and Web Analytics at MNIT Jaipur, JAIPUR, India from 16-12-2017 to 20-12-2017 International Conference on Doctors Colloquium : FIRE 2017 at IISC Bangalore, Bangalore, India from 09-12-2017 to 09-12-2017 International Conference on The Thirteenth International Conference on Signal Image Technologies and Internet Based Systems at MNIT Jaipur, Jaipur, India from 04-12-2017 to 07-12-2017 National Workshop on FDP on "Object Oriented Programming" at MNIT Jaipur, Jaipur, INDIA from 20-11-2017 to 29-11-2018 National Workshop on Intel Nervana Program at MNIT, Jaipur, India from 18-11-2017 to 18-11-2017 National Short Term Course on Real Time Systems at MNIT, Jaipur, India from 07-11-2017 to 09-11-2017 National Workshop on Proteus vsm Embedded System Workshop at MNIT, Jaipur, India from

28-10-2017 to 29-10-2017 National Workshop on Deep Learning on Parallel Architectures at Malaviya National Institute of Technology, Jaipur, India from 26-10-2017 to 27-10-2017 National Conference on Advanced Communication Technologies and Networks (ACTN) 2017 at MNIT, Jaipur, India from 24-10-2017 to 25-10-2017 National Conference on Data Mining and Machine Learning at MNIT, Jaipur, India from 14-10-2017 to 15-10-2017 National Short Term Course on Technical Document Preparation Using LaTeX at MNIT, Jaipur, India from 09-10-2017 to 13-10-2017 National Workshop on Five Day Workshop on Parallel Computing at Malaviya National Institute of Technology, Jaipur (MNIT), Jaipur, India from 28-09-2017 to 02-10-2017 National Short Term Course on Applications of Matlab in Engineering at MNIT, Jaipur, India from 20-07-2017 to 24-07-2017 National Short Term Course on Introduction to Data Structures and Programming in C++ at Malaviya National Institute of Technology, Jaipur, India from 01-07-2017 to 10-07-2017 National Short Term Course on Fundamentals of Databases at MNIT Jaipur, Jaipur, India from 23-06-2017 to 03-07-2017 National Workshop on "Introduction to Web Development" at MNIT Jaipur, JAIPUR, India from 13-06-2017 to 22-06-2017 International Conference on International Conference on Advances in Internet of Things and Connected Technologies (ICIoTCT 2017) at MNIT Jaipur, Jaipur, India from 26-05-2017 to 27-05-2017 National Short Term Course on Fundamentals of Computer Networks and Security at Malaviya National Institute of Technology, Jaipur, India from 24-05-2017 to 03-06-2017 National Workshop on Fundamentals of Computer networks and Security at MNIT Jaipur, Jaipur, INDIA from 22-05-2017 to 01-06-2017 International Workshop on Multimodal and Advanced Biometrics Authentication at MNIT Jaipur, Jaipur, India from 02-01-2017 to 11-01-2017 International Workshop on Biometric Based Authentication and De-identification for Privacy Protection at MNIT Jaipur, Jaipur, India from 19-12-2016 to 25-12-2016 International Conference on 8th International Conference on Intelligent Human Computer Interaction Pilani, Rajasthan, India at Organised by CSIR-CEERI Pilani, BITS Pilani and IIIT-Allahabad., Pilani, Rajasthan, India from 12-12-2016 to 13-12-2016 National Short Term Course on Big Data Analytics for Smart Grid at MNIT Jaipur, Jaipur, India from 10-12-2016 to 14-12-2016 National Workshop on Recent Advances in Engineering and Medical Imaging Techniques (RAEMIT-16) at MNIT Jaipur, Jaipur, India from 12-04-2016 to 16-04-2016 National Workshop on Parallel Computing at Malaviya National Institute of Technology, Jaipur, India from 08-04-2016 to 12-04-2016 National Workshop on Software Defined Networks at MNIT, Jaipur, India from 18-03-2016 to 22-03-2016 National Workshop on SoC and Embedded System Design at MNIT, Jaipur, India from 27-02-2016 to 02-03-2016 National Seminar on Biometrics and Security, Expert Talk by Prof. Anil K. Jain, , University Distinguished Professor, Department of CSE at Michigan State University, US at MNIT Jaipur, Jaipur, India from 11-01-2016 to 11-01-2016 National Workshop on Biomedical Imaging at MNIT Jaipur, Jaipur, India from 03-12-2015 to 03-12-2015 National Workshop on Machine Vision and Biometrics at MNIT, Jaipur, India from 17-10-2015 to 21-10-2015 National Workshop on One day Workshop on Real Time Embedded Systems & Robotic Applications at Malaviya National Institute of Technology, Jaipur, India from 24-09-2015 to 24-09-2015 National Workshop on One day Workshop on

Real Time Embedded Systems & Applications at Malaviya National Institute of Technology, Jaipur, India from 15-09-2015 to 15-09-2015 National Workshop on Cyber security and Cyber crime at Malaviya National Institute of Technology, Jaipur, India from 12-09-2015 to 12-09-2015 National Workshop on Code Modernization and Parallel Computing at Malaviya National Institute of Technology, Jaipur, India from 25-08-2015 to 26-08-2015 National Workshop on Data Analytics at MNIT Jaipur, Jaipur, India from 21-05-2015 to 23-05-2015 International Conference on Elsevier Third International Conference on Recent Trends in Computing (ICRTC) organized by the Dept. of CSE, SRM University at Dept. of CSE, SRM University, Ghaziabad, India from 12-03-2015 to 13-03-2015 National Conference on National Conference on Mathematical Analysis and Computation 2015 at MNIT Jaipur, Jaipur, India from 20-02-2015 to 21-02-2015 National Seminar on Recent Trends in Image Processing at Malaviya National Institute of Technology, Jaipur, India from 07-02-2015 to 07-02-2015 National Seminar on Non NLP at MNIT, Jaipur, India from 12-12-2014 to 14-12-2013 National Workshop on Parallel (GPU CUDA and OpenCL) and Heterogeneous Computing at Malaviya National Institute of Technology, Jaipur, India from 10-11-2014 to 11-11-2014 International Short Term Course on NS2 at K L University, Vijayawada, INDIA from 26-09-2014 to 27-09-2014 National Workshop on Dissemination of national knowledge network and national mission on education through Information and Communication Technology at Delhi Technological University organized by the Dept. of Computer Engineering, New Delhi, India from 09-09-2014 to 09-09-2014 National Workshop on Advanced Wireless Networks at MNIT, Jaipur, INDIA from 30-07-2014 to 02-08-2014 National Workshop on Conduct, rules - regulations and research proposal writing for faculty members of MNIT Jaipur at MNIT, Jaipur, India from 08-07-2014 to 09-07-2014 National Short Term Course on Computer Awareness for Staff of MNIT Jaipur at MNIT, Jaipur, India from 07-07-2014 to 11-07-2014 National Workshop on Faculty Development Program on Advanced Wireless Networks at Malaviya National Institute of Technology Jaipur, Jaipur, India from 30-06-2014 to 04-07-2014 National Workshop on Application of Wireless Sensor Networks for Disaster Management at Malaviya National Institute of Technology, Jaipur, India from 17-06-2014 to 18-06-2014 National Short Term Course on "Computer Awareness Program" at MNIT, Jaipur, India from 12-05-2014 to 16-05-2012 National Workshop on Embedded Systems at MNIT, Jaipur, India from 10-03-2014 to 14-03-2014 National Workshop on Biometrics and Privacy Protection at MNIT Jaipur, Jaipur, India from 23-12-2013 to 25-12-2013 National Workshop on Biometric and privacy protections at MNIT, Jaipur, India from 22-12-2013 to 24-12-2013 National Seminar on Challenges and Future Research Direction in Natural Language Processing at MNIT, Jaipur, India from 12-12-2013 to 13-12-2013 National Workshop on Challenges in BIG Data Research at Malaviya National Institute of Technology, Jaipur, India from 09-11-2013 to 13-11-2013 National Workshop on Challenges in Big Data Research at MNIT, Jaipur, India from 05-11-2013 to 08-11-2013 International Symposia on INTERNATIONAL SYMPOSIUM ON VLSI DESIGN AND TEST (VDAT) at MNIT JAIPUR, Jaipur, India from 27-07-2013 to 30-07-2013 National Short Term Course on Pattern Recognition Techniques at MNIT, Jaipur, India from 13-05-2013 to 17-05-2013 National Workshop on semantic web at

MNIT Jaipur, Jaipur, India from 23-04-2013 to 25-04-2013 International Conference on INTERNATIONAL CONFERENCE ON SECURITY OF INFORMATION AND NETWORKS (SINCONF) at MNIT JAIPUR, Jaipur, India from 25-10-2012 to 27-10-2012 International Conference on IEEE conference on Computational Intelligence, Modelling and Simulation (CIMSIm), IEEE Xplore and CSDL, Kuantan, Malaysia at Organized by Nottingham Trent University, U.K. , Kuantan, Malaysia from 25-09-2012 to 27-09-2012 National Short Term Course on Machine Intelligence at Malaviya National Institute of Technology, Jaipur, Jaipur, India from 10-09-2012 to 14-09-2012 National Workshop on Wireless Sensor Networks (UCOST Sponsored Faculty Development Workshop) at Graphic Era University, Dehradun, India from 04-08-2012 to 05-08-2012 National Short Term Course on Network Simulation using ns-2 at Graphic Era University, Dehradun, India from 25-02-2012 to 26-02-2012 National Workshop on Natural Language processing at Malaviya National Institute of Technology, Jaipur, India from 20-02-2012 to 24-02-2012 National Workshop on Training for Benchmark Lan Trainer kits at MNIT, Jaipur, India from 30-01-2012 to 31-01-2012 National Workshop on Scientific Computing using Python at MNIT, Jaipur, India from 02-04-2010 to 03-04-2010 National Short Term Course on Soft Computing Skills in Engineering at MNIT, Jaipur, India from 11-12-2008 to 24-12-2008 National Short Term Course on Emerging Trends and Tools in Open Source Computing at MNIT, Jaipur, India from 14-07-2008 to 26-07-2008 National Short Term Course on Finishing School for Engineering Graduates, MNIT Jaipur at MNIT, Jaipur, India from 23-05-2007 to 28-07-2007 National Short Term Course on Academic Exchange Program under Institutional Networking of TEQIP, MNIT Jaipur at MNIT, Jaipur, India from 12-04-2007 to 13-04-2007 National Short Term Course on Matlab Programming and Its Applications at MNIT , Jaipur, India from 12-09-2006 to 18-09-2006 National Short Term Course on Training program for Technicians & other staff of the departments/sections on "Computer Awareness" at MNIT, Jaipur, India from 06-06-2006 to 16-06-2006 National Short Term Course on Training program for Administrative & Account section staff on "Computer Awareness" at MNIT, Jaipur, India from 23-05-2006 to 02-06-2006 National Workshop on In-house workshop on TEQIP at MNIT, Jaipur, India from 17-05-2006 to 17-05-2006 National Workshop on Workshop on "Cyber Laws" at MNIT, Jaipur, India from 21-04-2006 to 23-04-2006 International Conference on International Conference on Energy and Environmental Technologies at Gold Palace Reorts, Jaipur, India from 08-10-2003 to 10-10-2003 National Short Term Course on Training program for Pfizer India Ltd. at MNIT, Jaipur, India from 25-02-2003 to 27-02-2003 National Workshop on Issues in Real Time computer Systems (ISTE-AICTE sponsored) at MNIT, Jaipur, India from 23-12-2002 to 04-01-2003 Related Links Malaviya National Institute of Technology Jaipur Jawahar Lal Nehru Marg, Jaipur-302017 (Rajasthan) INDIA webmaster[at]mnit.ac.in Disclaimer: Copyright © 2024 Malaviya National Institute of Technology Jaipur 18773533 Department of Computer Science & Engineering (Awards & Honors) (Malaviya National Institute of Technology Jaipur (An Institute of National Importance) About MNIT NIT Statutes & Act Reports MNIT Newsletters Administration Committees Minutes of

Meetings Others Continuing Students Prospective Students Departments Centres Research @ MNIT Facilities Office of Deans Other Central Units Media Centre Recruitment Awards & Honours "Dr. Mahipal Jadeja", Featured in OpenAI's ChatGPT for Education Newsletter for Design and development of Python Ki Pathshala (a multilingual, story-driven GPT for Python learning) given by OpenAI2025 "Dr. Neeta Nain", Best Paper of a Session for Research Paper Presentation given by IEEE International Conference on Computational Intelligence & Network Systems (CINS 2024), Dubai2024 "Dr. Mushtaq Ahmed", Outstanding Engineering Services to Society for given by The Institute of Engineers (India)2024 "Dr. Neeta Nain", Best Paper Award for International Conference given by The Eighth International Conference on Computer Vision and Image Processing, CVIP20232023 "Dr. Mushtaq Ahmed", Excellence in Education 2023 for Outstanding services in the field of Education and invaluable Contribution to the Society at large given by Association of Muslim Professional AMP2023 "Dr. Mushtaq Ahmed", ICECI 2023 International Conference paper1 for Best Paper Award: Deep Learning with encoders for Intrusion detection systems given by AMU Aligarh2023 "Dr. Mushtaq Ahmed", ICECI 2023 International Conference paper2 for Paper: An Expert system for analyzing the behavior of students in the higher Education given by AMU Aligarh2023 "Dr. Deepak Ranjan Nayak", International Travel Grant for Paper Presentation at ICIP-23 given by ANRF, DST, Govt of India2023 "Dr. Meenakshi Tripathi", Award of US\$5170 for For conducting IEEE CIS Summer School given by IEEE Computational Intelligence Society2022 "Dr. Lavika Goel", Commendable contribution to Science and Technology Award for given by Department of Science and Technology (DST), Rajasthan2022 "Dr. Neeta Nain", Digital India Week 2 - 7 July 2022, Organiser for Project: Child Face Age Progression and Regression to Trace Missing Children, selected for DIW given by Government of India, Meity and NIC2022 "Dr. Dinesh Gopalani", Outstanding Teacher Award for given by MNIT Jaipur2022 "Dr. Lavika Goel", Priti Shankar Stree Shakti Samman for Received the 2022 Priti Shankar Stree Shakti Samman for being a feminine faculty in CS & IT given by Rethink India2022 "Dr. Deepak Ranjan Nayak", 2020 CMES Young Researcher Award (1000\$) for Outstanding research in computer modeling and simulation given by CMES, Tech Science Press, USA2021 "Dr. Lavika Goel", IEEE India Best Women Professional Award 2021. for Best Women Professional of the year. given by IEEE India Council and Hope Foundation and Research Center at IIT Guwahati, Guwahati2021 "Dr. Meenakshi Tripathi", Completion of Certificate for course on "Cryptography" given by Coursera2020 "Dr. Arka Prokash Mazumdar", IEEE Senior Membership for given by IEEE2020 "Dr. Ramesh Babu Battula", Travel Grant for Conference given by COMSNETS 20192019 "Dr. Neeta Nain", NVIDIA GPU GRANT for Research given by NVIDIA2019 "Dr. Meenakshi Tripathi", Active Participation Woman Award for Research given by CSI-India2018 "Dr. Meenakshi Tripathi", Paper Presenter Award at International Conference for Paper Present given by CSI-India2018 "Dr. Ramesh Babu Battula", Best Bowler for given by MPL2017 "Dr. Deepak Ranjan Nayak", International Travel Grant for IEEE Conference Presentation given by SERB, DST, Govt. of India2017 "Dr. Deepak Ranjan Nayak", Outstanding Reviewer Award for Outstanding Contribution in Reviewing given by Computers and Electrical Engineering

Journal, Elsevier2017 "Dr. Ashish Kumar Tripathi", Qualified National Eligibility Test for Eligibility for Assistant Professor for given by UGC-Net2017 "Dr. Mahipal Jadeja", Travel Grant of 400 euros for attending and presenting my work at SCAI17 workshop which was held at Amsterdam, Netherlands. given by Microsoft, Facebook and Google2017 "Dr. Neeta Nain", Best Application Oriented Paper for Best Research Paper given by IETE – The Institution of Electronics and Telecommunications Engineers2016 "Dr. Deepak Ranjan Nayak", Best Paper Award for International Conference on Advance Computing, Networking and Informatics given by ICACNI20152015 "Dr. Lavika Goel", Qualified National Eligibility Test for Eligibility for Assistant Professor given by CBSE-UGC2015 "Dr. Satyendra Singh Chouhan", Travel Grant for Paper Presentation given by Microsoft Research(MSR)2015 "Dr. Lavika Goel", Young Scientist Award for Engineering/Artificial Intelligence given by Venus International Foundation at the VIFRA Annual Research Meet, Chennai2015 "Prof. Vijay Laxmi ", Distinguished Engineer Awards for given by Institution of Engineers2013 "Dr. Pilli Emmanuel Shubhakar", Information Security Education and Awareness Project Fellowship for Research in Information Security given by Department of Information Technology, Government of India2011 "Dr. Ramesh Babu Battula", Undavalli Vidya Ratna for Education given by Undavalli Association2010 "Dr. Prasanta Majumdar", Gold Medalist for Awarder for being first class first in the M Tech examination given by University of Kalyani, WB2009 "Dr. Neeta Nain", Best Paper Award for National Conference on Advancements in Information Technology and Internet Security given by AITIS 20082008 "Dr. Ramesh Babu Battula", GATE for 98+ given by MOE2007 "Dr. Ramesh Babu Battula", TA through GATE for 99%+ given by MOE2006 "Prof. Vijay Laxmi ", Career Award for Young Teachers Achievement for CAYT given by All India Council for Technical Education2004 "Dr. Namita Mittal", CAYT- Career Award for Young Teachers for Conducting research work given by AICTE2004 "Dr. Neeta Nain", Certificate of Merit for II Position in MCA given by Banasthali Vidya Peeth1991 "Dr. Neeta Nain", Among top 10 University Topper for Graduation given by MDU University Rohtak1988 "Dr. Neeta Nain", Best Cadet Award for National Integration Camp given by National Cadet Corps, Govt of India1985

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Publications (42) Journal Publications (42) 2024 2023 2022 2021 2020 2019 2018 2017 2016 2015 2014 2011 Conference Publications (75) Conference Publications (75) 2023 2022 2021 2020 2019 2018 2017 2016 2015 2014 2013 2012 2011 2010 2009 2008 2007 Book Publications (3) Book Publications (3) Book-Chapter Publications (5) Book-Chapter Publications (5) Academic Exposure Academic Exposure Joint Research Work Joint Research Work Events Organized (28) Events Organized (28) Events Attended (5) Events Attended (5) Professional Affiliations (6) Professional Affiliations (6) PhD Research Supervised (17) PhD Research Supervised (17) Awarded Ongoing PG Research Supervised (30) PG Research Supervised (30) 2024-2025 2023-2024 2022-2023 2021-2022 2020-2021 2019-2020 2018-2019 2017-2018 2016-2017 2015-2016 2014-2015 2013-2014 2012-2013 UG Research Supervised (53) UG Research Supervised (53) Research Projects (7) Research Projects (7) Consultancy Projects (1) Consultancy Projects (1) Administrative Responsibilities Administrative Responsibilities Patents Patents Awards & Honours Awards & Honours Invitation/Academic Visit (50) Invitation/Academic Visit (50) Outreach Activities (4) Outreach Activities (4) Malaviya National Institute of Technology JaipurJawahar Lal Nehru Marg,Jaipur-302017 (Rajasthan) INDIAwebmaster[at]mnit.ac.in Disclaimer: Copyright © 2024 Malaviya National Institute of Technology Jaipur 18773539 Mahesh Chandra Govil  
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currently interested in the following areas: 1. Networks on a Chip (Fault Tolerant, 2 D and 3 D Architectures) 2. Dynamic and Static Analysis of Malware on Desktop and Mobile Platforms 3. Simulation and Emulation of QoS/QoE aware Streaming Protocols 4. Network Attack models and countermeasures Professional Affiliations (4) Professional Affiliations (4) PhD Research Supervised (17) PhD Research Supervised (17) Awarded Ongoing Research Projects (7) Research Projects (7) Malaviya National Institute of Technology Jaipur Jawahar Lal Nehru Marg, Jaipur-302017 (Rajasthan) INDIAwebmaster[at]mnit.ac.in Disclaimer: Copyright © 2024 Malaviya National Institute of Technology Jaipur 18773541 Girdhari Singh (Malaviya National Institute of Technology Jaipur) Malaviya National Institute of Technology Jaipur (An Institute of National Importance) About MNIT NIT Statutes & Act Reports MNIT Newsletters Administration Committees Minutes of Meetings Others Continuing Students Prospective Students Departments Centres Research @ MNIT Facilities Office of Deans Other Central Units Media Centre Recruitment Prof. Girdhari Singh 23 Journal Publications 45 Conference Publications 11 PhD Research Supervised Qualifications Research Interests Software Engg., Intelligent Systems. Journal Publications (23) Journal Publications (23) 2021 2020 2019 2018 2017 2016 2015 2012 2011 Conference Publications (45) Conference Publications (45) 2020 2019 2018 2017 2016 2015 2014 2013 2012 2011 2010 2007 Book Publications (1) Book Publications (1) Events Organized (9) Events Organized (9) PhD Research Supervised (11) PhD Research Supervised (11) Awarded Ongoing Administrative Responsibilities Administrative Responsibilities Malaviya National Institute of Technology Jaipur Jawahar Lal Nehru Marg, Jaipur-302017 (Rajasthan) INDIAwebmaster[at]mnit.ac.in Disclaimer: Copyright © 2024 Malaviya National Institute of Technology Jaipur 18773542 Vijay Laxmi (Malaviya National Institute of Technology Jaipur) Malaviya National Institute of Technology Jaipur (An Institute of National Importance) About MNIT NIT Statutes & Act Reports MNIT Newsletters Administration Committees Minutes of Meetings Others Continuing Students Prospective Students Departments Centres Research @ MNIT Facilities Office of Deans Other Central Units Media Centre Recruitment Prof. Vijay Laxmi 47 Journal Publications 35 Conference Publications 13 Research Projects 27 PhD Research Supervised 2 Awards & Honours Qualifications Research Interests Information Security, Machine Vision, Embedded Systems, AI in Cyber Security. Brief Research Profile <https://orcid.org/0000-0002-3662-8487> Teaching Engagements Teaching Engagements Journal Publications (47) Journal Publications (47) 2020 2019 2018 2017 2016 2015 2014 2013 2011 2009 2008 2006 Conference Publications (35) Conference Publications (35) 2019 2018 2017 2016 2014 2013 Book-Chapter Publications (10) Book-Chapter Publications (10) Professional Affiliations (3) Professional Affiliations (3) PhD Research Supervised (27) PhD Research Supervised (27) Awarded Ongoing Research Projects (13) Research Projects (13) Awards & Honours Awards & Honours Malaviya National Institute of Technology Jaipur Jawahar Lal Nehru Marg, Jaipur-302017 (Rajasthan) INDIAwebmaster[at]mnit.ac.in Disclaimer: Copyright © 2024 Malaviya National Institute of Technology Jaipur 18773543 Dinesh Gopalani (Malaviya National Institute of Technology Jaipur) Malaviya National Institute of Technology Jaipur (An Institute of National Importance) About MNIT NIT Statutes & Act Reports MNIT Newsletters Administration Committees Minutes of Meetings Others Continuing Students Prospective Students Departments Centres Research @ MNIT Facilities Office of Deans Other Central Units Media Centre Recruitment Prof. Dinesh Gopalani 47 Journal Publications 35 Conference Publications 13 Research Projects 27 PhD Research Supervised 2 Awards & Honours Qualifications Research Interests Information Security, Machine Vision, Embedded Systems, AI in Cyber Security. Brief Research Profile <https://orcid.org/0000-0002-3662-8487> Teaching Engagements Teaching Engagements Journal Publications (47) Journal Publications (47) 2020 2019 2018 2017 2016 2015 2014 2013 2011 2009 2008 2006 Conference Publications (35) Conference Publications (35) 2019 2018 2017 2016 2014 2013 Book-Chapter Publications (10) Book-Chapter Publications (10) Professional Affiliations (3) Professional Affiliations (3) PhD Research Supervised (27) PhD Research Supervised (27) Awarded Ongoing Research Projects (13) Research Projects (13) Awards & Honours Awards & Honours Malaviya National Institute of Technology Jaipur Jawahar Lal Nehru Marg, Jaipur-302017 (Rajasthan) INDIAwebmaster[at]mnit.ac.in Disclaimer: Copyright © 2024 Malaviya National Institute of Technology Jaipur 18773543 Dinesh Gopalani

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**Professional Background**

**Teaching Engagements**

**Journal Publications** (33)  
2025  
2024  
2023  
2022  
2021  
2020  
2019  
2017  
2016  
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**Conference Publications** (42)  
2024  
2023  
2022  
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2007

**Book-Chapter Publications** (3)  
**Academic Exposure**  
Events Organized (5)  
**Professional Affiliations** (4)  
PhD Research Supervised (11)  
PG Research Supervised (11)  
UG Research Supervised (4)

Awards & Honours Outreach Activities (2)

Jawahar Lal Nehru Marg,Jaipur-302017 (Rajasthan)

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Ph.D. degree in Computer Science and Engineering from the MNIT in 2015 . She has more than 15 years of teaching/research experience in computer science and information security. She has published more than 100 research articles in leading journals, conference proceedings and books including IEEE Transactions, IJCS, Computer networks, journal of supercomputing etc.. Under her guidance 4 students have already awarded their Ph.D. degree and 5 more are working with her. She has supervised around 33 PG students and more than 60 UG students for their project work. She holds several professional designations including Dean at Rajasthan Skilled University Jaipur, BoS member of university of Kota, Ex- chairman of CSI Jaipur chapter, BoS member of Central University of Rajasthan etc. She was the organizing chair for various FDPs/conferences/workshops such as ANTS-23, ICDLAIR-2019, ATAL FDP on "Cyber Security", FDP on "Software Defined Networks", FDP on "Technical Writing: Tools and techniques" etc. She has also received funding from IEEE CIS for organizing Summer School in 2022 and 2023 respectively. She is a senior member of IEEE, member of ACM and lifelong member of CSI. Her research interests include information security, wireless sensor networks, IoT, Software Defined Networks, blockchain etc. Professional Background Online Course(s) Developed Online Course(s) Developed Research Lab(s) Developed Research Lab(s) Developed Journal Publications (34) Journal Publications (34) 2025 2024 2023 2022 2021 2020 2019 2018 2017 2015 2013 2012 Conference Publications (50) Conference Publications (50) 2024 2023 2022 2021 2020 2019 2018 2017 2015 2014 2013 2012 2010 Book-Chapter Publications (6) Book-Chapter Publications (6) Academic Exposure Academic Exposure Joint Research Work Joint Research Work Events Organized (16) Events Organized (16) Events Attended (4) Events Attended (4) Professional Affiliations (7) Professional Affiliations (7) PhD Research Supervised (11) PhD Research Supervised (11) Awarded Ongoing PG Research Supervised (31) PG Research Supervised (31) 2023-2024 2022-2023 2021-2022 2020-2021 2019-2020 2018-2019 2017-2018 2016-2017 2015-2016 2014-2015 2012-2013 2011-2012 2009-2010 UG Research Supervised (10) UG Research Supervised (10) Research Projects (2) Research Projects (2) Consultancy Projects (1) Consultancy Projects (1) Administrative Responsibilities Administrative Responsibilities Patents Patents Awards & Honours Awards & Honours Invitation/Academic Visit (16) Invitation/Academic Visit (16) Outreach Activities (14) Outreach Activities (14) Malaviya National Institute of Technology Jaipur Jawahar Lal Nehru Marg, Jaipur-302017 (Rajasthan) INDIA webmaster[at]mnit.ac.in Disclaimer: Copyright © 2024 Malaviya National Institute of Technology Jaipur 18773546 Mushtaq Ahmed

Sensor Networks, Fault Tolerant Systems, High speed Overlay Networking,, Blockchain, Network router design and algorithms, Wireless Ad hoc Networks, Opportunistic Networks. Brief Research Profile Dr Mushtaq Ahmed is a faculty in Computer Science and Engg. Department MNIT Jaipur for the past 25 years. He did his PhD from MNIT in 2012. He is teaching UG and PG Courses like Advanced Computer Architecture, Embedded System Design, VLSI Algorithms, Wireless Sensor Networks, Distributed Computing, etc. His research areas are High-Performance Computing, Wireless Sensor Networks, Cloud Computing, Embedded Systems Design, and Advanced Computer Architecture. He has published more than 80 peer-reviewed Journals and conference papers. He has Two patents. He has guided 6 Ph.D. and presently he is guiding seven research scholars in the area of Parallel Compilers, High-Speed Overlay Networking, Fault-Tolerant Systems, Wireless Sensor Networks, Multi-Core Architecture, Cloud Computing, and Blockchain. Dr. Mushtaq is a Fellow IE, Life Member of ACM, Life member of ISTE, Life Member of ACCS, Member of IEEE, and Member of IEANG. Professional Background Teaching Engagements Teaching Engagements Journal Publications (31) Journal Publications (31) 2025 2024 2023 2021 2019 2018 2017 2016 2015 2011 Conference Publications (57) Conference Publications (57) 2025 2024 2023 2022 2021 2020 2019 2018 2017 2016 2015 2014 2012 2011 2010 2009 2008 2005 Academic Exposure Academic Exposure Events Organized (25) Events Organized (25) Events Attended (39) Events Attended (39) Professional Affiliations (7) Professional Affiliations (7) PhD Research Supervised (14) PhD Research Supervised (14) Awarded Ongoing PG Research Supervised (22) PG Research Supervised (22) 2023-2024 2022-2023 2021-2022 2020-2021 2019-2020 2018-2019 2017-2018 2016-2017 2013-2014 Research Projects (3) Research Projects (3) Administrative Responsibilities Administrative Responsibilities Patents Patents Awards & Honours Awards & Honours Invitation/Academic Visit (56) Invitation/Academic Visit (56) Outreach Activities (16) Outreach Activities (16) Malaviya National Institute of Technology JaipurJawahar Lal Nehru Marg,Jaipur-302017 (Rajasthan) INDIAwebmaster[at]mnit.ac.in Disclaimer: Copyright © 2024 Malaviya National Institute of Technology Jaipur 18773552 Neeta Nain

(Malaviya National Institute of Technology Jaipur(An Institute of National Importance) About MNIT NIT Statutes & Act Reports MNIT Newsletters Administration Committees Minutes of Meetings Others Continuing Students Prospective Students Departments Centres Research @ MNIT Facilities Office of Deans Other Central Units Media Centre Recruitment Dr. Neeta Nain 48 Journal Publications 73 Conference Publications 5 Research Projects 11 PhD Research Supervised 9 Awards & Honours Qualifications Research Interests Image Processing, Pattern Recognition, Computer Graphics, Machine Learning, Deeplearning. Brief Research Profile Neeta Nain, PhD, presently working as Associate Professor, Department of Computer Science and Engineering, Malaviya National Institute of Technology Jaipur, has a teaching experience of over 23 years. Her research area is Pattern Recognition, Machine Learning and Biometrics. She has published more than eighty papers on these topics for various International Journals and conferences like Elsevier Pattern Recognition, Elsevier Journal of Visual Comm.

Infor. Representation, ACM Transactions on Asian Language Information Processing, IETE Journal of Research, Indian Academy of Sciences Sadhana, Springer Multimedia Tools and Applications, The Visual Computer, Artificial Intelligence Review, IEEE Computer Magazine etc. Program Chair, of The 13th, 14th and 15th IEEE International Conference on SIGNAL IMAGE TECHNOLOGY & INTERNET BASED SYSTEMS (SITIS2017, SITIS2018, SITIS2019). Program Chair, of the Fourth IAPR Endorsed International Conference on Computer Vision and Image Processing, CVIP2019. She has several sponsored Research projects under her supervision.

Journal Publications (48) Journal Publications (48) 2024 2023 2022 2020 2019 2018 2017 2016 2015 2014 2013 2012 2011 2009 2008 Conference Publications (73) Conference Publications (73) 2025 2024 2023 2022 2021 2020 2019 2018 2017 2016 2015 2014 2013 2012 2011 2008 2007 2006 Joint Research Work Joint Research Work Events Organized (21) Events Organized (21) Professional Affiliations (4) Professional Affiliations (4) PhD Research Supervised (11) PhD Research Supervised (11) Awarded Ongoing Research Projects (5) Research Projects (5) Administrative Responsibilities Administrative Responsibilities Awards & Honours Awards & Honours Invitation/Academic Visit (8) Invitation/Academic Visit (8) Outreach Activities (2) Outreach Activities (2) Malaviya National Institute of Technology Jaipur Jawahar Lal Nehru Marg, Jaipur-302017 (Rajasthan) INDIA webmaster[at]mnit.ac.in Disclaimer: Copyright © 2024 Malaviya National Institute of Technology Jaipur 18773553 Pilli Emmanuel Shubhakar ■■■■■■ ■■■■■■■■■■ ■■■■■■■■■■■■■■■■ ■■■■■■■■■■ ■■■■■■(■■■■■■■■■■■ ■■■■■■ ■■ ■■■■■■■■■■)Malaviya National Institute of Technology Jaipur (An Institute of National Importance) About MNIT NIT Statutes & Act Reports MNIT Newsletters Administration Committees Minutes of Meetings Others Continuing Students Prospective Students Departments Centres Research @ MNIT Facilities Office of Deans Other Central Units Media Centre Recruitment Dr. Pilli Emmanuel Shubhakar 38 Journal Publications 76 Conference Publications 10 Research Projects 16 PhD Research Supervised 1 Awards & Honours Qualifications Research Interests Security, Privacy and Forensics, Cloud Computing, Big Data, Internet of Things, Blockchain, Quantum Computing. Brief Research Profile Pilli Emmanuel Shubhakar has 25 years of teaching, research and administrative experience. He was awarded PhD from Indian Institute of Technology, Roorkee for the thesis on "A Framework for Network Forensic Analysis in 2012. He has coauthored two books - "Fundamentals of Network Forensics - A Research Perspective" for Springer in 2016 and "Cloud Security - Attacks, Techniques, Tools, and Challenges" for CRC Press (Taylor and Francis) in 2021. He has supervised 9 PhD Thesis and 44 M. Tech dissertations. He is presently guiding 3 M. Tech and 7 Ph. D students in Security & Forensics, Cloud Computing, Big Data, IoT, Blockchain and Quantum Computing. He is Convenor, Department (CSE) PG Committee and the Co - Principal Investigator of Electronics and ICT Academy Phase - II in MNIT. He has an additional role of Dean (Academic Affairs) and Dean (Faculty Welfare) in Indian Institute of Information Technology Kota. He is an Honorary Dean (Network & Hardware) in Vishvakarma Skills University, Jaipur. He is Senior Member of both IEEE and ACM. He is member of Cloud Computing Innovation Council of India (CCICI), Quantum Ecosystems Technology Council of India (QETCI) and Digital

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Technology Jaipur(An Institute of National Importance) About MNIT NIT Statutes & Act Reports MNIT Newsletters Administration Committees Minutes of Meetings Others Continuing Students Prospective Students Departments Centres Research @ MNIT Facilities Office of Deans Other Central Units Media Centre Recruitment Dr. Deepak Ranjan Nayak 44 Journal Publications 20 Conference Publications 2 Research Projects 6 PhD Research Supervised 5 Awards & Honours Qualifications Research Interests Medical Image Analysis, Machine Learning, Deep Learning, Pattern Recognition, Computer Vision, Hyperspectral Image Analysis. Professional Background Teaching Engagements Teaching Engagements Journal Publications (44) Journal Publications (44) 2025 2024 2023 2022 2021 2020 2019 2018 2017 2016 Conference Publications (20) Conference Publications (20) 2025 2024 2023 2022 2021 2018 2017 2015 2014 Book-Chapter Publications (1) Book-Chapter Publications (1) Editorial Services Editorial Services Events Organized (4) Events Organized (4) Events Attended (6) Events Attended (6) Professional Affiliations (3) Professional Affiliations (3) PhD Research Supervised (6) PhD Research Supervised (6) Awarded Ongoing PG Research Supervised (8) PG Research Supervised (8) 2023-2024 2022-2023 2021-2022 UG Research Supervised (3) UG Research Supervised (3) Research Projects (2) Research Projects (2) Administrative Responsibilities Administrative Responsibilities Awards & Honours Awards & Honours Invitation/Academic Visit (36) Invitation/Academic Visit (36) Outreach Activities (8) Outreach Activities (8) Recent Research Recent Research Multi-level 3DCNN with Min-Max Ranking Loss for Weakly-supervised Video Anomaly DetectionRead more.. Feature Modulating Two-stream Deep Convolutional Neural Network for Glaucoma Detection in Fundus ImagesRead more.. Malaviya National Institute of Technology JaipurJawahar Lal Nehru Marg,Jaipur-302017 (Rajasthan) INDIAwebmaster[at]mnit.ac.in Disclaimer: Copyright © 2024 Malaviya National Institute of Technology Jaipur 18773566 Dinesh Kumar Tyagi ■■■■■■ ■■■■■■■■■■ ■■■■■■■■■■ ■■■■■■■■■■(■■■■■■■■■■ ■■■■■■■■■■ ■■■■■■■■■■)Malaviya National Institute of Technology Jaipur(An Institute of National Importance) About MNIT NIT Statutes & Act Reports MNIT Newsletters Administration Committees Minutes of Meetings Others Continuing Students Prospective Students Departments Centres Research @ MNIT Facilities Office of Deans Other Central Units Media Centre Recruitment Dr. Dinesh Kumar Tyagi 7 Journal Publications 20 Conference Publications 2 Research Projects 6 PhD Research Supervised Qualifications Research Interests Computer Networks, WDM Networks, Intelligence at Edge Networks, Nature Inspired Algorithms , Blockchain, Internet of Things. Teaching Engagements Teaching Engagements Journal Publications (7) Journal Publications (7) 2024 2016 2012 2010 2009 Conference Publications (20) Conference Publications (20) 2024 2022 2019 2018 2016 2012 2008 2007 Events Organized (10) Events Organized (10) Professional Affiliations (3) Professional Affiliations (3) PhD Research Supervised (6) PhD Research Supervised (6) Ongoing PG Research Supervised (13) PG Research Supervised (13) 2023-2024 2022-2023 2021-2022 2020-2021 Research Projects (2) Research Projects (2) Administrative Responsibilities Administrative Responsibilities Invitation/Academic Visit (5) Invitation/Academic Visit (5) Outreach Activities (2) Outreach Activities (2)



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**Generative AI** in education. He has published several journal articles, book chapters and a reference book (Springer) in these domains. His research work is presented at reputed international conferences including GSB-SIGIR 2015 (Chile), WAAC 2016 (Japan), SCAI-ICTIR 2017 (Netherlands) and ICAAEE 2023 (Australia). He has supervised 3 Ph.D. students, 12 M.Tech students and currently, he is supervising 4 Ph.D. students and 3 M.Tech students. On his YouTube Channel-CS Simplified, he has uploaded more than 150 academic videos. To date, the channel has received more than 3,50,000 views. He has also developed a Massive Open Online Course (MOOC) on Python Programming, which has attracted over 1500 learners and boasts an impressive average rating of 4.8 out of 5.

**Dr. Mahipal Jadeja** has delivered numerous expert talks at prestigious venues including a session on AI-powered advancements in education, organised by Dr. Rea Lavi from the Massachusetts Institute of Technology(MIT), the top-ranked institute of the world (QS #1 since 2012).

**Teaching Engagements Teaching Engagements Online Course(s)**

Developed	Journal Publications	(14)	Conference Publications	(14)	Book Publications	(1)	Book-Chapter Publications	(5)	Academic Exposure Events Organized	(8)	PhD Research Supervised	(7)	Awarded Ongoing PG Research Supervised	(12)
2024	2023	2021	2017	2023	2022	2020	2017	2016	2015	2024-2025	2023-2024	2022-2023	2021-2022	

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About MNIT NIT Statutes & Act Reports MNIT Newsletters Administration Committees Minutes of Meetings Others Continuing Students Prospective Students Departments Centres Research @ MNIT Facilities Office of Deans Other Central Units Media Centre Recruitment Dr. Prasanta Majumdar 4 Journal Publications 2 Conference Publications 1 Awards & Honours Qualifications Research Interests Design and analysis of traffic grooming algorithms, Behavioural analysis of dynamically generated traffic demands, Fragmentation problems in spectrum domain under EON.  
Brief Research Profile Design and analysis of traffic grooming algorithms, Behavioural analysis of dynamically generated traffic demands, Fragmentation problems in spectrum domain under EON. Journal Publications (4) Journal Publications (4) 2020 2019 2018 2015 Conference Publications (2) Conference Publications (2) 2019 Awards & Honours Awards & Honours Malaviya National Institute of Technology JaipurJawahar Lal Nehru Marg,Jaipur-302017 (Rajasthan) INDIAwebmaster[at]mnit.ac.in Disclaimer: Copyright © 2024 Malaviya National

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Research Interests Intrusion Detection System, Cyber Security, Network Security, Machine and Deep Learning for Security, Generative Modeling. Professional Background Teaching Engagements Teaching Engagements Journal Publications (6) Journal Publications (6) 2023 2022 2021 2020 Conference Publications (6) Conference Publications (6) 2022 2021 2020 2019 Book-Chapter Publications (1) Book-Chapter Publications (1) Professional Affiliations (1) Professional Affiliations (1) Patents Patents Invitation/Academic Visit (2) Invitation/Academic Visit (2) Malaviya National Institute of Technology Jaipur Jawahar Lal Nehru Marg, Jaipur-302017 (Rajasthan) INDIAwebmaster[at]mnit.ac.in Disclaimer: Copyright © 2024 Malaviya National Institute of Technology Jaipur 18773584 Malaviya National Institute of Technology Jaipur (Malaviya National Institute of Technology Jaipur) Malaviya National Institute of Technology Jaipur (An Institute of National Importance) About MNIT NIT Statutes & Act Reports MNIT Newsletters Administration Committees Minutes of Meetings Others Continuing Students Prospective Students Departments Centres Research @ MNIT Facilities Office of Deans Other Central Units Media Centre Recruitment Prof. Virendra Singh Qualifications Research Interests Cyber Security, Computer Architecture, Processor architecture & micro-architecture, Memory system design, Reconfigurable computing, Adaptive computing/architectures, Compiler support for modern architectures, Fault-tolerant computing, Robust design and architectures, Self-healing system design, VLSI testing and design for testability, SoC/NoC design and test, Post silicon debug, High level synthesis, Formal verification, Trusted computing, FPGA based acceleration, Trusted hardware design, Cyber physical systems, Network router design and algorithms, Software defined networking (SDN), Blockchain. Brief Research Profile Faculty member, Indian Institute of Technology Bombay (Since Dec 2011) Faculty member, SERC, Indian Institute of Science (IISc), Bangalore (May 2007 - Dec 2011) Scientist, Central Electronics Engg. Research Institute (CEERI), Pilani (Mar 1997 - May 20) Malaviya National Institute of Technology Jaipur Jawahar Lal Nehru Marg, Jaipur-302017 (Rajasthan) INDIAwebmaster[at]mnit.ac.in Disclaimer: Copyright © 2024 Malaviya National Institute of Technology Jaipur 18773586 Malaviya National Institute of Technology Jaipur (Malaviya National Institute of Technology Jaipur) Malaviya National Institute of Technology Jaipur (An Institute of National Importance) About MNIT NIT Statutes & Act Reports MNIT Newsletters Administration Committees Minutes of Meetings Others Continuing Students Prospective Students Departments Centres Research @ MNIT Facilities Office of Deans Other Central Units Media Centre Recruitment Prof. Vudutala China Venkata Rao Qualifications Research Interests Distributed Parallel Computing, BigData Processing,, High Performance Computing, Application and System Benchmarks on Distributed Parallel Processing Platforms, HPC for AI and AI for HPC technologies programming Environment and Libraries, Digital Twin Modeling and Simulation, Implementation aspects for 5G/6G Tele traffic Engineering Applications - Linear Programming and Optimization. Brief Research Profile I worked in the Centre for Development of Advanced Computing (C-DAC), Pune/Bnagalore on "High Performance Computing (HPC) Technologies" from the year 1993 onwards. My

superannuation was in December 2020 as a Senior Director, at C-DAC, Pune. I've been working as Consultant in C-DAC, Pune from January 2021 onwards on "National Supercomputing Mission (NSM) Projects. Most of my project work at C-DAC, Pune has been related to Distributed Parallel Computing Technologies - Hardware, Software, Testing Distributed Parallel Computing Systems, Parallelization of large-scale applications, Application and System Benchmarks on PARAM Series of Supercomputers. I also worked as an Adjunct /Visiting Faculty in the Dept.. of CSE IIITDM-Kurnool (2020- 2024), NIT-Warangal (2023-24) and MNIT Jaipur (2023-24) & earlier. I was a visiting Faculty in the Dept of Computer Sciences at University of Minnesota (UofM) Minneapolis and Post Doctoral Fellow at Army High Performance Computing Centre at UofM (1997-1998). I worked on "Distributed Parallel Computing and Parallel Algorithms implementation for Graph Theory /Sparse Matrix Computations while I was at UofM. I received my Ph.D in Mathematics from IIT-Kanpur in the year 1992-93 with joint guidance from Dept of Mechanical Engineering and Department of Mathematics. I worked on implementation of Finite Element Adaptive Meshing (Grid Generation) algorithms for certain class of CFD applications.

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**Highlights**  
**Duration of the Program** 2 Years  
**Admission Through** GATE  
**Intake** 27  
**Aims and Objectives**  
**Programme Highlights**  
**Scheme and Syllabus**  
**Information Brochure**  
**Contact Details**  
**1st Year Coordinator** Dr. Pilli Emmanuel Shubhakar  
**Phone:** 01412713376 (O), **E-mail:** espilli.cse@mnit.ac.in  
**2nd Year Coordinator** Dr. Namita Mittal  
**Phone:** 01412713324 (O), **E-mail:** nmittal.cse@mnit.ac.in

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interested in learning advanced concepts and research in the field of information security. This is a 60-credit degree programme, which covers four semesters. Highlights Duration of the Program 2 Years Admission Through GATE Intake 25 Aims and Objectives Programme Highlights Scheme and Syllabus Information Brochure Contact Details 1st Year Coordinator Dr. Dinesh Kumar Tyagi Phone: 01412713571 (O), E-mail: dktyagi.cse@mnit.ac.in 2nd Year Coordinator Dr. Arka Prokash Mazumdar Phone: 01412713452 (O), E-mail: apmazumdar.cse@mnit.ac.in Malaviya National Institute of Technology Jaipur Jawahar Lal Nehru Marg, Jaipur-302017 (Rajasthan) INDIA webmaster[at]mnit.ac.in Disclaimer: Copyright © 2024 Malaviya National Institute of Technology Jaipur 18773592 2022\_CSE\_UG.pdf Scheme & Syllabi of B. Tech. (Computer Science and Engineering) July 2023 DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

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11 Pool 3: Honors Electives: 3 -0-0 (Credits 3) .....	78 Pool 3: Honors Electives: 3 -0-0 (Credits 3) .....
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13 Department of Computer Science and Engineering First Semester S. No Code Subject L-T-P Credit Type Institute Core Subjects 19 IC 22CPT10 3 Problem Solving using C 2-0-0 2 PC 22CPT10 4 Discrete Mathematics 3-0-0 3 PC 22CPP10 5 Problem Solving Using C Lab 0-0-2 1 PC 25 Second Semester S. No Code Subject L-T-P Credit Type Institute Core Subjects 18 IC 22CPT10 6 Data Structures 3-0-0 3 PC 22CPT10 7 Logic System Design 2-0-0 2 PC 22CPP10 8 Data Structures Lab 0-0-2 1 PC 22CPP10 9 Logic System Design Lab 0-0-2 1 PC 25 Third Semester S. No Code Subject L-T-P Credits Type 22CPT201 Data Communications 3-0-0 3 PC 22CPT202 Design and Analysis of Algorithms 3-0-0 3 PC 22CPT203 Digital Circuits and Microprocessors 3-0-0 3 PC 22CPT204 Foundation of Learning 3-0-0 3 PC 22CPT205 Object Oriented Analysis and Design 3-0-0 3 PC 22CPT206 Technical	

Writing 1-0-0 1 PC 22HST2 41 Social Sciences and Professional Ethics 3-1-0 4 BS 3  
 22CPP207 Design and Analysis of Algorithms Lab 0-0-4 2 PC 22CPP208 Digital  
 Circuits and Microprocessors Lab 0-0-2 1 PC 22CPP209 Object Oriented Analysis  
 and Design Lab 0-0-2 1 PC 22CPP210 Technical Writing Lab 0-0-2 1 PC 25 Fourth  
 Semester S. No Code Subject L-T-P Credits Type 22CPT211 Computer Networks  
 3-0-0 3 PC 22CPT212 Computer Organization and Architecture 3-1-0 4 PC  
 22CPT215 Theory of Computation 3-1-0 4 PC 22CPT213 Database Information  
 Systems 3-0-0 3 PC 22CPT214 Machine Learning 3-0-0 3 PC 22BMT201 Basics of  
 Managements 3-0-0 3 MM 22CPP216 Computer Networks Lab 0-0-4 2 PC 22CPP217  
 Database Information Systems Lab 0-0-4 2 PC 22CPP218 Machine Learning Lab  
 0-0-2 1 PC 25 Fifth Semester S. No Code Subject L-T-P Credits Type 22CPT301  
 Compiler Design 3-0-0 3 PC 22CPT302 Cryptography 3-0-0 3 PC 22CPT303  
 Operating System 3-0-0 3 PC 22CPT304 Software Engineering 3-0-0 3 PC  
 22CPT305 Emerging Technologies for CS 3-0-0 3 PC 22CPTxxx Program Elective -1  
 3-0-0 3 PE 22CPP306 Compiler Design Lab 0-0-2 1 PC 22CPP307 Cryptography Lab  
 0-0-2 1 PC 22CPP308 Operating System Lab 0-0-2 1 PC 21 4 Honors 22CPTxxx  
 Advance Data Structures and Algorithms 3 22CPTxxx Honors Elective -1\* 3 6 Minor  
 CSE 22CPT10 6 Data Structures 3 PC 22CPT303 Operating System 3 PC 6 Sixth  
 Semester S. No Code Subject L-T-P Credits Type 22CPT309 Artificial Intelligence  
 3-0-0 3 PC 22CPT310 Computer and Network Security 3-0-0 3 PC 22CPT311 Digital  
 Image Processing 3-0-0 3 PC 22CPT312 Parallel and Distributed Computing 3-0-0 3  
 PC 22EET313 Smart Grid 3-0-0 3 PLEAS 22CPTxxx Program Elective -2 3-0-0 3 PE  
 22CPP313 Computer and Network Security Lab 0-0-2 1 PC 22CPP314 Digital Image  
 Processing Lab 0-0-2 1 PC 22CPP315 Parallel and Distributed Computing Lab 0-0-2  
 1 PC 21 Honors 22CPTxxx Honors Elective -2\* 3 22CPTxxx Honors Elective -3\* 3 6  
 Minor CSE 22CPT211 Computer Networks 3 PC 22CPT213 Database Information  
 Systems 3 PC 6 5 Seventh Semester S. No Code Subject L-T-P Credits Type 1  
 22CPS401 Training Seminar 0-0-4 2 PC 2 22CPD402 Minor Project 0-0-6 3 PC 3  
 22CPTxxx Program Elective -3 3-0-0 3 PE 4 22CPTxxx Program Elective -4 3-0-0 3  
 PE 5 22CPTxxx Program Elective -5 3-0-0 3 PE 6 22CPTxxx Program Elective -4 Lab  
 0-0-2 1 PE 7 22CPTxxx Program Elective -5 Lab 0-0-2 1 PE 8 Open Elective – 1 3-0-0  
 3 OE 19 Honors 22CSTxxx Honors Elective -4\* 3 3 Minor CSE 22CPT304 Software  
 Engineering 3 PC 3 Eighth Semester S. No Code Subject L-T-P Credit s Type 1  
 22CPD403 Major Project 0-0-16 8 PC 2 22CPTxxx Program Elective -6 3-0-0 3 PE 3  
 22CPTxxx Program Elective -7 3-0-0 3 PE 4 22CPPxxx Program Elective -6 Lab 0-0-2  
 1 PE 5 22CPPxxx Program Elective -7 Lab 0-0-2 1 PE 6 Open Elective – 2 3-0-0 3 OE  
 19 6 Honors 22CSTxxx Honors Elective -5\* 3 3 Minor CSE 22CPT309 Artificial  
 Intelligence 3 PC 3 \* Honors Elective courses will be taken from PG departmental  
 subject pool 7 Semester -wise Scheme and Syllabus Scheme and Syllabus of 1st  
 Year Institute Core Subjects Programming with Python Prerequisite: Nil L T P C Total  
 hours: 28 2 0 0 2 Course Content Hrs. Unit 1 Introduction to computer system and  
 binary number systems – addition, subtraction (2's complement), multiplication, left  
 shifting and right shifting. 4 Unit 2 Introduction to Python: Python variables, Python  
 basic Operators, Understanding python blocks. Python Data Types, Declaring and  
 using Numeric data types: int, float etc. Python Program Flow Control Conditional

blocks: if, else and else if, Simple for loops in python, for loop using ranges, string, list and dictionaries. Use of while loops in python, Loop manipulation using pass, continue, break and else. Programming using Python conditional and loop blocks. 6 Unit 3 Python Complex data types: Using string data type and string operations, Defining list and list slicing, Use of Tuple data type. String, List and Dictionary. 6 Unit 4 Building blocks of python programs: string manipulation methods, List manipulation, Dictionary manipulation, Programming using string, list and dictionary in-built functions. Python Functions, Organizing python codes using functions, Introduction to classes. 6 Unit 5 Python File Operations: Reading files, Writing files in python, Case study: development of mini projects using libraries like matplotlib, numpy, etc. 6

References 1. Wesley J. Chun, "Core Python Applications Programming", 3rd Edition , Pearson Education, 2016. 2. Charles Dierbach, "Introduction to Computer Science using Python", Wiley, 2015. 3. Jeeva Jose & P. Sojan Lal, "Introduction to Computing and Problem Solving with PYTHON", Khanna Publishers, New Delhi, 2016. 4. Downey, A. et al., "How to think like a Computer Scientist: Learning with Python", John Wiley, 2015. 5. Mark Lutz, "Learning Python", 5th edition, Orelly Publication, 2013, ISBN 978- 1449355739 6. John Zelle, "Python Programming: An Introduction to Computer Science", Second edition, Course Technology Cengage Learning Publications, 2013, ISBN 978 - 1590282410 7. Michel Dawson, "Python Programming for Absolute Beginners" , Third Edition, Course Technology Cengage Learning Publications, 2013, ISBN 978-1435455009 8. David Beazley, Brian Jones., "Python Cookbook", Third Edition, Orelly Publication, 2013, ISBN 978- 1449340377 8

Programming with Python Lab Prerequisite: L T P C Total hours: 28 0 0 2 1 Course Content Hrs. The following proposed coverage are broad guiding areas lab. The programs mentioned here just sample programs and they are just for reference purpose. The instructor offering the course in consultation with the theory offered can adopt further variations in tune with concerned theory course. 1. Installation of Python Tool, Introduction to Python programming, and python datatypes [1 Lab] 2. Data types, Input/Output and library imports [1 Lab] 3. Python strings operations, Doc strings [1 Lab] 4. Objects - List, Tuples and Dictionaries [3 Lab] 5. Control flow, functions working and some advanced functions [2 Lab] 6. Python File Operations: Reading files, Writing files in python [1 Lab] 7. Introduction to classes [1 Lab] 8. Numpy, Matplotlib utility functions [2 Lab] References: 1. Core Python Applications Programming: Wesley J. Chun, Pearson Education, 2016. 2. Introduction to Computer Science using Python: Charles Dierbach, Wiley, 2015 3. Python for Programmers: Paul J. Deitel, Harvey Deitel , Pearson, 2020 . 4. Learning Python: Mark Lutz, Orelly Publication, 2013 5. Python Programming: An Introduction to Computer Science: John Zelle, Course Technology Cengage Learning Publications, 2013. 9

Scheme and Syllabus of 1st Semester First Semester S. No Code Subject L-T-P Credit Type Institute Core Subjects 19 IC 22CPT101 Discrete Mathematics 3-0-0 3 PC 22CPT102 Problem Solving using C 2-0-0 2 PC 22CPP103 Problem Solving Using C Lab 0-0-2 1 PC 25 10 Discrete Mathematics Prerequisite: Nil L T P C Total hours: 42 3 0 0 3 Course Content Hrs. Unit 1 Logic: Truth Tables, Conditionals ( $P \Rightarrow Q$ ), and Bi-conditionals ( $P \Leftrightarrow Q$ ), Negation, Converse, and Contrapositive, Existential and Universal Quantifiers ( $\forall, \exists, \exists!$ ), Proof Techniques (Contrapositive, Contradiction,

Induction), Counterexamples, and Proving Statements with Quantifiers, Predicate logic, first order logic, Logical Inferences. 8 Unit 2 Set Theory: Sets and Set Notation, the Empty Set, the Power Set, Cardinality rules and infinite sets, Union, Intersection, Complement, Subsets, Proving sets are equal, Axioms of Naïve Set Theory. 6 Unit 3 Relations: Cartesian Products and Relations, Equivalence Relations and Partitions, Partial Orderings, Lattices. 6 Unit 4 Functions: Definition of a Function, Domains and Co-domains, Composition and Inverses, Well -Defined, Injective, Surjective, and Bijective Functions, Recurrence Relations, Generating functions. 6 Unit 5 Abstract Algebra: Groups -Binary operation, and its properties, Definition of a group, Groups as symmetries, cyclic, dihedral, symmetric, matrix groups, Subgroups, Cosets, normal subgroups and quotient groups, Conjugacy classes, Lagrange's theorem, Monoid. 8 Unit 6 Number Theory: Prime Numbers, Euclid's Algorithm for GCD, The GCD - LCM product theorem, Extended Euclid's Algorithm, Linear Diophantine Equations, Modular Arithmetic, Chinese Remainder Theorem, Fast Modular Exponentiation, Fermat's little theorem, Euler's totient theorem, Euler's theorem. 8 References 1. Ronald L. Graham, Donald E. Knuth, Oren Patashnik, Concrete Mathematics: A Foundation for Computer Science (2nd Edition) 2. K. Rosen, Discrete Mathematics and Its Applications, 7th edition, McGraw -Hill, 2011. 3. M. Lipson, Schaum's Outline of Discrete Mathematics, revised 3rd edition, 2009. 4. D. Velleman, How to Prove it: A Structured Approach. Cambridge University Press, 1994 11 Problem solving using C Prerequisite: :NiL L T P C Total hours: 28 2 0 0 2 Course Content Hrs Unit 1 Introduction to Computers, Basic Computer Organization, Computational Thinking and problem solving, Planning the Computer Program - Debugging, Types of errors, Techniques of Problem. Aspects of programming language: Syntax, semantics. System Software, Application Software. Compiler - Compilation process - Compiler and interpreter. Basics: C language introduction, C language Standards, Data Types and Storage Classes: Different data types, Storage Classes – auto, static, extern, register. Reserved words, operators, constants in C, identifiers, printf/scanf (formatted printf/scanf), assignment statement, built -in data types – int, char, float, double; usage of sizeof(), integer arithmetic, typecasting 6 Unit 2 IF/IF.. ELSE control construct through maximum of two numbers, ternary operator for maximum of three numbers. SWITCH statement through figure to words problem Swapping of variables, Solving problem of gcd of two numbers. Introduction to 1D arrays in C, implementation of strings as char array, string function implementation: example problem could be palindrome. Loop constructs: significance of initialization, terminating condition and increment/decrement (pre/post increment/decrement operator usage). Usage of FOR/WHILE/DO..WHILE in problems like sum /maximum/ deviation of N numbers. Illustration of loops for solving computation of sin of a number 8 Unit 3 Problem Solving: Sorting an array consisting of zeros and ones, Partitioning an array, merging two sorted arrays, computation of square root of a number Recurrence through Factorial problem, binary search to illustrate divide and conquer approach, Fibonacci through recursion and problems with this approach, Fibonacci through storing previous values – introduction to dynamic programming, Nested loops through sorting methods; use of break and continue Bit vector implementation of set and usage of bitwise operators for testing membership (withing set), union and

intersection of two sets. Macro & Preprocessor in C Unit 4 Structures in C: struct and typedef through implementation of complex numbers Functions: Passing arguments in main() function, Call by value, Call by reference. Function for implementing raising a number to large power (logarithmic complexity) Multi -dimensional array (example problem can be matrix transpose/ addition) Command line arguments in C Passing variable number of arguments 6 Unit 5 Pointers: Introduction to pointers, pointer arithmetic, void \*, pointers v/s array, malloc() – case study linked list. Pointer to array versus array of pointers, pointers to structures, array of pointers, Pointer to functions. Enum operator. File Handling in C: Basics of working with text files, File read, write, append and other similar operations. 8 References 1. Education Solutions Limited, I. T. L. (2004). Introduction to Computer Science. India: Pearson Education. 2. How to Solve it by Computer, RG Dromey, PHI 3. The C Programming Language, Brian W. Kernighan and Dennis Ritchie, Latest Edition, Prentice Hall. 4. Programming in ANSI C, E. Balagurusamy, Latest Edition, McGraw Hill 5. Let us C, Yashavant Kanetkar, Latest Edition, BPB Publication 12 Problem solving using C Lab Prerequisite: L T P C Total hours: 28 0 0 2 1 Course Content Hrs. Unit 1 The following proposed coverage are broad guiding areas lab. The programs mentioned here just sample programs and they are just for reference purpose. The instructor offering the course in consultation with the theory offered can adopt further variations in tune with concerned theory course. 1. Basic C commands and First C program -printing hello world on the screen, programs related to basic arithmetic operations, swapping of numbers etc. (2 lab) 2. C Expressions: Programs involving concepts of C expressions like finding roots of quadratic equation, area of circle and simple interest calculation. (1 lab) 3. C operators: Programs requiring in -depth knowledge of various C operators (especially conditional operator, bitwise operators and sizeof operator). (1 lab) 4. Conditional statements: Programs with applications of c conditional statements: if, if else, nested if else, switch -case (1 lab) 5. Arrays and Loops: C programs for performing various operations (finding maximum, second -maximum, minimum, reversing an array etc) on 1 -D arrays and Applications of concepts of loops (leap year, palindrome, displaying prime numbers etc). (2 lab) 6. Functions and Recursions: Programs demonstrating use of functions (like adding N numbers, calculator etc) and Recursion (factorial, Fibonacci, GCD, binary search etc). (1 lab) 7. Strings, Pointers and Structures: Programs related to the following concepts: String manipulations, pointer to arrays, and pointer to functions and Structures (3 lab) File Management: Programs related to file handling (Finding the number of characters, words and lines of given text file and File handling programs) (1 lab) References: 1. Education Solutions Limited, I. T. L. (2004). Introduction to Computer Science. India: Pearson Education. 2. How to Solve it by Computer, RG Dromey, PHI 3. The C Programming Language, Brian W. Kernighan and Dennis Ritchie, Latest Edition, Prentice Hall. 4. Programming in ANSI C, E. Balagurusamy, Latest Edition, McGraw Hill 5. Let us C, Yashavant Kanetkar, Latest Edition, BPB Publication 13 Scheme and Syllabus of 2nd Semester Second Semester S. No Code Subject L-T-P Credit Type Institute Core Subjects 18 IC 22CPT104 Data Structures 3-0-0 3 PC 22CPT105 Logic System Design 2-0-0 2 PC 22CPP106 Data Structures Lab 0-0-2 1 PC 22CPP107 Logic System Design Lab 0-0-2 1 PC 25 14 Data Structures Prerequisite: :Nil L T P C Total hours: 42 3 0 0 3

Course Content Hrs Unit 1 Fundamentals of Data Structures, Memory Allocation, Abstract Data Types, Arrays, Lists Stack Implementation, Stack applications. Queue Implementation, Sequential, Circular, and Dequeue representation, Dynamic Queue implementation, Queue applications. 8 Unit 2 Searching and Sorting: Linear and Binary search, Bubble Sort, Selection Sort, Insertion Sort, Merge sort, Quick sort, Counting sort, Bucket sort, Radix sort, Heap sort, comparisons of sorting algorithms. 8 Unit 3 Hashing and Hash Tables: Hash functions, Open and closed hashing, Dynamic and extendible hashing, Hash collision, chaining, Hash Tables and Probing Techniques 8 Unit 4 Trees: Binary Tree and its representations, Tree traversal, Binary Search Tree, Threaded binary trees, Representing list as binary trees, Dynamic implementation of Binary tree and AVL tree, Tree applications, Interval tree, M-way search Tree, B-Tree and its variants , B+ Tree , Heaps and its applications 10 Unit 5 Graphs: Fundamentals of Graph, Adjacency Matrix and List; Graph Traversal using DFS and BFS. Dijkstra and Prim's algorithms. 8 References 1. T. Cormen , C. Lieserson, R. Rivest, and C. Stein, "Introductions to Algorithms", Prentice -Hall/India, 3rd edition, 2009 2. Aaron M. Tenenbaum, Y. Langsam, Moshe J. Augenstein, Data Structures Using C 3. Introduction to Algorithms ,Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, PHI, 2nd Edition. 4. Aho A.V., J.E. Hopcroft, J.D. Ullman, Data Structures and algorithms, Addison Wesley 5. Introduction to design & Analysis of Algorithms, Anany Levitin, 2nd Edition, Pearson. 15

Logic System Design Prerequisite: L T P C Total hours: 28 2 0 0 2 Course Content Hrs. Unit 1 Number Systems and Codes: Representation of Negative Numbers; 1's Complement and 2's Complement, Complement Arithmetic, BCD Arithmetic, Digital Codes - Excess -3 code, Gray code, Binary to Excess - code conversion and vice versa, ASCII code, EBCDIC code, Error Detection Codes 7 Unit 2 Logic Gates, Universal Gates and their characteristic: K -Map, SOP, POS 4 Unit 3 Combinational circuits: Adders, Subtractors, Binary Parallel Adder – Carry look ahead Adder, BCD Adder, Multiplexer, Demultiplexer, Comparator, Decoder and Encoder. 4 Unit 4 Sequential Circuits: Latches, Flip -Flops: RS, D Type, JK, and T Type and their conversion, Master -Slave Flip and Race Conditions. 5 Unit 5 Registers: Design of shift registers and their operations. 4 Unit 6 Counters: Asynchronous and Synchronous counters, Applications of counters. 4 References: 1. Herbert Taub, Donald L. Schilling, Digital Integrated Electronics, McGraw -Hill. 2. Fredrick J. Hill, Gerald R. Peterson, Computer aided logical design with emphasis on VLSI, Wiley 3. M. Morris Mano, Digital Logic and Computer Design, Person Education. 4. Malvino & Leach, Digital Principles and Applications 5. R P Jain, Modern Digital Electronics 16

Data Structures Lab Prerequisite: L T P C Total hours: 28 0 0 2 1 Course Content Hrs. Unit 1 The following topics are broad areas. The instructor offering the course in consultation with the theory offered can adopt further variations in tune with concerned theory courses. Arrays and Linked List: Programs involving creation of arrays, singly, double and circular linked list and performing various operations on them (updating/adding/deletion an element in the begin/middle/end of the list and linear search). Stack and Queue: Programs involving implementations and applications of stacks and queues (array and linked list implementations, Dynamic Queue implementation, applications like balanced brackets problem, infix to postfix



conversion) Unit 2 Comparison based sorting algorithms: Programs requiring in -depth knowledge of various comparison based sorting algorithms (bubble, insertion, merge, quick etc). Linear time sorting algorithms: Programs with applications of linear time sorting algorithms (counting sort, radix sort, bucket sort). Heaps: Programs involving creation of heap from the given list of elements, conversion of min heap to max heap (and vice versa), heap -sort Unit 3 Hashing: Programs demonstrating applications of hashing and hash functions (like phonebook problem). Tree traversals and binary search tree: Programs related to in order, pre order and post order traversals, creation of binary search tree, searching/inserting/deletion in binary search tree. Unit 4 AVL trees and B+ Trees: Programs in which efficient implementation of various key operations (insertion/deletion/updation/searching) on AVL trees and B+ Trees are required. Unit 5 Graphs: Programs demonstrating implementations and applications of graph traversal methods (BFS, DFS) and minimum spanning tree problem (Dijkstra and Prim's algorithms) References: 1. Introduction to Algorithms, T. Cormen, C. Lieserson, R. Rivest, and C. Stein,, Prentice Hall/India, 3rd edition, 2009. 2. Introduction to Algorithms, , Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, MIT Press, 3rd Edition, 2009 3. Fundamentals of Data Structures in C++, Ellis Horowitz, Sartaj Sahni and Dinesh P. Mehta, Galgotia Press, 2009 17 Logic System Design Lab Prerequisite: L T P C Total hours: 42 0 0 2 1 Course Content Hrs. Lab 1. Design and test a 2 -bit and 4 -bit half adder. Lab 2. Design and test a 2 -bit and 4 -bit adder (ripple, carry look ahead). Lab 3. Design and test of encoder/decoder (binary -gray, self -complementing). Lab 4. Design and test of parity generator and detector. Lab 5. Design and test of one bit error detecting and correcting circuit. Lab 6. Design and test of a 2 -bit multiplier. Lab 7. Design and test of n -bit comparator. Lab 8. Design and test of flip flops – RS/JK/D/T. Lab 9. Design and test of SISO and PIPO shift registers. Lab 10. Design and test of counters. Lab 11. Implementation and simplification of k -map (upto 3 variables) Lab 12. Implementation of Quine -Mccluskey's method. References: 1. Herbert Taub, Donald L. Schilling, Digital Integrated Electronics, McGraw -Hill. 2. Fredrick J. Hill, Gerald R. Peterson, Computer aided logical design with emphasis on VLSI, Wiley 3. M. Morris Mano, Digital Logic and Computer Design, Person Education. 4. Malvino & Leach, Digital Principles and Applications 5. R P Jain, Modern Digital Electronics 18 Scheme and Syllabus of 3rd Semester Third Semester S. No Code Subject L-T-P Credits Type 22CPT201 Data Communications 3-0-0 3 PC 22CPT202 Design and Analysis of Algorithms 3-0-0 3 PC 22CPT203 Digital Circuits and Microprocessors 3-0-0 3 PC 22CPT204 Foundation of Learning 3-0-0 3 PC 22CPT205 Object Oriented Analysis and Design 3-0-0 3 PC 22CPT206 Technical Writing 1-0-0 1 PC 22HST201 Social Sciences and Professional Ethics 3-1-0 4 BS 22CPP207 Design and Analysis of Algorithms Lab 0-0-4 2 PC 22CPP208 Digital Circuits and Microprocessors Lab 0-0-2 1 PC 22CPP209 Object Oriented Analysis and Design Lab 0-0-2 1 PC 22CPP210 Technical Writing Lab 0-0-2 1 PC 25 19 Data Communications Prerequisite: Nil L T P C Total hours: 42 3 0 0 3 Course Content Hrs Unit 1 Introduction to Data Communication: Overview of communication systems, Analog vs. digital communication, Elements of a digital communication system, Data Representation Communication channels and noise 6 Unit 2 Physical Layer: Signals - representation,

sampling, aliasing, quantization, transformations; filters, spectral analysis. Analog and Digital transmissions, conversions. Pulse transmission over Band limited signals, sampling theory; Pulse Modulations, metrics - bit transmission, signalling rate, error probability, S/N ratio, bandwidth requirement. Other Modulation. 8 Unit 3 Data Communication Network: OSI Model Physical layer: Importance, bit, bit rate, Signal Rate, bit Interval, Data Rate: Shannon Capacity, Nyquist bit rate, Line Configuration & Line Coding Schemes, Data Transmission: simplex, half -duplex or full -duplex mode , Topology, Signals: Period, frequency, phase, bandwidth. 10 Unit 4 Transmission Media: Guided and Unguided Media, Transmission Medium, Transmission Impairments; Multiplexing - FDM & TDM; Switching: Circuit, Message, Packet, Datagram, Virtual Networks, and DSL. Fiber Optic Communication Principles, loss, dispersion, light source and detectors. Spread spectrum, Multiple access: reservation based – TDMA, FDMA, CDMA; random access – Aloha, CSMA, ISMA; hybrid schemes; digital modulation schemes. Examples: Token Bus, Token Ring, Ethernet, including Gigabit Ethernet and Wi - Fi (802 .11). 10 Unit 5 Data Link Layer: Flow Control, Error, Error Control; Error Detection: Simple parity checking, 2D Parity Checking, arithmetic checksum, CRC. Error Correction Codes: Information theory, Shannon's theorem, Source coding, error control coding, (Block codes, Cyclic codes, Linear code, checksum). Flow Control, Sliding Window and Stop and Wait protocols. 8

References 1. Forouzan, Data Communications and Networking, McGraw Hill. 2. Tanenbaum, Computer Networks, Pearson India. 3. Haykins, Analog and Digital Communications, Wiley Publications. 4. Haykins, Digital Communication Systems, Wiley Publications. 5. B.P.Lathi: Modern Digital Communication, Oxford. 20

Digital Circuits and Microprocessors Prerequisite: Nil L T P C Total hours: 42 3 0 0 3 Course Content Hrs Unit 1 Sequential Circuits: Fundamental Mode Circuits Analysis, Synthesis of Flow Tables, Minimization, Transition Tables, Excitation maps, Output Maps, Clock Input Control, Extended State Table, Program Description, Synthesis, vector Operations, Logical Functions of Vectors, Incompletely Specified Sequential Circuits 20 Unit 2 Microprocessor: Introduction to x86 microprocessor, Addressing Modes, Instruction Set, Code Conversation, Directives, Control Operations, String Manipulation Operations. Programming in assembly Language. Interfacing Devices, 8255 PPI, 8259 PIC, 8237/8257 DMA Controller, 8279 Keyboard and display Controller, A/D converters, USB, DMA, Timing and delay, Stack and Subroutine, interrupts, Assembly Language programming, 22

References 1. Herbert Taub, Donald L. Schilling, Digital Integrated Electronics, McGraw -Hill, 2. Fredrick J. Hill, Gerald R. Peterson, Computer aided logical design with emphasis on VLSI, Wiley 3. Fredrick J. Hill, Gerald R. Peterson, Introduction to Switching Theory and Logical Design, Wiley 4. M. Morris Mano, Digital Logic and Computer Design, Person Education 5 Lance A. Leventhal, S. Cordes, Assembly language subroutines for the 8086, McGraw -Hill Book Co. 6 Randall Hyde, The Art of Assembly Language, 2nd Edition 7 The 80x86 Family: Design, Programming, and Interfacing, Pearson, John Uffenbeck. 21

Design and Analysis of Algorithms Prerequisite: Data Structures L T P C Total Hours: 42 3 0 0 3 Course Content Hrs Unit 1 Algorithm Analysis: Asymptotic notation, model of computation, time and space complexities, average and worst -case analysis, Master's Theorem, solving recurrence equations - iteration method, substitution,

recursion tree, master method. Amortised Analysis. Linear Search, Insertion Sort, Euclid's Algorithm for finding GCD (Lame's Theorem): Correctness, Best -Case, Average -Case and the Worst -Case Running Time Analysis. Permutation Model for Average -Case Analysis of an Algorithm for Finding Maximum Element in an Array 8 Unit 2 Divide and Conquer : General recurrence and methods for obtaining bounds on given recurrence. Binary Search, Merge Sort, and Maximum Subarray Sum Problem. Quick -sort: Correctness, Running Time Analysis, Order statistics - finding median and Worst -case Linear Time Algorithm for Selection Problem. Max -Min problem, Strassen's Algorithm for Matrix Multiplication, Karatsuba's Algorithm for Large Integer Multiplication 8 Unit 3 Dynamic Programming Approach: Introduction to dynamic programming - principal of optimality, Optimal substructure. Matrix Chain Multiplication Problem, Optimal Binary Search Tree Problem, Longest Common Subsequence Problem, 0/1 Knapsack Problem. Greedy Approach: Elements of Greedy Strategy - Greedy choice property, optimal substructure. Example Problems - Activity Selection Problem, Fractional Knapsack Problem, Huffman codes, Travelling Salesman Problem. 9 Unit 4 Graph Algorithms: Graph Traversal Algorithms (BFS, DFS), Shortest path algorithms (Bellman -ford, Dijkstra's, Transitive -Closure, Floyd -Warshall), minimum spanning tree algorithms Kruskal, Prim), Network -flow (ford -fulkerson) , applications of DFS: - bi-connectivity, topological sort, strongly -connected components, Articulation point. 9 Unit 5 Backtracking: Introduction to Backtracking, Enumerating Independent Sets of a Graph, Graph Coloring Problem and N -Queen's Problem. Complexity Classes: P, NP, NP -Hard and NP -Complete. NP-Complete Examples with Reductions: Satisfiability, Clique, Independent Set, Vertex Cover , Graph Coloring, Dominating Set, 8 References 1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, Third Edition, PHI, 2009. 2. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, Fundamentals of Computer Algorithms, Second Edition, Universities Press, 2011. 3. Michael T. Goodrich and Roberto Tamassia, Algorithm Design: Foundations, Analysis and Internet Examples, Second Edition, Wiley -India, 2006. 22 4. Michael R. Garey and David S. Johnson, Computers and Intractability: A Guide the theory of NP -Incompleteness, W.H. Freeman & Co., 1979. 5. Herbert S. Wilf, Algorithms and Complexity, AK Peters Ltd., 2003. 6. Jon Kleinberg and Eva Tardos. 2005. Algorithm Design. Addison -Wesley Longman Publishing Co., Inc., USA. 23

Foundations of Learning Prerequisite: Some basic set theory (what is a set and elementary set operations), combinatorics (knowing different ways of counting, inclusion -exclusion principle) and calculus (knowing derivatives and integrals) L T P C Total hours: 40 3 0 0 3 Course Content Hrs Unit 1 Linear Algebra i. Scalars, Vectors, Matrices and Tensors ii. Multiplying Matrices and Vectors iii. Identity and Inverse Matrices iv. Linear Dependence and Span v. Norms vi. Special Kinds of Matrices and Vectors vii. Eigen decomposition viii. Singular Value Decomposition ix. The Moore -Penrose Pseudoinverse x. The Trace Operator xi. The Determinant xii. Principal Component Analysis 12 Unit 2 Probability and Information Theory i. Random Variables ii. Probability Distributions iii. Marginal Probability iv. Conditional Probability v. The Chain Rule of Conditional Probabilities vi. Independence and Conditional Independence vii. Expectation, Variance and Covariance viii. Common Probability

Distributions ix. Useful Properties of Common Functions x. Technical Details of Continuous Variables xi. Information Theory xii. Structured Probabilistic Models 12

Unit 3 Statistical inference: statistical decision theory, statistical assumptions, estimation theory. Methods of estimation: method of moments, method of minimum variance 9

Unit 4 Statistical hypothesis testing, null and alternate hypotheses. Simple and composite hypotheses, Type -I and Type -II errors, Z -tests for difference of means, chi -square test, tests for correlation and regression. 9

References 1. Linear Algebra, Gilbert Strang, MIT Cambridge Press 2. Foundations of Learning, Julie Fisher, Open University Press 3. Foundations of Learning, Laurie L. Hazard, Jean -Paul Nadeau, Pearson 4. Deep learning, Ian Goodfellow, MIT Cambridge Press 5. Probability and Statistics for Machine Learning, Anirban Das Gupta, Springer 24

Object Oriented Analysis and Design Prerequisite: : Computer Programming skills L T P C Total hours: 40 3 0 0 3

Course Content Hrs

Part I Unit 1 Introduction to Object Oriented Programming fundamentals: Object Oriented Programming and Design, Review of abstraction Classes, Objects and Methods: Class, Object, Object reference, Constructor, Constructor Overloading 8

Unit 2 C++ Programming Basics: Fundamentals, variables and assignments, Input and Output, Data types and expressions, flow of control, subprograms, top -down design, predefined functions, user defined functions, procedural abstractions, local variables, overloading function names, operator overloading, parameter passing, this pointer, destructors, copy constructor, overloading the assignment operator, virtual functions, function calling functions, friend functions, recursive functions, recursive member functions. Static member function. 6

Unit 3 C++ Object oriented concepts: Objects and classes, use of file for I/O, formatting output with stream functions, Character I/O, inheritance, structures for diverse data, structures as function arguments, initializing structures, defining classes and member functions, public and private members, constructors for initialization, standard C++ classes, derived classes, flow of control, use of Boolean expressions, multiway branches, use and design of loops. Friend function and friend class 8

Part II Unit 4 Introduction to OOD, Unified Process, UML diagrams, Use Case, Use case Modelling, Relating Use cases – include, extend and generalization – When to use Use-cases, Class Diagram, Elaboration -Domain Model, Finding conceptual classes and description classes – Associations – Attributes – Domain model refinement, Finding conceptual class Hierarchies, Aggregation and Composition – Relationship between sequence diagrams and use cases, When to use Class Diagram 6

Unit 5 Dynamic Diagrams – UML interaction diagrams, System sequence diagram, Collaboration diagram, When to use Communication Diagrams, State machine diagram and Modelling –When to use State Diagrams, Activity diagram, When to use activity diagrams Implementation Diagrams -UML package diagram – When to use package diagrams, Component and Deployment Diagrams – When to use Component and Deployment diagrams 6

Unit 6 Design patterns: GRASP: Designing objects with responsibilities – Creator – Information expert – Low Coupling – High Cohesion – Controller Design Patterns – creational – factory method – structural – Bridge – Adapter – behavioural – Strategy – observer –Applying GoF design patterns – Mapping design to code 6

References 1. Deitel and Deitel, C++ How to Program, Third Edition, Pearson Publication. 2. Robert Lafore, Object Oriented

Programming in C++, Fourth Edition, SAMS publications. 3. Craig Larman, ■Applying UML and Patterns: An Introduction to Object -Oriented Analysis and Design and Iterative Development■, Third Edition, Pearson Education, 2005. 4. Ali Bahrami – Object Oriented Systems Development – McGraw Hill International Edition – 1999 25

Technical Writing Prerequisite: :NiL L T P C Total hours: 1 0 0 1 Course Content Hrs

Introduction to Documentation using Doxygen, Google Docs, Latex/ Overleaf. Drawing software: inkscape, xfig , open -office, and/or similar. Presentation using Beamer: Introduction to creating slides, adding frames, dividing the slide into multiple columns, adding different blocks, and similar. Graph plotting software (e.g., gnuplot). Version control tools - GIT /GitHub/SVN 7 Introduction: LaTeX, its installation, and different IDEs. The learner creates the first document using LaTeX, organizes content into sections using article and book class of LaTeX. Styling Pages: Reviewing different paper sizes, examines packages, formats the page by setting margins, customizing header and footer, changing the page orientation, dividing the document into multiple columns. Different types of error messages. Formatting Content: formatting text (styles, size, alignment), adding colors to text and entire page, and adding bullets and numbered items, the process of writing complex mathematics. Tables and Images: creating basic tables, adding simple and dashed borders, merging rows and columns, and handling situations where a table exceeds the size of a page. Add an image, explore different properties like rotate, scale, etc.. Referencing and Indexing: the learner learns to add cross -referencing (refer to sections, table, images), add bibliography (references), and create back index. 7 References 1. Latex - A document preparation system, 2/e, by Leslie Lamport, Addison -Wesley, 1994 2. <https://www.doxygen.nl/> 26 Social Sciences and Professional Ethics Prerequisite: Nil L T P C Total hours: 56 3 1 0 4 Course objectives: • Augmenting the understanding of society, societal issues and problems • To provide the students an insight into the multifaceted economic and financial environment • Development of a positive character, empathetic human being, responsible citizen • Inculcating a positive work culture respecting professional ethics Course Content Hrs Unit 1 Introducing Sociology Meaning, scope and evolution of Sociology, Key theoretical trajectories . Society, community, Social Institutions, Social Groups, Socialisation and Culture, Norms and Values, Agency and structure 10 Unit 2 Social Change Social Change, development and progress; Globalisation, Industrialisation, urbanisation and modernisation; Social mobility and social stratification 8 Unit 3 Social Issues Science technology and society; Digital divide, Appropriate technology, Gender inequality; Substance abuse, Consumerism, Environmental degradation and climate crisis, Nation building 10 Unit 4 Socio -economic environment Overview of Socio -economic policy environment; PESTLE analysis. Economic growth & development; primary, secondary and tertiary sectors; structural changes & emerging sectors of the Indian economy. Design and strategy of economic reforms and liberalization: India's growth post liberalization. 10 Unit 5 Finance and banking Banking and Financial Sector; Reforms & Challenges; Monetary & Fiscal Policies; meaning, importance & instruments. Global economic environment and opportunities. Intellectual property rights and R & D environment. 6 Unit 6 Ethics and values Professional Ethics: Need, importance and principles of Professional ethics, Ethics in relation with use of

technology and technology development, diversity inclusion and equity; Social responsibility . Constitutional values: Preamble and DPSP, Rights and duties

12

References

1. Haralambos, Michael & Holborn, Martin. Sociology: Themes and Perspective, Harper Collins. Eighth edition. 2014.
2. Ritzer, George. Sociological Theories, McGraw -Hill; Fifth edition. 2011
3. Lillie, William. An introduction to Ethics Allied Publishers Pvt. Ltd.; 1st edition (1967)
4. Lama, Dalai. Ethics for the New Millennium by the. Riverhead Books; Reissue edition (2001)
5. Uma Kapila, Indian Economy Performance and Policies, Academic Foundation, New Delhi
6. Ahluwalia, I.J. & IMD Little, India's Economic Reform and Development, Oxford University Press .

27

Design and Analysis of Algorithms Lab Pre-requisite: C Programming, Data Structures

L T P C 0 0 4 2

Course Content

1. Implementation of various sorting and searching algorithms (Revision)
2. Implement quick sort with three different positions of pivot element - first, last, random
3. Implement Tree traversal, and graph traversal (recursive algorithms)
4. Implement deterministic and randomized selection problem
5. Implement maximum subarray sum problem
6. Implement Karatsuba's Algorithm for Large Integer Multiplication
7. Implement matrix chain multiplication, longest common sub -sequences, 0/1 knapsack
8. A program to obtain the topological ordering of vertices in a given digraph.
9. Implement travelling salesman problem.
10. Print all the nodes reachable from a given starting node in a digraph using BFS method.
11. Check whether a given graph is connected or not using DFS method.
12. Find minimum cost spanning tree of a given undirected path using a Prim's algorithm.
13. From a given vertex in a weighted connected graph, find shortest paths to other vertices using Dijkstra's algorithm.

References

- 1 Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, Third Edition, PHI, 2009.
- 2 Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, Fundamentals of Computer Algorithms, Second Edition, Universities Press, 2011.
- 3 Michael T. Goodrich and Roberto Tamassia, Algorithm Design: Foundations, Analysis and Internet Examples, Second Edition, Wiley -India, 2006.

28

Digital Circuits and Microprocessors Lab Prerequisite: Basics of Digital Logic

L T P C 0 0 2 1

Course Content

1. Design and synthesis of pulse mode and clock mode circuits
2. Design and synthesis of clock mode circuits
3. Design and Simplification of incompletely specified sequential circuits
4. SPICE simulator based design and evaluation
5. X86 based Assembly language Programming
  - a. Arithmetic and logical operations
  - b. String manipulation
  - c. Number Conversion
  - d. Implementing a real -time clock.
  - e. Writing a program to control and monitor external devices through parallel port communication.
  - f. Developing a program to interface with a APC DAC.
  - g. Creating a program to implement a basic graphical user interface (GUI) using assembly language.
  - h. Implementing a program to perform image processing operations, such as image filtering or edge detection.
  - i. Designing a program to control and monitor a robotic arm using assembly language.
  - j. Developing a program to interface with an external memory device, such as EEPROM or flash memory.
  - k. Writing a program to implement a basic text -based adventure game using assembly language.
  - l. Developing a program to interface with a graphical LCD display using the 8086 microprocessor.
  - m. Creating a program to perform digital signal processing (DSP) operations, such as filtering or Fourier transforms.

References

1. Computer Aided

Logical Design with Emphasis on VLSI, 4th Edition, Frederick J. Hill, Gerald R. Peterson, by Wiley. 3. The 80x86 Family: Design, Programming, and Interfacing, 3rd Edition by John E. Uffenbeck, Pearson Education 29 Object Oriented Analysis and Design Lab Prerequisite: : Basic Computer Programming, Data Structures L T P C Total hours: 42 0 0 2 1 Course Content Hrs The laboratory course will be in two parts: Part I: Object oriented Programming (OOP). In this part, students will be given OOP assignments to cover the practical on: - Programs Using Functions - Simple Classes for understanding objects, member functions and Constructors - Classes with primitive data members - Classes with arrays as data members - Classes with pointers as data members – String Class - Classes with constant data members - Classes with static member functions - Compile time Polymorphism - Operator Overloading including Unary and Binary Operators - Function Overloading - Inheritance and - Runtime Polymorphism Part II: Object Oriented Methodology and Design In this part, students will be given experiments to design various UML diagrams such as USE case, Class Diagram, State Diagram, Activity Diagram, Sequence diagram etc., based on the given case study. 30 References 1. Deitel and Deitel, C++ How to Program, Third Edition, Pearson Publication. 2. Robert Lafore, Object Oriented Programming in C++, Fourth Edition, SAMS publications. 3 Craig Larman, ■Applying UML and Patterns: An Introduction to Object -Oriented Analysis and Design and Iterative Development■, Third Edition, Pearson Education, 2005. 4 Ali Bahrami – Object Oriented Systems Development – McGraw Hill International Edition – 1999 30 Technical Writing Lab Prerequisite: L T P C Total hours: 28 0 0 2 1 Course Content Hrs Unit 1 • Documentation using Google Docs and its usage for creating PPTs. • Introduction to Documentation using Doxygen and Graph plotting software (e.g., matplotlib in Python) • Using Drawing software (e.g. draw.io, open -office) • Documentation using Latex/ Overleaf o Presentation using Beamer: Introduction to creating slides, adding frames, dividing the slide into multiple columns, adding different blocks, etc. 8 Unit 2 Introduction: LaTeX and its installation. The learner creates the first document using LaTeX, organizes content into sections using article and book class of LaTeX. Styling Pages: Reviewing different paper sizes, examines packages, formats the page by setting margins, customizing header and footer, dividing the document into multiple columns. 8 Unit 3 Formatting Content: formatting text (styles, size, alignment), the process of writing complex mathematics. Tables and Images: creating basic tables, adding simple and dashed borders, merging rows and columns. 6 Referencing and Indexing: the learner learns to add cross -referencing, add bibliography (references). 6 References: 1. Latex - A document preparation system, 2/e, by Leslie Lamport, Addison -Wesley, 1994 2. <https://www.doxygen.nl/> 3. Other online resources 31 Scheme and Syllabus of 4th Semester Fourth Semester S. No Code Subject L-T-P Credits Type 22CPT211 Computer Networks 3-0-0 3 PC 22CPT212 Computer Organization and Architecture 3-1-0 4 PC 22CPT215 Theory of Computation 3-1-0 4 PC 22CPT213 Database Information Systems 3-0-0 3 PC 22CPT214 Machine Learning 3-0-0 3 PC 22BMT201 Basics of Managements 3-0-0 3 MM 22CPP216 Computer Networks Lab 0-0-4 2 PC 22CPP217 Database Information Systems Lab 0-0-4 2 PC 22CPP218 Machine Learning Lab 0-0-2 1 PC 25 32 Computer Networks Prerequisite: Data communication. L T P C Total hours: 42 3 0 0 3 Course Content

Hrs Unit - I Introduction: Internet – nuts and bolts, network service, network protocols, network edge, network core, performance metrics - delay, throughput, etc. protocols and service models. 4 Unit - II End-to-End protocols and Applications -I: Application layer: principles of application layers, Domain Name System (DNS), HTTP, FTP, E-mail, www and etc. Peer to peer systems, video streaming, Socket programming. Flow control – window/credit schemes, rate control schemes, Congestion control Transport layer and TCP/IP. Introduction to ATM networks and Network Management And Interoperability. 8 Unit - III End-to-End protocols and Applications -II : Introduction to transport layer, multiplexing and de-multiplexing, connection oriented and connection less end to end protocols, principles reliable data transfer, and congestion control. 11 Unit - IV Data Plane : Introduction to network layer, layer 3 devices and inside, addressing – IPv4, IPv6, etc. NAT, Control Plane : Retransmission algorithms. Stability of queuing systems.. High speed switches scheduling, BroadCast routing and spanning trees. Shortest path routing. Distributed routing algorithms, optimal routing, and traffic engineering. ICMP, SNMP, etc 11 Unit - V Future/Advanced Internet: Internet of Things (IoT) and applications, Software Defined Networks (SDN) : Control plane, data-plane, and issues, Information centric networks (ICN), Content distribution networks (CDN) and Future Internet.(5 Classes) 6 References 1. Data Networks: Bertsekas and Gallager, PHI 2. Computer Networks: L. Peterson and Davie, Elsevier 3. Computer Networking A top down Approach: J.F.Kurose, Pearson 4. Computer Networks : Andrew S. Tanenbaum, Pearson 33 Computer Organization and Architecture Prerequisite: Nil L T P C Total hours: 40 3 1 0 4 Course Content Hrs Unit 1 Organization of Computer Systems: CPU, Memory and I/O organization, Instruction encoding and addressing modes. Von-neumann versus Harvard Architecture, RISC and CISC architectures. Flynn Classification, Stack machines, subroutine calls, allocation and evaluation of data in stack machines. SIMD, SPMD and MIMD 8 Unit 2 CPU Organization: Addressing techniques, Instruction formats, Instruction set design, Instruction types: example for zero address, one address, two address and three address machines, Stack, accumulator and general purpose register organization. 8 Unit 3 Register Transfer Language: arithmetic, logic and shift micro operations and their hardware implementations as a simple ALU. Control Unit, Hardwired and Micro programmed control unit design. 8 Unit 4 Memory Organization: device characteristics, RAM organization, 1D and 2D organization, Virtual memory - Paging and Segmentation, High speed memories, Associative and Cache memory. Input-Output Design: IO interface, Bus structure, Modes of data transfer, Interrupts, Input Output Processor, Serial Communication Pipelining: Pipeline structure, Pipeline types - Instruction and Arithmetic pipelines. Interleaved memory organization, instruction prefetch, data buffers, pipeline performance measures. 8 Unit 5 Array processors: Routing mechanisms, Static v/s dynamic network. Multiprocessor systems, data flow concepts. Parallel processing languages. 8 References 1. William Stallings, "Computer Organization and Architecture – Designing for Performance", Pearson Education, Seventh Edition, 2006. 2. David A. Patterson and John L. Hennessy, "Computer Architecture -A Quantitative Approach", Elsevier, a division of reed India Private Limited, Fifth edition, 2012 3. John P. Hayes, "Computer Architecture and Organization", Tata McGraw Hill, Third Edition 4. Carl Hamacher,



Computer Organization, 5th Edition, Mc Graw Hill Publishers, 2002. 34 Theory of Computation Prerequisite: Nil L T P C Total hours: 40 3 1 0 4 Course Content Hrs

Unit 1 Basic Foundation : Review Of SET Theory, Automata Theory, Alphabet, Power Of Alphabet, Kleen Closure, Positive Closure, String, Empty String, Concatenation, Language . Finite Automata (F A): Introduction, Deterministic Finite Automata (DFA) - Formal Definition, Simpler Notations (State Transition Diagram, Transition Table), Language of A DFA. Nondeterministic Finite Automata (NFA) - Definition, Language of an NFA, Equivalence Of Deterministic and Nondeterministic Finite Automata, Applications of Finite Automata, Finite Automata with Epsilon Transitions, Eliminating Epsilon Transitions, Minimization Of Deterministic Finite Automata, FA with Output (Moore and Mealy Machines) and Inter Conversion. 8 Unit 2 REGULAR EXPRESSIONS (RE): Introduction, Identities of Regular Expressions, Finite Automata and Regular Expressions - Converting from DFA's to Regular Expressions, Converting Regular Expressions to Automata, Minimization of Finite Automata, Applications of Regular Expressions. REGULAR GRAMMARS: Chomsky Classification of Languages, Regular Grammars and FA, FA for Regular Grammar, Regular Grammar for FA. Proving Languages to be Non -Regular -Pumping Lemma, Applications, Closure Properties of Regular Languages. 8 Unit 3 CONTEXT FREE GRAMMER (CFG): Derivation Trees, Sentential Forms, Rightmost and Leftmost Derivations of Strings. Ambiguity in CFG's, Minimization of CFG's, Normal Forms (CNF, GNF), Pumping Lemma for CFL's 8 Unit 4 Pushdown Automata Theory : Push Down Automata, Deterministic and Nondeterministic PDA, PDA And Languages, Construction ; Acceptance of CFL, Acceptance by Final State and by Empty Stack and its Equivalence, Equivalence of CFG and PDA. Turing Machines (T M): Formal Definition and Behaviour, Languages of a TM, TM as Accepters, TM as a Computer of Integer Functions, TM with Storage in its State, TM as Subroutine, Minsky's Theorem, Types of TMs, Multitrack, Mutitape, Nondeterministic TM, Encoding of TM, Computability and Acceptability. 8 Unit 5 Recursive And Recursively Enumerable Languages (REL): Properties of Recursive and Recursively Enumerable Languages . Undecibility And Undecidable Problems: Post's Correspondence Problem (PCP), Universal Turing Machine, The Halting Problem, Undecidable Problems about TMs. Context Sensitive Language and Linear Bounded Automata (LBA), Chomsky Hierarchy, Decidability 8 References 1. John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman (2007), Introduction to Automata Theory Languages and Computation, Pearson Education, India. 2. Cohen, Introduction to Computer Theory, Addison Wesley. 3. Martin, Introduction to Languages and Theory of Computation, TMH. 4. Papadimitriou, Introduction to Theory of Computing, Prentice Hall. 5 K. L. P Mishra, N. Chandrashekar, Theory of Computer Science -Automata Languages and Computation, Prentice Hall of India, India. 35 Database Information Systems Prerequisite: :Nil L T P C Total hours: 40 3 0 0 3 Course Content Hrs Unit 1 Introduction to Database System Database approach and Information systems , Database System Architecture, current advances in database technology, Database Systems Development Life Cycle - Prototyping methodology three -schema architecture, three - tiered architecture Hierarchical model, Network model, Relational model, Object oriented model, Multidimensional model 6 Unit 2 Database Models: ER

-model notation, entity & entity type, relationship & relationship type, Degree, Cardinality & modality, Supertype/Subtype relationship Relational model concepts, Converting ER to Relational model 6 Unit 3 Introduction to SQL -DDL,DML and PCL, Advanced topics of SQL, PL/SQL language: Functions, Procedures & triggers, Views, Cursors etc. Formal query languages Relational Algebra and Relational Calculus Overview, Query processing and optimization 10 Unit 4 Relational schema, Functional dependencies, Inference axioms, Keys, closures, redundant FD's , Decompositions, Join Dependencies Normalization, normal forms:1NF, 2NF, 3NF, BCNF, 4NF, 5NF, Best Database Design criterion Transactions, concurrency control, Crash Recovery, Physical DB design, file organizations, Indexing Structures, File indexing, hashing 14 Unit 5 Client/Server database architecture Application Development, Database Security, Overview of Distributed database, Data Warehousing and Data mining, Data Analytics 4 References 1. Database System Concepts ,Silberschatz A, Korth H F, and Sudarshan S, , McGraw Hill,,6th Ed. 2. Modern Database Management systems , Hoffer J A, Prescott M B, and Topi H. Pearson Education Inc.,13th Edition 3. Fundamentals of Database Systems , Elmasri R, Navathe S B, Pearson Education, 7th Edition. . 4. Database Management System , Raghurama krishnan & Johannes Gehrke, McGraw -Hill 3rd edition 5 Commercial Application development using ORACLE Developer 2000 Forms 5.0 , Ivan Bayross, BPB Publications. 36 Machine Learning Prerequisite: Basic understanding of probability and statistics, linear algebra and calculus. A basic knowledge of programming (preferably Python) is essential. L T P C Total hours: 42 3 0 0 3 Course Content Hrs Unit 1 The learning problem – learning versus design, types of learning - supervised, unsupervised, reinforcement and other views of learning. 2 Unit 2 Training versus Testing: theory of generalization, interpreting the generalization bound. Generalization and over fitting: when does over fitting occur? Regularization, validation , cross validation. Bias -variance tradeoff. The Linear model: Linear classification, perceptron learning, linear regression, gradient descent, batch and stachastic gradient descent, convex functions, logistic regression, non linear transformation. 12 Unit 3 Generative vs discriminative models Supervised learning – Probability review, Bayes classifier, Naive Bayesian, MAP, MLE. K- nearest neighbor, measuring similarity using distance metrics, data normalization. Decision trees, constructing decision trees, ID3, C4.5. Random forest, Ensemble methods – bagging, boosting. Neural networks, going forward, biases, going backwards: back propagation of errors, MLP in practice, deriving back propagation network output and error, requirements of activation functions, learning rate, acceleration, decay, Loss functions - Sigmoid, Re lu. SVM (Linear), optimal separation, kernels. 16 Unit 4 Unsupervised learning – the general problem, hierarchical and partitional clustering, K -means clustering, density based clustering, DBSCAN, autoencoders 8 Unit 5 Assessing classification performance – accuracy, sensitivity, specificity, the area under the ROC curve, confusion matrices, FAR, TPR, TNR, FRR, precision and recall 4 References 1. A first course in Machine learning, Simon Rogers and mark Girolami, CRC Press 2. Learning from Data, Yaser S Abu -Mostafa, AML books 3. Machine learning, Marsland, CRC press 4. An Introduction to Machine Learning, Kubat Miroslav, Springer 37 Basics of Management Department: Department of Management Studies L T P C Prerequisite: None 3 0 0 3 Course Learning Objectives

By the end of this course student will be able to: 1. Demonstrate the roles, skills and functions of managers. 2. Develop the understanding and cognizance of the importance of management principles. 3. Make effective application of acquired knowledge to diagnose and solve organizational problems and develop optimal managerial decisions. 4. Understand seven Ps of marketing and digital marketing strategies 5. Get to know about key people management processes. 6. Understand the decisions and processes in operations management. 7. Gain knowledge of financial systems, institutions, regulators and instruments. 8. Diagnose and communicate the complexities associated with management of various issues in the organizations and integrate the learning in handling these complexities

**Course Content**

- General Management Processes and Principles : - Concept, Functions and Principles of Management, Roles and skills of Managers;
- Functions of Management: Planning, Decision Making; Organizing: Organizational Design & Organizational Structures; Leading, Motivation, Communication and Controlling;
- Introduction to Human Resource and Marketing Management: Trends and Practices in People Management; Marketing Management Process and decisions, Marketing Mix;
- Introduction to Finance and Operations Management: Overview of Financial Systems, Financial Institutions, Markets and Instruments; Decisions & processes in Operations Management.

**References**

1. Robbins, Stephen P. and Coulter, Mary ( 2019) 'Management', 14th edition, Prentice Hall of India
2. Dessler, G. & Varkkey, B. (2018). Human Resource Management, 15e, Pearson.
3. Laasch , O. (2021). Principles of Management -Practicing Ethics, Responsibility, Sustainability, 2nd Edition, Sage Publications.
4. Hill, Charles W L and McShane, Steven L. (2017) Principles of Management, Special Indian Edition, McGraw Hill Education
5. Khan, M. Y. and Jain P. K. (Latest edition). Financial Management, Text, Problems & Cases. Tata McGraw Hill Company, New Delhi.
6. Philip Kotler. (Latest edition). Marketing Management: Analysis, Planning, Implementation & Control. Prentice Hall of India.
7. Koontz, Harold and Weihrich, Heinz & Ramachandra Aryasri A. (2016). Principles of Management, Latest edition, McGraw Hill Education

**38 Computer Networks Lab**

**Prerequisite:** : The programming lab in C++, which means you need to be very comfortable with C++ and using standard debugging tools.

**L T P C** Total hours: 48 0 0 4 2

**Course Content**

Hrs

The laboratory experiments conducted on various tools

Lab 1 -3: Introduction networking (wireshark,, TCP dump, CISCO packet tracer )

Lab 3 -4: Introduction to socket programming

Lab 5 -9: Experiments on NS2 and NS3

Lab 10 -12 : Experiments Mininet

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**References**

1. Data Networks: Bertsekas and Gallager, PHI
2. Computer Networks: L. Peterson and Davie, Elsevier
3. Computer Networking A top down Approach: J.F.Kurose, Pearson
4. Computer Networks : Andrew S. Tanenbaum, Pearson

**39 Database Information Systems Lab**

**Prerequisite:** :Ni I L T P C

**Total hours:** 48 0 0 4 2

**Course Content**

Hrs

I Design exercises and various Tools of designing the ER diagram and its mapping to relational model

8

II Programming exercises on SQL –Detailed DDL commands and queries to create databses.

8

III Programming exercises on SQL –Detailed DML commands

10

IV Programming exercises on SQL –Detailed PCL commands

6

V Programming Exercise on advanced topics of SQL, PL/SQL language : Functions, Procedures, triggers, Views, Cursors etc.

8

VI There will be as semester Mini -Group Project on theme of Database

Information system 8 References 1. Database System Concepts ,Silberschatz A, Korth H F, and Sudarshan S, , McGraw Hill,,6th Ed. 2. Modern Database Management systems, Hoffer J A, Prescott M B, and Topi H.,Pearson Education Inc.,13th Edition 3. Fundamentals of Database Systems, Elmasri R, Navathe S B, Pearson Education, 7th Edition. . 4. Database Management System, Raghuramakrishnan & Johannes Gehrke, McGraw -Hill 3rd edition 5 Commercial Application development using ORACLE Developer 2000 Forms 5.0, Ivan Bayross, BPB Publications. 40 Machine Learning Lab Prerequisite: Python Programming L T P C Total hours: 42 0 0 2 1 Course Content Hrs 1 Perceptron Learning Algorithm: 1. Generate a linearly separable data (random) set of size 20. Plot the examples  $\{(x_n, y_n)\}$  as well as the target function  $f$  on a plane. Be sure to mark the examples from different classes differently, and add labels to the axes of the plot. 2. Run the perceptron learning algorithm on the data set above. Report the number of updates that the algorithm takes before converging. Plot the examples  $\{(x_n, y_n)\}$ , the target function  $f$ , and the final hypothesis  $g$  in the same figure. Comment on whether  $f$  is close to  $g$ . Repeat everything in (2) with another randomly generated data set of size 100. Compare your results with (2) 3 2 Linear Regression: Write a python script that can find  $w_0$  and  $w_1$  for an arbitrary dataset of number of hours studied versus rank of a students as  $\{(x_n, y_n)\}$  pairs. Find the linear model,  $y = w^T x$ , that minimizes the squared loss. Derive the optimal  $w$  for the total training loss:  $s \text{ MSE/RSS } L = \sum (y_n - w^T x_n)^2$ . Using the model predict the rank for the number of hours studied. Load the data stored in the file syntheticdata.mat. Fit a 4th order polynomial function  $f(x; w) = w_0 + w_1 x + w_2 x^2 + w_3 x^3 + w_4 x^4$  to this data. What do you notice about  $w_2$  and  $w_4$ ? ) Fit a function  $f(x; w) = w_0 + w_1 x + w_2 \sin((x-a)/b)$ , assuming  $a$  and  $b$  are fixed in some sensible range. Show a least square fit using this model. What do you notice about  $w_1$  and  $w_2$ . Comment about generalization and overfitting. 3 3 Logistic Regression: Handwritten Digits Data: You should download the two data files with handwritten digits data: training data (ZipDigits.train) and test data (ZipDigits.test). Each row is a data example. The first entry is the digit, and the next 256 are grayscale values between  $-1$  and  $1$ . The 256 pixels correspond to a  $16 \times 16$  image. For this problem, we will only use the 1 and 4 digits, so remove the other digits from your training and test examples. Please submit your Python code implementing the logistic regression for classification using gradient descent. Familiarize yourself with the data by giving a plot of two of the digit images. Develop two features to measure properties of the image that would be useful in distinguishing between 1 and 4. You may use symmetry and average intensity (as discussed in class). As in the text, give a 2-D scatter plot of your features: for each data example, plot the two features with a red x if it is a 4 and a blue dot if it is 1. Classifying Handwritten Digits: 1 vs. 4. Implement logistic regression for classification using gradient descent to find the best separator you can using the training data only (use your 2 features from the above question as the inputs). The output is  $+1$  if the example is a 1 and  $-1$  for a 4. Give separate plots of the training and test data, together with the separators. Compute  $E_{\text{train}}$  on your training data and  $E_{\text{test}}$ , the test error on the test data after 1000 iterations. Now repeat the above using a 3rd order polynomial transform. As your final deliverable to a customer, would you use the linear model with or without the 3rd order polynomial

transform? Explain. Regularization: Logistic regression can also be augmented with the  $L_2$ -norm regularization:  $\min E(w) + \lambda \|W\|_2^2$ , where  $E(w)$  is the logistic loss. Please change your gradient descent algorithm accordingly and use cross-validation to determine the best regularization parameter. Plot the training and testing performance curves. Indicate in the plot the best regularization parameter you obtained (using cross validation).

6.4.1.4 Neural Networks: In this problem you will implement forward and backward propagation methods for a multi-layer neural network with  $K$  hidden layers. Assume that  $K$  is a user input less than 10. Implement the networks separately with the following activation functions: Sigmoid: Derive the gradient of the activation function. Confirm with numerical differentiation. Tanh: Derive the gradient of the activation function. Confirm with numerical differentiation. Assume that the last layer has a linear activation function and the loss function is  $l(y, \hat{y}) = \|y - \hat{y}\|_2^2$ . Submit your code (along with any instructions necessary to run it), the forward pass outputs at each layer and the gradients of the parameters ( $W_{ij}^{(k)}, b_{ki}$ ). The input, output and the parameters of the network can be found in the MAT file associated with this problem. In this problem you will train a multi-layer neural network to recognize handwritten digits. Use the multi-layer neural network (with ReLU activation) that you implemented in the previous homework. Use 32 nodes in each layer and initialize the weights randomly. The data is also provided to you in a MAT file.

- Report the training and validation accuracy as a function of iterations (with 5 hidden layers). Report the convergence speed of the training procedure (with 5 hidden layers) for the Stochastic Gradient Descent optimization algorithm.
- Determine the number of hidden layers required via cross-validation. Report the training and validation accuracy for cross-validation.
- Finally, report the best test error that you can achieve.

6.5 Evaluation Metrics: Consider a theoretical biometric matcher that generates distance scores in the range  $[-\infty, \infty]$ . Assume that the genuine and impostor score distributions due to this matcher can be approximately modeled as  $N(30, 10)$  and  $N(60, 15)$ , respectively. Here,  $N(\mu, \sigma^2)$  denotes normal distribution with mean,  $\mu$ , and variance,  $\sigma^2$ . Suppose the following decision rule is employed:  $s$  is classified as a genuine score if  $s \leq \eta$ ; else it is classified as an impostor score. Here,  $\eta \in [0, 100]$ .

- Plot the genuine and impostor distributions in a single graph. The distributions should be contained in the range  $[0, 100]$ .
- If  $\eta = 50$ , what is the FMR (i.e., FAR) and FNMR (i.e., FRR) of the biometric matcher?
- Given  $s$  is classified as a genuine score if  $s \leq \eta$ ; else it is classified as an impostor score. If  $\eta = 75$ , what is the FMR (i.e., FAR) and FNMR (i.e., FRR) of the biometric matcher?
- Plot the DET curve of this matcher.
- Plot the ROC curve and AUC of this matcher.

4.6 SVM: Classify the digits data as given for exercise 4 using a Support Vector Machine. Compute the values of  $W$  and an offset  $b$ , also draw the hyperplane.

8.7 Decision Trees and Random Forest: Generate three tables: Table one with attributes: Id, Exercise, Family history, Heart Attack Risk. Table two with attributes: Id, Smoker, Obese, Heart Attack Risk. Table three: Id, Obese, Family history and Heart Attack Risk. Generate 100 samples randomly for the three tables. List three bootstrap samples, using these bootstrap samples create decision trees that will be in the random forest model using entropy based information gain as the feature selection criteria. Assuming the random forest uses majority voting, what prediction will it return for the query: EXERCISE =

rarely, SMOKER = false, OBESE = true, FAMILY = yes. 6 8 Clustering: A bank wants to detect fraudulent credit card transactions. Using random function generate data for lots of transactions (each transaction is an amount of money, a shop, and the time and date) and some information about which credit cards were stolen, and the transactions that were performed on the stolen card. Generate random data files for the above description of at least 200 transactions. Implement Agglomerative, Hierarchical and Density based clustering techniques to cluster people's transactions together to identify patterns, so that stolen cards can be detected as changes in pattern. How well do you think this will work? There is much more data of transactions when cards are not stolen, compared to stolen transactions. How does it affect the learning, and what can you do about it. 6 References 1. A first course in Machine learning, Simon Rogers and Mark Girolami, CRC Press 2. Learning from Data, Yaser S Abu -Mostafa, AML books 3. Machine learning, Marsland, CRC press 4. An Introduction to Machine Learning, Kubat Miroslav, Springer 42 Scheme and Syllabus of 5th Semester Fifth Semester S. No Code Subject L-T-P Credits Type 22CPT301 Compiler Design 3-0-0 3 PC 22CPT302 Cryptography 3-0-0 3 PC 22CPT303 Operating System 3-0-0 3 PC 22CPT304 Software Engineering 3-0-0 3 PC 22CPT305 Emerging Technologies for CS 3-0-0 3 PC 22CPTxxx Program Elective -1 3-0-0 3 PE 22CPP306 Compiler Design Lab 0-0-2 1 PC 22CPP307 Cryptography Lab 0-0-2 1 PC 22CPP308 Operating System Lab 0-0-2 1 PC 21 Honors CSTxxx Advance Data Structures and Algorithms 3 CSTxxx Honors Elective -1\* 3 6 Minor CSE 22CPT104 Data Structures 3 PC 22CPT303 Operating System 3 PC 6 43 Compiler Design Prerequisite: : Theory of Computation L T P C Total hours: 42 3 0 0 3 Course Content Hrs Unit 1 Language Translators: Compilers and Interpreters, Hybrid Compiler, Structure of a Compiler, Self Compiler and Cross Compiler. Lexical Analysis: Design and implementation of Lexical Analyzers, Finite automata and Regular expressions, Lex tool – the Lexical Analyzer Generator. 8 Unit 2 Syntax Analysis: Context Free Grammars, Derivation and Parse trees, Ambiguity of grammars. Bottom -up and Top -down Parsing - Shift Reduce Parser, Operator Precedence Parser, First and Follow functions, Left recursion, LL Parsers, Canonical collection of items, LR parsers, Conflict Resolution in LR parsers. 14 Unit 3 Syntax -Directed Translation: Syntax -directed definitions and translation schemes, Attributes and Translation Rules, Implementation of S -attributed and L-attributed definitions. Intermediate Code Generation: Intermediate codes, Three address codes, Translation of Expressions and Type Checking. 8 Unit 4 Code Optimization and Code Generation : Basic blocks, Flow graphs, DAG, Global data flow analysis, ud -chaining, Available expressions, Loop optimization, Compilation of Expression and Control structures. Error Detection and Recovery. 12 References 1. Aho, Lam, Sethi and Ullman: Compilers – Principles, Techniques and Tools, Pearson Education 2. Tremblay and Sorenson: The Theory and Practice of Compiler Writing, BS Publications. 3. Allen Holub : Compiler Design in C, Prentice Hall India. 44 Cryptography Prerequisite: Nil L T P C Total hours: 40 3 0 0 3 Course Content Hrs Unit 1 Introduction to Number Theory: Divisibility theory in integers. Extended Euclid's algorithm. Modular Arithmetic – exponentiation and inversion. Fermat's Little Theorem, Euler's Theorem. Solution to congruence's, Chinese Remainder Theorem.

Review of abstract algebra – Study of Ring  $Z_n$ , multiplicative group  $Z_n^*$  and finite field  $Z_p$  – Gauss Theorem (cyclicity of  $Z_p^*$ ) - Quadratic Reciprocity. Primality Testing – Fermat test, Carmichael numbers, SolovayStrassen Test, Miller Rabin Test – analysis

8 Unit 2 Conventional Encryption , Classical Techniques - substitution and transposition ciphers, study of basic cryptanalysis possible on classical ciphers, Modern Techniques - block and stream ciphers and RC4

8 Unit 3 Shannon's principles of diffusion and confusion, Design Principles of Block cipher: SPN and Feistel Structure, The Data Encryption Standard (DES) , AES

8 Unit 4 Asymmetric cryptography: Public Key Encryption, Diffie – Hellman Key Exchange algorithm, RSA algorithm and its limitations

8 Unit 5 Cryptographic hash functions, secure hash algorithm, Message authentication, digital signature, RSA digital signature

8 References 1. W. Stallings,"Cryptography and Network Security Principles and practice", 5/e, Pearson Education Asia, 2013 2. Behrouz A. Forouzan and Debdeep Mukhopadhyay, "Cryptography and Network Security", 2nd edition, Tata McGraw Hill, 2013 3. N. Koblitz, Number Theory and Cryptography, Springer, 2001 4. J. Katz and Y. Lindell, Introduction to Modern Cryptography, Third edition CRC press, 2020

45 Operating System L T P C Total Hours : 42 3 0 0 3 Prerequisite: Computer Organization and Architecture, Data structures and algorithms, Problem solving using C

Course Content Hrs Unit 1 Introduction: What is an operating system, Types of operating systems and differences among them, OS as a virtual machine; User and Operating -System Interface, System Calls, System Services, Linkers and Loaders, Booting, OS as a resource manager, Interrupts and traps, System calls, Limited direct execution, user versus kernel mode. CPU Scheduling: Process, Process v/s program, context switch, Process state diagram, CPU scheduling – FCFS, SJF, SRTF, Priority, Pre -emptive priority, Round Robin, MLFQ, Lottery, CFS, Multi -Processor Scheduling, Real -Time CPU Scheduling, Thread v/s process, Process and Thread APIs

10 Unit 2 Synchronization: Inter -process communication and Processes: IPC in Shared -Memory Systems and Message -Passing Systems, Race condition, mutual exclusion, The Critical -Section Problem (CSP), Algorithmic solutions to CSP – Dekker's, Peterson's, Lamport Bakery Solution; Hardware Support for Synchronization – Test and Set, Compare and Swap; OS support for synchronization - Mutex Locks, Semaphores, Monitors; Condition Variables; Classic Problems of Synchronization – Producer Consumer, Sleeping Barber; Dining Philosopher's Problem, Deadlock – Prevention, avoidance, detection and recovery, Safe state, Banker's algorithm. Livelock.

10 Unit 3 Memory Management: working set model, hardware support; Contiguous allocation - partitioned memory allocation – fixed and variable partitioning, memory management with bit maps – swapping – relocation - protection and sharing. Non contiguous allocation – Paging – principles , page allocation, segmentation. Virtual memory concepts, address translation, management of virtual memory, page replacement policies, protection and sharing, Thrashing; Caching principles and quantitative estimation of cache behavior

8 Unit 4 I/O Management: Overview of Mass -Storage Structure, HDD Scheduling, NVM Scheduling, Error Detection and Correction, Storage Device Management, Swap -Space Management, SSD (Solid State Disks); I/O Systems -Overview; I/O Hardware; Kernel I/O Subsystem, Transforming I/O Requests to Hardware Operations File management: File Concept,

Access Methods, Directory Structure, Protection, File-System Interface, Shared files. File -System Implementation: Structure and Operations; Directory Implementation; Allocation Methods; Free -Space Management; Case study: EXT, NTFS, HFS 8 Unit 5 Security and Protection: Program Threats – stack overflow, return to libc, RoP, heap spraying, integer overflow, format string attacks; System and Network Threats; User Authentication; Principles of Protection - Protection Rings, Domains; Access Matrix, Implementation of the Access Matrix – Access Control Lists, capabilities; Revocation of Access Rights, Role -Based Access Control, Mandatory Access Control, Capability - Based Systems 6 References 1. Remzi H. Arpaci -Dusseau and Andrea C. Arpaci -Dusseau, Operating Systems: Three Easy Pieces [online <http://pages.cs.wisc.edu/~remzi/OSTEP/>] 46 2. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, Operating System Concepts . 9th edition. Wiley. 3. Andrew Tanenbaum & Albert Woodhull, Operating Systems: Design and Implementation . Prentice -Hall. 4. Maurice J Bach, Design of Unix Operating System . AT&T; Bell Labs. 5. Andrew Tanenbaum, Modern Operating Systems , Prentice Hall. 6. William Stallings, Operating Systems: Internals and Design Principles , 9th Edition, Pearson. 7. Crowley: Operating System A Design Approach , TMH. 47 Software Engineering Prerequisite: :Nil L T P C Total hours: 42 3 0 0 3 Course Content Hrs Unit 1 Introduction to Software Engineering : The evolving Role of Software Engineering, The Changing Nature of Software, Legacy software, Software Evolution and Software Myths. Industrial Engineering Tools for Software Engineering. 8 Unit 2 Process Models : Software Process Models: The Waterfall Model, The Incremental Model, the RAD model, Evolution Process Model: Prototyping, The Spiral model, Concurrent Development Model. Agile Process Models: Extreme Programming (XP) 6 Unit 3 Software Project Management: Management Activities, Project Planning, Project scheduling, Risk management. Requirements Engineering. Feasibility study, requirement analysis, cost benefit analysis, planning systems, analysis tools and techniques. 6 Unit 4 System Design: design fundamentals, modular design, data and procedural design, object oriented design and UML. System Development : Code documentation, program design paradigms. 6 Unit 5 Software Testing : Test Strategies for Conventional Software, Test Strategies for Object – Oriented Software, Verification and Validation Testing, System Testing, Debugging. Black -Box and White -Box Testing, Basis Path Testing, Control Structure Testing, Regression Testing, Mutation Testing, Dataflow Testing. 8 Unit 6 Software Maintenance : Maintenance Characteristics, Maintainability, Maintenance Tasks and side effects 8 References 1. Pressman Roger S, Software Engineering A Practitioner's Approach, TATA McGraw -Hill Publications, 6th Edition, 2005, ISBN No. 007 -301933X 2. Ian Sommerville, Software Engineering, Pearson Education, 7th Edition, 2008, ISBN: 978 -81-7758 -530-8. 3. Ghezzi C. Jazayeri M and Mandrioli: Fundamentals of Software Engg. , PHI. 4. Rajib Mall, Fundamentals of software engineering. PHI Learning Pvt. Ltd.. 5. Unified Modeling Language Reference manual", Grady Booch, James Rumbaugh, Ivar Jacobson, Pearson India, ISBN – 9788177581614 R5. 48 Emerging Technologies for CS Prerequisite: Operating system, computer network, etc. L T P C Total hours: 42 3 0 0 3 Course Content Hrs Unit - I Introduction: emerging areas in CS, Internet of things (IoT) : introductions to IoT, sensors and its features,



architectures and challenges, Applications – smart city, smart grid, Industrial IoT, etc.

8 Unit - II Computing and Applications: introduction to Cloud computing, various cloud architectures and its applications, mobile edge computing, MEC architectures, design principles and applications, MEC integration with disruptive technologies.

8 Unit - III Blockchain: Introduction to blockchain, principles and technologies, cryptocurrencies, smart contracts, Major applications and issues. Drones – introduction, drone design principles, smart optimization, Theory of drones, applications, etc.

8 Unit - IV Decentralized learning: Introduction to decentralized learnings, types of learnings, aggregation and communication challenges, privacy and security. 3D printing : introduction to 3D printing and its applications Quantum technologies : introduction, requirements, challenges, Q -bit principles, quantum computing, quantum cryptography, etc.

8 Unit - V Future/Advanced trends: introduction to future social applications, augmented reality (AR), Virtual reality (VR), mixed reality (MR), extended reality (XR) and metaverse, design principles, major challenges and applications. 5G communication and its use cases, 5G and beyond technologies.

8 References

1. The course materials are mainly from the lecturing slides. Research papers from top conferences like SIGCOMM, MOBICOM, NSDI, MobiSys etc.

49 Compiler Design Lab

Prerequisite: : Theory of Computation L T P C 0 0 2 2

Course Content

1. Design and implement a lexical analyzer for a given language.
2. Design and implement a lexical analyzer using the Lex/Flex tool.
3. Implement an Operator precedence parser for a given operator grammar.
4. Implement First and Follow functions.
5. Develop an LL(1) parser for a given input grammar.
6. Develop an LR(1) parser for a given input grammar.
7. Intermediate Code generation for a given source code.
8. Control Flow graph generation from a given intermediate code.
9. DAG construction and performing local optimization.
10. Implementation of Constant Folding, Redundant-subexpression elimination, and other optimizations.

References

1. Aho, Lam, Sethi and Ullman: Compilers – Principles, Techniques and Tools, Pearson Education
2. Tremblay and Sorenson: The Theory and Practice of Compiler Writing, BS Publications.
3. Allen Holub : Compiler Design in C, Prentice Hall India.
4. John R. Levine, Tony Mason, Doug Brown : Lex & Yacc, O'Reilly.

50 Cryptography Lab

Prerequisite: : Ni I L T P C

Total hours: 40 0 0 2 2

Course Content

Hrs

Unit 1

- a. Euclidean and Extended Euclidean algorithm for finding the Greatest Common Divisor of two large integers. Computing the Multiplicative inverses in  $Z_n$ .
- b. Repeated square and multiply algorithm for modular exponentiation in  $Z_n$ .
- c. Determining the order of a group element. Finding a generator of a cyclic group.
- d. Chinese remainder theorem.
- e. Computation of Legendre symbol and Jacobi symbol
- f. Modular polynomial arithmetic
- g. RSA public key algorithm
- h. ElGamal Cryptosystem
- i. Rabin cryptosystem
- j. Diffie -Hellman Key exchange protocol.

Unit 2

- a. Fermat's factorization method
- b. Congruence of squares. Finding a congruence of squares modulo  $n$  to factor  $n$ .
- c. Construction of Finite Field of characteristic 2.
- d. Computations in elliptic curve over a finite field.

Unit 3

- a. Sieve of Eratosthenes
- b. Fermat primality test
- c. Solovay -Strassen probabilistic primality test
- d. Miller -Rabin probabilistic primality test

References

1. Menezes, P.C. van Oorschot, S.A. Vanstone: Handbook of Applied Cryptography: CRC Press, 1996
2. Abhijit Das and C.E.VeniMadhavan, Public -key Cryptography: Theory and Practice, Pearson, 2009.
3. Darrel Hankerson, Alfred

Menezes, Scott Vanstone, Guide to Elliptic Curve Cryptography, Springer - Verlag, 2004

Instructions: C/C++ Programming Language under Linux Operating System  
 gmp-man-6.1.2.pdf (Refer GMP library manual) Code should be well modularised and documented, Code should be well modularised and documented

51 Operating System Lab L T P C Number of Weeks: 14 0 0 2 2 Pre-requisite: C Programming, Linux basics, Python

Course Content

- 1) Write a C/Python program to simulate CPU scheduling. Following CPU scheduling mechanisms need to be implemented: a) SJFS, FCFS b) Priority (pre-emptive & non-pre-emptive) c) Round Robin d) MLFQ e) Lottery
- 2) Given a list of process IDs, write a program to develop a tree depicting ancestor/parent/child relationship. This shall be a dynamic scenario, and the tree should be updated every second (as new child processes may be created and some may be killed or terminated normally/abnormally).
- 3) Given two processes P1 and P2 (created as parent/child process through fork/ two threads within same process or two independent processes through two different programs) both of which increment a shared variable, implement Dekker's & Peterson's solutions.
- 4) Implementation of Lamport -Bakery solution for ( $N \geq 5$ ) processes. Each process shall increment a shared counter by one.
- 5) Modify solution to producer-consumer problem so that it works wherein producer produces one item but consumer consumes two items. If buffer has only one item, consumer relinquishes critical section and waits till there are two or more items. The solution should be a) threads based b) independent process based
- 6) Write a program to check if there is a deadlock in the resource-allocation graph. If not, how can the process be allocated resources with no deadlock ever occurring.
- 7) Implement Sleeping Barber and dining Philosophers problem using semaphores.
- 8) Write a program in C that reads a file from the file system and displays its contents on the screen. Implement error handling and permission checking.
- 9) Write a program in C that implements a simple memory allocation algorithm such as first-fit or best-fit, and tests its performance using a benchmark program.
- 10) You are given a file named "input.txt" that contains parameters related to a disk in the first six lines - number of cylinders (track), number of sectors, bytes per sector, RPM, average seek time, initial head position. These parameters are in different lines of the same file. Track 0 is the outermost one. The seventh line of the file should contain a sequence of requests for track (cylinder) numbers. Write a program to output a) Average Rotational delay b) Total Seek Time to service all the requests for
  - SSTF (Shortest Seek time first)
  - LOOK
- 11) Create a virtual machine using Virtual Box or VMware, install an operating system on it, and configure it to run a web server. Test the web server using a web browser and network analysis tools
- 12) Implement buffer overflow attack using stack smashing.
- 13) Write a shell script that performs the following tasks:
  - a) File manipulation: Create, delete, copy, and move files and directories.
  - 52 b) Text processing: Search for specific patterns in files and perform text transformations.
  - c) System monitoring: Retrieve system information like CPU usage, memory utilization, and disk space.
  - d) Automation: Automate a repetitive task on your Linux system using a shell script.
- 14) Implement a program in Linux that demonstrates the following process management concepts:
  - a) Process creation: Create child processes using the fork() system call.
  - b) Process termination: Terminate processes using the exit() system call.
  - c) Process synchronization: Synchronize

processes using semaphores, mutexes, or other synchronization mechanisms. d) Signal handling: Handle signals like SIGINT or SIGTERM in your program. 15) Develop a program that interacts with the Linux file system. Your program should enable users to: a) Create files and directories. b) Navigate through directories and display their contents. c) Copy or move files and directories. d) Change file permissions and ownership. 16) Write a simple Linux device driver that interacts with a custom hardware device or simulates a virtual device. Your device driver should: a) Implement read and write operations to interact with the device. b) Handle interrupts or other device -specific functionalities. c) Test the device driver by accessing the device and performing read/write operations.

References

1. Remzi H. Arpaci -Dusseau and Andrea C. Arpaci -Dusseau, Operating Systems:Three Easy Pieces [online <http://pages.cs.wisc.edu/~remzi/OSTEP/>]
2. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, Operating System Concepts . 9th edition. Wiley.
3. Andrew Tanenbaum & Albert Woodhull, Operating Systems: Design and Implementation . Prentice - Hall.
4. Maurice J Bach, Design of Unix Operating System . AT&T; Bell Labs.
5. Andrew Tanenbaum, Modern Operating Systems , Prentice Hall.
6. William Stallings, Operating Systems: Internals and Design Principles , 9th Edition, Pearson.
7. Crowley: Operating System A Design Approach , TMH.

53 Advanced Data Structures and Algorithms (Honors) Prerequisite: Data Structures, Design and Analysis of Algorithms L T P C Total hours: 42 3 0 0 3 Course Content Hrs. Unit 1 RAM model – Notations, Recurrence analysis - Master's theorem and its proof - Amortized analysis, Recurrence equations. 8 Unit 2 Advanced Data Structures: B -Trees, Binomial Heaps, Fibonacci Heaps, AVL trees, Red - black trees, B -trees, Splay trees, Interval trees; Disjoint set – union and path compression, Amortized analysis Greedy Algorithms: shortest distance, minimum spanning tree, interval scheduling, interval partitioning; Divide and Conquer: sorting, integer and polynomial multiplication. 10 Unit 3 Dynamic programming: Longest common subsequence. Chain of matrix multiplication, sequence alignment, Bellman Ford Convex hull and Voronoi diagrams, line segments, Optimal polygon triangulation; Primality testing, Integer factorization. 10 Unit 4 Graph algorithms: Matching and Flows; Parallel algorithms: Basic techniques for sorting, searching, merging. Intractability: Independent Set, Vertex Cover, Randomized algorithms, Probabilistic algorithms. 8 Unit 5 Approximate Algorithms: Vertex -cover, set -covering problems, Travelling Salesman problem. Complexity classes - NP-Hard and NP -complete Problems - Cook's theorem NP completeness reductions, undecidability 6 References: 1. Cormen, Leiserson, Rivest: Introduction to Algorithms, Prentice Hall of India. 2. Aho A.V , J.D Ullman: Design and analysis of Algorithms, Addison Wesley 3. Brassard : Fundamental of Algorithmics, PHI. 4. Sara Baase: Computer Algorithms: Introduction to Design and Analysis, Pearson Education. 5. Papadimitriou, Steiglitz: Combinatorial Optimization: Algorithms and Complexity, PHI 6. Motwani and Raghavan: Randomized Algorithms, Cambridge University Press

54 Scheme and Syllabus of 6th Semester Sixth Semester S. No Code Subject L-T-P Credits Type 22CPT309 Artificial Intelligence 3-0-0 3 PC 22CPT310 Computer and Network Security 3-0-0 3 PC 22CPT311 Digital Image Processing 3-0-0 3 PC 22CPT312 Parallel and Distributed Computing 3-0-0 3 PC 22EET313 Smart Grid 3-0-0 3 PLEAS 22CPTxxx Program

Elective -2 3-0-0 3 PE 22CPP313 Computer and Network Security Lab 0-0-2 1 PC  
 22CPP314 Digital Image Processing Lab 0-0-2 1 PC 22CPP315 Parallel and  
 Distributed Computing Lab 0-0-2 1 PC 21 Honors CSTxxx Honors Elective -1\* 3  
 CSTxxx Honors Elective -2\* 3 6 Minor CSE 22CPT211 Computer Networks 3 PC  
 22CPT213 Database Information Systems 3 PC 6 55 Artificial Intelligence  
 Prerequisite: Nil L T P C Total hours: 42 3 0 0 3 Course Content Hrs Unit 1 Overview  
 of AI, Problems, Shift in focus of AI towards providing smarter solutions, Change in  
 application domains of AI, State -of-the-art technologies in AI. Problem space and  
 searching techniques, Types of production system, Control strategies, Heuristic  
 search Techniques. Defining AI problems as a State Space Search: example,  
 Production Systems, Types of production systems, Search and Control Strategies,  
 Problem Characteristics. 6 Unit 2 Heuristic search techniques - Generate -and-test,  
 Hill Climbing, Best First Search, A\* , Problem Reduction, AO\*, Constraint Satisfaction  
 with inferencing, backtracking and local search, Mean -Ends Analysis. Knowledge  
 representation, Representation, mappings, approaches and issues. 8 Unit 3  
 Propositional Logic and theorem proving, First order Predicate logic: syntax and  
 semantics, Propositional v/s First Order Predicate Logic, Satisfiability problems, model  
 finding, Inference algorithms: Backward and forward chaining, Resolution (proof by  
 contradiction). Representing Simple facts in Logic, Representing Instances and Isa  
 relationships, Computable Functions and Predicates, Using First Order Logic,  
 Inferencing process and resolution, Unification algorithm. Knowledge Representation :  
 Ontologies, objects, events, PEAS, Forward v/s backward reasoning, Matching and  
 control knowledge, Levels of knowledge representation, entailment, implication,  
 contradiction, contingency, model checking, Modus ponens inference rule, CNF  
 clauses, Horn clauses. SAT Solvers: DPLL Weak Structures: Semantic Nets, Frames,  
 Strong Structures: Conceptual Dependencies, Scripts. Expert Systems and  
 applications : Representing and using domain knowledge, Expert system shells,  
 Knowledge Acquisition. 10 Unit 4 Game Playing : Minimax Search Procedures,  
 Adding alpha -beta cutoffs , State -of-the- Art Game Programs and modern examples,  
 Watson and how it solved Jeopardy. Information Retrieval - Google's page rank  
 algorithm, Introduction to natural language processing. 8 Unit 5 Uncertain knowledge  
 and reasoning Quantifying uncertainty, Probabilistic reasoning,, Graphical Models,  
 Bayesian networks, Bayesian inference, forward and backward inference, inference  
 by enumeration, and variable elimination algorithm, Probabilistic reasoning overtime,  
 Inference in temporal models. Sampling: prior sampling, rejection sampling, likelihood  
 weighting. Hidden markov models, the forward algorithm, the HMM Viterbi algorithm.  
 Concepts in Machine learning: Introduction , Foundations of AI v/s ML, When to use  
 ML and when not to use, Framework for AI/ML application to a problem, Taxonomy of  
 Computational Intelligence, Classification under Machine Learning. 10 References 1.  
 Artificial Intelligence: A Modern Approach by Russel and Norvig, Third Edition,  
 Pearson, 2015. 2. Artificial Intelligence: Elaine Rich, Kevin Knight, Mc -Graw Hill. 3.  
 Introduction to AI & Expert System: Dan W. Patterson, PHI. 56 Computer and  
 Network Security Prerequisite: : Cryptography, Computer networks, etc. L T P C Total  
 hours: 42 3 0 0 3 Course Content Hrs Unit - I Introduction: Introduction (a) Security(b)  
 Malware(c) OWASP top ten and other major security issues in the world(d) CVE and

other information (e) Introduce various types of security areas

5 Unit - II Software and OS Security: OS Security: Common Bugs, Buffer Overflow, Runtime Defenses against memory safety vulnerabilities, program verification and other vulnerabilities, Principles in OS Security; Mechanisms for confining bad code, Mechanisms for confining bad code: isolation, sandboxing, SFI and Virtualization, Trusted Computing

8 Unit - III Web Security: Secure web site design (SQL injection, XSS, etc.), Browser Security,

7 Unit - IV Network Security: TCP/IP, DDoS Attacks, Network worms and botnets: attacks and defenses, DNS and BGP security, Network defense tools – Firewall and Intrusion Detection .

11 Unit - V Future/Advanced Security: Introduction - The Security in Existing wireless Networks, Upcoming wireless networks and challenges, Thwarting and malicious behavior – Naming and addressing, security association and secure neighbor discovery, secure routing in multichip wireless networks and privacy protection. Mobile OS Security and Privacy: Android, IOS security challenges, processor security, privacy, anonymity and censorship and other security issues according to the current situations and future requirements

9 References

1. Security in Computing (3rd edition)
2. Cryptography and Networks 7 edition
3. The course materials are mainly from the lecturing slides I've made and research papers from top conferences like NDSS, USENIX, SIGCOMM, MOBICOM, NSDI, MobiSys etc.

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Digital Image Processing Prerequisite: Fundamental knowledge on signals and systems, basics of linear algebra and calculus, and programming skills

L T P C Total hours: 42 3 0 0 3

Course Content Hrs

Unit 1 Introduction to Digital Image Processing: Digital Image Representation, Fundamental Steps in DIP, Elements of Visual Perception, Image Sensing and Acquisition, Image Model, Sampling, Quantization, Basic Relationship Between the Pixels

6 Unit 2 Image Transforms: Discrete Fourier Transform (DFT), Properties of 2D DFT, Fast Fourier Transform, Inverse FFT, Discrete Cosine Transform and KL Transform, Discrete wavelet Transform, Convolution and Correlation

8 Unit 3 Image Enhancement: Spatial Domain - Basic Gray Level Transformations, Histogram processing, Smoothing and Sharpening Spatial Filters Frequency Domain - Smoothing and Sharpening frequency domain filters, Homomorphic filtering

8 Unit 4 Image Restoration: Overview of Degradation models, Unconstrained and constrained restorations, Inverse Filtering, Wiener Filter

6 Unit 5 Image Segmentation: Detection of discontinuities, edge linking and boundary detection, thresholding, region oriented segmentation Image Compression: Need for data compression, image compression models, loss-less and lossy compression

8 Unit 6 Representation and Description: Representation schemes, boundary descriptors, regional descriptors. Morphology: Dilation, erosion, opening, closing, Hit-or-Miss Transform, some basic morphological algorithms

6 References

1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Pearson , 3rd Edition, 2008
2. Castleman. Digital Image Processing. Prentice Hall.
3. Anil K. Jain, Fundamentals of Digital Image Processing, Pearson , 2002

58

Parallel and Distributed Computing Prerequisite: Programming in C, Data Structures, Operating Systems, Computer Architecture and Organization

L T P C Total hours: 40 3 0 0 3

Course Content Hrs

Unit 1 Parallel Computing, Sequential programs, Parallel Programs, Performance Metrics for Parallel Systems, Effect of Granularity on Performance, Scalability of Parallel Systems, Parallel Programming Platforms, Implicit Parallelism, SIMD & MIMD

systems, Clusters , Single -Core and Multi -Core Processors, Physical Organization of Parallel Platforms, Cache Coherence, Posix -Threads, problem -Solving using P - threads. 8 Unit 2 Programming Using the Message -Passing Paradigm - MPI Principles of Message Passing Programming; Building blocks (Sending and Receiving Operations); Communication Library calls; Collective communication and Computation library calls, Programming Shared Address Space Platforms – OpenMP, Directive Parallel Programming; The OpenMP programming Model (Concurrent Tasks, Synchronization Constructs, Data Handling); Open libraries; OpenMP - Environment Variables; 10 Unit 3 Parallel Programs, Matrix Computations, Matrix -Vector Multiplication, Matrix - Matrix Multiplication, Solving system of Linear Equations; Parallel Implementation of Sparse Matrix Computations with Vector; Sorting algorithms, Issues in Sorting on Parallel Computers , Bubble Sort and its Variants, Quicksort; Parallelizing Quicksort; Sequential and Parallel Implementation of all -pairs of Shortest Paths Algorithms; Sequential & Parallel Search Algorithms; Depth -First Search Algorithms; Best -First Search Algorithms 8 Unit 4 Programming on Multi -Core Systems with GPU accelerators, An Overview of Brief History of GPUs; An Overview of GPU Programming; An Overview of GPU Memory Hierarchy Features; An Overview of CUDA enabled NVIDIA GPUs, Introduction to CUDA C, Parallel Programming using OpenACC, CUDA APIs, CUDA Libraries for Numerical and Non -Numerical Computations; The OpenCL – Heterogeneous Programming; OpenCL Libraries, The OpenCL Memory Model, Execution Model; Platform and Devices; An Overview of OpenCL API; 6 Unit 5 An Overview of MapReduce, An Overview of MapReduce Programming, An Overview of Hadoop Architecture /Execution (Master/slave, Namenode/Datanode); Hadoop Distributed File System (HDFS), An Overview of Hadoop Components, Hadoop – Control Flow and Data Flow; An overview of Hive (Distributed Data Warehouse); Hbase (Distributed Column based database, PIG –(Data Flow Language) , Introduction to Spark, Spark RDD, Machine Learning Using Spark. 8 References 1. Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar: Introduction to Parallel Computing, Second Edition Pearson Education – 2007 2. Peter Pacheco, An Introduction to Parallel Programming, Morgan Kaufman Publishers, Elsevier (2011) 3. Jason Sanders, Edward Kandrot, CUDA By Example – An Introduction to General -Purpose GPU Programming, Addison Wesley (2011) 4. Rohit Chandra, Leonardo Dagum, Dave Kohr, Dror Maydan, Jeff McDonald, Ramesh Menon, Parallel Programming in OpenMP, Academic Press (2001) 59 5. Benedict R Gaster, Lee Howes, David R Kaeli Perhaad Mistry Dana Schaa, (2011), Heterogeneous Computing with OpenCL McGraw -Hill, Inc. Newyork 6. Michael J. Quinn, Parallel Programming in C with MPI and OpenMP McGraw -Hill International Ed (2003) 7. Aru C Murthy, Vinod Kumar Vavilapalli, Doug Eadline, Joseph Niemiec, and Jeff Markham, Apache Hadoop YARN Moving beyond MapReduce and Batch Processing with Apache Hadoop 2, Addison Wesley, 2014 60 Smart Grid Prerequisite : Data communication, computer networks, data science, etc. L T P C Total hours: 40 3 0 0 3 Course Content Hrs Unit - I Introduction to Power systems and Smart grid : power systems: Load and Generation, Power Flow Analysis, Economic Dispatch and Unit Commitment Problems, Smart Grid: Definition, Applications, Government and Industry, Standardization 4 Unit - II

Renewable Generation: Carbon Footprint, Renewable Resources: Wind and Solar, Microgrid Architecture, Tackling Intermittency, Stochastic Models and Forecasting 8

Unit - III Smart Grid Communications: Two-way Digital Communications Paradigm, Network Architectures, IP -based Systems, Power Line Communications, Advanced Metering Infrastructure Wide Area Measurement: Sensor Networks, Phasor Measurement Units, Communications Infrastructure, Fault Detection and Self -Healing Systems, Applications and Challenge 11

Unit - IV Renewable Generation: Carbon Footprint, Renewable Resources: Wind and Solar, Microgrid Architecture, Tackling Intermittency, Stochastic Models and Forecasting Intelligent Demand Response : Definition, Applications, and State -of-the Art, Pricing and Energy Consumption Scheduling, Controllable Load Models, Dynamics, and Challenges, Electric Vehicles and Vehicle -to-Grid Systems, Demand Side Ancillary Services 11

Unit - V Data science for economics and market operations: Energy and Reserve Markets, Market Power, Detection of market power using data science methods, Analysis of pricing patterns and market behaviour and Assessment of market concentration and its impact on competition and consumer welfare , Generation Firms - Optimization of scheduling and dispatch of generation units and Predictive maintenance using machine learning algorithms, improved operational efficiency through data -driven models. , Locational Marginal Prices - Prediction of local marginal prices using data science techniques, Analysis of historical data to identify correlations and patterns, Accurate price forecasting and risk management strategies. Financial Transmission Rights - Estimation of financial value of transmission rights, Optimization of allocation and trading of transmission rights, Predictive models for assessing financial risks and returns. Security and Privacy: Cyber Security Challenges in Smart Grid, Load Altering Attacks, False Data Injection Attacks, Defence Mechanisms, Privacy Challenges 6

References 1. This course does not have any official textbook. The main source of learning for the students is the set of handouts provided by the instructor. The students will also need to read several recent papers in the field of smart grid, e.g., in the IEEE Transactions on Smart Grid, the IEEE Innovative Smart Grid Technologies Conference, and the IEEE Conference on Smart Grid Communications. 2. The course materials are mainly from the lecturing slides made and research papers from top conferences like SIGCOMM, MOBICOM, NSDI, MobiSys etc. 61

Computer and Network Security Lab Prerequisite: : The programming lab in C++, which means you need to be very comfortable with C++ and using standard debugging tools. L T P C

Total hours: 28 0 0 2 2 Course Content Hrs The laboratory experiments conducted on various tools Lab 1 -3: Experiments on Network traffic scanning tools – Wireshark, Nmap, Nessus, etc tools Lab 3 -4: Experiments on control hijacking attacks, and OS security Lab 5 -9: Experiments on Network security (OpenSSL, OpenVAS, Snort, Metasploit, Firebug, etc.) Lab 10 -12 : Experiments on Web security (DVWA, snort, etc) 28

References 1. Security in Computing (3rd edition) 2. Cryptography and Networks 7 edition 3. The course materials are mainly from the lecturing slides I've made and research papers from top conferences like NDSS, USENIX, SIGCOMM, MOBICOM, NSDI, MobiSys etc. 62

Digital Image Processing Lab Prerequisite: Fundamental knowledge on image processing and programming skills L T P C 0 0 2 1

Course Content 1. Familiarization with various image processing tools 2. Basic

operations on images 3. Basic grey -level transformations 4. Image Negative 5. Logarithmic transformation 6. Power -law transformation 7. Perform the following over a given image 8. Grey level slicing 9. Zooming (Nearest neighbour interpolation, bilinear interpolation) 10. Bit-plane slicing 11. Histogram equalization and specification 12. Implementation of different image transforms (DFT, PCT, DWT, etc.) 13. Spatial filtering in presence of various noise 14. Filtering in frequency domain 15. Implementation of image deblurring techniques 16. Image segmentation (edge detection, line detection, point detection) 17. Implementation of region based image segmentation 18. Implementation of different morphological operations 19. Analysis of images using color models 20. Mini project References 1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Pearson , 3rd Edition, 2008 3. Anil K. Jain, Fundamentals of Digital Image Processing, Pearson , 2002 63 Parallel and Distributed Computing Lab Prerequisite : C Programming, DSA L T P C 0 0 2 1 Course Content 1. Implementation of pthreads, problem -solving using pThreads. 2. Problem -solving using openMP 3. Matrix multiplication using task. 4. Problem -solving using MPI, Sending and Receiving Operations 5. Parallel Programs, Matrix Computations, Matrix -Vector Multiplication, Matrix -Matrix Multiplication using MPI. 6. Parallel Implementation of Sparse Matrix Computations with Vector; Sorting Algorithms , Issues in Sorting on Parallel Computers; Bubble Sort and its Variants using GPU Resources. 7. Quicksort; Parallelizing Quicksort; Sequential and Parallel Implementation of all -pairs of Shortest Paths Algorithms; Sequential & Parallel Search Algorithms. 8. Depth -First Search Algorithms; Best -First Search Algorithms. Control Flow graph generation from a given intermediate code. 9. Implementation of MapReduce programs for large scale data handling. 10. Programming on Multi -Core Systems with GPU accelerators. References 1. Aru C Murthy, Vinod Kumar Vavilapalli, Doug Eadline, Joseph Niemiec, and Jeff Markham, Apache Hadoop YARN Moving beyond MapReduce and Batch Processing with Apache Hadoop 2, Addison Wesley, 2014 2. Benedict R Gaster, Lee Howes, David R Kaeli Perhaad Mistry Dana Schaa, (2011), Heterogeneous Computing with OpenCL McGraw -Hill, Inc. Newyork 3. Jason Sanders, Edward Kandrot, CUDA By Example – An Introduction to General -Purpose GPU Programming, Addison Wesley (2011) . 64 Pool 1: Electives: 3 -0-0 (Credits 3, Semesters 5/6 /7) 1. 5G and Beyond 2. Advanced Algorithms 3. Blockchain Technologies 4. Cyber Physical Systems 5. Deep Learning 6. Evolving Architectures 7. Malware Analysis 8. Artificial Neural Networks 9. Nature Inspired Algorithm 10. Parallelizing Compilers 11. VLSI Algorithms 12. Wireless Security 13. Wireless Networks 65 5G and Beyond Prerequisite: : Data communication, computer networks, etc. L T P C Total hours: 40 3 0 0 3 Course Content Hrs Unit - I Introduction to mobile networks : Mobile Networks (wireless communication), Need of Generations, Evolution of generation, Challenges of generations, 4G Network and architecture, From 4G to 5G, Network Architecture of 5G/6G, Challenges of 5G. 4 Unit - II 5G apps: 5G apps (pull from user demands) - app overview and 5G objectives, 5G apps in the automotive sector and D2D technologies, IoT applications and technologies: Internet of Things in 5G Era, 3GPP Standards for the Internet -of- Things, Other 5G apps and technologies : Media and Entertainment Sector, eHealth sector 8 Unit - III 5G Technologies: Overview and radio - 5G (core network): Network



slicing, C - RAN, NFV, SDN, 5G technologies (mobile edge computing, management and orchestration, discussion). 11 Unit - IV Overview of Active Research: 6G, vision and thoughts towards 6G, network intelligence for 5G and beyond 11 Unit - V Security for 5G and beyond : Overview of security for 5G and beyond, enhanced system level security design, blockchain for 5G and beyond. 6 References 1. Erik Dahlman, Stefan Parkvall, and Johan Sköld: 5G NR: The Next Generation Wireless Access Technology. Academic Press, 2018, ISBN: 9780128143230. 2. The course materials are mainly from the lecturing slides I have made and research papers from top conferences like SIGCOMM, MOBICOM, NSDI, MobiSys etc. 66 Advanced Algorithms Total Hours L T P C 42 3 0 0 3 Prerequisite: Data Structures, Design and Analysis of Algorithms, C programming Course Content Hrs Unit 1 Review of Data Structures - Height balanced trees, AVL, Red-black trees, splay trees, Binomial and Fibonacci heaps, treaps, suffix tree, Range minimum query, Aho- Corasick automata, Hash tables, Tries, van Emde boes tree. 8 Unit 2 String Algorithms: Exact String Matching: Rabin -Karp, KMP, Boyer Moore; Inexact string matching: Edit distance, Levenshtein distance computing algorithm. Computational Geometry: Convex Hull. Line-segment Intersection. Sweep Lines. Voronoi Diagrams. Range Trees. Optimal polygon triangulation. 8 Unit 3 Linear Programming: Formulation of Problems as Linear Programs. Duality. Simplex, Interior Point, and Ellipsoid Algorithms. Online Algorithms: Ski Rental. River Search Problem. Paging. The k-Server Problem. List Ordering and Move -to-Front. Parallel Algorithms: PRAM. Pointer Jumping and Parallel Prefix. Bitonic sorting, Odd-even sorting, Maximal Independent Set. 10 Unit 4 Approximation Algorithms: Greedy Approximation Algorithms. Dynamic Programming and Weakly Polynomial -Time Algorithms. Linear Programming Relaxations. Randomized Rounding. Vertex Cover, Wiring, and TSP. Fixed - Parameter Algorithms - Parameterized Complexity. Kernelization. Vertex Cover. Probabilistic algorithms: Primality testing, Integer factorization, Randomized algorithms: Monte Carlo – mincut, Las Vegas – quicksort 8 Unit 5 Complexity classes - NP-Hard and NP-complete Problems - Cook's theorem NP completeness reductions – SAT, 3SAT, vertex cover, Independent Set, Hamiltonian cycle, travelling salesman. 8 References 1. Cormen, Leiserson, Rivest: Introduction To Algorithms, Prentice Hall Of India. 2. Aho A.V , J.D Ullman: Design And Analysis Of Algorithms , Addison Wesley 3. Jon Kleinberg And Éva Tardos: Algorithm Design, Pearson. 4. Motwani And Raghavan : Randomized Algorithms , Cambridge University Press 5. Vazirani: Approximation Algorithms , Springer Verlag 6. Papadimitriou, Steiglitz: Combinatorial Optimization: Algorithms And Complexity , Phi. 67 Blockchain Technologies Prerequisite: : Nil L T P C Total hours: 35 3 0 0 3 Course Content Hrs Unit 1 Introduction to blockchain - Distributed Ledger Technology, Decentralization, Problems in Traditional Money transfer system, Digital Crypto currency, Bitcoin nuts and bolts, Generic elements of Blockchain, Bitcoin Network and Architecture, Block and transactions in a Blockchain, Advantages over Traditional Databases, Mining Mechanism, Types of Blockchain: Public, Private, Consortium, Hybrid 6 Unit 2 Cryptography: Elliptic Curve Cryptography, Hash Functions, Merkle Tree, Merkle Patricia Trie, Digital Signature, Wallets and Keys, User Addresses and Privacy CRYPTO CURRENCY History, Distributed ledger, Creation of Coins, Double spending, 3 Unit 3 Mechanics of Bitcoin,

Bitcoin protocols, Transaction in Bitcoin Network, AltCoins, Ethereum ,Transactions in Ethereum, EVM, Accounts, Transactions, Gas, Fees, Smart Contracts, Wallets managing and protecting crypto assets, Types of Wallets, different ways of storing Bitcoin keys, security measures, Tokenizing, Risk and challenges, 8 Unit 4 Bitcoin Mining and consensus –definition, working of Consensus Mechanism, Byzantine Generals Problem, Nakamoto consensus, Properties of consensus mechanism , incentives in consensus, Types of Consensus Algorithms, Proof of Work (PoW), Proof of Stake (PoS), Delegated Proof of Stake (DPoS), Proof of Importance (PoI), Proof of Capacity (PoC) ,The Proof of Elapsed Time (PoET), Hybrid Proof of Activity (PoA), Proof of Authority (PoA), Proof of Burn (PoB) Byzantine Fault Tolerance (BFT), and other flavours of consensus mechanisms , Pros and Cons of Consensus Mechanisms, ;, sybil resistance, Security analysis of various Consensus Mechanisms 9 Unit 5 Ethereum Syntax &, Structure ,Decentralized Apps (dApp), EVM, and the Ethereum blockchain, Eth 2.0, Sharding Chains ,Smart Contract, , MetaMask, Blockchain -based IoT Applications, Hyperledger, Components of Ethereum Ecosystem Smart contract on ethereum, Setting up Ethereum Node using Geth Client, Smart Contracts and DApps, Programming in solidity Truffle, Ganache CLI, Metamask, Remix, Solidity, Writing and Deploying Smart Contracts in Solidity, Connection to Web3.js Library, Vulnerabilities in Smart Contracts, Attacks, Prevention of Attacks, Decentralized Autonomous Organization (DAO), Building an Initial Coin Offering (ICO). Privacy and Scaling the blockchain, blockchain interoperability, future of blockchains 6 Unit 6 Use Cases and applications in Cryptocurrency and Other Sectors like Finance, Voting System, and Healthcare, Networks , Bitcoin: A Peer -to-Peer Electronic Cash System, Supply Chain Management (SCM) etc 3 References 1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder, “Bitcoin and Cryptocurrency Technologies”, Princeton University Press, 2016. 2. Lantz, Lorne, and Daniel Cawrey, “Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications” O’Reilly Media, 3. Imran Bashir, Mastering Blockchain: Distributed Ledger Technology, decentralization, and smart contracts explained, Packt Publishing Ltd, March 2018 68 Cyber -Physical Systems Prerequisite: : Data communication, computer networks, etc. L T P C Total hours: 40 3 0 0 3 Course Content Hrs Unit - I Introduction to CPS : Characteristics of Cyber -Physical Systems (CPS), Cyber - Physical Systems (CPS) in the real world, Basic principles of design and validation of, 4 Unit - II CPS Hardware: Industry 4.0, AutoSAR , IIOT implications, Building Automation, Medical CPS -CPS physical systems modeling and formalisms: CPS - Platform components - CPS HW platforms - Processors, Sensors, Actuators, 8 Unit - III CPS Network and systems: , CPS Network - WirelessHart, CAN, Automotive Ethernet, Scheduling Real Time CPS tasks Principles of Dynamical Systems - Dynamical Systems and Stability, Controller Design Techniques and Performance under Packet drop and Noise, 11 Unit - IV CPS Implementations and Intelligence: CPS implementation issues - From features to automotive software components, Mapping software components to ECUs, CPS Performance Analysis - effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion, and building real - time networks for CPS, CPS Intelligent CPS 11 Unit - V Applications and Security for CPS : Safe

Reinforcement Learning, Robot motion control, Autonomous Vehicle control, Gaussian Process Learning, Smart Grid Demand Response, Building Automation, Secure Deployment of CPS, Secure Task mapping and Partitioning, State estimation for attack detection, Automotive Case study : Vehicle ABS hacking Power Distribution Case study : Attacks on Smart Grids 6 References 1. "Introduction to Embedded Systems – A Cyber –Physical Systems Approach " - E. A. Lee, Sanjit Seshia 2. "Principles of Cyber -Physical Systems" - Rajeev Alur 3. The course materials are mainly from the lecturing slides I've made and research papers from top conferences like SIGCOMM, MOBICOM, NSDI, MobiSys etc. 69 Deep Learning Prerequisite: : Probability, Statistics, Algebra, Basic Computer Programming, Data Structures L T P C Total hours: 42 3 0 0 3 Course Content Hrs Unit 1 Course Overview: Introduction to Deep Learning and its Applications. Introduction to Statistical Learning: Multi -Layer Perceptron, Back Propagation, Linear Regression, Loss Functions and Optimization: Optimization, stochastic gradient descent, dropout, batch normalization, etc. 8 Unit 2 Convolutional Neural Networks: Convolution, pooling, Activation Functions, Back propagation of CNN, Weights as templates, Translation invariance, Training with shared parameters. CNN Architecture Design and Discussion: AlexNet, VGG, GoogLeNet, ResNet, Capsule Net, etc. Visualization and Understanding: Visualizing intermediate features and outputs, Saliency maps, Visualizing neurons, Cam -Grad, etc. 8 Unit 3 Sequential Modelling: Recurrent and Recursive Nets, RNN, LSTM, GRU, Image captioning, visual question answering, etc. 6 Unit 4 Generative Models: Encoder, Decoders, Variational Autoencoders, Generative Adversarial Networks like pix2pix, CycleGAN, etc. Transformers based Models:. 8 Unit 5 Deep Learning Applications: Object Detection: RCNN, Fast RCNN, Faster RCNN, YOLO and variants, Retina Net, etc., Adversarial Attacks on CNN Deep learning for NLP 8 Unit 6 Deep learning Libraries and Frameworks: Keras, TensorFlow, PyTorch, AutoML, etc 4 References 1. Ian Goodfellow and Yoshua Bengio and Aaron Courville, "Deep Learning," MIT Press. 2. Michael A. Nielsen, "Neural Networks and Deep Learning," Determination Press, 2015. 70 Evolving Architectures Prerequisite: Operating Systems, Computer Networks, DBMS, Algorithms L T P C Total hours: 42 3 0 0 3 Course Content Hrs Unit 1 Special, emerging and advanced topics in different areas of Computer Science and Engineering will be covered under this course. • Understand Taxonomy of new Architectures • Understand the Building Blocks of each architecture. • Install the Open -Source Tools • Study the State of the Art • Listen to an Expert (Academia / Industry) • Discuss Survey / Research Papers (Last 5 -7 years) • Case Studies of Tool or Simulator • Build some components for a Simple Model as assignment. 8 Unit 2 8 Unit 3 8 Unit 4 9 Unit 5 9 References 1. Research Papers from Journals and Conferences 2. Technical and Research Reports from Consortiums / Committees 3. Red Books, White Papers, Request For Comments (RFCs) 4. Manuals, Guides, Blogs 71 Malware Analysis Total Hours L T P C 42 3 0 0 3 Prerequisite: Fundamentals of Cryptography, Operating Systems, Computer Organization and Architecture, Data structures and algorithms, Programming Course Content Hrs Unit 1 Introduction: Introduction to malware, OS security concepts, malware threats, evolution of malware, malware types - viruses, worms, rootkits, trojans, bots, spyware, adwares, logic bombs, malware analysis, static malware

analysis, dynamic malware analysis. 8 Unit 2 Advanced Static Analysis: x86 Architecture, Analyzing Windows programs, Portable executable file format, disassembling malicious executable programs. Anti-static analysis techniques - obfuscation, packing, metamorphism, polymorphism. 8 Unit 3 Advanced Dynamic Analysis: Debugging malware - ollydbg, windbg, setting virtual environments - sandboxes, emulators, hypervisors, virtual machines, live malware analysis, dead malware analysis, analyzing traces of malware - system - calls, api -calls, registries, network activities. Anti-dynamic analysis techniques - anti-vm, runtime -evasion techniques. 9 Unit 4 Malware Functionality: Downloaders, Backdoors, Credential Stealers, Persistence Mechanisms, Privilege Escalation, Covert malware launching - Launchers, Process Injection, Process Replacement, Hook Injection, Detours, APC Injection. 8 Unit 5 Malware Detection Techniques: Signature -based techniques: malware signatures, packed malware signature, metamorphic and polymorphic malware signature. Non-signature based techniques: similarity -based techniques, machine -learning methods, invariant -inferences. 9 References 1. Thabet, A., Kleymentov, A.: Mastering Malware Analysis: A Malware Analyst's Practical Guide to Combating Malicious Software, APT, Cybercrime, and IoT Attacks. 2. Bruce Dang, Alexandre Gazet, and Elias Bachaalany: Practical Reverse Engineering: x86, x64, ARM, Windows Kernel, Reversing Tools, and Obfuscation 3. Peter Szor : The Art of Computer Virus Research and Defense, Addison Wesley Professional. 4. Eric Filiol: Computer Viruses: from theory to applications , Springer. 5. Michael Sikorski and Andrew Honig: Practical Malware Analysis: The Hands -On Guide to Dissecting Malicious Software, No Starch Press 6. Christopher Elisan: Advanced Malware Analysis, McGraw -Hill Osborne Media. 7. Michael Hale Ligh, Andrew Case: The Art of Memory Forensics: Detecting Malware, Wiley. 8. Published articles from reputed Journals and Conferences. 72 Artificial Neural Networks Prerequisite: : L T P C Total hours: 42 3 0 0 3 Course Content Hrs Unit 1 Overview of Biological Neurons, Structure of biological neurons relevant to Artificial Neural Networks(ANNs), Fundamental Concepts of Artificial Neural Networks Models of ANNs; Feedforward & feedback networks; learning rules; Hebbian learning rule, perception learning rule, delta learning rule, Widrow -Hoff learning rule, correction learning rule, Winner -take all learning rule, etc. 8 Unit 2 Single layer Perception Classifier: Classification model, Features & Decision regions; training & classification using discrete perceptron, algorithm, single layer continuous perceptron networks for linearly separable classifications. 9 Unit 3 Multi -layer Feed forward Networks: Linearly non -separable pattern classification, Delta learning rule for multi -perceptron layer, Generalized delta learning rule, Error back -propagation training, learning factors, Examples. 10 Unit 4 Single layer feedback Networks: Basic Concepts, Hopfield networks, Training & Examples., Associative memories: Linear Association, Basic Concepts of recurrent Auto associative memory: retrieval algorithm, storage algorithm; Bidirectional associative memory, Architecture, Association encoding & decoding, Stability. 9 Unit 5 Self organizing networks: Unsupervised learning of clusters, winner -take-all learning, recall mode, Initialisation of weights, separability limitations, Learning Vector Quantization (LVQ ). Applications of Artificial Neural Network in various domains 6 References 1. S. Haykin, "Neural Networks and Learning Machine"s , 3rd Edition ,

Prentice -Hall , 2008 , ISBN No. 0131471392 2. Jacek M. Zurada, "Introduction to Artificial Neural Systems , Jaico Publishing House; First edition. 3. B Yegnanarayana , "Artificial neural networks", 1st ed., Prentice Hall of India P Ltd, 2005. 73 Nature Inspired Algorithms Prerequisite: Programming in C L T P C Total hours: 40 3 0 0 3 Course Content Hrs Unit 1 Introduction to Algorithms, Optimization, and Search for optimality, computational intelligence, Nature Inspired solutions and characteristic, Nature inspired Meta -heuristics and its brief history. 8 Unit 2 Analysis of Optimization Algorithms, Nature Inspired Algorithms, parameter Tuning and control Constrained and unconstrained optimizations, Random Walks and Optimizations, evolutionary strategies and Evolutionary Algorithms (EA), Simulated Annealing (SA) Algorithm and its behaviour, Genetic Algorithms(GA) - genetic operator, parameters, fitness functions, genetic programming and convergence analysis, GA variants 10 Unit 3 Swarm Intelligence optimization, Particle Swarm Optimization(PSO) Algorithm, Ant Colony Optimization (ACO) Algorithms, Artificial Bee Colony ACO) optimization algorithms, Cuckoo Search (CS) Algorithms, Intelligent Water Drop Algorithm (IWD), Bat Algorithms (BA), Firefly Algorithms(FA) 8 Unit 4 Applications of nature -inspired algorithm, machine learning using nature inspired algorithm, data clustering using NIA. 6 Unit 5 Parallel processing of NIA using Hadoop, Parallel data clustering using NIA. Multi -objective optimization and applications. 8 74 Parallelizing Compiler s Prerequisite: Compiler Design L T P C Total hours: 42 3 0 0 3 Course Content Hrs Unit 1 Introduction – Compilation for parallel machines and automatic detection of parallelism, structure of a parallelizing compiler. 8 Unit 2 Dependence Theory and Practice - Types of dependences, data and control dependencies, dependence analysis, direction vectors, loop carried and loop independent dependences, tests for data dependence and their applicability, construction of data dependence and control dependence graphs. 18 Unit 3 Parallel Code Generation - Automatic extraction of parallelism, representation of iteration spaces of nested loops, loop based transformations such as loop distribution, loop coalescing, loop interchange and cycle shrinking transformation. 8 Unit 4 Interprocedural Analysis and Optimization - aliasing information, summary data flow analysis, interprocedural constant propagation, interprocedural data dependence analysis and parallelization of call statements. 8 References 1. Randy Allen, Ken Kennedy: Optimizing compilers for modern architectures. Morgan Kaufmann. 2. Steven Muchnick : Advanced Compiler Design & Implementation, Morgan Kaufmann. 3. Hector, Ullman, Widom : Database System Implementation, Pearson. 75 VLSI Algorithms Prerequisite: Compiler Design L T P C Total hours: 42 3 0 0 3 Course Content Hrs Unit 1 Introduction of VLSI Technology, VLSI design cycle, design styles, basic Layout rules and circuit abstraction, introduction to standard Cell, Gate array, FPGA 8 Unit 2 Overview of basic graph algorithms, Graph algorithms for physical Design Partitioning: Classification of partitioning algorithms, Karnighan -Lin Algorithm, FM Algorithm, Ratio cut algorithm 18 Unit 3 Floor -planning: Rectangular dual graph approach of floor -planning, hierarchical tree based approach, Integer programming based floor planning. Placement: placement by simulated annealing and force directed method 8 Unit 4 Routing: classification of routing algorithms, Global routing: Maze routing algorithms, line probe algorithms, Steiner tree based algorithms, Detailed, Single layer and two

layer routing algorithms, routing in FPGAs

8 References

1. Naveed Shervawani, "Algorithms for VLSI physical Design Automation" III Ed Springer
2. Sarrafzadeh and Wong "An introduction to VLSI Physical design" MGH
3. Sze: VLSI Technology
4. Weste and Eshraghan, "Introduction to VLSI Design". Pearson Edu.
5. Sadiq M. Sait, Habib Youssef, "VLSI Physical Design Automation: Theory and Practice", World Scientific Publishing Company;
6. Cormen Leiserson, Rivest, "Introduction to Algorithms", Pearson Edu.

76 Wireless Security Total Hours L T P C 42 3 0 0 3

Prerequisite: Fundamentals of Computer Networks, Wireless Networks, Cryptography

Course Content

Hrs Unit 1 Introduction to Wireless Security, Overview of wireless networks, Wireless network architecture, Wireless network security goals and objectives, 6

Unit 2 Wireless Network Vulnerabilities and Threats, Wireless network security threats, Active and passive attacks, Wireless network vulnerabilities, Common attacks on wireless networks 8

Unit 3 Wireless Security Protocols: Wired Equivalent Privacy (WEP), Wi-Fi Protected Access (WPA), Wi-Fi Protected Access II (WPA2) 802.11i 10

Unit 4 Wireless Authentication and Encryption protocols: Password-based authentication, Certificate-based authentication, Secure Wireless Network Design, Secure wireless network design principles, Secure network configuration 10

Unit 5 Placement of access points and antennas, Site survey and signal analysis, Wireless Security Standards and Policies, Wireless network security standards, Wireless security policies and guidelines regulatory compliance, Wireless Security Management and Monitoring, Wireless network management, Wireless network monitoring and auditing, Incident response

8 References

1. "Hacking Exposed Wireless: Wireless Security Secrets & Solutions" by Johnny Cache, Vincent Liu, and Billy Rios (2nd Edition, 2010)
2. "802.11 Wireless Networks: Security and Analysis" by Alan Holt and Chi-Yu Huang (1st Edition, 2010)
3. "Wireless Network Security: A Beginner's Guide" by Tyler Wrightson (1st Edition, 2011)
4. "Wireshark for Security Professionals: Using Wireshark and the Metasploit Framework" by Jesse Bullock and Jeff T. Parker (1st Edition, 2017)
5. "Wireless Network Security: A Practical Approach to Securing Your Wi-Fi Network".

77 Wireless Networks

Prerequisite: : Computer Networks L T P C Total hours: 40 3 0 0 3

Course Content

Hrs Unit 1 Introduction to Wireless Networking ,History of wireless networks, Difference between Wireless and Fixed Telephone Networks, Development of Wireless Networks, Wireless Network Architecture, Benefits of Wireless Networks, Wireless Networking Applications Radio propagation models, Narrowband digital modulation and Coding under wireless fading environments. 8

Unit 2 Medium Access and Resource allocation Techniques: Basics of CDMA and OFDM, Randomized medium access - Unslotted and Slotted Aloha, IEEE 802.11 CSMA protocol, channel allocation in (TDMA/FDMA/CDMA) -based wireless networks under the protocol model. Wireless LANs: Technology, IEEE 802.11 Wireless LAN Standard, Radio based Wireless LANs, Wi-Fi, Wimax 8

Unit 3 Routing Layer: Introduction, Routing protocols - Routing, Dynamic source routing, Destination sequence distance vector, Overview ad-hoc routing protocols , Application - RFID, Bluetooth, Zigbee, NFC 8

Unit 4 TCP enhancements for wireless protocols - Traditional TCP: Congestion control, fast retransmit/fast recovery, Implications of mobility - Classical TCP improvements: Indirect TCP, Snooping TCP, Mobile TCP, Time out freezing, Selective

retransmission, Transaction oriented TCP - TCP over 3G wireless networks. 8 Unit 5 Emerging industry standards such as 4G Cellular – 4G features and challenges - Applications of 4G – 4G Technologies: Multicarrier Modulation, 5G, IEEE 802.11p, Cognitive Radio 8 References 1. William Stallings , Wireless Communications and Networks, Pearson Education, 2009 2. Jon W. Mark and W. Zhuang , Wireless Communications and Networking, Pearson Ed, 2009 3. Upena Dalal, Wireless Communication and Networks, Oxford publications, 2015 78 Pool 2: Electives: (3 -0-0 (Theory) + 0 -0-2 (Practical)) (Credits 4, Semesters 7/8) 1 Advanced Computer Networks 2 Advanced Computer Networks Lab 3 Advanced Database Systems 4 Advanced Database Systems Lab 5 Biometrics 6 Biometrics Lab 7 Computer Vision 8 Computer Vision Lab 9 Data Analytics 10 Data Analytics Lab 11 Data Mining 12 Data Mining Lab 13 Decentralized Learning 14 Decentralized Learning Lab 15 Embedded System Design 16 Embedded System Design Lab 17 Full Stack Development 18 Full Stack Development Lab 19 Information Retrieval 20 Information Retrieval Lab 21 Internet of Things (IoT) 22 Internet of Things (IoT) Lab 23 IoT based Robotics 24 IoT based Robotics Lab 25 Natural Language Processing 26 Natural Language Processing Lab 27 Program Analysis 28 Program Analysis Lab 29 Social Network Analysis 30 Social Network Analysis Lab 31 Software Testing 32 Software Testing Lab 33 Topics in Computing 34 Topics in Computing Lab 35 Topics in Operating System 36 Topics in Operating System Lab 79 Advanced Computer Networks Prerequisite: : Data communication, computer networks, etc. L T P C Total hours: 40 3 0 0 3 Course Content Hrs Unit - I Software Defined Network -1: Logically -Centralized Control, SDN Software Stack, Data -Plane Verification, Forwarding Table Verification, Debugging - Diagnosis, Measurement – Overview, APIs. 8 Unit - II Software Defined Networks - II: Resource Management, Device Heterogeneity, Scalability: Data -Plane, Control -lane Extending Data -Plane: OpenFlow++, SDN Applications: Data -center & Cloud & Wide -Area -Networks. 8 Unit - III Advances in Wireless Networks: Wireless networking: Bluetooth, 802.11 standards, Information theory, bandwidth, multiple access, Wireless Terahertz Networks, 5G and 6G communication, Intelligent Transportation Systems. 8 Unit - IV Emerging networking technologies -I: Host configuration and service discovery principles, Future routing architectures, IPv6 deployment scenarios and challenges, IPv6 transition/integration, Advanced IP multicast, including IPv6 multicast and SSM. 8 Unit - V Emerging networking technologies - II : Data centre networks , Delay -tolerant networking Future home network, architectures, IP network management and monitoring, Social Networks 8 References 1. Software Defined Networking by Thomas D Nadeau and Ken Gray. 2. Hagen S, (2006). IPv6 Essentials. 3. The course materials are mainly from the lecturing slides made and research papers from top conferences like SIGCOMM, MOBICOM, NSDI, MobiSys etc. 80 Advanced Computer Networks Lab Prerequisite: : The programming lab in C++, which means you need to be very comfortable with C++ and using standard debugging tools. L T P C Total hours: 36 0 0 2 2 Course Content Hrs The laboratory experiments conducted on various tools Lab 1 -3: Experiments on SDN using mininet, NS,etc Lab 3 -4: Experiments on Internet of things using NS3, Netsim, etc Lab 5 -9: Experiments on Wireless networks using NS3, Netsim, etc Lab 10 -12 : Experiments on 5G and beyond using NS3, Netsim, etc 36 References 1.

Software Defined Networking by Thomas D Nadeau and Ken Gray. 2. Hagen S, (2006). IPv6 Essentials. 3. The course materials are mainly from the lecturing slides and research papers from top conferences like SIGCOMM, MOBICOM, NSDI, MobiSys etc. 81 Advanced Database Systems Prerequisite: : Database Information Systems L T P C Total hours: 42 3 0 0 3 Course Content Hrs Unit 1 Query Processing and Optimization – Implementation of Database operations, External Sorting, Size Estimations, Equivalence Rules, Heuristic -based Optimization, Materialized Views, Incremental View Maintenance. 14 Unit 2 Transaction Processing and Implementation - Concurrency Control Protocols, Two-phase Lock Protocol and its variants, Deadlock Prevention and Detection schemes and implementation, Timestamp -based Ordering Protocol, Log -based Recovery Management. 12 Unit 3 Modern Database Systems - Database System Architectures, Distributed Database Systems, Parallel Databases, Times in Databases, Multimedia Databases. 8 Unit 4 Distributed Databases - Data Storage, Global Catalog, Distributed Transaction Processing, Two -Phase Commit Protocol, Distributed Query Processing. 8 References 1. Silberschatz , Korth, Sudarshan : Database System Concepts, McGraw Hill. 2. Elmasri and Navathe : Fundamentals of Database Systems, 3rd Edition, Addison Wesley. 3. Hector, Ullman, Widom : Database System Implementation, Pearson. 4. Ceri and Pelagatti : Distributed Databases – Principles and Systems, McGraw Hill. 82 Advanced Database Systems Lab Prerequisite: : Database Information Systems L T P C 0 0 2 1 Course Content 1. Programming exercises on Query Processing and Implementation of Database operations. 2. Programming exercises on Query Optimization – Cost-based and Heuristic -based Optimization. 3. Programming exercises on Transaction Processing. 4. Programming exercises on Concurrency Control Protocols. 5. Programming exercises on Log -based Recovery Management. 6. Programming exercises on Distributed Transaction Processing, and Distributed Query Processing. References 1. Silberschatz ,Korth , Sudarshan : Database System Concepts, McGraw Hill. 2. Elmasri and Navathe: Fundamentals of Database Systems, 3rd Edition, Addison Wesley. 3. Hector, Ullman, Widom: Database System Implementation, Pearson. 4. Ceri and Pelagatti: Distributed Databases – Principles and Systems, McGraw Hill. 83 Biometrics Prerequisite: : A basic knowledge of statistics, linear algebra, and programming is expected. L T P C Total hours: 42 3 0 0 3 Course Content Hrs Unit 1 Introduction: Person recognition, Biometric systems, Biometric functionalities, biometrics system errors, the design cycle of biometric systems 6 Unit 2 Fingerprint recognition: friction ridge patterns, finger print acquisition, feature extraction and matching, palm prints 8 Unit 3 Face recognition: image acquisitions, face detection, feature extraction and matching, handling pose, illumination and expression variations 8 Unit 4 Iris recognition: image acquisition, Iris segmentation, Iris normalization, Iris encoding and matching, Iris quality assessment techniques 6 Unit 5 Additional Biometric Traits: Ear, Gait, Hand geometry, Soft biometrics Multimometrics: sources of multiple evidence, fusion levels: sensor, feature, score, rank and decision level fusion 8 Unit 6 Security of biometric systems: adversary attacks, attacks at user interface, attacks on biometric processing, attacks on template database 6 References 1. Introduction to Biometrics, Anil K Jain Arun Ross, Springer 2. The Science of Biometrics, Ravindra Das, Springer 3. Practical



Biometrics, Julian Ashbourn, Springer 4. Introduction to Biometrics, Anil K Jain Arun Ross, Springer 84 Biometrics Lab Prerequisite: A basic knowledge of statistics, linear algebra, and programming is expected. L T P C 0 0 2 1 Course Content Familiarization with image processing toolbox, implementation of fingerprint recognition algorithms and systems, feature extraction and matching algorithms, design of face recognition systems, face detection, implementation of iris recognition systems, design of multimodal biometric system using fingerprint, face, speech, etc., fusion strategies, design of biometric system using other biometric traits (ear, gait, Hand geometry, etc.), Security of biometric systems, Mini project References 1. Introduction to Biometrics, Anil K Jain Arun Ross, Springer 2. The Science of Biometrics, Ravindra Das, Springer 3. Practical Biometrics, Julian Ashbourn, Springer 85 Computer Vision Prerequisite: Fundamental knowledge on image processing and machine learning, basics of linear algebra and calculus, and programming skills L T P C Total hours: 42 3 0 0 3 Course Content Hrs Unit 1 Introduction to Computer Vision: Applications of Computer Vision, Basic concepts of Digital Image Formation, Capture and Representation, Pixel Relationships, Linear Filtering, Correlation, Convolution, Image in Frequency Domain, Fourier Transform 8 Unit 2 Visual Features and Representation: Edge, Corner Detection, SIFT, SURF, HoG, LBP, GLCM, etc. Feature Matching, Bag -of-words, VLAD, RANSAC, Hough Transform, Image Pyramids, 2D Transformations 12 Unit 3 Machine Learning for Computer Vision: Basic stages in Machine Learning, Image classification, Object Detection, Semantic Segmentation Overview of Machine Learning Algorithms: Neural Networks, Support Vector Machine (SVM), Dimensionality Reduction Techniques 6 Unit 4 Convolutional Neural Networks (CNNs): Introduction to CNNs, Evolution of CNN Architectures, Visualization and Understanding CNN CNNs for Different Computer Vision Tasks: Recognition, Detection, Segmentation, and Activity Recognition 8 Unit 5 Deep Generative Models in Vision: GANs, VAEs, etc. Modern Approaches: Attention Models in Vision, Vision Transformer (ViT) 8 References 1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2010 2. Simon Prince, Computer Vision: Models, Learning, and Inference, 2012 3. Bishop, Christopher M, Pattern Recognition and Machine Learning, Springer, 2006 4. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, 2016 86 Computer Vision Lab Prerequisite: Fundamental knowledge on image processing, machine learning, and programming skills L T P C Total hours: 28 0 0 2 2 Course Content Hrs Unit 1 1. Familiarization with various computer vision tools 2. Basic operations on images and videos 3. Linear filtering and convolution 4. Implementation of different image transforms 8 Unit 2 1. Implementation of various feature descriptors (SIFT, SURF, HoG, LBP, GLCM, etc.) Edge Detection , Line Detection and Corner Detection 2. Edge detection , line detection and corner detection 3. Implementation of feature matching algorithms 10 Unit 3 1. Multi -layer Perceptrons, Backpropagation and its applications 2. Implementation of CNN architectures for various tasks such as classification, segmentation, object detection, etc., and transfer learning 3. Implementation of GAN and ViT models 4. Mini project 10 References: 1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2010 2. Bishop, Christopher M, Pattern Recognition and Machine Learning, Springer, 2006 3. Ian Goodfellow, Yoshua

Bengio, Aaron Courville, Deep Learning, 2016

87 Data Analytics Prerequisite: Basic understanding of probability and statistics, linear algebra and calculus. A basic knowledge of programming (preferably Python) is essential. L T P C Total hours: 42 3 0 0 3 Course Content Hrs Unit 1 Data Understanding and Preparation Introduction, Reading data from various sources, Data visualization, Distributions and summary statistics, Relationships among variables, Extent of Missing Data. Segmentation, Outlier detection, Automated Data Preparation , Combining data files, Aggregate Data, Duplicate Removal, Sampling DATA, Data Caching, Partitioning data, Missing Values Data : Gather, extract, analyse, and manipulate data to draw conclusions or insights. With algorithms and coding with dataset available 10 Unit 2 Introduction to Data Mining: Classification - Naïve Bayes, Clustering - K means , Model development & techniques Data Partitioning, Model selection, Model Development Techniques, 10 Unit 3 Neural networks, Decision trees, Logistic regression, Discriminant analysis, Support vector machine, Bayesian Networks, Linear Regression, Logistic Regression, Association rules.. 10 Unit 4 Model Evaluation and Deployment Introduction, Model Validation, Rule Induction Using CHAID, Automating Models for Categorical and Continuous targets, Comparing and Combining Models, Evaluation Charts for Model Comparison, Meta Level Modelling, Deploying Model, Assessing Model Performance, Updating a Model. Visualisation 10 References 1. Daniel T. Larose and Chantal D. Larose, Discovering Knowledge in Data: An Introduction to Data Mining, 2nd Edition, Wiley, 2014. ISBN: 978 -0-470-90874 -7 2. Recommended Reading: Foster Provost and Tom Fawcett, Data Science for Business: What You Need to Know About Data Mining and Data -Analytic Thinking, O'Reilly, 2013. ISBN: 978 -1- 449-36132 -7

88 Data Analytics Lab Prerequisite: Python programming basics L T P C Total hours: 28 0 0 2 2 Course Content Hrs Unit 1 Visualization: a. Find the data distributions using box and scatter plot. b. Find the outliers using plot. c. Plot the histogram, bar chart and pie chart on sample data 4 Unit 2 Descriptive statistics in R a. Write an R script to find basic descriptive statistics using summary b. Write an R script to find subset of dataset by using subset Reading and writing different types of datasets a. Reading different types of data sets (.txt, .csv) from web and disk and writing in file in specific disk location. b. Reading Excel data sheet in R. c. Reading XML dataset in R. 6 Unit 3 Descriptive statistics in R a. Write an R script to find basic descriptive statistics using summary b. Write an R script to find subset of dataset by using subset Apply multiple regressions, if data have a continuous independent variable. Apply on above dataset. 6 Unit 4 a. Install relevant package for classification. b. Choose classifier for classification problem. c. Evaluate the performance of classifier. 6 Unit 5 Installing Hadoop, PIG, Hive, Visualizing Big data sets, Applying Parallel machine learning models to handle large scale data. 6 References: 1. Wes McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, O'Reilly Media, 2017. 2. Joshua N. Milligan, Learning Tableau: Create effective data visualizations, build interactive visual analytics and transform your organization, Packt Publishing Limited, 2020. 3. Nathan Marz, James Warren: Big Data: Principles and best practices of scalable realtime data systems, 2020. 89 Data Mining Prerequisite: : L T P C Total hours: 42 3 0 0 3 Course Content Hrs Unit 1 Overview of the Data Mining and

Knowledge Discovery from Databases Process, Data Warehousing and OLAP, Data Preprocessing: Summary Data Structures, dimensionality Reduction 6 Unit 2 Association Rule Mining: Frequent Item set Mining Methods, Rule Generation, Interestingness Measures 6 Unit 3 Classification: Decision Trees, Instance Based, Support Vector Machines, Computational Learning Theory, Associative Classification 10 Unit 4 Clustering: Partitional, Hierarchical, Density Based, Grid Based, Advanced Methods 7 Unit 5 Sequence Mining Complex Data Mining 6 Unit 6 Web Mining: Information Retrieval, Link Analysis, Search Engines, Usage Analysis Data Mining Applications 7 References 1. 1. J. Han and M. Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann/Elsevier India, 3rd edition, 2011. 2. Ian H. Witten and Eibe Frank, Data Mining: Practical Machine Learning Tools and Techniques (Second Edition), Morgan Kaufmann, 2005, ISBN: 0 -12-088407 -0. 90 Data Mining Lab Prerequisite: L T P C Total hours: 28 0 0 2 2 Course Content Hrs Unit 1 Implementation of Data Pre-processing 4 Unit 2 Implementation of Association Rule Mining 4 Unit 3 Implementation of Decision Trees and Support Vector Machines 6 Unit 4 Implementation of Various Clustering Algorithms 8 Unit 5 Implementation of Sequence Mining Algorithms 2 Unit 6 Implementation of Web Mining Algorithms 4 References 1. 1. J. Han and M. Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann/Elsevier India, 3rd edition, 2011. 2. Ian H. Witten and Eibe Frank, Data Mining: Practical Machine Learning Tools and Techniques (Second Edition), Morgan Kaufmann, 2005, ISBN: 0 -12-088407 -0. 91 Decentralized Learning Prerequisite: Machine learning, deep learning, etc. L T P C Total hours: 40 3 0 0 3 Course Content Hrs Unit - I Challenges in Big Data and Traditional AI: Understanding nature of Big Data, Data privacy as a bottleneck, Impact of training Data and model bias, Model drift and performance degradation, FL as the main solution for a data problems. 4 Unit - II Introduction to Federated Learning: Understanding the current state of ML, Distributed Learning, Understanding of FL, FL system considerations, FL system architecture, Understanding of FL system flow: from initialization to continuous operations, Basics of secure aggregation, Different designs of FL (HFL, VFL, FTL, RFL). 8 Unit - III Systems and Frameworks : Statistical and Systems Heterogeneity, Statistical and Systems Heterogeneity, Variations of federated aggregations, Local Training and Scalability of Federated Learning Systems, Straggler Management, Systems Bias in Federated Learning, Frameworks of FL (FATE, Flower, Tensorflow Federated(TFF), OpenFL, PySyft) 11 Unit - IV Privacy and Security: Data Leakage in Federated Learning, Differential Privacy within Federated Systems, Approach for protecting against Data Leakage, Private Parameter aggregation for Federated Learning, Security and Robustness to Federated Learning, Dealing with Byzantine threats to neural network. 11 Unit - V Decentralized learning for communication systems and blockchain for DL 6 References 1. Federated Learning with Python: Design and Implement a Federated Learning System and Develop Applications Using Existing Frameworks, George Jeno, Kiyoshi Nakayama, Packt Publishing, Limited, 2022. 2. Federated Learning: A Comprehensive Overview of Methods and Applications, Heiko Ludwig, Nathalie Baracaldo, Springer Nature, 2022. 3. The course materials are mainly from the lecturing slides I've made and research papers from top conferences like NDISS, USNIX, SIGCOMM, MOBICOM, NSDI, MobiSys etc. 92

Decentralized learning Lab Prerequisite: : The programming lab in python and ML tools L T P C Total hours: 36 0 0 2 2 Course Content Hrs The laboratory experiments conducted on various tools Lab 1 -3: Develop and FL setup using IOT devices and a sever setup to design FL average or other. Lab 3 -4: Collaborative Learning experiments using FL Lab 5 -9: Experiments on Data Model poisoning Lab 10 -12 : Projects on Decentralized learning 36 References 1. Federated Learning with Python: Design and Implement a Federated Learning System and Develop Applications Using Existing Frameworks, George Jeno, Kiyoshi Nakayama, Packt Publishing, Limited, 2022. 2. Federated Learning: A Comprehensive Overview of Methods and Applications, Heiko Ludwig, Nathalie Baracaldo, Springer Nature, 2022. 3. The course materials are mainly from the lecturing slides I?ve made and research papers from top conferences like NDISS, USNIX, SIGCOMM, MOBICOM, NSDI, MobiSys etc. 93 Embedded System Design Prerequisite: Compiler Design L T P C Total hours: 42 3 0 0 3 Course Content Hrs Unit 1 Introduction to embedded systems., design representations, level of abstractions, design methodologies. Models and architectures, Taxonomy of models and architectures 8 Unit 2 Brief descriptions of specification languages, Specification requirement for embedded systems, Spec Chart and Spec Chart Description. Design challenges & issues, hardware and software design, co -design of software and hardware, ASIC 18 Unit 3 Design quality estimation: Quality matrix, software and hardware estimation. 8 Unit 4 Microcontroller 8051: Architecture, programming , interfacing and use cases, Instruction addressing modes, Interrupts, Counters and timers. Introduction to the ARM processors. 8 References 1. Embedded Systems: Real -Time Operating Systems for Arm Cortex -M Microcontrollers" by Jonathan Valvano 2. Embedded Systems: Design and Applications with the 68HC12 and HCS12" by Steven Barrett and Daniel Pack 3. Embedded Systems: A Contemporary Design Tool" by James K. Peckol

94 Embedded System Design Lab Prerequisite: Digital Logic Design L T P C Total hours: 28 0 0 2 2 Course Content Hrs Unit 1 Proteus Introduction: Introduce students to the basic circuit simulations and simulator user interface of Proteus. LED Blinking: Design a simple embedded system using a microcontroller to blink set of LEDs at the specific patterns. Vary the blinking pattern and observe the LEDs behaviour . LCD Display: Write programs in the C programming language to initialize the 16x2 LCD and display the message. The messages to displayed are defined in the code. 8 Unit 2 Keypad Interfacing: Design the hex keypad using push button then displayed the pressed key on the LCD. Next use the predefined he keypad module to implement simple calculator. Seven Segment Display: design the seven segment display using LEDs. Use predefined seven segment module and interface it with hex keypad to display the pressed digit on the display. Digital Counter: Design four digit increment and decrement digital counter using a microcontroller and display the count on a 7 -segment display. 10 Unit 3 Elevator Movement: Design the program to simulate the movement of elevator and display the floor numbers when keys are pressed inside the elevators or it moves. Quiz Buzzer: Design a quiz buzzer system that will act as the central controller for the quiz system, managing participant buzzers and increment the counter for the team who press the buzzer button first. Date & Time: D esign an

embedded system to display the current date and time on an LCD (Liquid Crystal Display) using a Real -Time Clock (RTC) module. 10

References: 1. Embedded Systems: Real -Time Operating Systems for Arm Cortex -M Microcontrollers" by Jonathan Valvano 2. Embedded Systems: A Contemporary Design Tool" by James K. Peckol 95 Full Stack Development Prerequisite: L T P C Total Hours : 42 3 0 0 3

Course Content Hrs Unit 1 Introduction to Full Stack Development: Overview of full stack development, roles and responsibilities of a full stack developer, Understanding the client -server architecture. Front -End Development Fundamentals: Introduction to HTML5, CSS3, JavaScript, jQuery, Bootstrap. Building web pages with styling, programming concepts, and syntax. DOM manipulation and event handling. Introduction to responsive design and mobile -first development. 10

Unit 2 Front -End Frameworks: Introduction to popular front -end frameworks (e.g., React, Angular, Vue.js). Building dynamic and interactive web applications using a framework of choice Components, state management, and routing in front -end frameworks. Working with APIs to fetch and update data Handling, form input and validation. 10

Unit 3 Back -End Development Fundamentals: Introduction to server -side programming languages (e.g., PHP, Node.js, Python), Working with HTTP protocols and RESTful APIs, Handling data persistence with databases (SQL or NoSQL - MongoDB, Cassandra), Creating server -side routes and handling requests, Implementing user authentication and authorization. 8

Unit 4 Back -End Frameworks and APIs: Building server -side applications using a framework (e.g., Express, Django), Implementing APIs for data retrieval and manipulation, Database integration and querying, Securing APIs and implementing access control. Full Stack Frameworks: MEAN Stack (MongoDB, Express.js, Angular, Node.js), MERN Stack (MongoDB, Express.js, React, Node.js), LAMP Stack (Linux, Apache, MySQL, PHP). 8

Unit 5 Deployment and DevOps: Introduction to cloud platforms and hosting providers, Deploying web applications to cloud platforms, Continuous integration and deployment (CI/CD), Version control systems (e.g., Git) and collaboration tools. 6

References 1. "Full Stack JavaScript Development with MEAN" by Adam Bretz, Colin J. Ihrig, and Patrick Mulder (Publisher: Manning Publications, 2016) 2. "Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node" by Vasan Subramanian (Publisher: Apress, 2019) 3. "Full Stack Development for Beginners: Learn React, Node.js, MongoDB, and TypeScript" by Jonas Fehre (Publisher: Packt Publishing, 2021) 4. "Learning Web Design: A Beginner's Guide to HTML, CSS, JavaScript, and Web Graphics" by Jennifer Niederst Robbins (Publisher: O'Reilly Media, 2018) 96 5. "MongoDB: The Definitive Guide: Powerful and Scalable Data Storage" by Kristina Chodorow (Publisher: O'Reilly Media, 2013) 6. "JavaScript and jQuery: Interactive Front -End Web Development" by Jon Duckett (Publisher: Wiley, 2014) 7. "PHP and MySQL for Dynamic Web Sites: Visual QuickPro Guide" by Larry Ullman (Publisher: Peachpit Press, 2017) 8. "Bootstrap 4 Quick Start: A Beginner's Guide to Building Responsive Layouts with Bootstrap 4" by Jacob Lett (Publisher: Packt Publishing, 2018) 97 Full Stack Development Lab Prerequisite: . L T P C Hrs: 28 0 0 2 2 Course Content Hrs Unit 1 Creation of basic web pages/applications using HTML and CSS. Write JavaScript code to create interactive elements on a webpage, such as buttons, forms, and event handling. Use server -side

languages like Node.js, Python (with Flask/Django), or Ruby (with Ruby on Rails) to create a basic web application. Integrate a database (e.g., MySQL, PostgreSQL, MongoDB) with your web application to store and retrieve data. Implement user registration and login functionality using authentication techniques such as JWT (JSON Web Tokens) or OAuth. Create a RESTful API that allows users to perform CRUD (Create, Read, Update, Delete) operations on resources.

10 Unit 2 Use popular front -end frameworks like React, Angular, or Vue.js to build more dynamic and interactive web applications. Build a single -page application that communicates with the backend through APIs and updates the UI without full page reloads. Implement state management in your front -end application using tools like Redux or Vuex. Ensure your web application looks and functions well on different devices and screen sizes. Write unit tests for your code and debug common issues in both the front -end and back -end.

10 Unit 3 Deployment and Hosting: Deploy your full -stack application to a cloud platform (e.g., AWS, Azure, Heroku) and make it publicly accessible. Version Control: Use Git for version control to manage changes to your codebase effectively. Real-time Features: Integrate real -time communication features using technologies like WebSockets or WebRTC. Security Considerations: Implement security best practices to protect your application from common web vulnerabilities (e.g., Cross -Site Scripting, SQL Injection).

8 References

1. "Full Stack JavaScript Development with MEAN" by Adam Bretz, Colin J. Ihrig, and Patrick Mulder (Publisher: Manning Publications, 2016)
2. "Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node" by Vasani Subramanian (Publisher: Apress, 2019)
3. "Full Stack Development for Beginners: Learn React, Node.js, MongoDB, and TypeScript" by Jonas Fehre (Publisher: Packt Publishing, 2021)
4. "Learning Web Design: A Beginner's Guide to HTML, CSS, JavaScript, and Web Graphics" by Jennifer Niederst Robbins (Publisher: O'Reilly Media, 2018)
5. "MongoDB: The Definitive Guide: Powerful and Scalable Data Storage" by Kristina Chodorow (Publisher: O'Reilly Media, 2013)
6. "JavaScript and jQuery: Interactive Front -End Web Development" by Jon Duckett (Publisher: Wiley, 2014)
7. "PHP and MySQL for Dynamic Web Sites: Visual QuickPro Guide" by Larry Ullman (Publisher: Peachpit Press, 2017)
8. "Bootstrap 4 Quick Start: A Beginner's Guide to Building Responsive Layouts with Bootstrap 4" by Jacob Lett (Publisher: Packt Publishing, 2018)

99 Information Retrieval Prerequisite: nil L T P C Total hours: 40 3 0 0 3 Course Content Hrs

Unit 1 Introduction: Goals and history of IR. The impact of the web on IR. Basic IR Models: Boolean and vector -space retrieval models; ranked retrieval; text -similarity metrics; TF -IDF (term frequency/inverse document frequency) weighting; cosine similarity. Basic Tokenizing, Indexing, and Implementation of Vector -Space Retrieval: Simple tokenizing, stop-word removal, and stemming; inverted indices; efficient processing with sparse vectors;

8 Unit 2 Performance metrics: recall, precision, F -measure, and NDCG; Evaluations on benchmark text collections. Query Operations: Relevance feedback; Query expansion. Text Representation: Word statistics; Zipf's law; Porter stemmer; morphology; index term selection; using thesauri.

8 Unit 3 Web Search: Search engines; spidering; meta -crawlers; directed spidering; link analysis , HITS, hubs and authorities, Google PageRank); Text Categorization: Categorization algorithms: Rocchio, nearest neighbor

8 Unit 4 Text

Classification :Language -Model Based Retrieval : Using naive Bayes text classification for ad hoc retrieval. Improved smoothing for document retrieval. Text Clustering: Clustering algorithms: agglomerative clustering; k -means; expectation maximization (EM). Applications to web search and information organization. Recommender Systems: Read this paper by Herlocker et al. Collaborative filtering and content -based recommendation of documents and products. 8 Unit 5 Recommender Systems: Collaborative filtering and content -based recommendation of documents and products. Ethical Issues in IR: Privacy, Fairness, Fake news and disinformation, Filter bubble, Viewpoint diversity, fostering extremism, Internet addiction. Information Extraction and Integration: Extracting data from text; semantic web; collecting and integrating specialized information on the web. Question Answering: Semantic parsing. Question Answering from structured data and text. Deep Learning for IR: Word embeddings. Neural language models. 8 References 1. Modern Information Retrieval, Ricardo Baeza -Yates and Berthier Ribeiro -Neto, Addison - Wesley, 2000. <http://people.ischool.berkeley.edu/~hearst/irbook/> 2. Information Retrieval: Implementing and Evaluating Search Engines by S. Buttcher, C. Clarke and G. Cormack, MIT Press, 2010. 3. Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data by B. Liu, Springer, Second Edition, 2011. 4. Cross -Language Information Retrieval by By Jian -Yun Nie Morgan & Claypool Publisher series 2010 5. Multimedia Information Retrieval by Stefan M. R ger Morgan & Claypool Publisher series 2010. 6 Ricci, F.; Rokach, L.; Shapira, B.; Kantor, P.B. (Eds.), Recommender Systems Handbook. 1st Edition., 2011, 845 p. 20 illus., HarPCover, ISBN: 978 -0-387-85819 -7, Relevant Research Papers 100 Information Retrieval Lab L T P C Total hours: 28 0 0 2 2 Course Content Hrs Assignment 1 Pre-processing of a Text Document: Stop word removal, Stemmer, Lemmatizer, Cosine -Similarity Measure using TF -IDF 4 Assignment 2 Document similarity using Boolean Model / Extended Boolean Model / Vector Space Model 4 Assignment 3 Inverted Index and postings 2 Assignment 4 Simple web crawler 2 Assignment 5 Terrier search engine 4 Assignment 6 Parse XML text, generate Web graph and compute topic specific page rank - Page Rank Algorithm 4 Assignment 7 Mining Flipkart review and perform sentiment analysis based on both review and ratings. 4 Assignment 8 Perform movie recommendation system by scrapping real -time movie rating from imdb website. 4 References: 1. <https://www.analyticsvidhya.com/blog/2021/09/essential-text-pre-processing-techniques-for-nlp/> <https://www.kaggle.com/code/sudalairajkumar/getting-started-with-text-preprocessing> 2. <https://minoli110.medium.com/use-of-vector-space-model-vsm-to-calculate-the-similarity-between-2-text-documents-3dfb31138fc2> <https://github.com/manan-paneri-99/Vector-Space-based-Document-Retrieval-system> <https://www.geeksforgeeks.org/document-retrieval-using-boolean-model-and-vector-space-model/> 3. [https://medium.com/@fro\\_g/writing-a-simple-inverted-index-in-python-3c8bcb52169a](https://medium.com/@fro_g/writing-a-simple-inverted-index-in-python-3c8bcb52169a) <https://towardsdatascience.com/using-inverted-index-for-efficient-document-similarity-computation-a8d3fb8f0c12> 4. <https://towardsdatascience.com/web-scraping-with-scrapy-8071fd627051> <https://towardsdatascience.com/https-towardsdatascience-com-5-tips-to-create-a-more-reliable-web-crawler-3efb6878f8db> 5.

<http://terrier.org/docs/v2.2.1/index.html> <https://github.com/terrier> -org/terrier -core 6.  
<https://www.geeksforgeeks.org/xml> -parsing -python/  
<https://towardsdatascience.com/pagerank> -3c568a7d2332 7.  
<https://www.analyticsvidhya.com/blog/2022/09/sentiment> -analysis -on-flipkart  
 -dataset/ <https://machinelearningprojects.net/flipkart> -reviews -extraction  
 -and-sentiment -analysis/ 8. <https://www.geeksforgeeks.org/scrape> -imdb -movie  
 -rating -and-details -using -python/ <https://janineb.medium.com/movie>  
 -recommendation -system -d6aa8583cdb 101 Internet of Things Prerequisite: Nil L T  
 P C Total hours: 42 3 0 0 3 Course Content Hrs Unit 1 Introduction: Internet of Things  
 and Connected Products, IoT paradigm, Smart objects, Goal orientation,  
 Convergence of technologies; Business Aspects of the Internet of Things. IoT  
 Architectures and Protocols: Importance, Communication models in IoT, Layer s in  
 IoT architecture, Role of protocols in IoT communication. 6 Unit 2 Wireless  
 Technologies for IoT: Wi -Fi and 802.15.x family - features, range, power  
 consumption; Zigbee: Network topology, mesh networking, Zigbee stack, LoRaWAN,  
 SigFox, Cellular technologies for IoT (2G, 3G, 4G, NB -IoT, 5G). Latest developments  
 in communication technologies. 8 Unit 3 IoT Network Topologies: Overview (star,  
 mesh, hybrid, etc.), selection based on advantages and limitations. Network  
 Protocols: overview of IoT network protocols. IPv6 and its significance in IoT  
 addressing, 6LoWPAN - IPv6 over Low-power Wireless Personal Area Networks,  
 Header Compression. RPL - overview and operation, Case studies of network  
 protocols in IoT deployments. 10 Unit 4 IoT Application Protocols: Introduction  
 (MQTT, CoAP, HTTP, etc.), Comparison of IoT protocols (features, performance,  
 scalability), MQTT - Concepts, message structure, QoS levels, CoAP - Principles,  
 RESTful architecture, resource discovery, HTTP in IoT - Web services, REST APIs,  
 JSON/XML data formats. Data: OMA Lightweight M2M (LwM2M) protocol, OPC  
 Unified Architecture (OPC UA), BACnet, Modbus. Data Protocols and Formats: IoT  
 data formats (JSON, XML, CBOR, Protocol Buffers) . IoT Standards and  
 Interoperability 10 Unit 5 IoT Security Protocols: Security challenges and threats in  
 IoT, Secure communication protocols for IoT (DTLS, TLS, IPsec), Authentication and  
 access control in IoT, Security protocols for device management and firmware  
 updates, Privacy protection and data encryption in IoT. 4 Unit 6 Emerging Trends:  
 Blockchain, 5G and its impact, IoT and edge -cloud integration, latest advancements  
 in IoT architectures and protocols. 4 References 1. The Internet of Things: Key  
 Applications and Protocols, David Boswarthick, Olivier Hersent, and Omar Elloumi,  
 Wiley. 2. Building the Internet of Things with IPv6 and MIPv6, Daniel Minoli, Wiley. 3.  
 Architecting the Internet of Things, Dieter Uckelmann, Mark Harrison, and Florian  
 Michahelles, Springer. 4. Latest research articles. 102 Internet of Things Lab  
 Prerequisite: L T P C Total hours: 28 0 0 2 1 Course Content Hrs Unit 1 Setting up  
 communication using XBEE and BLE. Data Exchange and interfacing Sensors 8 Unit  
 2 Programming on Cooja and CoAP Setting up CoAP on programmable boards. 10  
 Unit 3 Using CoAP to set up communication. Implementation of homogeneous and  
 heterogeneous networks. Data processing on application layer. 10 References: 1.  
 Building the Internet of Things with IPv6 and MIPv6, Daniel Minoli, Wiley. 2.  
 Architecting the Internet of Things, Dieter Uckelmann, Mark Harrison, and Florian



Michahelles, Springer. 3. Latest research articles. 103 IoT based Robotics  
 Prerequisite: Nil L T P C Total hours: 42 3 0 0 3 Course Content Hrs Unit 1  
 Introduction to IoT and Robotics: Overview of IoT and Robotics; Historical  
 development of IoT and Robotics; Applications of IoT and Robotics; Types of IoT  
 devices; Types of Robotics; 6 Unit 2 Introduction to the Internet of Things. Protocols  
 and Architectures. IoT Hardware: IoT devices and sensors; IoT networks and  
 communication protocols; IoT gateways and controllers; IoT platforms and services 10  
 Unit 3 IoT Software: Introduction to IoT protocols; IoT data management and  
 analytics; IoT security and privacy; IoT programming and development; 8 Unit 4  
 Robotics Fundamentals: Robotics history and evolution; Robotics components and  
 structure. Robotics Hardware: Types of robots and their applications; Robotics  
 sensors and actuators; Robotics control systems; Robotics power systems. Robotics  
 Software: Robotics programming and development; Robotics motion planning and  
 control; Robotics perception and vision; Robotics intelligence and autonomy. 10 Unit 5  
 Robotics Applications: Industrial Robotics; Service Robotics; Medical Robotics 4 Unit  
 6 IoT and Robotics Integration: Use cases and examples; Challenges and  
 opportunities; Future trends and directions 4 References 1. The Internet of Things:  
 Key Applications and Protocols, David Boswarthick, Olivier Hersent, and Omar  
 Elloumi, Wiley 2. Building the Internet of Things with IPv6 and MIPv6, Daniel Minoli,  
 Wiley 3. Learn Robotics Programming, Danny Staple, Packt Publishing, 2nd ed. 4.  
 Robotics Simplified, Jisu Elsa Jacob and Manjunath N, BPB Publications. 104 IoT  
 based Robotics Lab Prerequisite: L T P C Total hours: 28 0 0 2 1 Course Content Hrs  
 Unit 1 Setting up communication using XBEE and BLE. Data Exchange and  
 interfacing Sensors 8 Unit 2 Interfacing with Actuators. Programming Motion and  
 automation. Controller based interfacing. 10 Unit 3 Visual interfacing and controlling  
 motion. Analysis of robotic arm and conveyor belts. 10 References: 1. Learn Robotics  
 Programming, Danny Staple, Packt Publishing, 2nd ed. 2. Robotics Simplified, Jisu  
 Elsa Jacob and Manjunath N, BPB Publications. 105 Natural Language Processing  
 Prerequisite: L T P C Total hours: 42 3 0 0 3 Course Content Hrs Unit 1 Introduction to  
 NLP - Various stages of NLP –The Ambiguity of Language: Why NLP Is Difficult Parts  
 of Speech: Nouns and Pronouns, Words: Determiners and adjectives, verbs, Phrase  
 Structure. Statistics Essential Information Theory : Entropy, perplexity, The relation to  
 language, Cross Entropy, Character Encoding, Word Segmentation, Sentence  
 Segmentation, Introduction to Corpora, Corpora Analysis. Inflectional and Derivation  
 Morphology, Morphological analysis and generation using Finite State Automata and  
 Finite State transducer. 6 Unit 2 Language Modelling, Words: Collocations -  
 Frequency -Mean and Variance –Hypothesis testing: The t test, Hypothesis testing of  
 differences, Pearson's chi -square test, Likelihood ratios. Statistical Inference: n  
 –gram Models over Sparse Data: Bins: Forming Equivalence Classes - N gram model  
 – Statistical Estimators - Combining Estimators 6 Unit 3 Word Sense Disambiguation,  
 Methodological Preliminaries, Supervised Disambiguation: Bayesian classification, An  
 informationtheoretic approach, Dictionary - Based Disambiguation: Disambiguation  
 based on sense, Thesaurusbased disambiguation, Disambiguation based on  
 translations in a second -language corpus. 6 Unit 4 Markov Model: Hidden Markov  
 model, Fundamentals, Probability of properties, Parameter estimation, Variants,

Multiple input observation. The Information Sources in Tagging: Markov model taggers, Viterbi algorithm, Applying HMMs to POS tagging, Applications of Tagging 6 Unit 5 Parsing, The Probability of a String, Problems with the Inside -Outside Algorithm, Parsing for disambiguation, Treebanks, Parsing models vs. language models, Phrase structure grammars and dependency, Lexicalized models using derivational histories, Dependency -based models. 8 Unit 5 Shallow Parsing and Chunking, Shallow Parsing with Conditional Random Fields (CRF), Lexical Semantics, WordNet, Thematic Roles, Semantic Role Labelling with CRFs. Statistical Alignment and Machine Translation, Text alignment, Word alignment, Information extraction, Text mining, Information Retrieval, NL interfaces, Sentimental Analysis, Question Answering Systems, Social network analysis, Text Summarization. 10 References 1. D. Jurafsky, J.H. Martin, Speech and Language Processing, 3rd Online Edition (available at <https://web.stanford.edu/~jurafsky/slp3/>). 2. J. Eisenstein, Introduction to Natural Language Processing, MIT Press, 2019. 106 Natural Language Processing Lab Prerequisite: L T P C Total hours: 28 0 0 2 2 Course Content Hrs Unit 1 Implementation of Pre -processing of Text (Tokenization, Stop word Removal, Stemming and Lemmatization etc.) and Morphological Analysis 6 Unit 2 Implementation of N -gram Models 4 Unit 3 Implementation of Word Sense Disambiguation 2 Unit 4 Implementation of POS Tagging and Named Entity Recognition 6 Unit 5 Implementation of CKY Parsing and Mini Project 10 References 1. D. Jurafsky, J.H. Martin, Speech and Language Processing, 3rd Online Edition (available at <https://web.stanford.edu/~jurafsky/slp3/>). 2. J. Eisenstein, Introduction to Natural Language Processing, MIT Press, 2019. 107 Program Analysis Prerequisite: Operating system, Computer Architecture and organization L T P C Total Hours: 42 3 0 0 3 Course Content Hrs Unit 1 Structure of a program, data flow and control flow, basic blocks, forward and backward flow analysis; Program Analysis Tools: debuggers, disassemblers, decompilers, emulators, virtualized environments 8 Unit 2 Dataflow Analyses and Transformations; Control Dependence Graph, Inter -procedural analysis, Program Analysis via Graph Reachability 8 Unit 3 Program Analysis Techniques: Static analysis, Dynamic analysis, Instrumentation, Hybrid analysis, Automatic Generation of High -Coverage Tests for Complex Systems Programs, Input fuzzing, 8 Unit 4 Control -flow analysis; Abstract interpretation; Symbolic execution and program testing, Mixing type checking and symbolic execution; Model checking 8 Unit 5 Case Study: C, JAVA, .apk, .elf for program analysis 10 References 1. Nielson, Nielson, and Hankin: Principles of Program Analysis, Springer. 2. Ravi Sethi, Alfred V. Aho, Monica S. Lam, D. Jeffrey Ulman: Compilers : Principles, Techniques, & Tools, 2nd Edition, Pearson 3. Muchnick: Advanced Compiler Design and Implementation, Morgan Kaufmann. 4. Published articles from reputed Journals and Conferences. 5. "Program Analysis and Compilation: Theory and Practice" by Thomas Reps, Mooly Sagiv, and J. Lim. (Year: 1997, Publisher: MIT Press) 6. "Program Analysis for Software Tools and Engineering" by Thomas Reps. (Year: 2007, Publisher: Springer) 7. "Data Flow Analysis: Theory and Practice" by Uday P. Khedker. (Year: 2015, Publisher: CRC Press) 8. "Formal Methods for Software Verification" by Grigore Rosu and Klaus Havelund. (Year: 2018, Publisher: CRC Press) 108 Program Analysis Lab

Prerequisite: L T P C Total hours: 28 0 0 2 1 Course Content Hrs. Unit 1

- 1) Analyze the program to identify any potential code optimization opportunities.
  - a) Write a program that contains multiple nested conditional statements (if, else if, else).
  - b) Use Egypt tool to create a flow graph of this program. Visualize the graph using Graphviz and SVG.
- 2) Design and implement a control flow analysis for detecting potential null pointer dereferences in each C/C++ codebase using the "Clang Static Analyzer" tool.
  - a) Choose a C/C++ codebase (your project or open -source project) with multiple occurrences of pointer usages and potential null pointer dereferences. Use the "Clang Static Analyzer" to perform control flow analysis on the selected codebase.
  - b) Identify expressions or code paths where the "Clang Static Analyzer" detects potential null pointer dereferences.
  - c) Note the location of potential null pointer dereferences identified by the tool.
- 3) Implement dynamic program analysis techniques to look for the pointers and array during runtime.
  - a) Generate a program flow during runtime using dynamic binary analysis tool.
  - b) Note the location of pointers and array identified by the tool.
- 4) Implement program analysis using emulators.
  - a) Write a simple C program that simulates a basic calculator.
  - b) Choose a suitable emulator tool (e.g., QEMU, Bochs, VirtualBox, etc.) and install it on your machine.
  - c) Compile the C program for the target architecture compatible with the emulator environment.
  - d) Run the program within the emulator environment.
  - e) Use the emulator's debugging and monitoring features to analyse the program's execution.
  - f) Find out the entry point of the program.
  - g) Trace the flow of the program execution, including function calls and return statements, using the emulator's tracing features.
- 5) Perform backward flow analysis using cflow to identify reaching definitions for each variable. Determine which assignments may influence the value of a variable at a particular point in the program.
  - a) Write a C program that includes assignments to variables and multiple points where variables are used and modified.
  - b) Execute the C program with cflow to perform backward flow analysis.
  - c) Observe the output generated by cflow, which represents the reaching definitions for each variable at different points in the program.
  - d) Identify and list the assignments that may influence the value of a variable at a particular point in the program.
- 6) Implement binary structure analysis on a compiled executable.
  - a) Choose a compiled binary your project or open -source binary.
  - b) Select the tool for examining ELF file.
  - c) Use the selected tool to analyse the binary and identify the number of registers used by the program.
  - d) Determine the entry point of the binary using the selected tool. The entry point is where the program's execution begins.
  - e) Examine the various sections of the binary (code section, data section, symbol table).
- 7) Implement a C program that takes input from users or external sources. Use fuzz testing tools to generate random or invalid inputs and analyse how the program handles such inputs.
  - a) Write the C code for the program that takes input from users or external sources.
  - b) Choose a fuzz testing tool (e.g., American Fuzzy Lop (AFL), libFuzzer) and install it on your system.
  - c) Modify the C program to accept input from the fuzz testing tool rather than traditional user input.
  - d) Execute the fuzz testing tool with the modified C program as the target.
  - e) Monitor the C program's behavior during the fuzz testing process. Identify any crashes, exceptions, or unexpected outputs.
  - f) Examine the logs or reports generated by the fuzz testing tool after the testing process.
- 8) Write a C program with several functions and use cflow to generate the function call

graph. Identify the functions that have the most dependencies (incoming and outgoing calls) and assess their importance in the program. Consider how reducing dependencies could improve code maintainability. a) Write a C program with several functions that demonstrate function call interactions. b) Use cflow to generate the function call graph for the C program. c) Visualize the call graph to analyse the relationships between functions. d) Find out the high control dependencies in the program.

References: 1. Nielson, Nielson, and Hankin: Principles of Program Analysis, Springer. 2. Ravi Sethi, Alfred V. Aho, Monica S. Lam, D. Jeffrey Ulman: Compilers : Principles, Techniques, & Tools, 2nd Edition, Pearson 3. Muchnick: Advanced Compiler Design and Implementation, Morgan Kaufmann. 4. Published articles from reputed Journals and Conferences. 5. "Program Analysis and Compilation: Theory and Practice" by Thomas Reps, Mooly Sagiv, and J. Lim. (Year: 1997, Publisher: MIT Press) 6. "Program Analysis for Software Tools and Engineering" by Thomas Reps. (Year: 2007, Publisher: Springer) 7. "Data Flow Analysis: Theory and Practice" by Uday P. Khedker. (Year: 2015, Publisher: CRC Press) 8. "Formal Methods for Software Verification" by Grigore Rosu and Klaus Havelund. (Year: 2018, Publisher: CRC Press)

110 Social Network Analysis Prerequisite: Data Structures and Algorithms L T P C Total hours: 42 3 0 0 3 Course Content Hrs Unit 1 Basics of Graph Theory: Basic definitions of graphs and multigraphs; adjacency matrices, independent sets and cliques, vertex colouring, chromatic number, matching, vertex cover, edge cover, independent set, cut -set, spanning trees. 8 Unit 2 Network Models: Properties of Real -World Networks: Degree Distribution, Clustering Coefficient, Average Path Length. Random Graphs, Small -World Model, Preferential Attachment Model, Modeling of Real -World Networks using Random Graphs, Small -World Model and Preferential Attachment Model 8 Unit 3 Network Centrality: Degree Centrality, Eigenvector Centrality, PageRank, Centrality, Closeness Centrality. 4 Unit 4 Basics of Deep Learning: Basic terminologies, Artificial Neural Networks (ANN) and their limitations, Convolution Neural Networks (CNNs), Limitations of CNNs on graph data 6 Unit 5 Deep Learning on Graphs: Theory of Graph Neural Networks (GNNs) (Graph Convolution Network (GCN), Graph Attention Network (GAT) and GraphSAGE), Semi supervised Node classification using GNNs, Real life applications of GNNs (including Google Maps, Pinterest ) 8 Unit 6 Applications of Graph Neural Networks for Network Analysis: Node classification, Link Prediction, Recommendations, Community Detection, MRI analysis, NLP related applications. 8

References 1. Social media mining: an introduction, Zafarani, Reza, Mohammad Ali Abbasi, and Huan Liu. Cambridge University Press, 2014. 2. Networks, Crowds, and Markets: Reasoning About a Highly Connected World by David Easley and Jon Kleinberg, Cambridge University Press. 3. Networks: An introduction by Mark Newman, Oxford university press, 2018. 4. Graph Representation Learning by William L. Hamilton, 2020.

111 Social Network Analysis Lab Prerequisite: Data Structures and Algorithms L T P C Total hours: 28 0 0 2 1 Course Content Hrs Unit 1 Graph Representation and Analysis: • Constructing adjacency matrices for given graphs and multigraphs. • Identifying independent sets and cliques in a network. • Investigating the chromatic number and vertex coloring of a graph. • Finding matching, vertex cover, and edge cover in various graphs. • Analyzing cut -sets and spanning trees in a network. 4 Unit

2 Real-World Network Properties: • Analyzing degree distributions in real -world networks. • Calculating clustering coefficients and average path lengths of networks. • Generating random graphs using different algorithms (e.g., Erdős -Rényi model). • Simulating small -world networks and comparing them with real -world networks. • Building networks based on preferential attachment and studying their properties. 4

Unit 3 Network Centrality Analysis: • Calculating degree centrality for nodes in a given network. • Implementing eigenvector centrality and PageRank algorithms. • Comparing different centrality measures and their outcomes. • Identifying influential nodes in social networks using centrality measures. • Analyzing closeness centrality and its impact on information flow. 4

Unit 4 Deep Learning Basics: • Implementing a simple artificial neural network (ANN) for classification. • Implementing convolutional neural networks (CNNs) for some real life application(s). 4

Unit 5 Graph Neural Network Implementation: • Implementing a basic Graph Convolution Network (GCN) from scratch. • Building a Graph Attention Network (GAT) and understanding its attention mechanism. • Developing a GraphSAGE model for node representation learning. • Comparing the performance of GNNs with traditional methods for node classification. 6

Unit 6 Real-Life Applications of GNNs: • Performing node classification using GNNs on benchmark datasets. • Predicting missing links in a given network using link prediction techniques. • Building a recommendation system based on GNN embeddings. • Detecting communities in social networks using GNN -based algorithms. 6

112 • Exploring how GNNs can be applied to analyze networks in MRI data and NLP tasks. References 1. Social media mining: an introduction, Zafarani, Reza, Mohammad Ali Abbasi, and Huan Liu. Cambridge University Press, 2014. 2. Networks, Crowds, and Markets: Reasoning About a Highly Connected World by David Easley and Jon Kleinberg, Cambridge University Press. 3. Networks: An introduction by Mark Newman, Oxford university press, 2018. 4. Graph Representation Learning by William L. Hamilton, 2020. 113

Software Testing Prerequisite: Software Engineering L T P C Total hours: 42 3 0 0 3 Course Content Hrs

Unit 1 Introduction : Software Testing, Importance of testing, Roles and Responsibilities, Testing Principles, Attributes of Good Test, V -Model, Test Case Generation, SDLC Vs STLC . 8

Unit 2 Types of Testing: Unit Testing, Integration Testing, System Testing, Regression Testing, Acceptance Testing, Functional/Non Functional Testing, Static and Dynamic Testing Categorization of testing methods : Manual Testing, Automation Testing and Automated Testing Vs. Manual Testing, Testing Tools. 6

Unit 3 Non Functional Testing: Performance Testing, Load Testing, Security Testing, Scalability Testing, Compatibility Testing, Stress Testing, Installation Testing. 6

Unit 4 Software Testing Methodologies: Validation & Verification, White Box Testing, Black Box Testing, Grey Box Testing. White/Glass Box Testing: Statement Coverage Testing, Branch Coverage Testing, Path Coverage Testing, Conditional Coverage Testing, Loop Coverage Testing, Mutation testing, Data Flow Testing. Black Box Testing: Boundary Value Analysis, Equivalence Class Partition, State Based Testing, Cause Effective Graph, Decision Table. 6

Unit 5 Software Testing Life Cycle: Requirements Analysis, Test Planning, Objective, Scope of Testing, Schedule, Approach, Roles & Responsibilities, Assumptions, Risks & Mitigations, Entry & Exit Criteria, Test Automation, Deliverables. 8

Unit 6 Test Cases Design : Write Test

cases, Review Test cases, Test Cases Template, Types of Test Cases, Difference between Test Scenarios and Test Cases, Test Oracle, Test Environment setup, Understand the SRS, Hardware and software requirements, Test Data. 8 References

1. A.P. Mathur, " Foundations of Software Testing", Pearson publications.
2. Naresh Chauhan , "Software Testing Principles and Practices " Oxford University Press, New Delhi.
3. Srinivasan Desikan and Gopalaswamy Ramesh, "Software Testing – Principles and Practices", Pearson Education.

114 Software Testing Lab Prerequisite: Software Engineering L T P C Total hours: 28 0 0 2 1 Course Content Hrs Unit 1 Study of Software Testing Automation Tools: Unit Testing (e.g. JUnit, CPPunit), Test Case Generation and Test Coverage. 8 Unit 2 Functional Testing using Automated Tools (e.g. selenium), Coverage Analysis, Test Sequence Generation and Validation. 10 Unit 3 Performance Testing using Automated Tools (e.g JMeter), Load Testing, Acceptance Testing, Mutation Testing, Defect Management. 10 References: 1. Book -1 : Foundations of Software Testing, by Aditya P. Mathur (Pearson) 2. Book -2: Software Testing: Principles and Practices, by Srinivasan Desikan and Gopalaswamy Ramesh (Pearson) 3. Book -3: Software Testing, by Yogesh Singh (Cambridge) 115 Topics in Computing Prerequisite: Operating Systems, Computer Networks, DBMS, Algorithms L T P C Total hours: 42 3 0 0 3 Course Content Hrs Unit 1 Cloud Computing: Virtualization and Containerization, Cloud Computing, Docker, Hypervisors 7 Unit 2 High Performance Computing: Big Data and Analytics, Data Science 7 Unit 3 Modern Networking: Internet of Things, Mobile Edge Computing, SDN and NFV 7 Unit 4 Distributed Ledger Technology: Blockchain, Bitcoin, Ethereum, Mining, Proof of Work, Proof of Stake, Wallets, Atomic Swap 7 Unit 5 Security Computing: Darknets, Deep and Dark Web, The Onion Routing 7 Unit 6 Quantum Computing: 7 References 1. William Stallng, "Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud", Addison - Wesley Professional, ISBN: 9780134175478 2. Kai Hwang, Jack Dongarra, Geoffrey C. Fox, "Distributed and Cloud Computing: From Parallel Processing to the Internet of Things" · 2013, Elsevier Science, ISBN: 9780128002049 3. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder, "Bitcoin and Cryptocurrency Technologies" Princeton University Press ISBN: 9781400884155 4. Documentation from torproject.org 116 Topics in Computing Lab Prerequisite: L T P C Total hours: 28 0 0 2 1 Course Content Hrs Assignment 1 Virtualization 2 Assignment 2 Virtual Machine Introspection 2 Assignment 3 Cloud Software Setup (OpenStack) 4 Assignment 4 Hadoop Ecosystem Setup 4 Assignment 5 Software Defined Network Setup 4 Assignment 6 Internet of Things: Environmental Setup 4 Assignment 7 Blockchain Implementation 4 Assignment 8 Quantum Computing Handson 4 References: 1. <https://help.ubuntu.com/community/Xen>  
<https://help.ubuntu.com/community/KVM/Installation>  
<http://www.ubuntu.com/download/desktop>      <http://www.centos.org/download/>      2.  
<https://code.google.com/archive/p/insight>      -vmi/      3.  
<http://docs.openstack.org/icehouse/install>      -guide/install/yum/content/      4.  
<https://hadoopecosystemtable.github.io/>      <https://hadoop.apache.org/>      5.  
<http://networkstatic.net/how-to-build-an-sdn-lab-without-needing-openflow-hardware/>      <http://networkstatic.net/openflow>      -openvswitch

-and-kvm-sdn-lab-installation -app/ 6. [http://www.nimbits.com/howto\\_install.jsp](http://www.nimbits.com/howto_install.jsp)  
<https://thingspeak.com/> <https://www.paraimpu.com/> <https://www.contiki-ng.org/> 7.  
<https://www.javatpoint.com/blockchain-java> <https://www.javatpoint.com/building-a-blockchain-using-python> 8. <https://qiskit.org/documentation/index.html> 117 Topics in Operating Systems Total Hours L T P C 42 3 0 0 3 Prerequisite: Fundamentals of Operating Systems and Computer Organization and Architecture Course Content Hrs Unit 1 Review of Operating System, Virtual Machines: Overview, Types of VMs and Their Implementations, Virtualization and Operating -System Components; Hypervisors 8 Unit 2 Design issues of Distributed OS, Distributed v/s network operating system. process management, inter -process communication, scheduling, deadlocks Communication: Client Server, RPC; Distributed Concurrency, Transactions. Design and implementation of distributed file systems, DFS Naming and Transparency, Remote File Access distributed shared memory 10 Unit 3 Embedded Operating System: ARM architecture, interrupts and exceptions; Process management, process synchronization, Threads, Memory management - paging, I/O buffer management, File systems 10 Unit 4 Real time Operating System: Scheduling, design principles, Uniprocessor real -time OS, Multi -processor real -time OS 8 Unit 5 Mobile Operating System: Android as a case study 6 References 1. "Operating System Internals and Design Principles" by William Stallings (9th Edition, 2021) 2. "Modern Operating Systems" by Andrew S. Tanenbaum and Herbert Bos (4th Edition, 2014) 3. "Operating System Concepts" by Abraham Silberschatz, Greg Gagne, and Peter B. Galvin (10th Edition, 2018) 4. "The Design and Implementation of the FreeBSD Operating System" by Marshall Kirk McKusick, George V. Neville -Neil, and Robert N.M. Watson (2nd Edition, 2015) 5. Published articles from reputed Journals and Conferences. 118 Topics in Operating Systems Lab Total Hours L T P C 28 0 0 2 2 Prerequisite: Fundamentals of Operating Systems and Computer Organization and Architecture Course Content Hrs Unit 1 - Install different operating systems (e.g., Windows, Linux distributions) on virtual machines to understand the installation process and gain familiarity with various OS environments. - Set up virtual networks with multiple VMs to learn about IP addressing, subnetting, DHCP, and DNS configurations. - Create vulnerable VMs and practice ethical hacking or penetration testing techniques to identify and fix security vulnerabilities. -Experiment with Docker to create, deploy, and manage containers for various applications and services. -Create VM clusters to simulate high availability and load -balancing scenarios for critical services. -Practice deploying virtual machines on cloud platforms like AWS, Azure, or Google Cloud to understand cloud infrastructure. -Explore container orchestration tools like Kubernetes and deploy multi -container applications on virtual machines. -Experiment with nested virtualization, where you run virtual machines inside virtual machines. 12 Unit 2 -Create a cluster of computers using a distributed OS like Linux -based ones (e.g., CentOS, Ubuntu) or specialized distributions like Beowulf. Learn how to configure the network and set up intercommunication between cluster nodes. -Implement load -balancing algorithms to distribute computational tasks evenly across nodes in the cluster, improving system performance. -Set up and experiment with distributed file systems like Hadoop Distributed File System (HDFS) or GlusterFS to understand data storage and retrieval across the cluster. - Run

parallel processing tasks across the cluster using tools like Apache Spark or MPI (Message Passing Interface) to solve computationally intensive problems. - Research and test various distributed algorithms, such as leader election, consensus protocols (e.g., Paxos, Raft), and distributed data structures (e.g., distributed hash tables).

10 Unit 3 -Write a simple C program on your host computer that prints "Hello, Embedded World!" (or any other basic functionality) to the console. -Use the ARM cross -compiler toolchain to cross -compile the C program for the ARM architecture. This will generate an ARM executable binary. -Create multiple tasks with different priorities and execution times using RTOS APIs.

6 References

1. "Operating System Internals and Design Principles" by William Stallings (9th Edition, 2021)
2. "Modern Operating Systems" by Andrew S. Tanenbaum and Herbert Bos (4th Edition, 2014)
3. "Operating System Concepts" by Abraham Silberschatz, Greg Gagne, and Peter B. Galvin (10th Edition, 2018)
4. "The Design and Implementation of the FreeBSD Operating System" by Marshall Kirk McKusick, George V. Neville -Neil, and Robert N.M. Watson (2nd Edition, 2015)
5. Published articles from reputed Journals and Conferences.

120 Pool 3: Honors Electives: 3 -0-0 (Credits 3) Honors Electives Credit L T P

1. Advances in Compiler Design 3 3 0 0
2. Android Programming 3 3 0 0
3. Big Data Analytics 3 3 0 0
4. Cloud Security 3 3 0 0
5. Cyber Security 3 3 0 0
6. Data Compression 3 3 0 0
7. Data Visualization 3 3 0 0
8. Digital Forensic 3 3 0 0
9. Distributed Systems 3 3 0 0
10. E-commerce 3 3 0 0
11. Embedded System Security 3 3 0 0
12. Hardware Software Codesign 3 3 0 0
13. Image Analysis 3 3 0 0
14. Intrusion Detection 3 3 0 0
15. Neural Network 3 3 0 0
16. Network on Chip 3 3 0 0
17. Network Performance Modeling 3 3 0 0
18. Parallel Processing & Algorithms 3 3 0 0
19. Parallelizing Compiler 3 3 0 0
20. Pattern Recognition 3 3 0 0
21. Public Key Infrastructure and Trust Management 3 3 0 0
22. Quantum Computing 3 3 0 0
23. Quantum Cryptography 3 3 0 0
24. Real Time Systems 3 3 0 0
25. Robotics and Control 3 3 0 0
26. Security Analysis of Protocols 3 3 0 0
27. Selected Topics in Cryptography 3 3 0 0
28. Social Media Mining 3 3 0 0
29. Software Project Management 3 3 0 0
30. System on Chip 3 3 0 0
31. Wireless Sensor Networks 3 3 0 0

121 Advances in Compiler Design Prerequisite: Basic course in Compiler Design L T P C

Total hours: 42 3 0 0 3 Course Content Hrs.

Unit 1 Modern Compiler Design – Structure of Compilers for Modern Programming Languages, Cross Compiler, Just -In-Time (JIT) and Adaptive Compilation 8

Unit 2 Runtime System Architectures. Parser Development - LR Parsers and LR Grammars – Design and Implementation. 10

Unit 3 Parser and Ambiguity, Conflict Resolution, Lex and Yacc Tools. Optimizing Compiler - Control -flow Analysis, Control -flow Graphs, Basic Blocks. 10

Unit 4 Data -flow Analysis Methods, Dependence Analysis, Global Optimizations, Loop Optimizations. 8

Unit 5 Peephole Optimization and Optimal Code Generation, Data Dependence Analysis in Loops, Loop Scheduling. 6

References: 1. Aho, Lam, Sethi and Ullman: Compilers – Principles, Techniques and Tools, Pearson Education

2. 3. 4. 2. Steven Muchnick : Advanced Compiler Design & Implementation, Morgan Kaufmann
3. Holub: Compiler Design in C, Prentice Hall India.
4. Keith Cooper and Linda Torczon : Engineering a Compiler, Morgan Kaufmann.

122 Android Programming Prerequisite: None L T P C

Total hours: 42 3 0 0 3 Course Content Hrs.

Unit 1 Basics: Review of Java Programming, Setting up and configuring Android



Studio setup, Android Emulator Hello Android example, AndroidManifest.xml, R.java file, Activity, Fragment, 10 Unit 2 Layout Manager - Relative Layout, Linear Layout, Table Layout, Grid Layout. Activity, Intent & Fragment: Activity Lifecycle, Activity Example, Intent – implicit and explicit, Intent filters, Fragment Lifecycle, Fragment Example 8 Unit 3 UI Widgets – buttons (toggle, switch, image), check box; Android Menu: Option Menu, Context Menu, Popup Menu; View. 8 Unit 4 Android Service: lifecycle, example, Data Storage, Shared Preference, SQLite, Content Provider, Android Notification Adding functionality: Multimedia API, Speech API, telephony API. 10 Unit 5 Location API Sensors: Sensor API, Working with WiFi, Working with Camera, Motion Sensor, Position Sensor; Android Graphics App development project. 6 References: 1. Official Android Website 123 Big Data Analytics Prerequisite: None L T P C Total hours: 42 3 0 0 3 Course Content Hrs. Unit 1 Overview of Database Management Systems, Introduction to Big Data, Introduction to distributed file system, Big Data and its importance, Four Vs, Drivers for Big data, Big data analytics. 8 Unit 2 Apache Hadoop & Hadoop Eco -System, Moving Data in and out of Hadoop, Understanding inputs and outputs of MapReduce, Data Serialization. Hadoop Architecture. 10 Unit 3 Hadoop Storage: HDFS, Common Hadoop Shell commands, Anatomy of File Write and Read, Name -Node, Secondary Name -Node, and Data -Node, Hadoop MapReduce paradigm, Map and Reduce tasks, Job. 10 Unit 4 Task trackers - Cluster Setup, SSH & Hadoop Configuration – HDFS Administering, Monitoring & Maintenance. Pig, Pig Latin Language, Hive Introduction, Hive queries. Spark Introduction. Cassandra CQL 8 Unit 5 Query language and CQL data model: Key space, Table definition, Column, and Data Types. Mongo DB Cluster analysis, K-means algorithm, Naïve Bayes, Parallel k - means using Hadoop, parallel particle swarm algorithm using MapReduce, case studies on big data mining. Parallel swarm Intelligence. 6 References: 1. Dan Sullivan, NoSQL for Mere Mortals 1st Edition., Pearson Publishers, 2014 2. Pramod J. Sadalage, Martin Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence 1st Edition, Pearson Publishers, ISBN -13: 978 -0321826626, 2017. 3. John D. Kelleher, Brian Mac Namee, Aoife D'Arcy, Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms, Worked Examples, and Case Studies (The MIT Press) 4. John D. Kelleher, Brendan Tierney, Data Science (MIT Press Essential Knowledge series). 124 Cloud Security Prerequisite: Computer Networks, Operating System L T P C Total hours: 42 3 0 0 3 Course Content Hrs. Unit 1 Introduction of Cloud Computing: Taxonomy and related technologies, Essential Characteristics, Service and Deployment Models 8 Unit 2 Virtualization: Types of Virtualization and Hypervisors, Virtualization at Storage, Compute and Network, Hypervisors (Types and Case studies), Virtual Machine Provisioning, Virtual Machine Migration. 10 Unit 3 Architectures: Standards, Orchestration, Provisioning, Portability, Interoperability, Federated Cloud, Security: CIA Triad, Vulnerabilities in Cloud, Threats to Infrastructure, Data and Access Control 10 Unit 4 Identity Management; Multi Tenancy Issues; Attack taxonomy; Intrusion Detection, VM Specific attacks, VM Introspection, Management; Trusted Cloud Initiative of Cloud Security Alliance (CSA). 8 Unit 5 Forensics: NIST Forensics Reference Architecture, Forensic Science Challenges, Architectural Issues, Evidence Collection and Analysis, Anti -Forensics,

Incident Response, Standards and Framework 6 References: 1. K. Hwang, G. C. Fox, and J. Dongarra, Distributed and Cloud Computing, 1st ed.: Morgan Kaufmann, 2011 2. R. Buyya, J. Broberg, and A. M. Goscinski, Cloud Computing: Principles and Paradigms: Wiley -Blackwell, 2011 3. S. Dinkar and G. Manjunath, Moving to the Cloud: Developing Apps in the New World of Cloud Computing Syngress Media, U.S., 2012. 4. W. Stallings, Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud, 1st ed.: Addison -Wesley Professional, 2015. 5. T. Erl, Z. Mahmood, and R. Puttini, Cloud Computing: Concepts, Technology & Architecture: Prentice Hall/PearsonPTR, 2014 6. R. L. Krutz and R. D. Vines, Cloud Security - A Comprehensive Guide to Secure Cloud Computing, Wiley Publishing, 2010 7. T. Mather, S. Kumaraswamy, and S. Latif, Cloud Security and Privacy - An Enterprise Perspective on Risks and Compliance, O Reilley Publishers, 2009. 8. V. (J. R.) Winkler, G. Speake, P. Foxhoven, Securing the Cloud: Cloud Computer Security Techniques and Tactics, Syngress, 2011. 125 Cyber Security Prerequisite: None L T P C Total hours: 42 3 0 0 3 Course Content Hrs. Unit 1 Overview of Cyber Security, Internet Governance – Challenges and Constraints, Cyber Threats, Need for a Comprehensive Cyber Security Policy. Cyber Security Safeguards (Overview): Access control, Audit, Authentication, Biometrics, Cryptography, Deception, Denial of Service Filters, Ethical Hacking, Firewalls, Intrusion Detection Systems, Response, Scanning, Security policy, Threat Management. 8 Unit 2 Network Security & Web Security: Security Issues in TCP/IP, which includes TCP, DNS, Routing (basic problems of security in TCP/IP, IPsec, BGP Security, DNS Cache poisoning, etc), Network Defense tools such as Firewalls, Filtering, DNSSec, NSec3, Distributed Firewalls. 10 Unit 3 Web Application Security: Cross -Site Scripting Attacks, Cross -Site Request Forgery, SQL Injection Attacks Intrusion, Physical Theft, Abuse of Privileges, Unauthorized Access by Outsider, Malware infection, Intrusion detection and Prevention Techniques, Anti-Malware software, Network based Intrusion detection Systems, Network based Intrusion Prevention Systems, Host based Intrusion prevention Systems, Security Information Management, Network Session Analysis, System Integrity Validation 10 Unit 4 Cyber Forensics: Introduction to Cyber Forensics, Handling Preliminary Investigations, Controlling an Investigation, Conducting diskbased analysis, Investigating Information -hiding, Scrutinizing E -mail, Validating Email header information, Tracing Internet access, Tracing memory in real-time. 8 Unit 5 Security in Mobile Platforms: Android vs. iOS security model, threat models, information tracking, rootkits, Threats in mobile applications, analyzer for mobile apps to discover security vulnerabilities, Viruses, Spywares, and keyloggers and malware detection. Cyberspace and the Law 6 References: 1. Latest research papers, journals and articles 2. Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Nina Godbole and SunitBelapure. 3. Cybersecurity Essentials By Charles J. Brooks, Christopher Grow, Philip Craig, Donald Short · 2018 4. Cybersecurity: Attack and Defense Strategies: Infrastructure Security with Red Team and Blue Team TacticsBook by ErdalOzkaya and Yuri Diogenes 126 Data Compression Prerequisite: Object Oriented Analysis and Design L T P C Total hours: 42 3 0 0 3 Course Content Hrs. Unit 1 Introduction: Compression techniques, lossless compression, lossy compression, measures of performance,

modeling and coding. 8 Unit 2 Mathematical preliminaries - Overview, introduction to information theory, models, physical models, probability models, Markov models. 10 Unit 3 Basic Coding Schemes: Statistical Methods - Shannon -Fano Algorithm, Huffman Algorithm, Adaptive Huffman Coding. Arithmetic Coding (Encoding, Decoding, Adaptive Coding). Dictionary Methods - LZ77, LZ78, LZW Algorithms. Case study of lossless compression standards. 10 Unit 4 Lossless Compression standards: zip, gzip, bzip, unix compress, GIF, JBIG. Image and Video Compression: Discrete Cosine Transform, JPEG. Wavelet Methods - Discrete Wavelet Transform, JPEG 2000 8 Unit 5 Motion Compensation, Temporal and Spatial Prediction. MPEG and H.264. Audio Compression: Digital Audio, WAVE, FLAC, MPEG -1/2 Audio Layers. 6 References: 1. Khalid Sayood. 2012. Introduction to Data Compression (4th ed.). Elsevier 2. David Salomon, Giovanni Motta. 2010. Handbook of Data Compression. Springer, London 127 Data Visualization Prerequisite: None L T P C Total hours: 42 3 0 0 3 Course Content Hrs. Unit 1 Modern Visualisation tools and techniques, Create multiple versions of digital visualizations using various software packages. 8 Unit 2 Identify appropriate data visualization techniques given particular requirements imposed by the data. 10 Unit 3 Apply appropriate design principles in the creation of presentations and visualizations; Analyse, critique, and revise data visualizations 8 Unit 4 Information overload and issues in decision making Design of visual encoding schemes to improve comprehension of data and their use in decision making 6 Unit 5 Use of Tableau - Data visualization tool for data analysts, scientists, statisticians, etc. to visualize the data and get a clear opinion based on the data analysis, Comparing classifiers - ROC curves, McNemar's test, other statistical tests. 10 References: 1. A first course Sosulski, K. (2018). Data Visualization Made Simple: Insights into Becoming Visual. New York: Routledge 2. The Visual Display of Quantitative Information (2nd Edition). E. Tufte. Graphics Press, 2001. 128 Digital Forensics Prerequisite: Operating Systems, Computer Networks & Security L T P C Total hours: 42 3 0 0 3 Course Content Hrs. Unit 1 File System Forensics: Duplicating hard disks for "dead analysis", reading hidden data on a disk's Host Protected Area (HPA), Direct versus BIOS access, dead versus live acquisition 8 Unit 2 Disk partitions - DOS, Apple, and GPT partitions, BSD disk labels, Sun Volume; multiple disk volumes - RAID and disk spanning. 10 Unit 3 Analyzing FAT, NTFS, Ext2, Ext3, UFS1, and UFS2 file systems, Finding evidence: File metadata, recovery of deleted files, Using The Sleuth Kit (TSK), Autopsy Forensic Browser, and related open source tools 10 Unit 4 Web Forensics: network -based evidence in Windows and Unix environments, Reconstructing Web browsing, email activity, Tracing domain name ownership and the source of e -mails 8 Unit 5 System Forensics: Windows Registry changes, Duplicating and analyzing the contents of PDAs and flash memory devices Electronic document, computer image verification and authentication. 6 References: 1. Brian Carrier. File System Forensic Analysis, Addison Wesley 2. Chris Prosise, Kevin Mandia. Incident Response and Computer Forensics, McGraw Hill. Course Technology. 3. Linda Volonino, Reynaldo Anzaldua, and Jana Godwin. Computer Forensics: Principles and Practices, Prentice Hall. 4. Keith J. Jones, Richard Bejtlich, and Curtis W. Rose. Real Digital Forensics: Computer Security and Incident Response, Addison Wesley. 5. Vacca, John R., Computer Forensics Computer Crime

Scene Investigation, Charles River Media. 6. Nelson, Phillips, Enfinger, Steuart. Guide to computer Forensics and Investigation 129

**Distributed Systems** Prerequisite: None  
 L T P C Total hours: 42 3 0 0 3 Course Content Hrs.

**Unit 1 Introduction to Distributed Systems, OS and Advanced OS, various distributed systems, Trends in Distributed System and challenges, Networking: network protocols, point-to-point communication.** Introduction – Clocks, events and process states – Synchronizing physical clocks Logical time and logical clocks – Global states, Limitations, Lamport's logical clock, vector clock, causal ordering, global state, Cuts. Distributed Mutual Exclusion: Lamport, Recart -agrawala, and Maekawa's algorithms; Suzuki -kasami broadcast algorithm, and Raymond's tree based algorithm, Elections algorithms 8

**Unit 2 Transactions and Concurrency Control – Transactions -Nested transactions – Locks – Optimistic concurrency control – Timestamp ordering – Atomic Commit Distributed transactions: two phase commit, three -phase commit, ACID/BASE models Techniques of Inter process Communication: the API for internet protocols – External data representation and Multicast communication, Sun RPC: programming and implementation, Network virtualization: Overlay networks. Case study: MPI Remote Method Invocation And Objects: Remote Invocation – Introduction – Request -reply protocols – Remote procedure call – Remote method invocation. Case study: Java RMI – Group communication – Publish -subscribe systems – Message queues – Shared memory approaches – Distributed objects.** 10

**Unit 3 Case study: Enterprise Java Beans -from objects to components. Distributed Deadlock Detection: Resource Vs. Communication deadlock, Replication, Strategies to handle deadlock, Ho -Ramamoorthy, Path -Pushing, Edge -Chasing, Diffusion Computation - based algorithms. Agreement Protocols: System model, Classification of agreement problems, Solutions to Byzantine Agreement (BA) problems. Distributed Scheduling: Issues in Load Distribution, Components of a load distribution algorithm, Load Distribution Algorithms, V -system, Sprite, and Condor.** 10

**Unit 4 Network file systems: design, NFS, AFS (scale), DFS & CIFS (cache control), CODA (redundancy) Google File System (GFS), Hadoop Distributed File System (HDFS) Distributed Shared Memory: Algorithms for implementing DSMs, Memory Coherence, and Coherence Protocols, IVY Process Management: Process Migration: Features, Mechanism – Threads: Models, Issues, Implementation.** 8

**Unit 5 Resource Management: Introduction Features of Scheduling Algorithms –Task Assignment Approach – Load Balancing Approach – Load Sharing Approach Recovery: Classification of failures, Synchronous and Asynchronous Check pointing and Recovery. Fault Tolerance: Commit Protocols, Voting Protocols, Failure Resilient Processes. Protection and Security: Access Matrix Model, Implementation of access matrix, Unix, and Amoeba. Case study -Distributed systems.** 6

**References:** 1. Andrew S. Tanenbaum, Maarten Van Steen, "Distributed Systems Principles and Paradigm," 2nd Edition, Pearson 2. George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair "Distributed Systems Concepts and Design," 5th Edition, Pearson 130 3. M. Singhal & N. Shivaratri, "Advanced Concepts in Operating Systems: Distributed, Database and Multiprocessor Operating Systems", Tata McGraw Hill, 2015 4. John Bloomer, "Power Programming with RPC," O'Reilly & Associates, Inc 5. Advanced Programming in the Unix Environment by W. Richard Stevens, Addison -Wesley. 6.

Liu M.L., "Distributed Computing, Principles and Applications", Pearson Education 7.

Distributed Systems - An Algorithmic approach by Sukumar Ghosh. 131 E-Commerce

Prerequisite: knowledge of Digital Market, Basics of Computer Network and security L

T P C Total hours: 42 3 0 0 3 Course Content Hrs. Unit 1 Introduction: Definition of Electronic Commerce, technology and prospects, incentives for engaging in electronic commerce, needs of E -Commerce, E -Commerce Infrastructure, advantages and disadvantages, Impact of E -commerce on business, E - Commerce Models. 8 Unit 2 Network Infrastructure for E - Commerce. Internet and Intranet based E -commerce: Issues, problems and prospects, Network Infrastructure, Network Access Equipments, Broadband telecommunication. Mobile Commerce: Introduction, Wireless Application Protocol, WAP technology, Mobile Information device 10 Unit 3 Web Security: Security Issues on web, Importance of Firewall, components of Firewall, Transaction security, Emerging client server, Security Threats, Network Security, Factors to consider in Firewall design, Limitation of Firewalls. Encryption: Encryption techniques, Symmetric Encryption: Keys and data encryption standard, Triple encryption, Secret key encryption. 10 Unit 4 Asymmetric encryption: public and private pair key encryption, Digital Signatures, Virtual Private Network. Customer Service Expectations of the E -commerce Experience. 6 Unit 5 Electronic Payments: Overview, The SET protocol, Payment: Smart card, credit card, magnetic strip card, E -Checks, Credit/Debit card based EPS, online Banking. EDI Application in business, E - Commerce Law, Forms of Agreement, Govt. policies and Agenda 8 References: 1. Turban, "Electronic Commerce 2004: A Managerial Perspective", Pearson Education 2. Pete Lohsin , John Vacca "Electronic Commerce", New Age International 3. Bajaj and Nag, "E -Commerce the cutting edge of Business", TMH 6 4. Laudon, "E-Commerce: Business, Technology, Society", Pearson Education 132 Embedded System Security Prerequisite: None L T P C Total hours: 42 3 0 0 3 Course Content Hrs. Unit 1 Security Flaws and Attacks in Embedded systems: Code injection, Invasive and Non invasive physical and logical attacks 8 Unit 2 Defenses Against Code Injection Attacks: Methods using Address Obfuscation and Software Encryption, Anomaly Detection. 10 Unit 3 Safe Languages, Code Analyzers Compiler, Library, and Operating System Support for embedded systems 10 Unit 4 Security, Control Flow Checking, IP Protection: Encryption of IP Cores, additive and Constraint -Based watermarking. 8 Unit 5 Implementation of DES 3DES, AES, RC4, MD5, RSA algorithms 6 References: 1. Security in Embedded Hardware 133 Hardware Software Codesign Prerequisite: Logic System Design/ Digital Logic Design L T P C Total hours: 42 3 0 0 3 Course Content Hrs. Unit 1 Codesign overview, device Modeling and methodologies of system design 8 Unit 2 Hardware software partitioning and scheduling, Co simulation. 10 Unit 3 Synthesis and verifications, Architecture, Interface and reconfiguration. 10 Unit 4 System on chip, Application specific processors (DSP) 8 Unit 5 Codesign tools and case studies 6 References: 1. A Practical Introduction to Hardware/Software Codesign, Patrick Schaumont, Springer, 2009, ISBN 978 -1-4419 -5999 -7 2. Specification and Design of Embedded Systems Daniel D. Gajski, Frank Vahid, S. Narayan, & J. Gong, Prentice Hall, 1994 3. Hardware / Software Co -Design: Principles and Practice, JStaunstrup and Wayne Wolf, Prentice Hall, 1994 134 Image Analysis Prerequisite: None L T P C Total hours:

42 3 0 0 3 Course Content Hrs. Unit 1 Image Preliminaries & Image Processing: Overview, Computer imaging systems, Human visual system, image model, etc. Geometric transformations: Translation, rotation, scaling and shearing. 8 Unit 2 Frequency transformation: Discrete Fourier transform (DFT), fast Fourier transform (FFT), shorttime Fourier transform (STFT), Multi -resolution Expansions: Wavelet Transforms in 1 -D and 2 - D. The Fast Wavelet Transform Wavelet Packets Transform 10 Unit 3 Feature Extraction and Dimension Reduction Color, Texture, Shape and structure Features in spatial and frequency domains, Corner Detection, Hough Transform, Principal Component Analysis, Linear Discriminant Analysis, Feature Reduction in Input and Feature Spaces. Image Segmentation. Gray -level thresholding, Supervised vs. Unsupervised thresholding, Binarization using Otsu's method, Locally adaptive thresholding. 10 Unit 4 Color -based segmentation, Region oriented segmentation, Use of motion in segmentation, Spatial techniques, Frequency domain techniques. Features Based Image Matching:Scale Space Image Processing. 8 Unit 5 Different Feature descriptors: Key Point Detection, SIFT descriptor SURF descriptor Bag of Visual Words approach, Geometric consistency check, Vocabulary tree Panoramic Imaging, Template Matching, Mono Panorama, Stereo Panorama. 6 References: 1. J G Proakis and D G Manolakis, "Digital Signal Processing," Pearson, Fourth edition 2. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Prentice Hall, 3rd Edition, 2007. 3. Bishop, Pattern Recognition and Machine Learning 4. Duda, Pattern Classification. 135 Intrusion Detection Prerequisite: None L T P C Total hours: 42 3 0 0 3 Course Content Hrs. Unit 1 Introduction - Intrusion Detection System (IDS), Intrusion Prevention System (IPS). 8 Unit 2 Unauthorized access – buffer overflow, packet fragmentation, out -of-spec packets Review of Network protocol – TCP/IP, Intrusion detection through tcpdump 10 Unit 3 IDS and IPS – Architecture and internals. Malicious and non -malicious traffic, IP headers, TCP, UDP and ICMP protocols and header formats. 10 Unit 4 Header information to detect intrusion, logs and their analysis. 6 Unit 5 IDS through reaction and response Intrusion analysis – data correlation, tools, SNORT - A case study 8 References: 1. Matt Fearnow, Stephen Northcutt, Karen Frederick, and Mark Cooper. Intrusion Signatures and Analysis, SAMS. 2. Carl Endorf, Gene Schultz, Jim Mellander, Intrusion Detection and Prevention, McGraw Hill 3. Paul E. Proctor. The Practical Intrusion Detection Handbook, Prentice Hall. 4. Stephen Northcutt and Judy Novak. Network Intrusion Detection, SAMS. 136 Neural Networks Prerequisite: Basic understanding of probability and statistics, linear algebra and calculus. A basic knowledge of programming (preferably Python) is essential. L T P C Total hours: 42 3 0 0 3 Course Content Hrs. Unit 1 Introduction to Neural Architecture, McCulloch -Pitts networks, Learning Rules, Perceptrons. 8 Unit 2 Regression and least mean square algorithm, Multilayer perceptrons. 8 Unit 3 Back propagation: generalized delta rule, limitations, modifications – momentum, variable learning rate, conjugate gradient, Radial -basis function networks. 10 Unit 4 Support vector Machines, Unsupervised learning and self -organization, Boltzmann machines and deep networks, Convolutional networks. 10 Unit 5 Recurrent networks, Associative Memories, Adaptive Resonance Theory, Applications of Neural Networks. 6 References: 1. Simon Haykin: Neural Networks: A Comprehensive Foundation, Pearson 137 Network on Chip Prerequisite: Computer

Architecture, Logic System Design L T P C Total hours: 42 3 0 0 3 Course Content Hrs. Unit 1 The Concept of route packet not wires for On -Chip Interconnection Networks, Topology and design architecture of Network -on-Chip, Area and power trade off NoC protocols. 8 Unit 2 Routing and Flow Control mechanism, Verification of Communications in Networks - on-Chips. Application Mapping on Network -on-Chip. 10 Unit 3 Resource Allocation for QoS On -Chip Communication, routing techniques in different 2D/ 3D NoC topology, performance evaluation in terms of throughput, latency, jitter. 10 Unit 4 Signal Integrity and Reliability of Network -on-Chip, Testing of Network -on- Chip Architectures, Test and Fault Tolerance for NoC Infrastructures. 8 Unit 5 Reconfigurable Network -on-Chip Design, Security in NoCs. Energy and Power estimation techniques Network -on-Chips. 6 References: 1. Giovanni De Micheli, Luca Benini, Davide Bertozzi, Networks on Chips: Technology and Tools, Morgan Kaufmann, 2006. 2. Fayez Gebali, Haytham Elmiligi, Mohamed Watheq El -Kharashi, Networks - Chips: Theory and Practice, CRC Press, 2017. 3. Sudeep Pasricha, Nikil Dutt, On -Chip Communication Architectures: System on Chip Interconnect, Morgan Kaufmann, 2010. 138

Network Performance Modelling Prerequisite: None L T P C Total hours: 42 3 0 0 3 Course Content Hrs. Unit 1 Introduction to Network Modeling: Network modeling, Computer Network as a discrete event system, Modeling and measurement tools, Network performance metrics – first order and second order metrics, Network capacity, Difference between throughput and capacity 8 Unit 2 Network Calculus: Models for data flows, arrival curves and service curves, Greedy shapers, Basic min -plus and maxplus calculus, min -plus and max -plus systems, Optimal smoothing, FIFO systems and aggregate scheduling, Time varying shapers, Systems with losses 6 Unit 3 Case studies – (1) Analyzing spanning tree based data forwarding using network calculus, (2) Bound on loss rate Stochastic Scheduling and Resource Allocation: Stochastic scheduling, dynamic resource allocation, Dynamic programming models for stochastic scheduling, Queuing networks – open loop and closed loop networks, Jackson networks, Network fairness – proportional and max -min fairness, Markov process and its application for analyzing network resource allocation and fairness, available bandwidth estimation 11 Unit 4 Case studies – (1) TCP/IP flow and congestion control, (2) Modeling dynamic routing and scheduling as a queuing network problem, (3) Analysis of IEEE 802.11 channel access using two dimensional Markov process. Network Games: Introduction to game theory, Zero sum games, Nash equilibrium, Pareto optimality, Cooperative and Non -cooperative games, General network games – resource sharing games, routing games, congestion games, Mechanism design. Case studies – (1) Selfish routing in networks and price of anarchy , (2) Oblivious routing, (3) Network resource allocation games. 11 Unit 5 Protocol Analysis: Modeling discrete event system using petri -nets, basics of petri nets, stochastic petri nets, queuing petri nets, properties of petri nets, structural analysis of petri nets, Petri net modeling tools – simQPN, Case studies – (1) Wireless channel model using stochastic petri net, (2) Data center network throughput analysis using queuing Petri Nets 6 References: 1. "Routing, Flow, and Capacity Design in Communication and Computer Networks", Michael Pióro, Deepankar Medhi, ISBN: 0125571895, Publisher: Morgan Kaufmann 2. The Network Calculus Book by Jean -Yves Le Boudec and Patrick Thiran is available for free

download:[http://ica1www.epfl.ch/PS\\_files/NetCal.html](http://ica1www.epfl.ch/PS_files/NetCal.html) 3. Anurag Kumar, D. Manjunath and Joy Kuri, "Communication Networking: An Analytical Approach" Morgan Kaufman Publishers 4. Dimitri P. Bertsekas and Robert G. Gallager, "Data Networks": Materials are available at <http://web.mit.edu/dimitrib/www/datanets.html> 5. "Network Optimization: Continuous and Discrete Models", D. Bertsekas 6. Research Publications - will be discussed and distributed time to time 139 Parallel Processing & Algorithms Prerequisite: None L T P C Total hours: 42 3 0 0 3 Course Content Hrs.

Unit 1 Introduction to parallel computing. Parallel processing terminology, Pipelining Vs Data parallelism, Control parallelism, Scalability, Control parallel approach, Data parallel approach, Data parallel approach with I/O. 8 Unit 2 The PRAM Shared-Memory Model, Distributed -Memory or Graph Models, Circuit Model and Physical Realizations PRAM and Basic Algorithms, PRAM Submodels and Assumptions, Data Broadcasting, Semigroup or Fan -In Computation, Parallel reduction, Prefix sums, List ranking, Preorder tree traversal, Merging two sorted lists, Graph coloring, Reducing the number of processors, Problems defying fast solutions on PRAMS. 10 Unit 3 Thread and process level parallel architectures: MIMD, multi -threaded architectures. Distributed and shared memory MIMD architectures. Dynamic interconnection networks. Mapping and scheduling: Mapping data to processors on processor arrays and multicomputer s, Dynamic Load Balancing on multicomputers, Static scheduling on UMA multiprocessors, Deadlock. Parallel programming and parallel algorithms: Programming models, parallel programming on multiprocessors and multicomputers. 10 Unit 4 Parallel algorithm structure, analyzing parallel algorithm. Elementary parallel algorithms, Matrix algorithms, sorting, Graph algorithms. Parallel Algorithm Complexity, Asymptotic Complexity, Algorithm Optimality and Efficiency, Complexity Classes, Parallelizable Tasks and the NC Class, Parallel Programming Paradigms, Solving Recurrences 8 Unit 5 Sorting and Selection Network: Design of Sorting Networks, Batchier Sorting Networks, Mesh -Base Architectures: Sorting on a 2D Mesh or Torus, Routing on a 2D Mesh or Torus, Numerical 2D Mesh Algorithms, Low -Diameter Architectures: Hypercubes and Their Algorithms, Sorting and Routing on Hypercubes 6 References: 1. J. Jaja, An Introduction to Parallel Algorithms, Addison Wesley, 1992 2. F. T. Leighton, Introduction to Parallel Algorithms and Architectures: Arrays, Trees, Hypercubes, Morgan Kaufmann Publishers, San Mateo, California, 1992 3. Behrooz Parhami, Introduction to Parallel Processing, Algorithms and Architecture, Kluwer Academic Publishers, 2002ed 140 Parallelizing Compiler Prerequisite: Basic course in Compiler Design L T P C Total hours: 42 3 0 0 3 Course Content Hrs. Unit 1 Introduction – Compilation for parallel machines and automatic detection of parallelism, structure of a parallelizing compiler. 8 Unit 2 Dependence Theory and Practice - Types of dependences, data and control dependencies, dependence analysis. 10 Unit 3 Direction vectors, loop carried and loop independent dependences, tests for data dependence and their applicability, construction of data dependence and control dependence graphs. 10 Unit 4 Parallel Code Generation - Automatic extraction of parallelism, representation of iteration spaces of nested loops, loop based transformations such as loop distribution, loop coalescing, loop interchange and cycle shrinking transformation. 8 Unit 5 Interprocedural Analysis and Optimization - aliasing information, summary data flow analysis, interprocedural constant



propagation, interprocedural data dependence analysis and parallelization of call statements. 6 References: 1. Randy Allen, Ken Kennedy: Optimizing compilers for modern architectures. Morgan Kaufmann 2. Steven Muchnick : Advanced Compiler Design & Implementation, Morgan Kaufmann. 141 Pattern Recognition Prerequisite: An undergraduate level understanding of probability, statistics and linear algebra is assumed. A basic knowledge of Python is essential. L T P C Total hours: 42 3 0 0 3 Course Content Hrs. Unit 1 The classification process: features, training and learning, approaches to classification Non metric methods: Information, Entropy and Impurity, decision tree classifier - ID3, C4.5. Discriminant functions: linear discriminant functions, piece - wise linear discriminant functions, generalized discriminant functions. 8 Unit 2 Statistical pattern recognition: measured data and measurement errors, probability theory, conditional probability and Bayes rule, Naive Bayes classifier, Continuous random variables, The multivariate Gaussian, Covariance matrix and Mahalanobis distance Parametric learning: Bayesian decision theory, discriminant functions and decision boundaries, MAP (Maximum A Posteriori Estimator) 10 Unit 3 Non Parametric learning: Histogram estimator and Parzen windows, k -NN classification, Artificial Neural Networks, Kernel Machines, SVM. Feature extraction and selection: reducing dimensionality, feature selection - Inter/Intra class distance. 10 Unit 4 Feature extraction: Principal component analysis, Linear discriminant analysis. Unsupervised learning: Clustering, K - Means clustering, Fuzzy c -Means clustering, (Agglomerative) Hierarchical clustering 8 Unit 5 Estimating and Comparing Classifiers: No free lunch, Bias and variance trade -off, cross -validation and resampling methods, Measuring classifier performance, Comparing classifiers - ROC curves, McNemar's test, other statistical tests 6 References: 1. Pattern Classification, Duda Hart, Wiley 2. Pattern Recognition and Classification, Geoff Dougherty, Springer 3. Statistical Pattern Recognition, Andrew R Webb, Wiley 4. Pattern Recognition and Machine Learning, Christopher Bishop, Springer 5. Pattern Recognition and Image Analysis, Earl Gose, Johnsonbaugh, PHI 142 Public Key Infrastructure and Trust Management Prerequisite: L T P C Total hours: 4 0 3 0 0 3 Course Content Hrs. Unit 1 Public key infrastructure - components and architecture. PKI interoperability, deployment and assessment PKI data structures – certificates, validation, revocation, authentication, cross certification. 10 Unit 2 Repository, Certification Authority (CA) and Registration Authority (RA), trusted third party, digital certificates PKI services – authentication, non -repudiation, privilege management, privacy, secure communication. 12 Unit 3 Key management – certificate revocation list, root CA, attacks on CA, key backup. 12 Unit 4 PKI standards – SSL, LDAP, IPSec, X.500, X.509, S/MIME Trust models – strict v/s loose hierarchy, four corners distribution. Certificate path processing – path construction and path validation. 6 References: 1. Ashutosh Saxena, Public Key Infrastructure, Tata McGraw Hill 2. Carlisle Adams, Steve Lloyd. Understanding PKI: Concepts, Standards, and Deployment Considerations, Addison Wesley. 3. John R. Vacca. Public Key Infrastructure: Building Trusted Applications and Web Services, AUERBACH. 4. Messaoud Benantar, Introduction to the Public Key Infrastructure for the Internet, Pearson Education. 143 Quantum Computing Prerequisite: None L T P C Total hours: 42 3 0 0 3 Course Content Hrs. Unit 1 Introduction to quantum computing 8 Unit 2

Relevant Linear algebra for quantum computing, Postulates of quantum mechanics, 10 Unit 3 Classical computing, Quantum circuits, Quantum Fourier Transform 10 Unit 4 Quantum search algorithms, Physical realization of quantum computers. 8 Unit 5 Quantum noise, Quantum operations, quantum information and quantum channel 6 References: 1. Pittenger A. O., An Introduction to Quantum Computing Algorithms 2. Nielsen M. A., Quantum Computation and Quantum Information, Cambridge University Press. 3. Benenti G., Casati G. and Strini G., Principles of Quantum Computation and Information, Vol. I: Basic Concepts, Vol II: Basic Tools and Special Topics, World Scientific. 144 Quantum Cryptography Prerequisite: L T P C Total hours: 42 3 0 0 3 Course Content Hrs. Unit 1 Preliminaries: Quantum Information Theory, Quantum Information Theory, Unconditional Secure Authentication and Entropy. 8 Unit 2 Quantum Key Distribution: Quantum Channel, Public Channel, QKD Gain, Finite Resources, Adaptive Cascade: Introduction, Error Correction and the Cascade Protocol, Adaptive Initial Block -Size Selection, Fixed Initial Block -Size, Dynamic Initial BlockSize. 10 Unit 3 Attack Strategies on QKD Protocols: Attack Strategies in an Ideal Environment, Individual Attacks in an Realistic Environment. QKD Systems, Statistical Analysis of QKD Networks in Real -Life Environment: Statistical Methods, Results of the Experiments, Statistical Analysis. 10 Unit 4 QKD Networks Based on Q3P : QKD Networks, PPP, Q3P, Routing and Transport. QuantumCryptographic Networks from a Prototype to the Citizen. 8 Unit 5 The Ring of Trust Model, Model of the Point of Trust Architecture, Communication in the Point of Trust Model, Exemplified Communications, A Medical Information System Based on the Ring of Trust. 6 References: 1. Quantum Cryptography and Secret -Key Distillation, Gilles van Assche, Cambridge University Press, 2006. 2. Paul Kaye, Raymond Laflamme, and Michele Mosca, An Introduction to Quantum Computing, Oxford University Press (2007). 3. Michael A. Nielsen and Isaac L. Chuang, Quantum Computation and Quantum Information, Cambridge University Press (2000). 145 Real Time Systems Prerequisite: None L T P C Total hours: 40 3 0 0 3 Course Content Hrs. Unit 1 Introduction : Definition, Typical Real Time Applications; Digital Control, High Level Controls, Signal Processing etc., Release Times, Deadlines, and Timing Constraints, Hard Real Time Systems and Soft Real Time Systems, Reference Models for Real Time Systems: Processors and Resources, Temporal Parameters of Real Time Workload, Periodic Task Model, Precedence Constraints and Data Dependency 7 Unit 2 Real Time Scheduling: Common Approaches to Real Time Scheduling: Clock Driven Approach, Weighted Round Robin Approach, Priority Driven Approach, Dynamic Versus Static Systems, Optimality of Effective -Deadline -First (EDF) and Least -Slack - Time -First (LST) Algorithms, Offline Versus Online Scheduling, Scheduling Aperiodic and Sporadic jobs in Priority Driven and Clock Driven Systems 8 Unit 3 Resources Access Control: Effect of Resource Contention and Resource Access Control (RAC), Nonpreemptive Critical Sections, Basic Priority -Inheritance and Priority -Ceiling Protocols, Stack Based Priority -Ceiling Protocol, Use of Priority -Ceiling Protocol in Dynamic Priority Systems, Preemption Ceiling Protocol, Access Control in Multiple - Unit Resources, Controlling Concurrent Accesses to Data Objects 8 Unit 4 Multiprocessor System Environment :Multiprocessor and Distributed System Model, Multiprocessor Priority -Ceiling

Protocol, Schedulability of FixedPriority End -to-End Periodic Tasks, Scheduling Algorithms for End -to-End Periodic Tasks, Endto -End Tasks in Het erogeneous Systems, Predictability and Validation of Dynamic Multiprocessor Systems, Scheduling of Tasks with Temporal Distance Constraints. 9 Unit 5 Real Time Communication : Model of Real Time Communication, Soft and Hard RTCommunication systems , Priority -Based Service and Weighted Round -Robin Service Disciplines for Switched Networks, Medium Access Control Protocols forBroadcast Networks, Internet and Resource Reservation P rotocols, Real Time Protocols, Communication in Multicomputer System. An Overview of Real Time Operating Systems and Databases: Features of RTOS, UNIX as RTOS, POSIX Issues, Temporal Consistency, Concurrency Control. 8 References: 1. Real Time Systems: Theory and Practice – Mall Rajib, Pearson Education, 2009 2. Real-Time Systems: Scheduling, Analysis, and Verification – Albert M. K. Cheng, Wiley, 2002. 3. H. Kopetz, "Real time systems: Design Principles for distributed embedded applications", Springer Publications, 2011. 4. Douglass, Real Time UML: Advances in the UML for Real -Time Systems, 3/e, AddisonWesley, 2004. 5. Awad, Kuusela& Ziegler, Object -Oriented Technology for Real Time Systems: A Practical Approach Using OMT and Fusion, l/e, Pearson Education, 1996. 6. Ward & Mellor, Structured Development for Real -Time Systems, Vol. III: Implementation Modeling Techniques, Prentice Hall, 1986. 146 Robotics and Control Prerequisite: None L T P C Total hours: 42 3 0 0 3 Course Content Hrs. Unit 1 Introduction to robotics -origin of automation, Classification of robots, Rotations and translation of vectors. 8 Unit 2 Transformations and Euler angle representations, Homogeneous transformations, Problems, Trajectory planning. 10 Unit 3 Actuators, Velocity and position sensors. Range, proximity, touch sensors. 10 Unit 4 Control of Robot Manipulators: PD control, Nonlinear Control, Stability, Lyapunov's Direct Method. 8 Unit 5 Adaptive Control, Robot Vision, Image segmentation, Template matching, Polyhedral objects, Shape analysis, Grasping and industrial automation. 6 References: 1. M. Spong, S. Hutchinson, and M. Vidyasagar, Robot Modeling and Control Wiley (2006) 2. Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, "Industrial Robotics, Technology programming and Applications", 3. Craig. J. J. "Introduction to Robotics - mechanics and control", Addison - Wesley, 1999 4. Nagrath Gopal "Control Systems Engineering -Principles and Design" New Age Publishers 5. K. Ogata, "Modern control engineering", Pearson 2002. 147 Security Analysis of Protocols Prerequisite: L T P C Total hours: 4 0 3 0 0 3 Course Content Hrs. Unit 1 Cryptographic background; Authentication, Key establishment and IP security; 8 Unit 2 Denial of service; Anonymity and MIX networks; Fairness and contract signing, Privacy and protection of individual information; Wireless security (mobile phones, WiFi); 12 Unit 3 Protocol analysis tools: Finite -state checking; Infinite -state symbolic analysis; Probabilistic model checking; Game -based verification; Process algebras (spi -calculus and applied pi calculus); Protocol logics (BAN, DDMP, Isabelle); 12 Unit 4 Introduction to Probabilistic polynomial time calculus; Relating cryptographic and formal models. 8 References: 1. Latest reputed conference and journal articles as chosen by the instructor. 2. Maximum Security, 2nd Edition, SAMS Books by Anonymous, 1998 3. Maximum Linux Security, SAMS Books by Anonymous, 2000,

ISBN: 0 -672- 31670 -6. 4. 10 Risks of PKI: What You're not Being Told about Public Key Infrastructure, by Ellison and Schneier 148 Selected Topics in Cryptography Prerequisite: L T P C Total hours: 4 0 3 0 0 3 Course Content Hrs. Unit 1 Basic Concepts: Information theoretic vs. computational security. One way functions, Pseudo randomness generators and functions, Permutations, hash functions. 8 Unit 2 Private -key encryption using pseudo randomness. Private -key authentication. – Public key encryption (and number theory). Public key authentication. 12 Unit 3 Interactive protocols: Touch of complexity theory, Interactive proof systems; 0 -knowledge proof systems, 0 -knowledge authentication, Electronic cash; non -interactive zero -knowledge. 12 Unit 4 Oblivious transfer: Definitions, constructions, and applications, Secure Multiparty computations, Database (differential) privacy. – Proofs of work – Block -chain consensus protocols. 8 References: 1. Introduction to Modern Cryptography: Principles and Protocols, by Jonathan Katz and Yehuda Lindell 2. A Graduate Course in Applied Cryptography by Dan Boneh and Victor Shoup 3. The Joy of Cryptography by Mike Rosulek. 4. Oded Goldreich: Foundations of Cryptography Vol 1 and Vol 2 149 Social Media Mining Prerequisite: None L T P C Total hours: 42 3 0 0 3 Course Content Hrs. Unit 1 Online Social Networks (OSNs): Introduction - Types of social networks (e.g., Twitter, Facebook), Measurement and Collection of Social Network Data. 8 Unit 2 Social Networks - Basic Structure and Measures, Basics of Text Processing over Social Data, Entity linking and entity resolution for Social data. 10 Unit 3 Characteristics of OSNs: Information Diffusion, Experimental studies over OSNs, Sampling, Fundamentals of Social Data Analytics: Topic Models, Random Walks, Heterogeneous Information Networks 10 Unit 4 Applied Social Data Analytics: Recommendation Systems, Community identification and link prediction. 8 Unit 5 Advanced Topics: Online experiments for Computational Social Science, Big Data Sampling 6 References: 1. Matthew A. Russell. Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Google+, Github, and More, 2nd Edition, O'Reilly Media 2. Jennifer Golbeck, Analyzing the social web, Morgan Kaufmann 3. Charu Aggarwal (ed.), Social Network Data Analytics, Springer 4. Reza Zafarani, Mohammad Ali Abbasi, Huan Liu, Social Media Mining An Introduction, Cambridge University Press 150 Software Project Management Prerequisite: Software Engineering, Computer Programming (C/Java/Python/C++), Microsoft Excel L T P C Total hours: 42 3 0 0 3 Course Content Hrs. Unit 1 Software Project Concepts: Software Project Categorization, Stakeholders, Software project Activities, Practices & Standards, Selecting Process Models (Spiral, Incremental, Prototyping, RAD, Agile). 8 Unit 2 Estimation & Evaluation techniques, Cost Benefit Analysis, Risk Analysis for Project Evaluation, Program management, Project effort and cost estimation; Basis of estimation, Estimation method categorization, SLOC, Function Point Analysis, COCOMO, Putnam's work. Estimation using FP. 10 Unit 3 Project Planning: Stepwise planning, Activity based approach (WBS), Sequencing and Scheduling of Activities, Critical Path Method. Risk Analysis and Management: Risk Identification, Projection, Risk Identification, Projection, Risk Refinement, Risk Monitoring and Management Schedule and Cost Monitoring: Collecting Data & Reporting, Graphical Visualization techniques, Cost Monitoring, Earned Value analysis, Requirements management, Change Control. 10 Unit 4 Contract Management: Types

of Contracts, Stages in Contract Placement, Typical Terms of a Contract, Contract Management and Acceptance. 6 Unit 5 Software Configuration Management (SCM), SCM Tools, Project Reviews Testing and Software Reliability, Metrics, ISO and CMMI, Project Scheduling & Tracking, Software Quality Assurance, Software Configuration Management 8 References: 1. Bob Hughes, Mike Cotterell, Rajib Mall, "Software Project Management", 6th Edition, Tata McGraw Hill, 2017. 2. Pankaj Jalote, Software Project Management in Practice. 3. Roger S. Pressman, Software Engineering 4. Royce, "Software Project Management", Pearson Education, 1999. 5. Robert K. Wysocki, Effective Software Project Management, Wiley, 2009. 151 System on Chip Prerequisite: None L T P C Total hours: 42 3 0 0 3 Course Content Hrs. Unit 1 Transaction -Level Modeling& Electronic System -Level Languages, 8 Unit 2 Hardware Accelerators, Media Instructions, Co-processors 10 Unit 3 System -Level Design Methodology ,High -Level Synthesis (Cto -RTL), 10 Unit 4 Hardware Synthesis and Architecture Techniques Source -Level Optimizations. 8 Unit 5 Scheduling Resource, Binding and Sharing. 6 References: 1. De Micheli, editor Special Issue on Hardware/Software Co -design Proceedings of IEEE, Vol 85, No. 3, March 1997 2. D. D. Gajski, F. Vahid, S. Narayan, J. Gong :Specification and Design of Embedded Systems, Prentice Hall, Englewood Cliffs, NJ, 1994 3. J. Staunstrup and W. Wolf, editors: Hardware/Software Co -Design: Principles and Practice Kluwer Academic Publishers, 1997 4. G. DeMicheli, R. Ernst, and W. Wolf, editors, Readings in Hardware/Software Co -Design, Academic Press, 2002. 152 Wireless Sensor Networks Prerequisite: None L T P C Total hours: 42 3 0 0 3 Course Content Hrs. Unit 1 Introduction: Introduction to adhoc /sensor networks: Key definitions of adhoc/sensor networks, unique constraints and challenges, advantages of adhoc/sensor network, driving applications, issues in adhoc wireless networks/sensor network, data dissemination and gathering, Historical Survey of Sensor Networks 8 Unit 2 Basic Architectural Framework:Traditional layered stack, Cross -layer designs, Sensor network architecture, Physical Layer, Basic Components, Hardware Platforms: Motes, Sensor Devices, Types of Sensors, Sensor's Specification 8 Unit 3 MAC Protocols : Fundamentals of MAC protocols - Low duty cycle protocols and wakeup concepts - Contention Based protocols - Schedule -based protocols - SMAC - BMAC - Traffic -adaptive medium access protocol (TRAMA) - The IEEE 802.15.4 MAC protocol. Routing P rotocols: Issues in designing a routing protocol, classification of routing protocols, table -driven, on -demand, hybrid, flooding, hierarchical, and power aware routing protocols. 12 Unit 4 Sensor network security: Security Requirements, Issues and Challenges in Security Provisioning, Network Security Attacks, Layer wise attacks in wireless sensor networks, possible solutions for jamming, tampering, black hole attack, flooding attack. Key Dis tribution and Management. 8 Unit 5 Secure Routing – SPINS, reliability requirements in sensor networks. Programming in WSNs: Challenges and limitations of programming WSNs, Introduction to TinyOS, - Programming in Tiny OS using NesC, Emulator TOSSIM, Open research issues 6 References: 1. Feng Zhao, Leonidas Guibas, " Wireless Sensor Network", Elsevier, 1st Ed. 2004 (ISBN: 13 - 978-1-55860 -914-3) 2. Kazem, Sohraby, Daniel Minoli, TaiebZnati, "Wireless Sensor Network: Technology, Protocols and Application", John Wiley and Sons 1st Ed., 2007 (ISBN: 978 -0-471-74300 -2). 3. Raghavendra, Cauligi

S, Sivalingam, Krishna M., ZantiTaieb, "Wireless Sensor Network", Springer 1st Ed. 2004 (ISBN: 978 -4020 -7883 -5). 4. E. H. Callaway, Jr. E. H. Callaway, Wireless Sensor Networks Architecture and Protocols:, CRC Press , 2009

MTech\_2021\_CS.pdf MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR DEPARTMENT of Computer Science and Engineering M.Tech. Computer Science and Engineering Semester. I S.No. Course Code Course Title Course Category Type Credit L T P 1. 21CST501 Advanced Data Structures and Algorithms PC Theory 3 3 0 0 2 21CST503 Parallel and Distributed Computing PC Theory 4 3 0 2 3. 21CST502 Advanced Databases PC Theory 3 3 0 0 4. 21CST813 Department Elective – 1 PE Theory 3 3 0 0 5. 21CST814 Department Elective – 2 PE Theory 3 3 0 0 6. 21CSP504 Programming Lab -1 PC Lab 2 0 1 2 Total 18 Semester. II S.No. Course Code Course Title Course Category Type Credit L T P 1. 21CST507 Research Methodology PC Theory 2 2 0 0 2 21CST842 Department Elective – 3 PE Theory 3 3 0 0 3. 21CST843 Department Elective – 4 PE Theory 3 3 0 0 4. 21CST844 Department Elective – 5 PE Theory 3 3 0 0 5. 21CST845 Department Elective – 6 PE Theory 3 3 0 0 6. 21CSP506 Programming Lab -2 PC Lab 2 0 1 2 7. 21CSP505 Design Lab /Computing Tools PC Lab 2 0 1 2 Total 18 Semester. III S.No. Course Code Course Title Course Category Type Credit L T P 1. 21CSS603 Technical Documentation and Presentation PC --- 2 0 1 2 2 21CSP602 Literature Review PC --- 2 0 1 2 3. 21CSD601 Dissertation – 1 PC --- 8 0 0 16 Total 12 Semester. IV S.No. Course Code Course Title Course Category Type Credit L T P 1. 21CSD604 Dissertation – 2 PC --- 12 0 0 24 Total 12 Total Credits: 60 MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST501 Course Name : Advanced Data Structures and Algorithms Credits : 3 L - 3 T - 0 P - 0 Course Type : Core Prerequisites: None Course Contents RAM model – Notations, Recurrence analysis - Master's theorem and its proof - Amortized analysis, Recurrence equations. Advanced Data Structures: B -Trees, Binomial Heaps, Fibonacci Heaps, AVL trees, Red -black trees, B -trees, Splay trees, Interval trees; Disjoint set – union and path compression, Amortized analysis Greedy Algorithms: shortest distance, minimum spanning tree, interval scheduling, interval partitioning; Divide and Conquer: sorting, integer and polynomial multiplication; Dynamic programming: Longest common subsequence. Chain of matrix multiplication, sequence alignment, Bellman Ford Convex hull and Voronoi diagrams, line segments, Optimal polygon triangulation; Primality testing, Integer factorization; Graph algorithms: Matching and Flows; Parallel algorithms: Basic techniques for sorting, searching, merging. Intractability: Independent Set, Vertex Cover, Randomized algorithms, Probabilistic algorithms. Approximate Algorithms: Vertex -cover, set -covering problems, Travelling Salesman problem. Complexity classes - NP-Hard and NP -complete Problems - Cook's theorem NP completeness reductions, undecidability Recommended Readings Text Books: - 1. Cormen, Leiserson, Rivest: Introduction to Algorithms, Prentice Hall of India. 2. AhoA.V , J.D Ullman: Design and analysis of Algorithms, Addison Wesley 3. Brassard : Fundamental of Algorithmics, PHI. 4. Sara Baase: Computer Algorithms: Introduction to Design and Analysis, Pearson Education. 5. Papadimitriou, Steiglitz: Combinatorial Optimization: Algorithms and Complexity, PHI 6. Motwani and Raghavan:

Randomized Algorithms, Cambridge University Press 7. Vazirani: Approximation Algorithms, Springer Verlag 8. Joseph Ja'Ja': Introduction to Parallel Algorithms, Addison -Wesley 9. Kleinberg, Tardos: Algorithm Design, Addison Wesley. 10. Dexter Kozen: The Design and Analysis of Algorithms. Springer, 1992 11. Sanjoy Dasgupta, Christos Papadimitriou, and Umesh Vazirani: Algorithms, McGraw Hill. 12. Robert Sedgewick and Kevin Wayne. Algorithms 4/e. Addison -Wesley. 13. Robert Tarjan: Data Structures and Network Algorithms, Society for Industrial and Applied Mathematics

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR**

Department/Centre : Department of Computer Science & Engineering Course Code : 21CST503 Course Name : Parallel and Distributed Computing Credits : 4 L - 3 T - 0 P - 2 Course Type : Core Prerequisites: Programming in C, Data Structures, Operating Systems, Computer Architecture and Organization, Computer Networks

**Course Contents** Parallel Computing, Sequential programs, Parallel Programs, Performance Metrics for Parallel Systems, Effect of Granularity on Performance, Scalability of Parallel Systems, Parallel Programming Platforms, Implicit Parallelism, SIMD & MIMD systems, Clusters, Single -Core and Multi -Core Processors, Physical Organization of Parallel Platforms, Cache Coherence, Interconnection Networks for Parallel Computers. Programming Using the Message -Passing Paradigm - MPI Principles of Message Passing Programming; Building blocks (Sending and Receiving Operations); Communication Library calls; Collective communication and Computation library calls, Programming Shared Address Space Platforms – OpenMP, Directive Parallel Programming; The OpenMP programming Model (Concurrent Tasks, Synchronization Constructs, Data Handling); Open libraries; OpenMP -Environment Variables; Parallel Programs, Matrix Computations, Matrix Vector Multiplication, Matrix - Matrix Multiplication, Solving system of Linear Equations; Parallel Implementation of Sparse Matrix Computations with Vector; Sorting algorithms, Issues in Sorting on Parallel Computers; Bubble Sort and its Variants, Quicksort; Parallelizing Quicksort; Sequential and Parallel Implementation of all -pairs of Shortest Paths Algorithms; Sequential & Parallel Search Algorithms; Depth -First Search Algorithms; Best - First Search Algorithms, Programming on Multi -Core Systems with GPU accelerators An Overview of Brief History of GPUs; An Overview of GPU Programming; An Overview of GPU Memory Hierarchy Features; An Overview of CUDA enabled NVIDIA GPUs, Introduction to CUDA C, Parallel Programming using OpenACC, CUDA APIs, CUDA Libraries for Numerical and Non -Numerical Computations; The OpenCL – Heterogeneous Programming; OpenCL Libraries, The OpenCL Memory Model, Execution Model; Platform and Devices; An Overview of OpenCL API; An Overview of MapReduce, An Overview of MapReduce Programming, An Overview of Hadoop Architecture /Execution (Master/slave, Namenode/Datanode); Hadoop Distributed File System (HDFS), An Overview of Hadoop Components, Hadoop – Control Flow and Data Flow; An overview of Hive (Distributed Data Warehouse); Hbase (Distributed Column based database, PIG –(Data Flow Language); Recommended Readings Text Books: - 1. Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar: Introduction to Parallel Computing, Second Edition Pearson Education – 2007 2. Peter Pacheco, An Introduction to Parallel Programming, Morgan Kaufman Publishers, Elsevier (2011) 3. Jason

Sanders, Edward and Kandrot, CUDA By Example – An Introduction to General-Purpose GPU Programming, Addison Wesley (2011) 4. Rohit Chandra, Leonardo Dagum, Dave Kohr, Dror Maydan, Jeff McDonald, Ramesh Menon, Parallel Programming in OpenMP, Academic Press (2001) 5. Benedict R Gaster, Lee Howes, David R Kaeli, Perhaad Mistry Dana Schaa, (2011), Heterogeneous Computing with OpenCL McGraw-Hill, Inc. New York 6. Michael J. Quinn, Parallel Programming in C with MPI and OpenMP McGraw-Hill International Ed (2003) 7. Arun C Murthy, Vinod Kumar Vavilapalli, Doug Eadline, Joseph Niemiec, and Jeff Markham, Apache Hadoop YARN Moving beyond MapReduce and Batch Processing with Apache Hadoop 2, Addison Wesley, 2014

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR**  
Department/Centre : Department of Computer Science & Engineering Course Code : 21CST502 Course Name : Advances in Databases Credits : 3 L - 3 T - 0 P - 0 Course Type : Core Prerequisites: Basic course in Database Management Systems Course Contents Query Processing and Optimization – Implementation of Database operations, External Sorting, Size Estimations, Equivalence Rules, Heuristic-based Optimization, Materialized Views, Incremental View Maintenance. Transaction Processing - Concurrency Control Management, Serializability, Two-phase Lock Protocol, Deadlock Prevention and Detection, Timestamp-based Ordering Protocol, Log-based Recovery Management. Modern Database Systems - Database System Architectures, Distributed Database Systems, Parallel Databases, Times in Databases, Multimedia Databases Distributed Databases - Data Storage, Global Catalog, Distributed Transaction Processing, Two-Phase Commit Protocol, Distributed Query Processing. Recommended Readings Text Books: - 1. Silberschatz, Korth, Sudarshan : Database System Concepts, McGraw Hill. 2. Elmasri and Navathe : Fundamentals of Database Systems, 3rd Edition, Addison

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR**  
Department/Centre : Department of Computer Science & Engineering Course Code : 21CSP504 Course Name : Programming Lab – 1 Credits : 2 L - 0 T - 1 P - 2 Course Type : Core Prerequisites: Course Contents Programming exercises and experiments in Algorithms Dynamic programming and Approximate Algorithms. Combinatorial algorithms, Randomized algorithms, Graph algorithms: Parallel algorithms: Basic techniques for sorting, searching, merging Programming exercises and experiments in Parallel and Distributed Computing. Parallel processing terminology, Pipelining Vs Data parallelism, multi-threaded architectures. Parallel reduction, Prefix sums, List ranking, preorder tree traversal, Merging two sorted lists Distributed and shared memory, Hadoop and MapReduce Programming exercises and experiments in Advanced Data structure and database . Advanced Lists, Segment Tree, Trie, Binary indexed tree. Self-Balancing BSTs, N-ary Tree. Disjoint Set, Suffix Array and Tree. Recommended Readings Text Books: - 1. Cormen, Leiserson, Rivest: Introduction to Algorithms, Prentice Hall of India 2. N. Deo: Graph Theory with Application to Engineering and Computer Science, Prentice-Hall 3. Ghosh, Moona and Gupta, Foundations of parallel processing, Narosa publishing. 4. Ed. Afonso Ferreira and Jose' D. P. Rolin, Parallel Algorithms for irregular problems - State of the art, Kluwer Academic Publishers

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR**  
Department/Centre : Department of Computer Science & Engineering Course Code :



21CST507 Course Name : Research Methodology Credits : 2 L - 2 T - 0 P - 0 Course Type : Core Prerequisites: None Course Contents Unit I: Data Structures and Algorithms: Review of Data Structures, and most commonly used algorithms in Computer Science and Engineering – Sorting, DFS/BFS, Pattern Searching. Unit II: Linear Algebra: Vectors - linear vector spaces, linear independence, norms and inner products, Basis and dimension, Matrices, Matrix operations, Inverse of a matrix Orthogonalization, Properties of determinants, Eigenvalues and eigenvectors, SVD and pseudo inverse, KL or hotelling transform. Unit III: Transforms Signals and representation, Convolution, Frequency Transforms, Properties of Fourier Transform, DFT, DCT and FFT, Introduction to wavelets, applications in Computer Science and Engineering Unit III: Probability and Statistics Statistics: Introduction to statistical analysis, hypothesis testing – null and alternate, statistical tests – chi- square, ANOVA, data validation Probability models and axioms, Bayes' rule, discrete and continuous random variables, Probability distributions: normal distribution and properties, conditional, marginal and joint probability distribution, PRNG (pseudo random number generators) - randomness tests, introduction to information theory and cryptography: an Introduction Unit IV: Machine Learning: Linear and non -linear regression, supervised learning – neural network, binary decision diagram, SVM, k -NN, unsupervised learning – Clustering, Hidden Markov Models, Introduction to deep learning. Unit V: Case Studies in Research Domain s of CSE. Recommended Readings Text Books: - 1. Gilbert Strang: Linear Algebra, MIT Cambridge Press. 2. Sheldon Ross: First Course in Probability, Pearson. 3. Mark Girolami, Simon Rogers: First Course In Machine Learning, CRC Press. 4. Anirban Das Gupta: Probability and Statistics for Machine Learning, Springer. 5. The Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani, second ed, Springer 6. Ian Goodfellow: Deeplearning, MIT Cambridge Press. MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CSP506 Course Name : Programming Lab – 2 Credits : 2 L - 1 T - 0 P - 3 Course Type : Elective Prerequisites: Programming Skills, Data Structures, Computer Networks Course Contents 1) Programming exercises and experiments in Operating Systems a. Kernel compilation and configuration, kernel modules, system calls and in -line assembly. b. Memory management, process management and scheduling c. Interrupts and interrupt handlers, synchronization etc. 2) Programming exercises and experiments in Advanced Database management systems. a. Cloud Databases: MongoDB/Cassandra etc. b. Transaction Processing: Practice on transaction processing 3) Programming assignments on NetSim and Libalium Recommended Readings Text Books: - 1. Stevens, W. R., “Unix Network Programming: Vol. II”, 2nd Ed., Pearson Education 2. Daniel P.Bovet, Marco Cesati, O'Reilly , “Understanding the Linux Kernel” Thir d Edition, 2005 3. Robert Love , “Linux Kernel Development”, Pearson Education, Third Edition, 2010 4. LAN Trainer user Manual. 5. Lee chao, “Cloud Database Development and Management”, CRC Publisher, 2013 MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAI PUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CSP505 Course Name : Design Lab / Computing Tools Credits : 2 L - 0 T - 1 P - 2 Course Type : Core Prerequisites: Students must have prior programming experience

in C/C++ or any language; mathematics through differential equations, and numerical analysis Course Contents Operating Systems and Unix Environments: features of UNIX/Linux for scientific and technical computing; languages, compilers, debuggers, performance tools, make files, build systems, shell scripting, file management, source code control. Research Documentation and Simple Data Visualization: tools for generating research and code documentation: LATEX, D oxygen, plotting tools. Software Best Practices: software design cycle, regression testing, defensive programming, verification, code coverage Scientific Libraries: availability of common math libraries and usage for scientific computing.High performance C omputing (HPC): Tool and techniques. Recommended Readings Text Books: - 1. Eric S. Raymond, The Art of Unix Programming, Addison -Wesley 2003 2. Heister, T. and Rebholz, L. G., Introduction to Scientific Computing for Scientists and Engineers. De Gruyter Press, 2015. 3. John Levesque, High Performance Computing: Programming and Applications Electives Courses for PG -CSE 1. 21CST802 Advanced Computer Networks 2. 21CST824 Network on Chip 3. 21CST803 Advances in Compiler Design 4. 21CST804 Android Programming 5. 21CST806 Computer Vision 6. 21CST807 Cyber Physical Systems 7. 21CST808 Data Analytics 8. 21CST809 Data Compression 9. 21CST810 Data Mining 10. 21CST812 Deep Learning 11. 21CST815 Distributed Systems 12. 21CST816 E-Commerce 13. 21CST817 Hardware Software Codesign 14. 21CST818 Image Analysis 15. 21CST819 Information Retrieval 16. 21CST820 Internet of Things 17. 21CST822 Natural Language Processing 18. 21CST823 Nature Inspired Algorithms 19. 21CST825 Network Performance Modelling 20. 21CST826 Neural Networks 21. 21CST827 Parallel Processing & Algorithms 22. 21CST828 Parallelizing Compiler 23. 21CST830 Quantum Computing 24. 21CST831 Real Time Systems 25. 21CST832 Robotics and Control 26. 21CST801 5G Technology 27. 21CST834 Selected Topics in Operating System 28. 21CST833 Selected Topics in Computing 29. 21CST835 Social Media Mining 30. 21CST836 Social Network Analysis 31. 21CST837 Software Project Management 32. 21CST838 Software Testing and Validation 33. 21CST840 VLSI Algorithms 34. 21CST841 Wireless Sensor Networks 35. 21CST821 Machine Learning 36. 21CST829 Pattern Recognition 37. 21CST805 Big Data Analytics 38. 21CST811 Data Visualization 39. 21CST839 System on Chip 40. 21CSL760 Program Analysis MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST802 Course Name : Advanced Computer Networks Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Wireless networking: Bluetooth, 802.11 standards Information theory, bandwidth, multiple access Wireless Terahertz Networks 5G and 6G communication Intelligent Transportation Systems Emerging networking technologies: Host configuration and service discovery principles Future routing architectures IPv6 deployment scenarios and challenges, IPv6 transition/integration Advanced IP multicast, including IPv6 multicast and SSM Software -defined networking Delay - tolerant networking Future home network architectures IP network management and monitoring. Social Networks Recommended Readings Text Books: - 1. Tanenbaum A S and Wetherall D J (2010). Computer Networks. 2. Hagen S, (2006). IPv6 Essentials. 3. Recent publications on

the relevant fields MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR  
 Department/Centre : Department of Computer Science & Engineering Course Code : 21CST824 Course Name : Network on Chip Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Computer Architecture, Logic System Design Course Contents The Concept of route packet not wires for On -Chip Interconnection Networks, Topology and design architecture of Network -on-Chip, Area and power trade off NoC protocols, Routing and Flow Control mechanism, Verification of Communications in Networks -on-Chips. Application Mapping on Network -on-Chip, Resource Allocation for QoS On -Chip Communication, routing techniques in different 2D/ 3D NoC topology, performance evaluation in terms of throughput, latency, jitter. Signal Integrity and Reliability of Network -on-Chip, Testing of Network -on- Chip Architectures, Test and Fault Tolerance for NoC Infrastructures, Reconfigurable Network -on-Chip Design, Security in NoCs. Energy and Power estimation techniques Network -on-Chips Recommended Readings Text Books: - 1. Giovanni De Micheli, Luca Benini, Davide Bertozzi, Networks on Chips: Technology and Tools, Morgan Kaufmann, 2006. 2. Fayez Gebali, Haytham Elmiligi, Mohamed Watheq El -Kharashi, Networks on - Chips: Theory and Practice, CRC Press, 2017. 3. Sudeep Pasricha, Nikil Dutt, On -Chip Communication Architectures: System on Chip Interconnect, Morgan Kaufmann, 2010. MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST803 Course Name : Advances in Compiler Design Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Basic course in Compiler Design Course Contents Modern Compiler Design – Structure of Compilers for Modern Programming Languages, Cross Compiler, Just -In-Time (JIT) and Adaptive Compilation, Runtime System Architectures. Parser Development - LR Parsers and LR Grammars – Design and Implementation, Parser and Ambiguity, Conflict Resolution, Lex and Yacc Tools. Optimizing Compiler - Control -flow Analysis, Control -flow Graphs, Basic Blocks, Data -flow Analysis Methods, Dependence Analysis, Global Optimizations, Loop Optimizations, Peephole Optimization and Optimal Code Generation, Data Dependence Analysis in Loops, Loop Scheduling. Recommended Readings Text Books: - 1. Aho, Lam, Sethi and Ullman: Compilers – Principles, Techniques and Tools, Pearson Education 2. Steven Muchnick : Advanced Compiler Design & Implementation, Morgan Kaufmann 3. Holub: Compiler Design in C, Prentice Hall India. 4. Keith Cooper and Linda Torczon : Engineering a Compiler, Morgan Kaufmann. MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST804 Course Name : Android Programming Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Basics: Review of Java Programming, Setting up and configuring Android Studio setup, Android Emulator Hello Android example, AndroidManifest.xml, R.java file, Activity, Fragment, Layout Manager - Relative Layout, Linear Layout, Table Layout, Grid Layout. Activity, Intent & Fragment: Activity Lifecycle, Activity Example, Intent – implicit and explicit, Intent filters, Fragment Lifecycle, Fragment Example, UI Widgets – buttons (toggle, switch, image), check box; Android Menu: Option Menu, Context Menu, Popup Menu; View. Android Service: lifecycle, example, Data Storage, Shared Preference, SQLite,

Content Provider, Android Notification Adding functionality: Multimedia API, Speech API, telephony API, Location API Sensors: Sensor API, Working with WiFi, Working with Camera, Motion Sensor, Position Sensor; Android Graphics App development project. Recommended Readings Text Books: - 1. Official Android Website

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR** Department/Centre : Department of Computer Science & Engineering Course Code : 21CST806 Course Name : Computer Vision Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Introduction, Pixels and Filters, Image pyramids and Fourier transform, Hough transform, Edge detection, RANSAC, Feature detectors, Harris, Feature descriptors, Corner detection and matching, 2D transformations, Image homographs, Camera models, camera calibration, radiometry, color, shading, Bag of words, SIFT, SURF, Segmentation, Image indexing and search, Nearest Neighbor Match, Object Recognition, Face recognition, Differential motion: Optical flow, Feature Tracking & Motion Layers, Performance Evaluation Recommended Readings Text Books: - 1. Computer Vision: Algorithms and Applications, by Richard Szeliski 2. Computer Vision: A Modern Approach, by David Forsyth and Jean Ponce. 3. Computer Vision: Models, Learning, and Inference by, Simon J. D. Prince, Cambridge University Press. 4. Concise Computer Vision: An Introduction Into Theory and Algorithms, by Reinhard Klette, Springer

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR** Department/Centre : Department of Computer Science & Engineering Course Code : 21CST807 Course Name : Cyber Physical Systems Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Characteristics of Cyber -Physical Systems (CPS) Cyber -Physical Systems (CPS) in the real world, Basic principles of design and validation of CPS, Industry 4.0, AutoSAR, IIOT implications, Building Automation, Medical CPS CPS physical systems modeling and formalisms: CPS - Platform components - CPS HW platforms - Processors, Sensors, Actuators, CPS Network - WirelessHart, CAN, Automotive Ethernet, Scheduling Real Time CPS tasks. Principles of Dynamical Systems - Dynamical Systems and Stability, Controller Design Techniques and Performance under Packet drop and Noise CPS implementation issues - From features to automotive software components, Mapping software components to ECUs, CPS Performance Analysis - effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion, and building real -time networks for CPS Safe Reinforcement Learning: Robot motion control, Autonomous Vehicle control Gaussian Process Learning, Smart Grid Demand Response , Building Automation Secure Deployment of CPS: Secure Task mapping and Partitioning, State estimation for attack detection, Automotive Case study : Vehicle ABS hacking, Power Distribution Case study : Attacks on SmartGrids Recommended Readings Text Books: - 1. "Introduction to Embedded Systems – A Cyber –Physical Systems Approach" - E. A. Lee, Sanjit Seshia 2. "Principles of Cyber -Physical Systems" - Rajeev Alur

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR** Department/Centre : Department of Computer Science & Engineering Course Code : 21CST808 Course Name : Data Analytics Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Fundamentals of Learning, Basic Programming skills, Course Contents Introduction: Data Analytics, Big Data, Current landscape of perspectives -

Skill sets needed; Statistical Inference -Populations and samples, Statistical modeling, Probability: Probability theory, conditional probability; probability distributions, fitting a model. Basic Analysis Techniques, Basic analysis techniques, Statistical hypothesis generation and testing, Chi -Square test, t -Test, Analysis of variance, Correlation analysis, Maximum likelihood test Exploratory Data Analysis (EDA) and the Data Science Process: Basic tools (plots, graphs and summary statistics) of EDA - Philosophy of EDA - The Data Science Process, Data Visualization - Basic principles, ideas and tools for data visualization. Python for common data analysis: libraries like NumPy, Pandas matplotlib, and seaborn. Data wrangling and management: Accessing database, CSV, and JSON data, Data cleaning and transformations, APIs and other tools for scraping the Web, Data Management : knowledge of SQL such as MySQL, NoSQL like MongoDB, Cassandra etc. Python for Data cleaning and transformations using Pandas and Sklearn. Mining Social -Network Graphs - Social networks as graphs - Clustering of graphs - Direct discovery of communities in graphs - Partitioning of graphs - Neighborhood properties in graphs. Recommended Readings Text Books: - 1. Trevor Hastie Robert Tibshirani Jerome Friedman, The Elements of Statistical Learning, Data Mining, Inference, and Prediction, 2nd Edn, Springer, 2014 2. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O'Reilly. 2014. 3. Jiawei Han, Micheline Kamber and Jian Pei. Data Mining: Concepts and Techniques, Third Edition. ISBN 0123814790. 2011. 4. Mohammed J. Zaki and Wagner Miera Jr. Data Mining and Analysis: Fundamental Concepts and Algorithms. Cambridge University Press. 2014.

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR** Department/Centre : Department of Computer Science & Engineering Course Code : 21CST809 Course Name : Data Compression Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Object Oriented Analysis and Design Course Contents Introduction: Compression techniques, lossless compression, lossy compression, measures of performance, modeling and coding. Mathematical preliminaries - Overview, introduction to information theory, models, physical models, probability models, Markov models. Basic Coding Schemes: Statistical Methods - Shannon -Fano Algorithm, Huffman Algorithm, Adaptive Huffman Coding. Arithmetic Coding (Encoding, Decoding, Adaptive Coding). Dictionary Methods - LZ77, LZ78, LZW Algorithms. Case study of lossless compression standards. Lossless Compression standards: zip, gzip, bzip, unix compress, GIF, JBIG. Image and Video Compression: Discrete Cosine Transform, JPEG. Wavelet Methods - Discrete Wavelet Transform, JPEG 2000. Motion Compensation, Temporal and Spatial Prediction. MPEG and H.264. Audio Compression: Digital Audio, WAV, FLAC, MPEG -1/2 Audio Layers. Recommended Readings Text Books: - 1. Khalid Sayood. 2012. Introduction to Data Compression (4th ed.). Elsevier 2. David Salomon, Giovanni Motta. 2010. Handbook of Data Compression. Springer, London

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR** Department/Centre : Department of Computer Science & Engineering Course Code : 21CST810 Course Name : Data Mining Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Introduction to data mining: Motivation and significance of data mining, data mining functionalities, interestingness measures, classification of data mining system, major issues in data

mining. Data pre -processing: Need, data summarization, data cleaning, data integration and transformation, data reduction techniques – Singular Value Decomposition (SVD), Discrete Fourier Transform (DFT), Discrete Wavelet Transform ((DWT), data discretization and concept hierarchy generalization. Mining frequent patterns, a ssociations and correlations: Basic concepts, efficient and scalable frequent itemset mining algorithms, mining various kinds of association rules – multilevel and multidimensional, association rule mining versus correlation analysis, constraint based asso ciation mining. Classification and prediction: Definition, decision tree induction, Bayesian classification, rule based classification, classification by backpropagation and support vector machines, associative classification, lazy learners, prediction, ac curacy and error measures. Cluster analysis: Definition, clustering algorithms partitioning, hierarchical, density based, grid based and model based; Clustering high dimensional data, constraint based cluster analysis, outlier analysis – density based and distance based. Data mining on complex data and applications: Algorithms for mining of spatial data, multimedia data, text data; Data mining applications, social impacts of data mining, trends in data mining.

Recommended Readings Text Books: - 1. Han, J . and Kamber, M., “Data Mining - Concepts and Techniques”, 3rd Ed., Morgan Kaufmann Series . 2. Ali, A. B. M. S. and Wasimi, S. A., “Data Mining - Methods and Techniques”, Cengage Publishers. 3. Tan, P.N., Steinbach, M. and Kumar, V., “Introduction to Data Mining”, Addison Wesley – Pearson 4. Pujari, A. K., “Data Mining Techniques”, 4th Ed., Sangam Books.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST812 Course Name : Deep Learning Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Course Overview: Introduction to Deep Learning and its Applications. Introduction to Statistical Learning: Multi -Layer Perceptron, Back P ropagation, Linear Regression, etc. Convolutional Neural Networks: Convolution, pooling, Activation Functions, Back propagation of CNN, Weights as templates, Translation invariance, Training with shared parameters. CNN Architecture Design and Discussion: A lexNet, VGG, GoogLeNet, ResNet, Capsule Net, etc. Loss Functions and Optimization: Optimization, stochastic gradient descent, dropout, batch normalization, etc. Sequential Modelling: Recurrent and Recursive Nets, RNN, LSTM, GRU, Image captioning, visual qu estion answering, etc. Visualization and Understanding: Visualizing intermediate features and outputs, Saliency maps, Visualizing neurons, Cam -Grad, etc. Generative Models: VariationalAutoencoders, Generative Adversarial Networks like pix2pix, CycleGAN, et c Deep Reinforcement Learning: Reinforcement Learning (RL) Background, Policy gradients, hard attention Q -Learning Deep Learning Applications: Object Detection: RCNN, Fast RCNN, Faster RCNN, YOLO, Retina Net, SSD, etc. Semantic Segmentation: DeepLabV3, PS P Net, etc. Adversarial Attacks on CNN

Recommended Readings Text Books: - 1. Ian Goodfellow and YoshuaBengio and Aaron Courville, “Deep Learning,” MIT Press. 2. Michael A. Nielsen, “Neural Networks and Deep Learning,” Determination Press, 2015. MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST815 Course Name : Distributed Systems Credits : 3

L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents

Introduction to Distributed Systems, OS and Advanced OS, various distributed systems, Trends in Distributed System and challenges, Networking: network protocols, point -to-point communication. Introduction – Clocks, events and process states – Synchronizing physical clocks - Logical time and logical clocks – Global states, Limitations, Lamport’s logical clock, vector clock, causal ordering, global state, Cuts. Distributed Mutual Exclusion: Lamport, Recart -agrawala, and Maekawa’s algorithms; Suzuki-kasami broadcast algorithm, and Raymond’s tree based algorithm, Elections algorithms, Transactions and Concurrency Control – Transactions -Nested transactions – Locks – Optimistic concurrency control – Timestamp ordering – Atomic Commit Distributed transactions: two phase commit, three -phase commit, ACID/BASE models Techniques of Inter process Communication: the API for internet protocols – External data representation and Multicast communication, Sun RPC: programming and implementation, Network virtualization: Overlay networks. Case study: MPI Remote Method Invocation And Objects: Remote Invocation – Introduction – Request -reply protocols – Remote procedure call – Remote method invocation. Case study: Java RMI – Group communication – Publish -subscribe systems – Message queues – Shared memory approaches – Distributed objects – Case study: Enterprise Java Beans -from objects to components. Distributed Deadlock Detection: Resource Vs. Communication deadlock, Replication, Strategies to handle deadlock, Ho -Ramamoorthy, Path -Pushing, Edge -Chasing, Diffusion Computation -based algorithms. Agreement Protocols: System model, Classification of agreement problems, Solutions to Byzantine Agreement (BA) problems. Distributed Scheduling: Issues in Load Distribution, Components of a load distribution algorithm, Load Distribution Algorithms, V -system, Sprite, and Condor. Network file systems: design, NFS, AFS (scale), DFS & CIFS (cache control), CODA (redundancy) Google File System (GFS), Hadoop Distributed File System (HDFS) Distributed Shared Memory: Algorithms for implementing DSMs, Memory Coherence, and Coherence Protocols, IVY Process Management: Process Migration: Features, Mechanism – Threads: Models, Issues, Implementation. Resource Management: Introduction - Features of Scheduling Algorithms –Task Assignment Approach – Load Balancing Approach – Load Sharing Approach Recovery: Classification of failures, Synchronous and Asynchronous Check pointing and Recovery. Fault Tolerance: Commit Protocols, Voting Protocols, Failure Resilient Processes. Protection and Security: Access Matrix Model, Implementation of access matrix, Unix, and Amoeba. Case study -Distributed systems Recommended Readings Text Books: - 1. Andrew S. Tanenbaum, Maarten Van Steen, “Distributed Systems Principles and Paradigm,” 2nd Edition, Pearson 2. George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair “Distributed Systems - Concepts and Design,” 5th Edition, Pearson 3. M. Singhal & N. Shivaratri, “Advanced Concepts in Operating Systems: Distributed, Database and Multiprocessor Operating Systems”, Tata McGraw Hill, 2015 4. John Bloomer, “Power Programming with RPC,” O’Reilly & Associates, Inc 5. Advanced Programming in the Unix Environment by W. Richard Stevens, Addison -Wesley, 6. Liu M.L., “Distributed Computing, Principles and Applications”, Pearson Education, 7. Distributed Systems - An Algorithmic approach by Sukumar Ghosh MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY

JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST816 Course Name : E -Commerce Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: knowledge of Digital Market, Basics of Computer Network and security Course Contents Introduction: Definition of Electronic Commerce, technology and prospects, incentives for engaging in electronic commerce, needs of E -Commerce, E -Commerce Infrastructure, advantages and disadvantages, Impact of E -commerce on business, E -Commerce Models. Network Infrastructure for E - Commerce. Internet and Intranet based E -commerce: Issues, problems and prospects, Network Infrastructure, Network Access Equipments, Broadband telecommunication. Mobile Commerce: Introduction, Wireless Application Protocol, WAP technology, Mobile Information device. Web Security: Security Issues on web, Importance of Firewall, components of Firewall, Transaction security, Emerging client server, Security Threats, Network Security, Factors to consider in Firewall design, Limitation of Firewalls. Encryption: Encryption techniques, Symmetric Encryption: Keys and data encryption standard, Triple encryption, Secret key encryption; Asymmetric encryption: public and private pair key encryption, Digital Signatures, Virtual Private Network. Customer Service Expectations of the E -commerce Experience, Electronic Payments: Overview, The SET protocol, Payment: Smart card, credit card, magnetic strip card, E -Checks, Credit/Debit card based EPS, online Banking. EDI Application in business, E- Commerce Law, Forms of Agreement, Govt. policies and Agenda Recommended Readings Text Books: - 1. Turban, "Electronic Commerce 2004: A Managerial Perspective", Pearson Education 2. Pete Lohsin , John Vacca "Electronic Commerce", New Age International 3. Bajaj and Nag, "E -Commerce the cutting edge of Business", TMH 6 4. Laudon, "E -Commerce: Business, Technology, Society", Pearson Education MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST817 Course Name : Hardware Software Codesign Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Logic System Design/ Digital Logic Design Course Contents Codesign overview, device Modeling and methodologies of system design, Hardware software partitioning and scheduling, Co simulation, synthesis and verifications, Architecture, Interface and reconfiguration, System on chip, Application specific processors ( DSP), Codesign tools and case studies Recommended Readings Text Books: - 1. A Practical Introduction to Hardware/Software Codesign, Patrick Schaumont, Springer, 2009, ISBN 978 -1-4419 -5999 -7 2. Specification and Design of Embedded Systems Daniel D. Gajski , Frank Vahid, S. Narayan, & J. Gong, Prentice Hall, 1994 3. Hardware / Software Co -Design: Principles and Practice, JStaunstrup and Wayne Wolf, Prentice Hall, 1994. MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST818 Course Name : Image Analysis Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Image Preliminaries & Image Processing: Overview, Computer imaging systems, Human visual system, image model, etc. Geometric transformations: Translation, rotation, scaling and shearing. Frequency transformation: Discrete Fourier transform (DFT), fast Fourier transform (FFT), short - time Fourier transform (STFT), Multi -resolution Expansions:



Wavelet Transforms in 1 -D and 2 - D. The Fast Wavelet Transform Wavelet Packets Transform. Feature Extraction and Dimension Reduction Color, Texture, Shape and structure Features in spatial and frequency domains, Corner Detection, Hough Transform, Principal Component Analysis, Linear Discriminant Analysis, Feature Reduction in Input and Feature Spaces. Image Segmentation. Gray -level thresholding, Supervised vs. Unsupervised thresholding, Binarization using Otsu's method, Locally adaptive thresholding, Color -based segmentation, Region oriented segmentation, Use of motion in segmentation, Spatial techniques, Frequency domain techniques. Features Based Image Matching: Scale Space Image Processing, Different Feature descriptors: Key Point Detection, SIFT descriptor SURF descriptor Bag of Visual Words approach, Geometric consistency check, Vocabulary tree Panoramic Imaging, Template Matching, Mono Panorama, Stereo Panorama. Recommended Readings Text Books: - 1. J G Proakis and D G Manolakis, "Digital Signal Processing," Pearson, Fourth edition 2. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Prentice Hall, 3rd Edition, 2007. 3. Bishop, Pattern Recognition and Machine Learning 4. Duda, Pattern Classification MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST819 Course Name : Information Retrieval Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Introduction to Information Retrieval: The nature of unstructured and semi -structured text. Inverted index and Boolean queries. Text Indexing, Storage and Compression: Text encoding: tokenization, stemming, stop words, phrases, index optimization. Index compression: lexicon compression and postings, lists compression. Gap encoding, gamma codes, Zipf's Law. Index construction. Postings size estimation, merge sort, dynamic indexing, positional indexes, n -gram indexes, real -world issues. Retrieval Models: Boolean, vector space, TFIDF, Okapi, probabilistic, language modeling, latent semantic indexing. Vector space scoring. The cosine measure. Efficiency considerations. Document length normalization. Relevance feedback and query expansion. Rocchio. Performance Evaluation: Evaluating search engines. User happiness, precision, recall, F -measure. Creating test collections: kappa measure, interjudge agreement. Text Categorization and Filtering: Introduction to text classification. Naive Bayes models. Spam filtering. Vector space classification using hyperplanes; centroids; k Nearest Neighbors. Support vector machine classifiers. Kernel functions. Boosting. Text Clustering: Clustering versus classification. Partitioning methods. k -means clustering. Mixture of Gaussians model. Hierarchical agglomerative clustering. Clustering terms using documents. Advanced Topics: Summarization, Topic detection and tracking, Personalization, Question answering, Cross language information retrieval. Web Information Retrieval: Hypertext, web crawling, search engines, ranking, link analysis, PageRank, HITS, XML and Semantic web. Recommended Readings Text Books: - 1. Manning, Raghavan and Schutze, Introduction to Information Retrieval, Cambridge University Press. 2. Baeza -Yates and Ribeiro -Neto, Modern Information Retrieval, Addison -Wesley. 3. SoumenChakrabarti, Mining the Web, Morgan -Kaufmann 4. David A. Groosman, Information Retrieval, Algorithm and Heuristics, Springer MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY

JAIPUR Department/Centre : Department of Computer Science & Engineering Course  
 Code : 21CST820 Course Name : Internet of Things Credits : 3 L - 3 T - 0 P - 0  
 Course Type : Elective Prerequisites: Networks, Wireless Communication Course  
 Contents Introduction: Internet of Things and Connected Products, IoT paradigm,  
 Smart objects, Goal orientation, Convergence of technologies; Business Aspects of  
 the Internet of Things. Internet and "Things": Layers, Protocols, Packets, Services,  
 Performance parameters of a packet network and applications: Web, Peer-to-peer,  
 Sensor networks, and Multimedia. Hardware and Software: Hardware components,  
 Microcontrollers and Software; Operating Systems. Protocols and Platforms -IoT  
 Communication Protocols, Transport Protocols, Application Protocols; Cloud  
 computing for IoT. Services and Attributes: Data creation, Data gathering and Data  
 dependency; Robustness, Scaling, Privacy, Security, Trust. Designing & Developing  
 IoT applications: Introduction, IoT Design Methodology , Python Data Types & Data  
 Structures, Control Flow, Functions, Modules, Packages, File Handling, Date/ Time  
 Operations, Classes, Python Packages Application: Implications for the society, IoT  
 case study. Recommended Readings Text Books: - 1. The Internet of Things: Key  
 Applications and Protocols, David Boswarthick, Olivier Hersent, and Omar Elloumi,  
 Wiley 2. Building the Internet of Things with IPv6 and MIPv6, Daniel Minoli, Wiley. 3.  
 Latest research articles MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY  
 JAIPUR Department/Centre : Department of Computer Science & Engineering Course  
 Code : 21CST822 Course Name : Natural Language Processing Credits : 3 L - 3 T - 0  
 P - 0 Course Type : Elective Prerequisites: Data structures and algorithms, and strong  
 programming skills Course Contents Introduction to NLP tasks in syntax, semantics,  
 and pragmatics. Applications such as information extraction, question answering, and  
 machine translation. The problem of ambiguity. The role of machine learning. Brief  
 history of the field. N-gram Language Models. The role of language models. Simple N  
 -gram models. Estimating parameters and smoothing. Evaluating language models.  
 Part Of Speech Tagging and Sequence Labeling Lexical syntax. Hidden Markov  
 Models (Forward and Viterbi algorithms and EM training). Neural Networks and LSTM  
 Introduction to perceptron and backpropagation, LSTM Recurrent Neural Networks  
 Syntactic parsing Grammar formalisms and treebanks. Efficient parsing for context  
 -free grammars (CFGs). Statistical parsing and probabilistic CFGs (PCFGs).  
 Lexicalized PCFGs. Neural shift-reduce dependency parsing Semantic Analysis  
 Lexical semantics and word-sense disambiguation. Compositional semantics.  
 Semantic Role Labeling and Semantic Parsing. Information Extraction (IE) Named  
 entity recognition and relation extraction. IE using sequence labeling. Machine  
 Translation (MT) Basic issues in MT. Statistical translation, word alignment, phrase  
 -based translation, and synchronous grammars. Advanced Language Processing  
 Advance language modeling (including LDA), other applications like summarization,  
 question answering Recommended Readings Text Books: - 1. Speech and Language  
 Processing: An Introduction to Natural Language MALAVIYA NATIONAL INSTITUTE  
 OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science &  
 Engineering Course Code : 21CST823 Course Name : Nature Inspired Algorithms  
 Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Programming  
 languages, Data structures and Algorithms Course Contents Introduction to

Algorithms, Optimization, Search for optimality, computational intelligence, Nature Inspired solutions and characteristic, Nature inspired Metaheuristics and its brief history, Analysis of Optimization Algorithms, Nature Inspired Algorithms, parameter Tuning and control Constrained and unconstrained optimizations, Random Walks and Optimizations, evolutionary strategies and Evolutionary Algorithms (EA), Simulated Annealing (SA) Algorithm and its behavior, Genetic Algorithms(GA) - genetic operator, parameters, fitness functions, genetic programming and convergence analysis, GA variants, Differential Evolution (DE), various Applications. Swarm Intelligence optimization, Particle Swarm Optimization(PSO) Algorithm, Ant Colony Optimization (ACO) Algorithms, Artificial Bee Colony (ABC) optimization algorithms, Cuckoo Search (CS) Algorithms, Intelligent Water Drop Algorithm (IWD), Bat Algorithms(BA), Firefly Algorithms(FA) Framework for self-tuning algorithms, Dealing with constraints, constraints handling, fitness functions, multi-objective optimization techniques and its applications, Hybrid algorithms, Ways to Hybridize Recommended Readings Text Books: - 1. Nature-Inspired Optimization Algorithms – by Xin-She Yang (Author), June 30, 2016 2. Mathematical Foundations of Nature-Inspired Algorithms, Xin-She Yang, Xing-Shi He, Springer; 1st ed. 2019 edition 3. Nature-Inspired Metaheuristic Algorithms: Second Edition, Xin-She Yang, Luniver Press 4. Introduction to Evolutionary Computing, A. E Eiben and J. E. Smith, Second Printing, Springer, 2007 5. Evolutionary Algorithms in Engineering Applications, Editors: Dipankar Dasgupta and Zbigniew Michalewicz, Springer-Verlag, 1997 6. D. E. Goldberg, Genetic Algorithms in search, Optimization and Machine Learning, Pearson India, 7. Optimization Techniques and Applications with Examples By Xin-She Yan, Wiley publisher MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST825 Course Name : Network Performance Modelling Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Introduction to Network Modeling: Network modeling, Computer Network as a discrete event system, Modeling and measurement tools, Network performance metrics – first order and second order metrics, Network capacity, Difference between throughput and capacity Network Calculus: Models for data flows, arrival curves and service curves, Greedy shapers, Basic min-plus and max-plus calculus, min-plus and max-plus systems, Optimal smoothing, FIFO systems and aggregate scheduling, Time varying shapers, Systems with losses, Case studies – (1) Analyzing spanning tree based data forwarding using network calculus, (2) Bound on loss rate Stochastic Scheduling and Resource Allocation: Stochastic scheduling, dynamic resource allocation, Dynamic programming models for stochastic scheduling, Queuing networks – open loop and closed loop networks, Jackson networks, Network fairness – proportional and max-min fairness, Markov process and its application for analyzing network resource allocation and fairness, available bandwidth estimation, Case studies – (1) TCP/IP flow and congestion control, (2) Modeling dynamic routing and scheduling as a queuing network problem, (3) Analysis of IEEE 802.11 channel access using two dimensional Markov process. Network Games: Introduction to game theory, Zero sum games, Nash equilibrium, Pareto optimality, Cooperative and Non-cooperative games, General network games – resource sharing games, routing games,

congestion games, Mechanism design, Case studies – (1) Selfish routing in networks and price of anarchy, (2) Oblivious routing, (3) Network resource allocation games

Protocol Analysis: Modeling discrete event system using petri -nets, basics of petri nets, stochastic petri nets, queuing petri nets, properties of petri nets, structural analysis of petri nets, Petri net modeling tools – simQPN, Case studies – (1) Wireless channel model using stochastic petri net, (2) Data center network throughput analysis using queuing Petri Nets

Recommended Readings Text Books: - 1. "Routing, Flow, and Capacity Design in Communication and Computer Networks", Michał Pióro, Deepankar Medhi, ISBN: 0125571895, Publisher: Morgan Kaufmann 2. The Network Calculus Book by Jean -Yves Le Boudec and Patrick Thiran is available for free download: [http://ica1www.epfl.ch/PS\\_files/NetCal.htm](http://ica1www.epfl.ch/PS_files/NetCal.htm) 3. Anurag Kumar, D. Manjunath and Joy Kuri, "Communication Networking: An Analytical Approach" Morgan Kaufman Publishers 4. Dimitri P. Bertsekas and Robert G. Gallager, "Data Networks" : Materials are available at <http://web.mit.edu/dimitrib/www/datanets.html> 5. "Network Optimization: Continuous and Discrete Models", D. Bertsekas 6. Research Publications - will be discussed and distributed time to time

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST826 Course Name : Neural Networks Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Basic understanding of probability and statistics, linear algebra and calculus. A basic knowledge of programming (preferably Python) is essential. Course Contents Introduction to Neural Architecture, McCulloch -Pitts networks, Learning Rules, Perceptrons, Regression and least mean square algorithm, Multilayer perceptrons, Back propagation: generalized delta rule, limitations, modifications – momentum, variable learning rate, conjugate gradient. Radial -basis function networks, Support vector Machines, Unsupervised learning and self-organization, Boltzmann machines and deep networks, Convolutional networks, Recurrent networks, Associative Memories, Adaptive Resonance Theory, Applications of Neural Networks.

Recommended Readings Text Books: - 1. Simon Haykin : Neural Networks: A Comprehensive Foundation, Pearson

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST827 Course Name : Parallel Processing & Algorithms Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Introduction to parallel computing. Parallel processing terminology, Pipelining Vs Data parallelism, Control parallelism, Scalability, Control parallel approach, Data parallel approach, Data parallel approach with I/O. The PRAM Shared-Memory Model, Distributed-Memory or Graph Models, Circuit Model and Physical Realizations PRAM and Basic Algorithms, PRAM Submodels and Assumptions, Data Broadcasting, Semigroup or Fan-In Computation, Parallel reduction, Prefix sums, List ranking, Preorder tree traversal, Merging two sorted lists, Graph coloring, Reducing the number of processors, Problems defying fast solutions on PRAMS. Thread and process level parallel architectures: MIMD, multi-threaded architectures. Distributed and shared memory MIMD architectures. Dynamic interconnection networks. Mapping and scheduling: Mapping data to processors on processor arrays and multicomputers, Dynamic Load Balancing on multicomputers, Static scheduling on UMA

multiprocessors, Deadlock. Parallel programming and parallel algorithms: Programming models, parallel programming on multiprocessors and multicomputers. Parallel algorithm structure, analyzing parallel algorithm. Elementary parallel algorithms, Matrix algorithms, sorting, Graph algorithms. Parallel Algorithm Complexity, Asymptotic Complexity, Algorithm Optimality and Efficiency, Complexity Classes, Parallelizable Tasks and the NC Class, Parallel Programming Paradigms, Solving Recurrences Sorting and Selection Network: Design of Sorting Networks, Batcher Sorting Networks, Mesh -Base Architectures: Sorting on a 2D Mesh or Torus, Routing on a 2D Mesh or Torus, Numerical 2D Mesh Algorithms, Low -Diameter Architectures: Hypercubes and Their Algorithms, Sorting and Routing on Hypercubes

Recommended Readings Text Books: - 1. J. Jaja, An Introduction to Parallel Algorithms, Addison Wesley, 1992. 2. F. T. Leighton, Introduction to Parallel Algorithms and Architectures: Arrays, Trees, Hypercubes, Morgan Kaufmann Publishers, San Mateo, California, 1992 3. Behrooz Parhami, Introduction to Parallel Processing, Algorithms and Architecture, Kluwer Academic Publishers, 2002

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST828 Course Name : Parallelizing Compiler Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Basic course in Compiler Design Course Contents Introduction – Compilation for parallel machines and automatic detection of parallelism, structure of a parallelizing compiler. Dependence Theory and Practice - Types of dependences, data and control dependencies, dependence analysis, direction vectors, loop carried and loop independent dependences, tests for data dependence and their applicability, construction of data dependence and control dependence graphs. Parallel Code Generation - Automatic extraction of parallelism, representation of iteration spaces of nested loops, loop based transformations such as loop distribution, loop coalescing, loop interchange and cycle shrinking transformation. Interprocedural Analysis and Optimization - aliasing information, summary data flow analysis, interprocedural constant propagation, interprocedural data dependence analysis and parallelization of call statements. Recommended Readings Text Books: - 1. Randy Allen, Ken Kennedy: Optimizing compilers for modern architectures. Morgan Kaufmann 2. Steven Muchnick : Advanced Compiler Design & Implementation, Morgan Kaufmann.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST830 Course Name : Quantum Computing Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Introduction to quantum computing, Relevant Linear algebra for quantum computing, Postulates of quantum mechanics, Classical computing, Quantum circuits, Quantum Fourier Transform Quantum search algorithms, Physical realization of quantum computers. Quantum noise, Quantum operations, quantum information and quantum channel Recommended Readings Text Books: - 1. Pittenger A. O., An Introduction to Quantum Computing Algorithms 2. Nielsen M. A., Quantum Computation and Quantum Information, Cambridge University Press. 3. Benenti G., Casati G. and Strini G., Principles of Quantum Computation and Information, Vol. I: Basic Concepts, Vol II: Basic Tools and Special Topics, World Scientific .

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY

JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST831 Course Name : Real Time Systems Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Introduction : Definition, Typical Real Time Applications; Digital Control, High Level Controls, Signal Processing etc., Release Times, Deadlines, and Timing Constraints, Hard Real Time Systems and Soft Real Time Systems, Reference Models for Real Time Systems: Processors and Resources, Temporal Parameters of Real Time Workload, Periodic Task Model, Precedence Constraints and Data Dependency. (7 hours) Real Time Scheduling: Common Approaches to Real Time Scheduling: Clock Driven Approach, Weighted Round Robin Approach, Priority Driven Approach, Dynamic Versus Static Systems, Optimality of Effective -Deadline -First (EDF) and Least -Slack -Time -First (LST) Algorithms, Offline Versus Online Scheduling, Scheduling Aperiodic and Sporadic jobs in Priority Driven and Clock Driven Systems. (8 hours) Resources Access Control: Effect of Resource Contention and Resource Access Control (RAC), Non - preemptive Critical Sections, Basic Priority -Inheritance and Priority -Ceiling Protocols, Stack Based Priority -Ceiling Protocol, Use of Priority -Ceiling Protocol in Dynamic Priority Systems, Preemption Ceiling Protocol, Access Control in Multiple -Unit Resources, Controlling Concurrent Accesses to Data Objects. (8 hours) Multiprocessor System Environment :Multiprocessor and Distributed System Model, Multiprocessor Priority -Ceiling Protocol, Schedulability of Fixed - Priority End -to-End Periodic Tasks, Scheduling Algorithms for End -to-End Periodic Tasks, End - to-End Tasks in Heterogeneous Systems, Predictability and Validation of Dynamic Multiprocessor Systems, Scheduling of Tasks with Temporal Distance Constraints. (9 hours) Real Time Communication : Model of Real Time Communication, Soft and Hard RTCommunication systems , Priority -Based Service and Weighted Round -Robin Service Disciplines for Switched Networks, Medium Access Control Protocols for Broadcast Networks, Internet and Resource Reservation Protocols, Real Time Protocols, Communication in Multicomputer System. An Overview of Real Time Operating Systems and Databases: Features of RTOS, UNIX as RTOS, POSIX Issues, Temporal Consistency, Concurrency Control. (8 hours) Recommended Readings Text Books: - 1. Real Time Systems: Theory and Practice – Mall Rajib, Pearson Education, 2009 2. Real -Time Systems: Scheduling, Analysis, and Verification – Albert M. K. Cheng, Wiley, 2002. 3. H. Kopetz, "Real time systems: Design Principles for distributed embedded applications", Springer Publications, 2011. 4. Douglass, Real Time UML: Advances in the UML for Real -Time Systems, 3/e, Addison - Wesley, 2004. 5. Awad, Kuusela& Ziegler, Object -Oriented Technology for Real Time Systems: A Practical Approach Using OMT and Fusion, 1/e, Pearson Education, 1996. 6. Ward & Mellor, Structured Development for Real -Time Systems, Vol. III: Implementation Modeling Techniques, Prentice Hall, 1986. MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST832 Course Name : Robotics and Control Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Introduction to robotics -origin of automation, Classification of robots, Rotations and translation of vectors, Transformations and Euler angle representations, Homogeneous transformations, Problems, Trajectory planning,

Actuators, Velocity and position sensors. Range, proximity, touch sensors, Control of Robot Manipulators: PD control, Nonlinear Control, Stability, Lyapunov's Direct Method, Adaptive Control, Robot Vision, Image segmentation, Template matching, Polyhedral objects, Shape analysis, Grasping and industrial automation

Recommended Readings Text Books: - 1. M. Spong, S. Hutchinson, and M. Vidyasagar, Robot Modeling and Control Wiley (2006) 2. Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, "Industrial Robotics, Technology programming and Applications", 3. Craig. J. J. "Introduction to Robotics - mechanics and control", Addison - Wesley, 1999 4. Nagrath Gopal "Control Systems Engineering -Principles and Design" New Age Publishers 5. K. Ogata, "Modern control engineering", Pearson 2002.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY  
JAIPUR Department/Centre : Department of Computer Science & Engineering  
Course Code : 21CST801 Course Name : 5G TECHNOLOGY Credits : 3 L - 3 T - 0 P - 0  
Course Type : Elective Prerequisites: None Course Contents

Introduction and Key Specs of 5G Technologies, Opportunities and Challenges in mmWave MIMO Communication, Channel Models for mmWave MIMO Systems, Hybrid Signal Processing for mmWave MIMO, Digital and Analog Beamforming, Hybrid RF/ BB Precoder and Combiner Design for mmWave MIMO, Hybrid Transceiver Architectures for mmWave MIMO, Sparse Signal Processing and Channel Estimation for mmWave MIMO, Optimal Design of Beams and Sensing Matrix for Channel Estimation. Overview of Sub 6GHz Multiple Antenna, MIMO and MU-MIMO Technologies, Signal Processing for MIMO Systems, Optimal Power Allocation and Precoding for MIMO, Introduction to 5G Massive MIMO Systems, Key Features of Massive MIMO and Advantages over Point-to-Point and MU-MIMO, Signal Processing Operations for Massive MIMO in UL and DL, Massive MIMO Channel Model – Large/ Small Scale Fading, Properties of Random Vectors and Massive MIMO Analysis, Analysis of Spectral Efficiency in Massive MIMO Systems and Power Scaling, Pilot Design and Channel Estimation in Massive MIMO Systems Transmitter and Receiver Schemes with Imperfect CSI, Spectral Efficiency Analysis of Massive MIMO with Imperfect CSI, Power Scaling in Massive MIMO with Imperfect CSI and Comparison with Perfect CSI, Multi-Cell Massive MIMO Model, Channel Estimation with Pilot Reuse and Pilot Contamination. New Modulation Schemes for 5G - Spatial Modulation (SM), Space Shift Keying (SSK) and Optimal Receiver, Generalized Spatial Modulation (GSM), Spectral Efficiency Comparison of GSM with Conventional V-BLAST. Introduction to Non-Orthogonal Multiple Access (NOMA) Technology, Efficiency of NOMA wrt to Conventional Orthogonal Multiple Access (OMA), Fixed NOMA Protocol for UL/ DL – Performance Analysis, Ordered NOMA Protocol and Performance Analysis, Comparison with Fixed NOMA, Optimal Power Allocation for NOMA Systems Overview of Multicarrier Modulation, Introduction to OFDM and MIMO OFDM Transceiver Design, Motivation for Filter Band Multi Carrier (FBMC) Technology in 5G, System Model for FBMC and Signal Processing, Offset QAM (OQAM) Modulation and Transceiver Design, MIMO-FBMC System – Transmit/ Receive Signal Processing, Introduction to Full-Duplex Technology, Key Features and Advantages of Full Duplex Systems, Linear/ Non-Linear Self-Interference and Analog, Digital Cancellation Stages Introduction to 5G New Radio (NR) Standard, Introduction to 5G

NB -IoT Technology, Overview of LTE- Cat M1 and Cat NB 1 Standards/ Systems 5G advanced concepts : Softwareization, virtualization, NFV, VNFV, 5G Slicing and etc Machine Type Communication(MTC) : Use cases and categorization, MTC Requirements, Fundamental techniques for MTC, Massive MTC, Ultra - reliable low -latency MTC, D2D Communication: from 4G to 5G, Radio resource management for mobile broadband D2D, Multi -hop D2D, communications for proximity and emergency services, Multi -operator D2D communication. 5G Radio Access Technologies: Access design principles for multi -user communications, Multi -carrier with filtering, Non -orthogonal schemes for efficient multiple access, Radio access for dense deployments, Radio access for V2X communication, Radio access for massive machine -type communication. Recommended Readings Text Books: - 1. Asif Osseiran, Jose F.Monserrat and Patrick Marsch, "5G Mobile and Wireless Communications Technology", Cambridge University Press, 2016. 2. Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", Wiley, 2015 3. Patrick Marsch, Omer Bulakci, Olav Queseth and Mauro Boldi, "5G System Design – Architectural and Functional Considerations and Long Term Research", Wiley, 2018

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST834 Course Name : Selected Topics in Operating System Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Operating Systems Course Contents Introduction: Introduction and Background, Power of abstractions, Hardware resources, OS Functionalities, Managing the CPU and Memory. OS -Structure: Commercial OS, Monolithic structure, DOS like -structures. SPIN Approach to extensibility, Logical Protection Domains, Customized OS, Mechanism for events. Exokernel and MicroKernel: Approach to extensibility, Default core services in Exokernel, Secure Binding, Memory Management, L3 MicroKernel Approach, Potentials for Performance Loss, Strikes against Microkernel, Address Space Switches, Thread switches and IPC. Virtualization: Introduction, Platform Virtualization, Hypervisors, Full Virtualization, Para Virtualization. Memory Virtualization: Memory Subsystem recall, Shadow page table. VM oblivious page sharing, Memory Allocation Policies. CPU Virtualization and Device Virtualization: Control and Data transfer in Action, Disk IO Virtualization Protection & Security: Potential Security violations, External versus Internal Security, Policies and Mechanisms, Protection Domain, Design Principles for Secure Systems, Access Matrix Model & its Implementation., Case Studies: Unix Operating system, Hydra Kernel, Amoeba, Andrew. Recommended Readings Text Books: - 1. Abraham Silberschatz, Peter B. Galvin and Greg Gagne, Operating System Concepts, 9th Edition, Wiley 2. Virtualization Essentials by Matthew Portnoy, Second Edition 3. Advanced Concepts In Operating Systems by Singhal, Tata McGraw -Hill Education 4. Daniel Bovet and Marco Cesati, Understanding the Linux Kernel, 3rd Edition, O' Reilly Media, 2008. 5. <https://in.udacity.com/course/advanced-operating-systems--ud189/>

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST833 Course Name : Selected Topics in Computing Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Programming in C / Python, Operating Systems, Database Management Systems, Computer Networks, Computer Architecture Course



Contents Topics will be announced by the Course Instructor at the beginning of the course depending on the emerging and evolving architectures. However, a sample list of topics are given for 2020 -21 as below: Cluster and Grid Computing, Cloud Computing Big Data Analytics, Data Science, Data Lakes Internet of Things, 5G and beyond Software Defined Networks, Network Function Virtualization Quantum Computing, Block Chain Recommended Readings Text Books: - 1. Request for Comments, Red Books, White Papers 2. Research Papers on various aspects as decided by the Instructor 3. Lecture Notes of the Instructor 4. William Stallings, Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud, Addison-Wesley Professional, 2016 5. Kai Hwang, Min Chen, Big -Data Analytics for Cloud, IoT and Cognitive Computing, Wiley - Blackwell, 2017 MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST835 Course Name : Social Media Mining Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Online Social Networks (OSNs): Introduction - Types of social networks (e.g., Twitter, Facebook), Measurement and Collection of Social Network Data, Social Networks - Basic Structure and Measures, Basics of Text Processing over Social Data, Entity linking and entity resolution for Social data. Characteristics of OSNs: Information Diffusion, Experimental studies over OSNs, Sampling, Fundamentals of Social Data Analytics: Topic Models, Random Walks, Heterogeneous Information Networks Applied Social Data Analytics: Recommendation Systems, Community identification and link prediction. Advanced Topics: Online experiments for Computational Social Science, Big Data Sampling Recommended Readings Text Books: - 1. Matthew A. Russell. Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Google+, Github, and More, 2nd Edition, O'Reilly Media 2. Jennifer Golbeck, Analyzing the social web, Morgan Kaufmann 3. Charu Aggarwal (ed.), Social Network Data Analytics, Springer 4. Reza Zafarani, Mohammad Ali Abbasi, Huan Liu, Social Media Mining An Introduction, Cambridge University Press MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST836 Course Name : Social Network Analysis Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Network Models: Properties of Real -World Networks: Degree Distribution, Clustering Coefficient, Average Path Length. Random Graphs , Small -World Model, Preferential Attachment Model, Modeling of Real -World Networks using Random Graphs, Small -World Model and Preferential Attachment Model Network Measures: Centrality: Degree Centrality, Eigenvector Centrality, Katz Centrality, PageRank, Centrality, Closeness Centrality, Group Centrality. Transitivity and Reciprocity, Balance and Status, Similarity: Structural Equivalence, Regular Equivalence. Community Analysis: Community Detection, Community Detection Algorithms: Member -Based Community Detection, Group -Based Community Detection. Community Evolution: How Networks Evolve, Community Detection in Evolving Networks. Community Evaluation: Evaluation with Ground Truth, Evaluation without Ground Truth . Recommendation: Classical Recommendation Algorithms: Content -Based Methods, Collaborative Filtering (CF), Extending Individual Recommendation to Groups of Individuals, Recommendation

Using Social Context, Evaluating Recommendations: Evaluating Accuracy of Predictions, Evaluating Relevancy of Recommendations Graph Representation Learning, Knowledge Graphs and Meta Paths, Graph Convolutional Networks, Link Prediction, Influence Maximization & Outbreak Detection. Recommended Readings Text Books: - 1. Networks, Crowds, and Markets: Reasoning About a Highly Connected World by David Easley and Jon Kleinberg. 2. Networks: An introduction by Mark Newman. 3. The Development of Social Network Analysis” by Linton C Freeman 4. Zafarani, Reza, Mohammad Ali Abbasi, and Huan Liu. Social media mining: an introduction. Cambridge University Press

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR** Department/Centre : Department of Computer Science & Engineering Course Code : 21CST837 Course Name : Software Project Management Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Software Engineering, Computer Programming (C/Java/Python/C++), Microsoft Excel Course Contents Software Project Concepts : Software Project Categorization, Stakeholders, Software project Activities, Practices & Standards, Selecting Process Models (Spiral, Incremental, Prototyping, RAD, Agile). Estimation & Evaluation techniques, Cost Benefit Analysis, Risk Analysis for Project Evaluation, Program management, Project effort and cost estimation; Basis of estimation, Estimation method categorization, SLOC, Function Point Analysis, COCOMO, Putnam’s work. Estimation using FP. Project Planning: Stepwise planning, Activity based approach (WBS), Sequencing and Scheduling of Activities, Critical Path Method. Risk Analysis and Management: Risk Identification, Projection, Risk Identification, Projection, Risk Refinement, Risk Monitoring and Management Schedule and Cost Monitoring: Collecting Data & Reporting, Graphical Visualization techniques, Cost Monitoring, Earned Value analysis, Requirements management, Change Control. Contract Management: Types of Contracts, Stages in Contract Placement, Typical Terms of a Contract, Contract Management and Acceptance. Software Configuration Management (SCM), SCM Tools, Project Reviews Testing and Software Reliability, Metrics, ISO and CMMI, Project Scheduling & Tracking, Software Quality Assurance, Software Configuration Management Recommended Readings Text Books: - 1. Bob Hughes, Mike Cotterell, Rajib Mall, “Software Project Management”, 6th Edition, Tata McGraw Hill, 2017. 2. Pankaj Jalote, Software Project Management in Practice. 3. Roger S. Pressman, Software Engineering 4. Royce, “Software Project Management”, Pearson Education, 1999. 5. Robert K. Wysocki, Effective Software Project Management, Wiley, 2009.

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR** Department/Centre : Department of Computer Science & Engineering Course Code : 21CST838 Course Name : Software Testing and Validation Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Software engineering, basic computer programming skills Course Contents Testing Environment and Test Processes: Software Testing Environment, Overview of Software Testing Process, Organizing for Testing, Developing the Test Plan, Verification Testing, Analyzing and Reporting Test Results, Acceptance Testing. Levels of Testing, Unit Testing, Integration Testing, Defect Bash Elimination. System Testing, Usability and Accessibility Testing, Configuration Testing, Compatibility Testing. Functional and Non-functional system testing, Compliance Testing, Load Testing, Performance Testing and Security Testing. Static

and dynamic testing, Black -box or functional testing, Equivalence partitioning, BVA, structural, White box or glass box testing, Mutation Testing, Data flow testing. Test Automation: Software Testing Tools, Software Test Automation, Debugging, Case study. Recommended Readings Text Books: - 1. Srinivasan Desikan and Gopalaswamy Ramesh, "Software Testing – Principles and Practices", Pearson Education 2. A.P. Mathur, Foundations of Software Testing, Pearson publications 3. Naresh Chauhan , "Software Testing Principles and Practices " Oxford University Press , New Delhi . 4. Ilene Burnstein, " Practical Software Testing", Springer International Edition. 5. Renu Rajani, Pradeep Oak, "Software Testing – Effective Methods, Tools and Techniques", Tata McGraw Hill. 6. William Perry, "Effective Methods of Software Testing", Third Edition, Wiley Publishing

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR**  
 Department/Centre : Department of Computer Science & Engineering  
 Course Code : 21C ST840 Course Name : VLSI Algorithms  
 Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None

**Course Contents**  
 Logic synthesis & verification: Introduction to combinational logic synthesis, Binary Decision Diagram, Hardware models for High -level synthesis. VLSI Algorithms Partitioning: Problem formulation, classification of partitioning algorithms, Group migration algorithms, simulated annealing & evolution, other partitioning algorithms. Placement, floor planning & pin assignment: Problem formulation, simulation base placement algorithms, other placement algorithms, constraint -based floorplanning, floor planning algorithms for mixed block & cell design. General & channel pin assignment. Global Routing: Problem formulation, classification of global routing algorithms, Maze routing algorithm, line probe algorithm, Steiner Tree based algorithms, ILP based approaches. Detailed routing: problem formulation, classification of routing algorithms, single layer routing algorithms, two -layer channel routing algorithms, three -layer channel routing algorithms, and switchbox routing algorithms. Over the cell routing & via minimization: two layers over the cell routers, constrained & unconstrained via minimization Compaction: problem formulation, one -dimensional compaction, two dimension -based compaction, hierarchical compaction.

**Recommended Readings Text Books:** - 1. Naveed Sherwani, "Algorithms for VLSI Physical Design Automation", 3rd Edition, 2005, Springer International Edition 2. S.H. Gerez, "Algorithms for VLSI Design Automation", 1999, WILEY Student Edition, John Wiley & Sons (Asia) Pvt. Ltd. 3. Christoph Meine I& Thorsten Theobold, "Algorithms and Data Structures for VLSI Design", KAP, 2002. 4. Rolf Drechsler : "Evolutionary Algorithm for VLSI", Second edition

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR**  
 Department/Centre : Department of Computer Science & Engineering  
 Course Code : 21CST841 Course Name : Wireless Sensor Networks  
 Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None

**Course Contents**  
 Introduction: Introduction to adhoc/sensor networks: Key definitions of adhoc/ sensor networks, unique constraints and challenges, advantages of adhoc/sensor network, driving applications, issues in adhoc wireless networks/sensor network, data dissemination and gathering, Historical Survey of Sensor Networks Basic Architectural Framework: Traditional layered stack, Cross -layer designs, Sensor network architecture, Physical Layer, Basic Components, Hardware Platforms: Motes, Sensor Devices, Types of Sensors, Sensor's Specification MAC

Protocols : Fundamentals of MAC protocols - Low duty cycle protocols and wakeup concepts - Contention Based protocols - Schedule-based protocols - SMAC - BMAC - Traffic-adaptive medium access protocol (TRAMA) - The IEEE 802.15.4 MAC protocol. Routing Protocols: Issues in designing a routing protocol, classification of routing protocols, table-driven, on-demand, hybrid, flooding, hierarchical, and power aware routing protocols. Sensor network security: Security Requirements, Issues and Challenges in Security Provisioning, Network Security Attacks, Layer wise attacks in wireless sensor networks, possible solutions for jamming, tampering, black hole attack, flooding attack. Key Distribution and Management, Secure Routing – SPINS, reliability requirements in sensor networks. Programming in WSNs: Challenges and limitations of programming WSNs, Introduction to TinyOS, -Programming in Tiny OS using NesC, Emulator TOSSIM, Open research issues Recommended Readings Text Books: - 1. Feng Zhao, Leonidas Guibas, “Wireless Sensor Network”, Elsevier, 1st Ed. 2004 (ISBN: 13 - 978-1-55860 -914-3) 2. Kazem, Sohraby, Daniel Minoli, Taieb Znati, “Wireless Sensor Network: Technology, Protocols and Application”, John Wiley and Sons 1st Ed., 2007 (ISBN: 978 -0-471-74300 -2). 3. Raghavendra, Cauligi S, Sivalingam, Krishna M., Zanti Taieb, “Wireless Sensor Network”, Springer 1st Ed. 2004 (ISBN: 978 -4020 -7883 -5). 4. E. H. Callaway, Jr. E. H. Callaway, Wireless Sensor Networks Architecture and Protocols:, CRC Press , 2009 MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST821 Course Name : Machine Learning Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Basic understanding of probability and statistics, linear algebra and calculus. A basic knowledge of programming (preferably Python) is essential. Course Contents Advanced linear Algebra (e.g., SVD). The learning problem – learning versus design, types of learning - supervised, unsupervised, reinforcement and other views of learning. Linear Modeling: A least squares approach, linear modeling, making predictions, vector/matrix notation, linear regression, nonlinear response from a linear model. Generalization and over-fitting. The Bayesian approach to machine learning: exact posterior, marginal likelihoods Probability based learning: Bayes theorem, Bayesian prediction, conditional independence and factorization, the Naive Bayes model. Error based learning: simple linear regression, multi variable linear regression with gradient descent Logistic regression – gradient descent, nonlinear transformations the Z space. Similarity based learning: nearest neighbor, k - nearest neighbors, efficient distance computations: the KD trees Information based learning: learning and trees, Classification and regression trees. Ensemble methods, Boosting, Bagging, Random forests. Neural networks – the perceptron, Multilayer perceptron, activation functions, gradient descent, deriving back propagation. Multi-task and transfer learning, Deep-learning. Linear discriminant analysis (LDA), Principal component analysis (PCA) SVM - optimal separation, the margin and support vectors, a constrained optimization problem, kernels – polynomial, radial basis, sigmoid Performance Measures and Evaluation – for categorical targets, prediction scores, multinomial targets, continuous targets. Clustering – the general problem, hierarchical and partitional clustering, K-means clustering. Recommended Readings Text Books: - 1. Learning from Data, Yaser S Abu-Mostafa, AML books 2. Machine learning,

Marsland, CRC press 3. An Introduction to Machine Learning, KubatMiroslav, Springer 4. Fundamentals of Machine Learning for predictive data analytics, John D Kelleher, MIT Press

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR**  
 Department/Centre : Department of Computer Science & Engineering Course Code : 21CST829 Course Name : Pattern Recognition Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: An undergraduate level understanding of probability, statistics and linear algebra is assumed. A basic knowledge of Python is essential.

**Course Contents** The classification process: features, training and learning, approaches to classification Non metric methods: Information, Entropy and Impurity, decision tree classifier - ID3, C4.5. Discriminant functions: linear discriminant functions, piece -wise linear discriminant functions, generalized discriminant functions. Statistical pattern recognition: measured data and measurement errors, probability theory, conditional probability and Bayes rule, Naive Bayes classifier, Continuous random variables, The multivariate Gaussian, Covariance matrix and Mahalanobis distance Parametric learning: Bayesian decision theory, discriminant functions and decision boundaries, MAP (Maximum A Posteriori Estimator) Non Parametric learning: Histogram estimator and Parzen windows, k -NN classification, Artificial Neural Networks, Kernel Machines, SVM. Feature extraction and selection: reducing dimensionality, feature selection - Inter/Intra class distance, Feature extraction: Principal component analysis, Linear discriminant analysis. Un supervised learning: Clustering, K - Means clustering, Fuzzy c -Means clustering, (Agglomerative) Hierarchical clustering Estimating and Comparing Classifiers: No free lunch, Bias and variance trade -off, cross -validation and resampling methods, Measuring classifier performance, Comparing classifiers - ROC curves, McNemar's test, other statistical tests

**Recommended Readings Text Books:** - 1. Pattern Classification, Duda Hart, Wiley 2. Pattern Recognition and Classification, Geoff Dougherty, Springer 3. Statistical Pattern Recognition, Andrew R Webb, Wiley 4. Pattern Recognition and Machine Learning, Christopher Bishop, Springer 5. Pattern Recognition and Image Analysis, Earl Gose, Johnsonbaugh, PHI

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR**  
 Department /Centre : Department of Computer Science & Engineering Course Code : 21CST805 Course Name : Big Data Analytics Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None

**Course Contents** Overview of Database Management Systems, Introduction to Big Data, Introduction to distributed file system, Big Data and its importance, Four Vs, Drivers for Big data, Big data analytics. Apache Hadoop & Hadoop Eco -System, Moving Data in and out of Hadoop, Understanding inputs and outputs of MapReduce, Data Serialization. Hadoop Architecture, Hadoop Storage: HDFS, Common Hadoop Shell commands, Anatomy of File Write and Read, Name -Node, Secondary Name -Node, and Data -Node, Hadoop MapReduce paradigm, Map and Reduce tasks, Job, Task trackers - Cluster Setup, SSH & Hadoop Configuration – HDFS Administering, Monitoring & Maintenance. Pig, Pig Latin Language, Hive Introduction, Hive queries. Spark Introduction. Cassandra CQL query language and CQL data model: Key space, Table definition, Column, and Data Types. Mongo DB Cluster analysis, K -means algorithm, Naïve Bayes, Parallel k -means using Hadoop, parallel particle swarm algorithm using MapReduce, case studies on big data mining. Parallel swarm Intelligence.

Recommended Readings Text Books: - 1. Dan Sullivan, NoSQL for Mere Mortals 1st Edition., Pearson Publishers, 2014 2. Pramod J. Sadalage, Martin Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence 1st Edition, Pearson Publishers, ISBN -13: 978-0321826626, 2017. 3. John D. Kelleher, Brian Mac Namee, Aoife D'Arcy, Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms, Worked Examples, and Case Studies (The MIT Press) 4. John D. Kelleher, Brendan Tierney, Data Science (MIT Press Essential Knowledge series).

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST811 Course Name : Data Visualization Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Modern Visualisation tools and techniques, Create multiple versions of digital visualizations using various software packages; Identify appropriate data visualization techniques given particular requirements imposed by the data; Apply appropriate design principles in the creation of presentations and visualizations; Analyse, critique, and revise data visualizations Information overload and issues in decision making Design of visual encoding schemes to improve comprehension of data and their use in decision making Use of Tableau - Data visualization tool for data analysts, scientists, statisticians, etc. to visualize the data and get a clear opinion based on the data analysis, Comparing classifiers - ROC curves, McNemar's test, other statistical tests. Recommended Readings Text Books: - 1. A first course Sosulski, K. (2018). Data Visualization Made Simple: Insights into Becoming Visual. New York: Routledge. 2. The Visual Display of Quantitative Information (2nd Edition). E. Tufte. Graphics Press, 2001.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST839 Course Name : System on Chip Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Transaction -Level Modeling & Electronic System -Level Languages, Hardware Accelerators, Media Instructions, Co -processors, System -Level Design Methodology ,High -Level Synthesis (C - to-RTL), Hardware Synthesis and Architecture Techniques Source -Level Optimizations. Scheduling Resource, Binding and Sharing. Recommended Readings Text Books: - 1. De Micheli, editor Special Issue on Hardware/Software Co -design Proceedings of IEEE, Vol 85, No. 3, March 1997 2. D. D. Gajski, F. Vahid, S. Narayan, J. Gong :Specification and Design of Embedded Systems, Prentice Hall, Englewood Cliffs, NJ, 1994 3. J. Staunstrup and W. Wolf, editors: Hardware/Software Co -Design: Principles and Practice Kluwer Academic Publishers, 1997 4. G. DeMicheli, R. Ernst, and W. Wolf, editors, Readings in Hardware/Software Co -Design, Academic Press, 2002.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CSL760 Course Name : Program Analysis Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Introduction to analysis tools: debugging, disassembly, emulators, virtualization Introduction: Program Representation, Syntactic Analysis, Program Semantics, Static and dynamic analysis, Syntactic Analysis, Dataflow Analysis and Abstract Interpretation , Interprocedural analysis, Context -sensitive, Pointer analysis, Call Graph Construction, slicing and profiling, Control Flow Analysis, Dynamic

Analysis for Data Race Detection Model Checking, Symbolic execution, Program Repair, Hoare Logic, SMT solver s Recommended Readings Text Books: - 1. Pierce, Benjamin C. Types and Programming Languages. MIT Press, 2002. 2. Winskel, Glynn. The Formal Semantics of Programming Languages: An Introduction. MIT Press, 1993. 3. Nielson, Nielson, and Hankin. Principles of Program Analysis. Springer, 2010. 4. Baier, and Katoen. Principles of Model Checking. MIT Press, 2008. 5. Chlipala, Adam. Certified Programming with Dependent Types: A Pragmatic Introduction to the Coq Proof Assistant. MIT Press, 2013. MTech\_2021\_IS.pdf

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR DEPARTMENT of Computer Science and Engineering M.Tech. Computer Science and Information Security Semester. I S.No. Course Code Course Title Course Category Type Credit L T P 1. 21CST523 Cryptography PC Theory 3 3 0 0 2 21CST521 Advanced Data Structures and Algorithms PC Theory 3 3 0 0 3. 21CST522 Computer and Network Security PC Theory 4 3 0 2 4. 21CST854 Department Elective – 1 PE Theory 3 3 0 0 5. 21CST855 Department Elective – 2 PE Theory 3 3 0 0 6. 21CSP524 Programming Lab -1 PC Lab 2 0 1 2 Total 18 Semester. II S.No. Course Code Course Title Course Category Type Credit L T P 1. 21CST526 Research Methodology PC Theory 2 2 0 0 2 21CST872 Department Elective – 3 PE Theory 3 3 0 0 3. 21CST873 Department Elective – 4 PE Theory 3 3 0 0 4. 21CST874 Department Elective – 5 PE Theory 3 3 0 0 5. 21CST875 Department Elective – 6 PE Theory 3 3 0 0 6. 21CSP525 Design Lab PC Lab 2 0 1 2 7. 21CSP527 Security Tools Lab PC Lab 2 0 1 2 Total 18 Semester. III S.No. Course Code Course Title Course Category Type Credit L T P 1. 21CSS623 Technical Documentation and Presentation PC --- 2 0 1 2 2 21CSP622 Literature Review PC --- 2 0 1 2 3. 21CSD621 Dissertation – 1 PC --- 8 0 0 16 Total 12 Semester. IV S.No. Course Code Course Title Course Category Type Credit L T P 1. 21CSD624 Dissertation – 2 PC --- 12 0 0 24 Total 12 Total Credits: 60

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST523 Course Name : Cryptography Credits : 3 L - 3 T - 0 P - 0 Course Type : Core Prerequisites: None Course Contents Number theory: Prime numbers, GCD, Euclidean Algorithm, Extended Euclidean Algorithm, Fermat's theorem, Euler's theorem, Chinese remainder theorem, Discrete logarithms, Primality testing algorithms, Probability, Bays Theorem. Introduction to Information security and cryptography, Basic terminology and concepts, Classical Cryptographic techniques and their cryptanalysis, Shannon perfect secrecy, One Time Pad, Pseudo random generators, Semantic security, indistinguishability based Security. Stream ciphers and RC4, Various types of attacks, Chosen -Plaintext Attack. Chosen -Ciphertext Attack etc. Block Ciphers: Data Encryption Standard (DES), Advanced Encryption Standard (AES), DES attacks, Modes of operations One -way function, trapdoor one -way function, Public key cryptography, RSA cryptosystem, Diffie -Hellman key exchange algorithm, ElGamal Cryptosystem Cryptographic hash functions, secure hash algorithm, Message authentication, digital signature, RSA digital signature. Recommended Readings Text Books: - 1. William Stallings, Cryptography and Network Security: Principles and Practice, Prentice Hall 2. Douglas R. Stinson, Cryptography: Theory and Practice, Chapman and Hall 3. J. Katz and Y. Lindell, Introduction to Modern Cryptography,

CRC press 4. N. Koblitz, Number Theory and Cryptography, Springer, 2001

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre :  
Department of Computer Science & Engineering Course Code : 21CST521 Course  
Name : Advanced Data Structures and Algorithms Credits : 3 L - 3 T - 0 P - 0 Course  
Type : Core Prerequisites: None Course Contents RAM model – Notations,  
Recurrence analysis - Master's theorem and its proof - Amortized analysis,  
Recurrence equations. Advanced Data Structures: B -Trees, Binomial Heaps,  
Fibonacci Heaps, AVL trees, Red -black trees, B -trees, Splay trees, Interval trees; D  
isjoint set – union and path compression, Amortized analysis. Greedy Algorithms:  
shortest distance, minimum spanning tree, interval scheduling, interval partitioning;  
Divide and Conquer: sorting, integer and polynomial multiplication; Dynamic  
programming: Longest common subsequence. Chain of matrix multiplication,  
sequence alignment, Bellman Ford. Convex hull and Voronoi diagrams, line  
segments, Optimal polygon triangulation; Primality testing, Integer factorization;  
Graph algorithms: Matching and Flows; Parallel algorithms: Basic techniques for  
sorting, searching, merging. Intractability: Independent Set, Vertex Cover  
Randomized algorithms, Probabilistic algorithms. Approximate Algorithms: Vertex  
-cover, set -covering problems, Travelling Salesman problem. N Complexity classes -  
NP-Hard and NP -complete Problems - Cook's theorem NP completeness reductions,  
undecidability. Recommended Readings Text Books: - 1. Cormen, Leiserson, Rivest:  
Introduction to Algorithms, Prentice Hall of India. 2. AhoA.V , J.D Ulman: Design and  
analysis of Algorithms, Addison Wesley 3. Brassard : Fundamental of Algorithmics,  
PHI 4. Sara Baase: Computer Algorithms: Introduction to Design and Analysis,  
Pearson Education. 5. Papadimitriou, Steiglitz: Combinatorial Optimization: Algori  
thms and Complexity, PHI. 6. Motwani and Raghavan: Randomized Algorithms,  
Cambridge University Press 7. Vazirani: Approximation Algorithms, Springer Verlag  
8. Joseph Ja'Ja': Introduction to Parallel Algorithms, Addison -Wesley 9. Kleinberg,  
Tardos: Algorit hm Design, Addison Wesley. 10. Dexter Kozen: The Design and  
Analysis of Algorithms. Springer, 1992. 11. SanjoyDasgupta, Christos Papadimitriou,  
and UmeshVazirani: Algorithms, McGraw Hill. 12. Robert Sedgewick and Kevin  
Wayne. Algorithms 4/e. Addison -Wesle y. 13. Robert Tarjan: Data Structures and  
Network Algorithms, Society for Industrial and Applied Mathematics. MALAVIYA  
NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department  
of Computer Science & Engineering Course Code : 21CST522 Course Name :  
Computer and Network Security Credits : 4 L - 3 T - 0 P - 2 Course Type : Core  
Prerequisites: None Course Contents Introduction (a) Security(b) Malware(c) OWASP  
top ten and other major security issues in the world(d) CVE and other information(e)  
Introduce various type of security areas Software and OS Security: Common Bugs,  
Buffer Overflow, Runtime Defences against memory safety vulnerabilities, program  
verification and other vulnerabilities, Principles in OS Security; Mechanisms for  
confining bad code, Mechanisms for confining bad code : isolation, sandboxing, SFI  
and Virtualization, Trusted Computing Network and Web Security: Secure web site  
design (SQL injection, XSS, etc.), Browser Security, Security problems in network  
protocols: TCP/IP, DDoS Attacks, Network worms and bot -nets: attacks and  
defences, DNS and BGP security, Network defence tools – Firewall and In trusion



Detection. Future Networks Security: Introduction - The Security in Existing wireless Networks, Upcoming wireless networks and challenges, Thwarting and malicious behaviour – Naming and addressing, security association and secure neighbour discovery, secure routing in multichip wireless networks and privacy protection. Mobile OS Security and Privacy: Android, IOS security challenges, processor security, privacy, anonymity and censorship and other security issues according to the current situations and future requirements Recommended Readings Text Books: - 1. Security in Computing (3rd edition) 2. Research publications on security MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CSP524 Course Name : Programming Lab 1 Credits : 2 L - 0 T - 1 P - 2 Course Type : Core Prerequisites: Programming skills required Course Contents Programming exercises and experiments in Computer Networks and Security. a. Experiments on LAN Trainer Kit: Performance study of data link layer protocols, implementation and testing Network Layer routing protocols, understanding the steps involved in RC4 algorithm encryption b. Programming exercises using sockets c. Design and implementation of a Data Sniffer Programming exercises and experiments in Advanced Data Structures a. Primality testing b. Recursive algorithms c. Sorting algorithms d. Heaps, priority queues, and binary search trees e. Red-black trees f. Graph based algorithms g. String matching algorithms Programming on advanced data structures by choosing the right data representation formats based on the requirements of the problem and selecting the right algorithmic paradigm (such as greedy, dynamic programming, divide and conquer etc.). Implement the basic cryptographic algorithms: a. Euclidean and Extended Euclidean algorithm for finding the Greatest Common Divisor of two large integers. b. Chinese remainder theorem. c. Modular polynomial arithmetic d. Diffie - Hellman Key exchange protocol Implement the advanced cryptographic algorithms: Congruence of squares. Finding a congruence of squares modulo  $n$  to factor  $n$ . Construction of Finite Field of characteristic 2. Computations in elliptic curve over a finite field Recommended Readings Text Books: - 1. Menezes, P.C. van Oorschot, S.A. Vanstone: Handbook of Applied Cryptography: CRC Press, 1996. 2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, "Introduction to Algorithms (3rd Edition)", T. Publisher: MIT Press. 3. Peter Brass, "Advanced Data Structures", Cambridge University Press, 2008. 4. Abhijit Das and C.E.VeniMadhavan, Public-key Cryptography: Theory and Practice, Pearson, 2009. Bottom of Form 5. Introduction to Modern Cryptography, Jonathan Katz and Yehuda Lindell. 6. LAN Trainer user Manual MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST526 Course Name : Research Methodology Credits : 2 L - 2 T - 0 P - 0 Course Type : Core Prerequisites: None Course Contents Unit I: Data Structures and Algorithms: Review of Data Structures , and most commonly used algorithms in Computer Science and Engineering – Sorting, DFS/BFS, and Pattern Searching. Unit II: Linear Algebra: Vectors - linear vector spaces, linear independence, norms and inner products, Basis and dimension, Matrices, Matrix operations, Inverse of a matrix Orthogonalization, Properties of determinants, Eigenvalues and eigenvectors, SVD and pseudo inverse, KL or hotelling transform.

Unit III: Transforms Signals and representation, Convolution, Frequency Transforms, Properties of Fourier Transform, DFT, DCT and FFT, Introduction to wavelets, applications in Computer Science and Engineering Unit III: Probability and Statistics Statistics: Introduction to statistical analysis, hypothesis testing – null and alternate, statistical tests – chi-square, ANOVA, data validation Probability models and axioms, Bayes' rule, discrete and continuous random variables, Probability distributions: normal distribution and properties, conditional, marginal and joint probability distribution, PRNG (pseudo random number generators) - randomness tests, introduction to information theory and cryptography: an Introduction Unit IV: Machine Learning: Linear and non-linear regression, supervised learning – neural network, binary decision diagram, SVM, k-NN, unsupervised learning – Clustering, Hidden Markov Models, Introduction to deep learning. Unit V: Case Studies in Research Domains of CSE. Recommended Readings Text Books: - 1. Gilbert Strang: Linear Algebra, MIT Cambridge Press. 2. Sheldon Ross: First Course in Probability, Pearson. 3. Mark Girolami, Simon Rogers: First Course In Machine Learning, CRC Press. 4. Anirban Das Gupta: Probability and Statistics for Machine Learning, Springer. 5. The Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani, second ed, Springer 6. Ian Goodfellow: Deep learning, MIT Cambridge Press.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CSP525 Course Name : Design Lab Credits : 2 L - 0 T - 1 P - 2 Course Type : Core Prerequisites: Students must have prior programming experience in C/C++ or any language; mathematics through differential equations, and numerical analysis Course Contents Operating Systems and Unix Environments: features of UNIX/Linux for scientific and technical computing; languages, compilers, debuggers, performance tools, make files, build systems, shell scripting, file management, source code control. Research Documentation and Simple Data Visualization: tools for generating research and code documentation: LATEX, Doxygen, plotting tools. Software Best Practices: software design cycle, regression testing, defensive programming, verification, code coverage Scientific Libraries: availability of common math libraries and usage for scientific computing. High performance Computing (HPC): Tool and techniques operating Systems and Unix Environments: features of UNIX/Linux for scientific and technical computing; languages, compilers, debuggers, performance tools, make files, build systems, shell scripting, file management, source code control. Research Documentation and Simple Data Visualization: tools for generating research and code documentation: LATEX, Doxygen, plotting tools. Software Best Practices: software design cycle, regression testing, defensive programming, verification, code coverage Scientific Libraries: availability of common math libraries and usage for scientific computing. High performance Computing (HPC): Tool and techniques.

Recommended Readings Text Books: - 1. Eric S. Raymond, The Art of Unix Programming, Addison-Wesley 2003. 2. Heister, T. and Rebholz, L. G., Introduction to Scientific Computing for Scientists and Engineers. De Gruyter Press, 2015. 3. John Levesque, High Performance Computing: Programming and Applications MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CSP527 Course Name :

Security Tools Lab Credits : 2 L - 0 T - 1 P - 2 Course Type : Core Prerequisites: NIL  
 Course Contents Etherreal/ Wireshark real time network analyzer, packet sniffing techniques ,TCPDump, Safety control using Metasploit , Vulnerability assessment using Nessus tool, Intrusion detection using Snort, Wireless safety tools, Network tracking using Nagios, Kali Linux tools, Hardware and software security tools  
 Recommended Readings Text Books: - 1. On line resources Electives Courses for CS -IS 1. 21CST802 Advanced Computer Networks 2. 21CST804 Android Programming 3. 21CST848 Biometrics 4. 21CST850 Cloud Security 5. 21CST851 Cyber Security 6. 21CST852 Data Compression 7. 21CST853 Deep Learning 8. 21CST856 Digital Forensics 9. 21CST857 Embedded System Security 10. 21CST858 Internet of Things 11. 21CST871 Wireless Security 12. 21CST859 Intrusion Detection 13. 21CST861 Nature Inspired Algorithms 14. 21CST862 Network Performance Modelling 15. 21CST863 Pattern Recognition 16. 21CIL736 Program Analysis 17. 21CST864 Public Key Infrastructure and Trust Management 18. 21CST865 Quantum Cryptography 19. 21CST866 Security Analysis of Protocols 20. 21CST821 Machine Learning 21. 21CST867 Selected Topics in Cryptography 22. 21CST868 Social Network Analysis 23. 21CST869 Software Testing and Validation 24. 21CST870 VLSI Algorithms 25. 21CST849 Blockchain Technologies MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST802 Course Name : Advanced Computer Networks Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Wireless networking: a. Bluetooth, 802.11 standards b. Information theory, bandwidth, multiple access c. Wireless Terahertz Networks d. 5G and 6G communication e. Intelligent Transportation Systems Emerging networking technologies: a. Host configuration and service discovery principles b. Future routing architectures c. IPv6 deployment scenarios and challenges, IPv6 transition/integration d. Advanced IP multicast, including IPv6 multicast and SSM e. Software -defined networki ng f. Delay -tolerant networking g. Future home network architectures h. IP network management and monitoring i. Social Networks Recommended Readings Text Books: - 1. Tanenbaum A S and Wetherall D J (2010). Computer Networks. 2. Hagen S, (2006). IPv6 Essentials. 3. Recent publications on the relevant fields MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST804 Course Name : Android Programming Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Basics: Review of Java Programming, Setting up and configuring Android Studio setup, Android EmulatorHello Android example, Android Manifest.xml, R.java file, Activity, Fragment, Layout Manager - Relative Layout, Linear Layout, Table Layout, Grid Layout A ctivity, Intent & Fragment: Activity Lifecycle, Activity Example, Intent – implicit and explicit, Intent filters, Fragment Lifecycle, Fragment Example, UI Widgets – buttons (toggle, switch, image), check box; Android Menu: Option Menu, Context Menu, Popup Menu; View Android Service: lifecycle, example, Data Storage, Shared Preference, SQLite, Content Provider, Android Notification Adding functionality: Multimedia API, Speech API, telephony API, Location API Sensors: Sensor API, Working with WiFi, Working with Camera, Motion Sensor, Position Sensor; Android Graphics App development project Recommended

Readings Text Books: - 1. Official Android Website MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST848 Course Name : Biometrics Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: A basic knowledge of statistics, linear algebra, and programming is expected. Course Contents Introduction: Person recognition, Biometric systems, Biometric functionalities, biometrics system errors, the design cycle of biometric systems. Fingerprint recognition: friction ridge patterns, fingerprint acquisition, feature extraction and matching, palm prints. Face recognition: image acquisitions, face detection, feature extraction and matching, handling pose, illumination and expression variations Iris recognition: image acquisition, Iris segmentation, Iris normalization, Iris encoding and matching, Iris quality assessment techniques Additional Biometric Traits: Ear, Gait, Hand geometry, Soft biometrics Multibiometrics: sources of multiple evidence, fusion levels: sensor, feature, score, rank and decision level fusion. Security of biometric systems: adversary attacks, attacks at user interface, attacks on biometric processing, attacks on template database. Recommended Readings Text Books: - 1. Introduction to Biometrics, Anil K Jain Arun Ross, Springer 2. The Science of Biometrics, Ravindra Das, Springer 3. Practical Biometrics, Julian Ashbourn, Springer MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST850 Course Name : Cloud Security Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Computer Networks, Operating System Course Contents Introduction of Cloud Computing: Taxonomy and related technologies, Essential Characteristics, Service and Deployment Models. Virtualization: Types of Virtualization and Hypervisors, Virtualization at Storage, Compute and Network, Hypervisors (Types and Case studies), Virtual Machine Provisioning, Virtual Machine Migration. Architectures: Standards, Orchestration, Provisioning, Portability, Interoperability, Federated Cloud, Security: CIA Triad, Vulnerabilities in Cloud, Threats to Infrastructure, Data and Access Control; Identity Management; Multi Tenancy Issues; Attack taxonomy; Intrusion Detection, VM Specific attacks, VM Introspection, Management; Trusted Cloud Initiative of Cloud Security Alliance (CSA). Forensics: NIST Forensics Reference Architecture, Forensic Science Challenges, Architectural Issues, Evidence Collection and Analysis, Anti-Forensics, Incident Response, Standards and Framework Recommended Readings Text Books: - 1. K. Hwang, G. C. Fox, and J. Dongarra, Distributed and Cloud Computing, 1st ed.: Morgan Kaufmann, 2011 2. R. Buyya, J. Broberg, and A. M. Goscinski, Cloud Computing: Principles and Paradigms: Wiley -Blackwell, 2011 3. S. Dinkar and G. Manjunath, Moving to the Cloud: Developing Apps in the New World of Cloud Computing Syngress Media, U.S., 2012. 4. W. Stallings, Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud, 1st ed.: Addison -Wesley Professional, 2015. 5. T. Erl, Z. Mahmood, and R. Puttini, Cloud Computing: Concepts, Technology & Architecture: Prentice Hall/Pearson PTR, 2014. 6. R. L. Krutz and R. D. Vines, Cloud Security - A Comprehensive Guide to Secure Cloud Computing, Wiley Publishing, 2010 7. T. Mather, S. Kumaraswamy, and S. Latif, Cloud Security and Privacy - An Enterprise Perspective on Risks and Compliance, O Reilly Publishers, 2009. 8. V. (J.

R.) Winkler, G. Speake, P. Foxhoven, Securing the Cloud: Cloud Computer Security Techniques and Tactics, Syngress, 2011. MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST851 Course Name : Cyber Security Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: NIL Course Contents Overview of Cyber Security, Internet Governance – Challenges and Constraints, Cyber Threats, Need for a Comprehensive Cyber Security Policy. Cyber Security Safeguards (Overview): Access control, Audit, Authentication, Biometrics, Cryptography, Deception, Denial of Service Filters, Ethical Hacking, Firewalls, Intrusion Detection Systems, Response, Scanning, Security policy, Threat Management. Network Security & Web Security: Security Issues in TCP/IP, which includes TCP, DNS, Routing (basic problems of security in TCP/IP, IPsec, BGP Security, DNS Cache poisoning, etc), Network Defense tools such as Firewalls, Filtering, DNSSec, NSec3, Distributed Firewalls, Web Application Security: Cross -Site Scripting Attacks, Cross -Site Request Forgery, SQL Injection Attacks Intrusion, Physical Theft, Abuse of Privileges, Unauthorized Access by Outsider, Malware infection, Intrusion detection and Prevention Techniques, Anti - Malware software, Network based Intrusion detection Systems, Network based Intrusion Prevention Systems, Host based Intrusion prevention Systems, Security Information Management, Network Session Analysis, System Integrity Validation. Cyber Forensics: Introduction to Cyber Forensics, Handling Preliminary Investigations, Controlling an Investigation, Conducting disk - based analysis, Investigating Information -hiding, Scrutinizing E -mail, Validating Email header information, Tracing Internet access, Tracing memory in real -time. Security in Mobile Platforms: Android vs. iOS security model, threat models, information tracking, rootkits, Threats in mobile applications, analyzer for mobile apps to discover security vulnerabilities, Viruses, Spywares, and keyloggers and malware detection. Cyberspace and the Law Recommended Readings Text Books: - 1. Latest research papers, journals and articles 2. Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Nina Godbole and SunitBelapure. 3. Cybersecurity Essentials By Charles J. Brooks, Christopher Grow, Philip Craig, Donald Short - 2018 4. Cybersecurity: Attack and Defense Strategies: Infrastructure Security with Red Team and Blue Team TacticsBook by ErdalOzkaya and Yuri Diogenes MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST852 Course Name : Data Compression Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Object Oriented Analysis and Design Course Contents Introduction: Compression techniques, lossless compression, lossy compression, measures of performance, modeling and coding. Mathematical preliminaries - Overview, introduction to information theory, models, physical models, probability models, Markov models. Basic Coding Schemes: Statistical Methods - Shannon -Fano Algorithm, Huffman Algorithm, Adaptive Huffman Coding. Arithmetic Coding (Encoding, Decoding, Adaptive Coding). Dictionary Methods - LZ77, LZ78, LZW Algorithms. Case study of lossless compression standards. Lossless Compression standards: zip, gzip, bzip, unix compress, GIF, JBIG. Image and Video Compression: Discrete Cosine Transform, JPEG. Wavelet

Methods - Discrete Wavelet Transform, JPEG 2000. Motion Compensation, Temporal and Spatial Prediction. MPEG and H.264. Audio Compression: Digital Audio, WAVE, FLAC, MPEG -1/2 Audio Layers. Recommended Readings Text Books: - 1. Khalid Sayood. 2012. Introduction to Data Compression (4th ed.). Elsevier. 2. David Salomon, Giovanni Motta. 2010. Handbook of Data Compression. Springer, London.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST853 Course Name : Deep Learning Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Course Overview: Introduction to Deep Learning and its Applications. Introduction to Statistical Learning: Multi -Layer Perceptron, Back Propagation, Linear Regression, etc. Convolutional Neural Networks: Convolution, pooling, Activation Functions, Back propagation of CNN, Weights as templates, Translation invariance, Training with shared parameters. CNN Architecture Design and Discussion: AlexNet, VGG, GoogLeNet, Res Net, Capsule Net, etc. Loss Functions and Optimization: Optimization, stochastic gradient descent, dropout, batch normalization, etc. Sequential Modelling: Recurrent and Recursive Nets, RNN, LSTM, GRU, Image captioning, visual question answering, etc. Visualization and Understanding: Visualizing intermediate features and outputs, Saliency maps, Visualizing neurons, Cam -Grad, etc. Generative Models: Variational Autoencoders, Generative Adversarial Networks like pix2pix, CycleGAN, etc. Deep Reinforcement Learning: Reinforcement Learning (RL) Background, Policy gradients, hard attention Q -Learning Deep Learning Applications: Object Detection: RCNN, Fast RCNN, Faster RCNN, YOLO, Retina Net, SSD, etc., Semantic Segmentation: DeepLabV3, PSP Net, etc. Adversarial Attacks on CNN.

Recommended Readings Text Books: - 1. Ian Goodfellow and Yoshua Bengio and Aaron Courville, "Deep Learning," MIT Press. 2. Michael A. Nielsen, "Neural Networks and Deep Learning," Determination Press, 2015.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST856 Course Name : Digital Forensics Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Operating Systems, Computer Networks & Security Course Contents File System Forensics: Duplicating hard disks for "dead analysis", reading hidden data on a disk's Host Protected Area (HPA), Direct versus BIOS access, dead versus live acquisition, Disk partitions - DOS, Apple, and GPT partitions, BSD disk labels, Sun Volume; multiple disk volumes - RAID and disk spanning; Analyzing FAT, NTFS, Ext2, Ext3, UFS1, and UFS2 file systems, Finding evidence: File metadata, recovery of deleted files, Using The Sleuth Kit (TSK), Autopsy Forensic Browser, and related open source tools Web Forensics: network -based evidence in Windows and Unix environments, Reconstructing Web browsing, email activity, Tracing domain name ownership and the source of e -mails System Forensics: Windows Registry changes, Duplicating and analyzing the contents of PDAs and flash memory devices Electronic document, computer image verification and authentication. Recommended Readings Text Books: - 1. Brian Carrier. File System Forensic Analysis, Addison Wesley. 2. Chris Prosise, Kevin Mandia. Incident Response and Computer Forensics, McGraw Hill. Course Technology. 3. Linda Volonino, Reynaldo Anzaldúa, and Jana Godwin. Computer Forensics: Principles and

Practices, Prentice Hall. 4. Keith J. Jones, Richard Bejtlich, and Curtis W. Rose. Real Digital Forensics: Computer Security and Incident Response, Addison Wesley. 5. Vacca, John R., Computer Forensics Computer Crime Scene Investigation, Charles River Media. 6. Nelson, Phillips, Enfinger, Stuart. Guide to computer Forensics and Investigation MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering Course Code : 21CST857 Course Name : Embedded System Security Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Security Flaws and Attacks in Embedded systems: Code injection, Invasive and Non invasive physical and logical attacks Defenses Against Code Injection Attacks: Methods using Address Obfuscation and Software Encryption, Anomaly Detection. Safe Languages, Code Analyzers Compiler, Library, and Operating System Support for embedded systems. security, Control Flow Checking, IP Protection: Encryption of IP Cores, additive and Constraint -Based watermarking. Implementation of DES 3DES, AES, RC4, MD5, RSA algorithms Recommended Readings Text Books: - 1. Security in Embedded Hardware MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering Course Code : 21CST858 Course Name : Internet of Things Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Computer Networks, Wireless Communication Course Contents Introduction: Internet of Things and Connected Products, IoT paradigm, Smart objects, Goal orientation, Convergence of technologies; Business Aspects of the Internet of Things. Internet and "Things": Layers, Protocols, Packets, Services, Performance parameters of a packet network and applications: Web, Peer -to-peer, Sensor networks, and Multimedia. Hardware and Software: Hardware components, Microcontrollers and Software; Operating Systems. Protocols and Platforms -IoT Communication Protocols, Transport Protocols, Application Protocols; Cloud computing for IoT. Services and Attributes: Data creation, Data gathering and Data dependency; Robustness, Scaling, Privacy, Security, Trust. Designing & Developing IoT applications: Introduction, IoT Design Methodology , Python Data Types & Data Structures, Control Flow, Functions, Modules, Packages, File Handling, Date/ Time Operations, Classes, Python Packages Application: Implications for the society, IoT case study. Recommended Readings Text Books: - 1. The Internet of Things: Key Applications and Protocols, David Boswarthick, Olivier Hersent, and Omar Elloumi, Wiley 2. Building the Internet of Things with IPv6 and MIPv6, Daniel Minoli, Wiley. 3. Latest research articles MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering Course Code : 21CST871 Course Name : Wireless Security Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Computer Networks Course Contents Foundations of Wireless Security: Wireless as a necessity, advantages and disadvantages, information security and wireless LANs, wireless LAN standards and types, Wireless LAN vulnerabilities. Risks and Threats of Wireless: Social Engineering, phishing, search engine scanning, Denial -of-service, malicious code, War driving, rogue access points, RFID. Wireless Security Models: Wireless Security Basics, Equivalent Privacy Standard (WEP), Extensible Authentication Protocol (EAP), Wi -Fi Protected Access (WPA), WPA2, 802.11i, attacks on WEP, EAP, WPA,

802.11i. Designing a secure wireless network: Basic principles of security design - layering, limiting, diversity, obscurity, simplicity; network segmentation, hardware placement, wireless device security. Wireless security Policy: policy overview, risk assessment, designing security policy, impact analysis, wireless security policy areas, types of wireless security policies. Recommended Readings Text Books: - 1. Wireless Security Handbook, by A aron E. Earle, Auerbach Publications 2. CWSP Guide to Wireless Security, by Mark Ciampa, 1st Edition. MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST859 Course Name : Intrusion Detection Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Introduction - Intrusion Detection System (IDS), Intrusion Prevention System (IPS), Unauthorized access – buffer overflow, packet fragmentation, out -of-spec packets Review of Network protocol – TCP/IP, Intrusion detection through tcpdump. IDS and IPS – Arch itecture and internals. Malicious and non -malicious traffic, IP headers, TCP, UDP and ICMP protocols and header formats, Header information to detect intrusion, logs and their analysis, IDS through reaction and response Intrusion analysis – data correlatio n, tools, SNORT - A case study. Recommended Readings Text Books: - 1. Matt Fearnow, Stephen Northcutt, Karen Frederick, and Mark Cooper. Intrusion Signatures and Analysis, SAMS. 2. Carl Endorf, Gene Schultz, Jim Mellander, Intrusion Detection and Prev ention, McGraw Hill. 3. Paul E. Proctor. The Practical Intrusion Detection Handbook, Prentice Hall. 4. Stephen Northcutt and Judy Novak. Network Intrusion Detection, SAMS. MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST861 Course Name : Nature Inspired Algorithms Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Data structures Course Contents Introduction to Algorithms, Optimization, Search for optimality, computational intelligence, Nature Inspired solutions and characteristic, Nature inspired Metaheuristics and its brief history, Analysis of Optimization Algorithms, Nature Inspired Algorithms , parameter Tuning and controlConstrained and unconstrained optimizations, Random Walks and Optimizations, evolutionary strategies and Evolutionary Algorithms (EA), Simulated Annealing (SA) Algorithm and its behavior, Genetic Algorithms(GA) - genetic operat or, parameters, fitness functions, genetic programming and convergence analysis, GA variants, Differential Evolution (DE), various Applications. Swarm Intelligence optimization, Particle Swarm Optimization(PSO) Algorithm, Ant Colony Optimization (ACO) Alg orithms, Artificial Bee Colony ACO) optimization algorithms, Cuckoo Search (CS) Algorithms, Intelligent Water Drop Algorithm (IWD), Bat Algorithms(BA), Firefly Algorithms(FA) Framework for self -tuning algorithms, Dealing with constraints, constraints hand ling, fitness functions ,multi -objective optimization techniques and its applications , Hybrid algorithms, Ways to Hybridize. Recommended Readings Text Books: - 1. Nature -Inspired Optimization Algorithms – by Xin -She Yang (Author), June 30, 2016 2. Mathematical Foundations of Nature -Inspired Algorithms, Xin -She Yang, Xing -Shi He, Springer; 1st ed. 2019 edition 3. Nature -Inspired Metaheuristic Algorithms: Second Edition, Xin -She Yang, Luniver Press 4. Introduction to Evolutionary Computing, A. E Ei ben and J. E. Smith, Second Printing, Springer, 2007 5.



Evolutionary Algorithms in Engineering Applications, Editors: Dipankar Dasgupta and Zbigniew Michalewicz, Springer -Verlag, 1997

6. D. E. Goldberg, Genetic Algorithms in search, Optimization and Machine Learning, Pearson India

7. Optimization Techniques and Applications with Examples By Xin -She Yan, Wiley publisher

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR**

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST862

Course Name : Network Performance Modelling

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: None

**Course Contents**

Introduction to Network Modeling: Network modeling, Computer Network as a discrete event system, Modeling and measurement tools, Network performance metrics – first order and second order metrics, Network capacity, Difference between throughput and capacity

**Network Calculus:** Models for data flows, arrival curves and service curves, Greedy shapers, Basic min -plus and max - plus calculus, min -plus and max -plus systems, Optimal smoothing, FIFO systems and aggregate scheduling, Time varying shapers, Systems with losses, Case studies – (1) Analyzing spanning tree based data forwarding using network calculus, (2) Bound on loss rate

**Stochastic Scheduling and Resource Allocation:** Stochastic scheduling, dynamic resource allocation, Dynamic programming models for stochastic scheduling, Queuing networks – open loop and closed loop networks, Jackson networks, Network fairness – proportional and max -min fairness, Markov process and its application for analyzing network resource allocation and fairness, available bandwidth estimation, Case studies – (1) TCP/IP flow and congestion control, (2) Modeling dynamic routing and scheduling as a queuing network problem, (3) Analysis of IEEE 802.11 channel access using two dimensional Markov process.

**Network Games:** Introduction to game theory, Zero sum games, Nash equilibrium, Pareto optimality, Cooperative and Non -cooperative games, General network games – resource sharing games, routing games, congestion games, Mechanism design, Case studies – (1) Selfish routing in networks and price of anarchy, (2) Oblivious routing, (3) Network resource allocation games

**Protocol Analysis:** Modeling discrete event system using Petri -nets, basics of Petri nets, stochastic Petri nets, queuing Petri nets, properties of Petri nets, structural analysis of Petri nets, Petri net modeling tools – simQPN, Case studies – (1) Wireless channel model using stochastic Petri net, (2) Data center network throughput analysis using queuing Petri Nets

**Recommended Readings**

**Text Books:**

1. "Routing, Flow, and Capacity Design in Communication and Computer Networks", Michael Pióro, Deepankar Medhi, ISBN: 0125571895, Publisher: Morgan Kaufmann
2. The Network Calculus Book by Jean -Yves Le Boudec and Patrick Thiran is available for free download: [http://ica1www.epfl.ch/PS\\_files/NetCal.htm](http://ica1www.epfl.ch/PS_files/NetCal.htm)
3. Anurag Kumar, D. Manjunath and Joy Kuri, "Communication Networking: An Analytical Approach" Morgan Kaufman Publishers
4. Dimitri P. Bertsekas and Robert G. Gallager, "Data Networks": Materials are available at <http://web.mit.edu/dimitrib/www/datanets.html>
5. "Network Optimization: Continuous and Discrete Models", D. Bertsekas
6. Research Publications - will be discussed and distributed time to time

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR**

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST863

Course Name : Pattern Recognition

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: An

undergraduate level understanding of probability, statistics and linear algebra is assumed. A basic knowledge of Python is essential.

**Course Contents**

The classification process: features, training and learning, approaches to classification

Non metric methods: Information, Entropy and Impurity, decision tree classifier- ID3, C4.5. Discriminant functions: linear discriminant functions, piece -wise linear discriminant functions, generalized discriminant functions. Statistical pattern recognition: measured data and measurement errors, probability theory, conditional probability and Bayes rule, Naive Bayes classifier, Continuous random variables, The multivariate Gaussian, Covariance matrix and Mahalanobis distance

Parametric learning: Bayesian decision theory, discriminant functions and decision boundaries, MAP (Maximum A Posteriori Estimator)

Non Parametric learning: Histogram estimator and Parzen windows, k -NN classification, Artificial Neural Networks, Kernel Machines, SVM. Feature extraction and selection: reducing dimensionality, feature selection - Inter/Intra class distance, Feature extraction: Principal component analysis, Linear discriminant analysis. Unsupervised learning: Clustering, K - Means clustering, Fuzzy c -Means clustering, (Agglomerative) Hierarchical clustering. Estimating and Comparing Classifiers: No free lunch, Bias and variance trade -off, cross -validation and resampling methods, Measuring classifier performance, Comparing classifiers - ROC curves, McNemar's test, other statistical tests.

**Recommended Readings Text Books:** - 1. Pattern Classification, Duda Hart, Wiley 2. Pattern Recognition and Classification, Geoff Dougherty, Springer 3. Statistical Pattern Recognition, Andrew R Webb, Wiley 4. Pattern Recognition and Machine Learning, Christopher Bishop, Springer 5. Pattern Recognition and Image Analysis, Earl Gose, Johnsonbaugh, PHI

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR**

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CIL736 Course Name : Program Analysis Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None

**Course Contents**

Introduction to analysis tools: debugging, disassembly, emulators, virtualization

Introduction: Program Representation, Syntactic Analysis, Program Semantics, Static and dynamic analysis, Syntactic Analysis, Dataflow Analysis and Abstract Interpretation, Interprocedural analysis, Context -sensitive, Pointer analysis, Call Graph Construction, slicing and profiling, Control Flow Analysis, Dynamic Analysis for Data Race Detection

Model Checking, Symbolic execution, Program Repair, Hoare Logic, SMT solvers

**Recommended Readings Text Books:** - 1. Pierce, Benjamin C. Types and Programming Languages. MIT Press, 2002. 2. Winskel, Glynn. The Formal Semantics of Programming Languages: An Introduction. MIT Press, 1993. 3. Nielson, Nielson, and Hankin. Principles of Program Analysis. Springer, 2010. 4. Baier, and Katoen. Principles of Model Checking. MIT Press, 2008. 5. Chlipala, Adam. Certified Programming with Dependent Types: A Pragmatic Introduction to the Coq Proof Assistant. MIT Press, 2013.

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR**

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST864 Course Name : Public Key Infrastructure and Trust Management Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None

**Course Contents**

Public key infrastructure - components and architecture. PKI interoperability, deployment and assessment

PKI data structures – certificates, validation, revocation,

authentication, cross - certification. Repository, Certification Authority (CA) and Registration Authority (RA), trusted third party, digital certificates PKI services – authentication, non -repudiation, privilege management, privacy, secure communication. Key management – certificate revocation list, root CA, attacks on CA, key backup. PKI standards – SSL, LDAP, IPSec, X.500, X.509, S/MIME Trust models – strict v/s loose hierarchy, four corners distribution. Certificate path processing – path construction and path validation. Recommended Readings Text Books: - 1. Ashutosh Saxena, Public Key Infrastructure, Tata McGraw Hill 2. Carlisle Adams, Steve Lloyd. Understanding PKI: Concepts, Standards, and Deployment Considerations, Addison Wesley. 3. John R. Vacca. Public Key Infrastructure: Building Trusted Applications and Web Services, AUERBACH. 4. Messaoud Benantar, Introduction to the Public Key Infrastructure for the Internet, Pearson Education.

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre :**  
**Department of Computer Science & Engineering Course Code : 21CST865 Course Name : Quantum Cryptography Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective**  
**Prerequisites: None Course Contents Preliminaries: Quantum Information Theory, Quantum Information Theory, Unconditional Secure Authentication and Entropy. Quantum Key Distribution: Quantum Channel, Public Channel, QKD Gain, Finite Resources, Adaptive Cascade: Introduction, Error Correction and the Cascade Protocol, Adaptive Initial Block -Size Selection, Fixed Initial Block -Size, Dynamic Initial Block - Size. Attack Strategies on QKD Protocols: Attack Strategies in an Ideal Environment, Individual Attacks in an Realistic Environment. QKD Systems, Statistical Analysis of QKD Networks in Real-Life Environment: Statistical Methods, Results of the Experiments, Statistical Analysis. QKD Networks Based on Q3P : QKD Networks, PPP, Q3P, Routing and Transport. Quantum - Cryptographic Networks from a Prototype to the Citizen. The Ring of Trust Model, Model of the Point of Trust Architecture, Communication in the Point of Trust Model, Exemplified Communications, A Medical Information System Based on the Ring of Trust.**  
**Recommended Readings Text Books: - 1. Quantum Cryptography and Secret -Key Distillation, Gilles van Assche, Cambridge University Press, 2006. 2. Paul Kaye, Raymond Laflamme, and Michele Mosca, An Introduction to Quantum Computing, Oxford University Press (2007). 3. Michael A. Nielsen and Isaac L. Chuang, Quantum Computation and Quantum Information, Cambridge University Press (2000).**

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre :**  
**Department of Computer Science & Engineering Course Code : 21CST866 Course Name : Security Analysis of Protocols Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective**  
**Prerequisites: None Course Contents Cryptographic background; Authentication, Key establishment and IP security; Denial of service; Anonymity and MIX networks; Fairness and contract signing, Privacy and protection of individual information; Wireless security (mobile phones, WiFi); Protocol analysis tools: Finite -state checking; Infinite -state symbolic analysis; Probabilistic model checking; Game -based verification; Process algebras (spi -calculus and applied pi calculus); Protocol logics (BAN, DDMP, Isabelle); Introduction to Probabilistic polynomial time calculus; Relating cryptographic and formal models. Recommended Readings Text Books: - 1. Latest reputed conference and journal articles as chosen by the instructor. 2.**

Maximum Security, 2nd Edition, SAMS Books by Anonymous, 1998, 3. Maximum Linux Security, SAMS Books by Anonymous, 2000, ISBN: 0 -672- 31670 -6. 4. 10 Risks of PKI: What You're not Being Told about Public Key Infrastructure, by Ellison and Schneier MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST860 Course Name : Machine Learning Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Basic understanding of probability and statistics, linear algebra and calculus. A basic knowledge of programming (preferably Python) is essential. Course Contents Advanced linear Algebra (e.g., SVD). The learning problem – learning versus design, types of learning - supervised, unsupervised, reinforcement and other views of learning. Linear Modelling: A least squares approach, linear modeling, making predictions, vector/matrix notation, linear regression, nonlinear response from a linear model. Generalization and over-fitting. The Bayesian approach to machine learning: exact posterior, marginal likelihoods Probability based learning: Bayes theorem, Bayesian prediction, conditional independence and factorization, the Naive Bayes model. Error based learning: simple linear regression, multi variable linear regression with gradient descent Logistic regression – gradient descent, nonlinear transformations the Z space. Similarity based learning: nearest neighbor, k - nearest neighbors, efficient distance computations: the KD trees Information based learning: learning and trees, Classification and regression trees. Ensemble methods, Boosting, Bagging, Random forests. Neural networks – the perceptron, Multilayer perceptron, activation functions, gradient descent, deriving back propagation. Multi - task and transfer learning, Deep learning. Linear discriminant analysis (LDA), Principal component analysis (PCA) SVM - optimal separation, the margin and support vectors, a constrained optimization problem, kernels – polynomial, radial basis, sigmoid Performance Measures and Evaluation – for categorical targets, prediction scores, multinomial targets, continuous targets. Clustering – the general problem, hierarchical and partitional clustering, K -means clustering. Recommended Readings Text Books: - 1. Learning from Data, Yaser S Abu -Mostafa, AML books 2. Machine learning, Marsland, CRC press 3. An Introduction to Machine Learning, Kubat Miroslav, Springer 4. Fundamentals of Machine Learning for predictive data analytics, John D Kelleher, MIT Press 5. Learning from Data, Yaser S Abu -Mostafa, AML books MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST867 Course Name : Selected Topics in Cryptography Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Maths Course Contents Basic Concepts: Information theoretic vs. computational security. One way functions, Pseudo randomness generators and functions, Permutations, hash functions. Private -key encryption using pseudo randomness. Private -key authentication. – Public key encryption (and number theory). Public key authentication. Interactive protocols: Touch of complexity theory, Interactive proof systems; 0 -knowledge proof systems, 0 -knowledge authentication, Electronic cash; non -interactive zero-knowledge. Oblivious transfer: Definitions, constructions, and applications, Secure Multiparty computations, Database (differential) privacy. – Proofs of work – Block -chain consensus protocols.

Recommended Readings Text Books: - 1. Introduction to Modern Cryptography: Principles and Protocols, by Jonathan Katz and Yehuda Lindell 2. A Graduate Course in Applied Cryptography by Dan Boneh and Victor Shoup 3. The Joy of Cryptography by Mike Rosulek. 4. Oded Goldreich: Foundations of Cryptography Vol 1 and Vol 2

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST868 Course Name : Social Network Analysis Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Data Structures and Algorithms Course Contents Network Models: Properties of Real -World Networks: Degree Distribution, Clustering Coefficient, Average Path Length. Random Graphs , Small -World Model, Preferential Attachment Model, Modeling of Real -World Networks using Random Graphs, Small -World Model and Preferential Attachment Model Network Measures: Centrality: Degree Centrality, Eigenvector Centrality, Katz Centrality, PageRank, Centrality, Closeness Centrality, Group Centrality. Transitivity and Reciprocity, Balance and Status, Similarity: Structural Equivalence, Regular Equivalence. Community Analysis: Community Detection, Community Detection Algorithms: Member -Based Community Detection, Group -Based Community Detection. Community Evolution: How Networks Evolve, Community Detection in Evolving Networks. Community Evaluation: Evaluation with Ground Truth, Evaluation without Ground Truth Recommendation: Classical Recommendation Algorithms: Content -Based Methods, Collaborative Filtering (CF), Extending Individual Recommendation to Groups of Individuals, Recommendation Using Social Context, Evaluating Recommendations: Evaluating Accuracy of Predictions, Evaluating Relevancy of Recommendations Graph Representation Learning, Knowledge Graphs and Meta Paths, Graph Convolutional Networks, Link Prediction, Influence Maximization & Outbreak Detection.

Recommended Readings Text Books: - 1. Networks, Crowds, and Markets: Reasoning About a Highly Connected World by David Easley and Jon Kleinberg. 2. Networks: An introduction by Mark Newman. 3. The Development of Social Network Analysis" by Linton C Freeman 4. Zafarani, Reza, Mohammad Ali Abbasi, and Huan Liu. Social media mining: an introduction. Cambridge University Press

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST869 Course Name : SOFTWARE TESTING & VALIDATION Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Software engineering, basic computer programming skills Course Contents Testing Environment and Test Processes: Software Testing Environment, Overview of Software Testing Process, Organizing for Testing, Developing the Test Plan, Verification Testing, Analyzing and Reporting Test Results, Acceptance Testing. Levels of Testing, Unit Testing, Integration Testing, Defect Bash Elimination. System Testing, Usability and Accessibility Testing, Configuration Testing, Compatibility Testing. Functional and Non -functional system testing, Compliance Testing, Load Testing, Performance Testing and Security Testing. Static and dynamic testing, Black -box or functional testing, Equivalence partitioning, BVA, structural, White box or glass box testing, Mutation Testing, Data flow testing. Test Automation: Software Testing Tools, Software Test Automation, Debugging, Case study.

Recommended Readings Text Books: - 1. Srinivasan Desikan and Gopalaswamy Ramesh, "Software

Testing – Principles and Practices”, Pearson Education,. 2. A.P. Mathur, Foundations of Software Testing, Pearson publications 3. Naresh Chauhan , “Software Testing Principles and Practices ” Oxford University Press , New Delhi . 4. Elene Burnstein, “ Practical Software Testing”, Springer International Edition. 5. Renu Rajani, Pradeep Oak, “Software Testing – Effective Methods, Tools and Techniques”, Tata McGraw Hill. 6. William Perry, “Effective Methods of Software Testing”, Third Edition, Wiley Publishing.

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR**  
 Department/Centre : Department of Computer Science & Engineering Course Code : 21CST870 Course Name : VLSI Algorithms Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Logic synthesis & verification: Introduction to combinational logic synthesis, Binary Decision Diagram, Hardware models for High -level synthesis. VLSI Algorithms Partitioning: Problem formulation, classification of partitioning algorithms, Group migration algorithms, simulated annealing & evolution, other partitioning algorithms. Placement, floor planning & pin assignment: Problem formulation, simulation base placement algorithms, other placement algorithms, constraint -based floorplanning, floor planning algorithms for mixed block & cell design. General & channel pin assignment. Global Routing: Problem formulation, classification of global routing algorithms, Maze routing algorithm, line probe algorithm, Steiner Tree based algorithms, ILP based approaches. Detailed routing : problem formulation, classification of routing algorithms, single layer routing algorithms, two -layer channel routing algorithms, three -layer channel routing algorithms, and switchbox routing algorithms. Over the cell routing & via minimization: two layer s over the cell routers, constrained & unconstrained via minimization. Compaction: problem formulation, one -dimensional compaction, two dimension -based compaction, hierarchical compaction. Recommended Readings Text Books: - 1. Naveed Sherwani, “Algorithms for VLSI Physical Design Automation”, 3rd

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR**  
 Department/Centre : Department of Computer Science & Engineering Course Code : 21CST849 Course Name : Blockchain Technologies Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Network Security, Cryptography, Course Contents INTRODUCTION TO BLOCKCHAIN Distributed Ledger Technology, Decentralization, Bitcoin Network and Architecture, Block in a Blockchain, Advantages over Traditional Databases, Mining Mechanism, Types of Blockchain: Public, Private, Consortium, Cryptography: Elliptic Curve Cryptography, Hash Functions, Merkle Tree, Merkle Patricia Trie, Digital Signature, Wallets and Keys, User Addresses and Privacy CRYPTO CURRENCY History, Distributed ledger, Creation of Coins, Double spending, Bitcoin protocols, Transaction in Bitcoin Network, AltCoins, Ethereum, EVM, Accounts, Transactions, Gas, Fees, Smart Contracts, Eth 2.0 MINING AND CONSENSUS Definitions, Types of Mining Algorithms, Proof of Work, Proof of Stake, Proof of Burn. Sharding Chains SMART CONTRACTS ON ETHEREUM Setting up Ethereum Node using Geth Client, Smart Contracts and DApps, Truffle, Ganache CLI, Metamask, Remix, Solidity, Writing and Deploying Smart Contracts in Solidity, Connection to Web3.js Library, Vulnerabilities in Smart Contracts, Attacks, Prevention of Attacks, Decentralized Autonomous Organization (DAO), Building an Initial Coin Offering (ICO). BLOCKCHAIN USE CASES AND APPLICATIONS Use -Cases in Cryptocurrency

and Other Sectors like Finance, Voting System, and Healthcare, etc. Future of Blockchain. Recommended Readings Text Books: - 1. Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction MTech\_2015\_CSIS.pdf Department of Computer Science and Engineering Malaviya National Institute of Technology MTech Part-Time (Computer Engineering and Information Security) (2016-17 onwards) I Semester (Autumn Semester) CWS PRS MTE ETE PRE 1 CST701 Advance Cryptography PC 3 3 0 0 2 20 -30 50 - 2 3 CST705 Machine Learning PC 3 3 0 0 2 20 -30 50 - 4 5 6 CSP711 Information Security Lab PC 3 1 0 3 -60 - -40 9 \* Typical distribution. Can be changed by Course Instructor/Coordinator by announcing at beginning of semester. II Semester (Spring Semester) CW S PRS MTE ETE PRE 1 Elective-I PE 3 3 0 0 2 20 -30 50 - 2 3 Elective-III PE 3 3 0 0 2 20 -30 50 - 4 5 6 Lab Elective -I PE 3 1 0 3 -60 - -40 9 \* Typical distribution. Can be changed by Course Instructor/Coordinator by announcing at beginning of semester. \*\* Two Electives need to be taken from Department Elective List. 18 Exam DurationRelative Weightage\* Course Title Subject AREA CreditL T P S.NoCourse CodeCourse Title\*\* Subject AREA CreditL Total TOTAL CREDITS (Sem I-II) Department of Computer Science and Engineering Malaviya National Institute of Technology MTech Part-Time (Computer Engineering and Information Security) (2016-17 onwards) III Semester (Autumn Semester) CWS PRS MTE ETE PRE 1 2 CST703 Advance Data Structures & Algorithms PC 3 3 0 0 2 20 -30 50 - 3 4 CST707 Security Engineering PC 3 3 0 0 2 20 -30 50 - 5 CSP709 Advance Programming Lab PC 3 1 0 3 -60 - -40 6 9 \* Typical distribution. Can be changed by Course Instructor/Coordinator by announcing at beginning of semester. IV Semester (Spring Semester) CWS PRS MTE ETE PRE 1 2 Elective-II PE 3 3 0 0 2 20 -30 50 - 3 4 Elective-IV PE 3 3 0 0 2 20 -30 50 - 5 Elective-V PE 3 3 0 0 2 20 -30 50 - 6 9 \* Typical distribution. Can be changed by Course Instructor/Coordinator by announcing at beginning of semester. \*\* Two Electives need to be taken from Department Elective List. 18 CreditL T P Exam DurationRelative Weightage\* S.NoCourse CodeCourse Title Subject AREA Total S.NoCourse CodeCourse Title\*\* CreditL T P Exam DurationRelative Weightage\* Total TOTAL CREDITS (Sem III-IV) Subject AREA Department of Computer Science and Engineering Malaviya National Institute of Technology MTech Part-Time (Computer Engineering and Information Security) (2016-17 onwards) V Semester (Autumn Semester) CWS PRS MTE ETE PRE 1 CSISS600 Seminar PC 4 - - - - -100 - 2 CSISD601 Dissertation PC 16 - - - - - - - - - 20 VI Semester (Spring Semester) CW S PRS MTE ETE PRE 1 CSISD602 Dissertation PC 16 - - - - - - - - - 16 36 72TotalS.NoCourse CodeCourse Title Subject AREA CreditL T P Exam DurationRelative Weightage\* S.NoCourse CodeCourse Title Subject AREA CreditL T P Exam DurationRelative Weightage\* TOTAL CREDITS (Sem I-VI)TOTAL CREDITS (Sem V-VI)Total Department of Computer Science and Engineering Malaviya National Institute of Technology MTech Full Time (Computer Engineering and Information Security) (2016-17 onwards) CST701 Advanced Cryptography (3-0-0) Introduction(10 T): Mathematical foundations: Group theory (Groups, Rings and Fields), Symmetric key cryptography vs. public key cryptography, One-way functions based on mathematical problems, Security problems of text book cryptosystems, Number theory, Algorithms in public key cryptography. Lattice Based

Cryptography(15 T): Introduction to Lattices, The Hermite normal form, Ajtai's worst-case/average-case connection, Discrete Gaussians, Smoothing Parameter, Leftover Hash Lemma, The lattice trapdoor construction of Micciancio-Peikert, The Gorbunov-Vaikuntanathan- Wee LWE-based Attribute-Based Encryption Scheme, Attribute-Based Encryption, LWE-based homomorphic encryption, Continue LWE-based homomorphic encryption, Ideal Lattices, The NTRU cryptosystem, Multilinear maps from ideal lattices. Advanced Topics in Cryptography(15 T): Interactive Proofs, Zero-Knowledge Proofs (concurrent zero knowledge, upper and lower bounds on round complexity, black-box vs. non-blackbox zero knowledge), Zero-Knowledge Proofs of Knowledge, Non-Interactive Zero-Knowledge Proofs, Secure Protocols. Two-party Secure Computation, Multiparty Secure Computation, Chosen Ciphertext Security. Oblivious transfer: Definitions, constructions, and applications, Byzantine agreement, private information retrieval, threshold cryptography, voting protocols, auctions, privacy preserving data mining, credential systems, Text Books: 1. Cryptography: Theory and Practice , by Douglas R. Stinson. 2. A Course in Number Theory and Cryptography by Neal Koblitz ,Springer. 3. Algebraic aspects of cryptography Neal Koblitz ,Springer 4. Cryptography and Networks Security, William Stallings 5. Introduction to Modern Cryptography, Jonathan Katz and Yehuda Lindell 6. Security and cooperation in wireless networks, Levente buttyane and Jean-Pierre hubaux 7. Applied Cryptography, by Bruce Schneier 8. Lattice-based Cryptography, by Daniele Micciancio, Oded Regev 9. Complexity of Lattice problems: a cryptographic perspective, by Daniele Micciancio and Shafi Goldwasser's. 10. A Graduate Course in Applied Cryptography, by Dan Boneh and Victor Shoup CST702 Special Topics in OS (3-0-0)

Advanced Topics: Advanced scheduling techniques for processes and threads; kernel architectures and implementation of CFS in recent kernels; Access control schemes in OS; Multimedia OS and design features; Introduction to networked, distributed file systems; Virtualisation and cloud OS; Introduction to embedded and Mobile OS; Distributed shared memory : distributed scheduling, failure recovery, resource security and protection, Configuring Services Registry settings, System Configuration Settings, Manage Users Manage the system, Supporting address translation (NAT); Introduction to Performance Tuning : Maintenance and troubleshooting Introductions Text: Recent papers from USENIX and Journals

CST703 Advance Data Structures and Algorithms (3-0-0) RAM model: Growth of functions, Notations, Recurrence analysis - Master's theorem and its proof, Probabilistic analysis, Amortized analysis. Advanced Data Structures: B-Trees, Binomial Heaps, Fibonacci Heaps, AVL trees, Red-black trees, B-trees, Splay trees, Disjoint set, Hash tables, Bloom filters. Graph Algorithms: DFS, BFS, Shortest path, MST, Articulation Point, Topological sorting, Connected components, Network Flow, Matchings. Interval scheduling algorithms, Knapsack problem. Dynamic programming: Longest common subsequence. Chain of matrix multiplication, Optimal binary tree. Convex hull and Voronoi diagrams, line segments, Optimal polygon triangulation. Approximate Algorithms: Vertex-cover, set-covering problems, Travelling Salesman



problem. Randomized algorithms: Use of probabilistic inequalities in analysis, applications using examples. Randomized Algorithms : Computing the Median, Randomized Divide-and-Conquer Number-Theoretic Algorithms: Greatest common divisor, Modular arithmetic, Chinese remainder theorem, Cryptosystems , Primality testing, Integer factorization, Discrete logarithm, Polynomial representations, Operations, FFT as an example. Parallel algorithms: Basic techniques for sorting, searching, merging. Complexity classes - NP-Hard and NP-complete Problems - Cook's theorem, Undecidability, NP completeness reductions. Texts/References: 1)Cormen, Leiserson, Rivest: Introduction to Algorithms , Prentice Hall of India. 2)Jon Kleinberg , Eva Tardos : Algorithm Design, Pearson 3)Aho A.V , J.D Ullman: Design and analysis of Algorithms , Addison Wesley 4)Motwani and Raghavan: Randomized Algorithms , Cambridge University Press 5)Joseph Ja'Ja': Introduction to Parallel Algorithms , Addison-Wesley 6)Vazirani: Approximation Algorithms , Springer Verlag

CST704 Critical Infrastructure Protection (3-0-0) PRE-REQUISITES: Computer Networks, Network Security COURSE OUTCOMES: 1.Describe what digital investigation is, the sources of evidence, and the limitations of forensics. 2.Describe the legal requirements for use of seized data, data collection, and storage 3.Reconstruct application history from application artifacts and replay of attack 4.Capture and interpret network traffic, analyze mobile devices, and inspect for presence of malware 5.Apply forensics tools to investigate security breaches and identify anti-forensic methods. COURSE OUTLINE: Introduction to Critical Infrastructure Assurance and Protection: Critical Infrastructure Functions, Evolution of Critical Infrastructure Demand, Capacity, Fragility, and the Emergence of Networks Beyond National Frameworks: Areas of Potential Risk or Concern The Reinvention of Information Sharing and Intelligence: Data vs Information vs Intelligence, Open-Source Information and Intelligence Emergency Preparedness and Readiness: First Responder, First Responder Classifications Know Protocols to Secure, Mitigate, and Remove HAZMAT, Importance of Implementing an Emergency Response Plan Security Vulnerability Assessment: Risk Assessment, Threat Risk Equations , Quantitative vs Qualitative Risk Assessments, Threat, Vulnerability, Countermeasures, Vulnerability Assessment Framework Information Sharing and Analysis Centers: Critical Infrastructure Asset, Supply Chain, Public Transit, Transportation Technology, Water, Financial Services, Electricity, Information Technology, Internet Infrastructure, Cyber Threats & Cyber Security, Telecommunications, Energy Resource, Chemical, Healthcare, Food and Agriculture Supervisory Control and Data Acquisition: Vulnerability Concerns about Control Systems , Insecure Connectivity to Control Systems, Issues in Securing Control Systems Critical Infrastructure Information: Enforcement of FOUO Information, Export-Controlled Information, Source Selection Data, Privacy Information, Unclassified Controlled Nuclear Information, Critical Energy Infrastructure Information , Controlled Unclassified Information TEXT BOOKS: 1.Robert S. Radvanovsky and Allan McDougall, Critical Infrastructure: Homeland Security and Emergency Preparedness, Third Edition, CRC Press, 2013 2.Tyson Macaulay, Critical Infrastructure: Understanding Its Component Parts, Vulnerabilities, Operating Risks,

and Interdependencies, CRC Press, 2008 3. Robert Radvanovsky and Jacob Brodsky, Handbook of SCADA / Control Systems, Second Edition, CRC Press, 2016 4. Eric D. Knapp and Joel Thomas Langill, Industrial Network Security: Securing Critical Infrastructure Networks for Smart Grid, SCADA, and Other Industrial Control Systems, Second Edition, CRC Press, 2014 CST705 Machine Learning (3-0-0) Introduction: Basic concepts. Supervised learning: Supervised learning setup. LMS. Logistic regression. Perceptron. Exponential family. Generative learning algorithms. Gaussian discriminant analysis. Naive Bayes. Support vector machines. Model selection and feature selection. Ensemble

methods: Bagging, boosting. Evaluating and debugging learning algorithms. Learning theory: Bias/variance tradeoff. Union and Chernoff/Hoeffding bounds. VC dimension. Worst case (online) learning. Unsupervised learning: Clustering. K-means. EM. Mixture of Gaussians. Factor analysis. PCA (Principal components analysis). ICA (Independent components analysis). Reinforcement learning and control: MDPs. Bellman equations. Value iteration and policy iteration. Linear quadratic regulation (LQR). LQG. Q-learning. Value function approximation. Policy search. Reinforce. POMDPs. References: 1. Tom M. Mitchell, Machine Learning, McGraw Hill, 2014 2. Bishop, C. M. Pattern Recognition and Machine Learning. Springer. 2007. 3. Marsland, S. Machine Learning: An Algorithmic Perspective. CRC Press. 2009. (Also uses Python.) 4. Richard O. Duda, David G. Stork, Peter E. Hart, Pattern Classification, Wiley 2007 5. Dougherty, Pattern Recognition and Classification, Springer 2011. 6. Bayesian Reasoning and Machine Learning, David Barber, CRC Press 7. A First Course in Machine Learning, Simon Rogers and Mark Girolami, Chapman & Hall/CRC

CST706 Malware Analysis (3-0-0) Malware: Types – Virus, Worms, Trojans, Logic Bombs, etc., infection modes, payload and its delivery mechanisms. Analysis Tools and their design: Disassemblers, Unpackers, Scanners, Decompilers, Emulators, Virtualization techniques Anti-analysis techniques: Obfuscation techniques, Packing, Encryption, Polymorphism, metamorphism. Analysis Techniques: Signature based, Non-signature based, Static, dynamic, behavioral, anomaly detection. Case Study: Android Malware Text/Reference Books 1. Peter Szor: The Art of Computer Virus Research and Defense, Addison Wesley Professional. 2. Eric Filiol: Computer Viruses: from theory to applications, Springer. 3. Michael Sikorski and Andrew Honig: Practical Malware Analysis: The Hands-On Guide to Dissecting Malicious Software, No Starch Press 4. Christopher Elisan: Advanced Malware Analysis, McGraw-Hill Osborne Media. 5. Michael Hale Ligh, Andrew Case: The Art of Memory Forensics: Detecting Malware, Wiley. 6. Bruce Dang, Alexandre Gazet: Practical Reverse Engineering, Wiley. CST 707 Security Engineering (3-0-0) Introduction to Security Engineering: Passwords and their limitations, attacks on passwords, CAPTCHA, Biometrics. Access Control: ACL, sandboxing, virtualization, trusted computing. Multi-level and Multi-lateral security. Secure systems: hardware, software and communication systems – design issues and analysis. Secure software architecture: models and principles, hardware design related security – smart cards and other security

solutions, communication protocols and application systems associated with security. Securing services: Security in Metered Services, pre-payment meters. Secure printing and Seals. Tamper resistance mechanisms. References: 1. Ross Anderson's Security Engineering , Second Edition 2. Bruce Schneier. Secrecy, Security, and Obscurity . Crypto-Gram, 2002 Additional References : 1.Latest reputed conference and journal articles as chosen by the instructor. 2.William R. Cheswick, Steven M. Bellovin, and Aviel D. Rubin. Firewalls and Internet Security, Second Edition , Addison-Wesley, 2003.

3.Bruce Schneier. Applied Cryptography, Second Edition , Wiley, 1996. 4.Niels Ferguson and Bruce Schneier. Practical Cryptography , Wiley, 2003. 5.Matt Bishop. Introduction to Computer Security , Addison-Wesley, 2004. 6.Andrew Tanenbaum. Modern Operating Systems, Fourth Edition , Pearson, 2014. 7.Andrew Tanenbaum and David Wetherall. Computer Networks, Fifth Edition , Pearson, 2010. 8.Steven M. Bellovin. Thinking Security, Addison-Wesley, 2015.

CST708 Advance Database Systems (3-0-0) Issues in the Implementation of Database Systems. Query Processing and Optimization – Implementation of Database operations, External Sorting, Size Estimations, Equivalence Rules, Heuristic-based Optimization, Materialized Views, Incremental View Maintenance. Transaction Processing - Concurrency Control Management, Serializability, Two-phase Lock Protocol, Deadlock Prevention and Detection, Timestamp-based Ordering Protocol, Log-based Recovery Management. Database System Architectures, Distributed Databases, Distributed Transactions, Data Storage, Two-Phase Commit Protocol, Distributed Query Processing, Parallel Databases, Times in Databases, Multimedia Databases. Text and References: 1.Silberschatz A, Korth HF, Sudarshan S, Database System Concepts, McGraw Hill. 2.Elmasri R and Navathe SB, Fundamentals of Database Systems, 3rd Edition, Addison Wesley,2000. This book covers most of the material on the course. 3.Ceri S, Pelagatti G, Distributed Databases – Principles and Systems, McGraw Hill. 4.Date CJ, An Introduction to Database Systems , 7th Edition, Addison Wesley. 5.Khashafian S and Baker AB, Multimedia and Imaging Databases , Morgan Kaufmann. CST710 Software Testing (3-0-0) Introduction to Faults, Errors, and Failures, Basics of software testing, Testing objectives, Principles of testing, Requirements, behavior and correctness, Testing and debugging, Verification, Validation and Types of testing. Static and Dynamic Testing: Static testing, static analysis tools, white box testing, Unit/Code functional testing, Code coverage testing, Code complexity testing, Black Box testing, Requirements based testing, Boundary value analysis, Equivalence partitioning, state/graph based testing, Model based testing and model checking, Differences between white box and Black box testing. Integration, System, and Acceptance Testing: Top down and Bottom up integration, Bi-directional integration, System integration, Design/Architecture verification, Beta testing, Scalability testing, Stress testing, Security testing, Penetration testing, Vulnerability testing, Acceptance testing: Acceptance criteria, test cases selection and execution. Test Selection & Minimization for Regression Testing: Regression testing, Regression test process, Initial Smoke or

Sanity test, Selection of regression tests, Execution Trace, Dynamic Slicing, Test Minimization, Tools for regression testing, Defect seeding. Test Management and Automation: Test Planning, Management, Execution and Reporting, Software Test Automation: Scope of automation, Design & Architecture for automation, Generic requirements for test tool framework, Test tool selection. References: 1. S. Desikan and G. Ramesh, "Software Testing: Principles and Practices", Pearson Education. 2. Aditya P. Mathur, "Fundamentals of Software Testing", Pearson Education. 3. Naik and Tripathy, "Software Testing and Quality Assurance", Wiley. 4. Myers, Glenford J., "The art of software testing", John Wiley & Sons.

CST712 Advances in Compiler Design (3-0-0) A Tour of Compiler Design, Structure of Compilers for Modern Programming Languages, LR Parsers and LR Grammars – Design and Development, Lex and Yacc Tools. Optimizing Compiler, Control-flow Analysis, Control-flow Graphs, Basic Blocks, Data-flow Analysis, Dependence Analysis, Global Optimizations, Loop Optimizations, Peephole Optimization and Optimal Code Generation, Data Dependence Analysis in Loops, Loop Scheduling, Static Single Assignment, Just-In-Time (JIT) and Adaptive Compilation, Runtime System Architectures and Automatic Memory Management Techniques. Text and References: 1.Aho, Alfred V ., Sethi, Ravi, Ullman, Jeffrey D., Compilers: Principles, Techniques and Tools, Addison-Wesley. 2.Steven Muchnick, Advanced Compiler Design & Implementation, Morgan Kaufmann. 3.Keith Cooper and Linda Torczon, Engineering a Compiler, Morgan Kaufmann. CST714 Advances in Real-time Systems (3-0-0) Misconceptions about Real-Time computing. Real-time System requirements. Specification of timing constraints. Real-time scheduling, Requirements and Issues, Terminology, Modeling, Static and Dynamic Scheduling schemes, priority driven scheduling of periodic tasks, Schedulability Tests, Aperiodic Task Scheduling, Practical factors/overheads. Resources and resource access control, Multiprocessor Real Time Systems, Problems and Issues. Scheduling in Multiprocessor Systems. Scheduling flexible computations and tasks with Temporal Distance Constraints. Time Critical Applications and Recent Trends in Real Time Computing. Reference Books 1. Real-Time Systems, Jane W.S.Liu, Pearson, 2006 2. Real-Time Systems, C.M.Krishna and Kang G.Shin , McGraw-Hill Education ,1997.

CST716 Image Analysis (3-0-0) Aim of the Course By the end of the semester, students will be able to: 1.Students can able to understand and perform basic image analysis, modelling and visualization problems. 2.Students can able to comprehend challenging research topics and proposes solutions for a real- time in image analysis. IMAGE PRELIMINARIES and IMAGE PROCESSING Digital image representation, Fundamental steps in image processing, Image Acquisition: Energy, the optical system, image sensor and digital image formation. Gray scale and color images. Elements of visual perception, Image model, Sampling and quantization, Relationship between pixels, imaging geometry. Image Point Processing : Gray-level mapping, non-liner gray-level mapping, image histogram, histogram stretching, histogram equalization, thresholding. Neighborhood Processing : Median filter, mean filter, correlation and image sharpening. Color image processing. Morphology: Dilation &

Erosion, closing & opening and boundary detection. Geometric transformations : Translation, rotation, scaling and shearing. Frequency transformation : Discrete Fourier transform (DFT), fast Fourier transform (FFT), short-time Fourier transform (STFT), Multi-resolution Expansions : Wavelet Transforms in 1-D and 2-D. The Fast Wavelet Transform, Wavelet Packets Transform. FEATURE EXTRACTION AND DIMENSION REDUCTION Color, Texture, Shape and structure Features in spatial and frequency domains, Corner Detection, Hough Transform, Principal Component Analysis, Linear Discriminate Analysis, Feature Reduction in Input and Feature Spaces. IMAGE SEGMENTATION Gray-level thresholding, Supervised vs. Unsupervised thresholding, Binarization using Otsu's method, Locally adaptive thresholding, Color-based segmentation, Region oriented segmentation, Use of motion in segmentation, Spatial techniques, Frequency domain techniques. FEATURES BASED IMAGE MATCHING: Scale Space Image Processing, Different Feature descriptors: Key Point Detection, SIFT descriptor SURF descriptor Bag of Visual Words approach, Geometric consistency check, Vocabulary tree PANORAMIC IMAGING Template Matching, Mono Panorama, Stereo Panorama. TEXT BOOKS 1. J G Proakis and D G Manolakis, "Digital Signal Processing," Pearson, Fourth edition 2. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Prentice Hall, 3rd Edition, 2007. 3. Bishop, Pattern Recognition and Machine Learning 4. Duda-Pattern Classification CST718 Wireless Security (3-0-0) Introduction(10 T): Wireless networking technology: fundamentals in wireless communication, Wireless MAC standards, Wireless networks: wireless sensor networks, MANETs, WMNs, CRNs, etc. Security definitions and concepts, Attacks and risks in wireless networks/communications. Wireless MAC Security (7 T): attacks on IEEE 802.11, anonymity, confidentiality, availability and integrity in IEEE 802.11. WPA, WPA2 (IEEE 802.11i). Security issues IEEE 802.16, IEEE 802.15.

4, and IEEE 802.22. RFID Security(10 T): Introduction to RFID security, Physical form factor, threat and target identification and Management of RFID security. Tag data security : Potential attacks: skimming and eavesdropping , Measures to protect RFID data transmission, Physical security, Protocol-based security (Encryption and mutual authentication, Effect of security protocols on performance, Frequencies and security, ePassports: standardized security protocols). Safeguarding personal privacy: Potential threats to personal privacy, EPCglobal: recommended industry practices for safeguarding consumer privacy, Regulatory measures: India, U.S., Europe, and Japan. Advances in Wireless Security(13 T): Secure and resilient data aggregation, Key pre-distribution and management, Encryption and authentication, Security in group communication, Trust establishment and management, Denial-of-service attacks and Energy-aware security mechanisms. Text books: No text book and use selected research articles to teach. CST720 Security and Privacy in Social Networks (3-0-0) Brief introduction to OSNs: History and definition of Privacy; Vocabulary, history, terms; Types of consumers, privacy; Myths or why we don't care? Duality of privacy and security: Privacy and security; The role of usability; Crypto and its failure; Privacy and anonymity; Anonymization techniques; Why hasn't privacy/security duality yielded more? Terminology and key players: Tracking; Technologies for

tracking; Technical vectors of leakage and ways of identifying them; Role of JavaScript; Role of protocols. Personally Identifiable Information: What is personally identifiable information; People search engines; Introduction to Mobile OSNs; Special purpose OSNs: Pinterest, SnapChat, Ask.fm, WhatsApp; Privacy settings in OSNs; PII leakage in OSNs Linkage: Semantics and the compositional problem; Collateral Damage of Privacy; Economics of Privacy: Privacy of mixed data sets, OSNs; Privacy across time References: 1.Latest reputed conference and journal articles as chosen by the instructor. 2.Charlie Kaufman, Radia Perlman, Mike Speciner, Network Security: Private Communication in a Public World, 2nd edition, 2002, Prentice Hall. 3.Simson Garfinkel, Gene Spafford, Web Security, Privacy and Commerce, 2002, O'Reilly 4.Ross Anderson, Security Engineering, John Wiley and Sons, 2001

5.Cryptography and Network Security: Principles and Practice, by William Stallings , Prentice Hall, Hardcover. Fifth Edition is out also. See <http://williamstallings.com/Crypto3e/Crypto3e-student.html> for student online help. 6. Network Security Essentials: Applications and Standards, by William Stallings. Prentice Hall, Hardcover, Published November 1999, 366 pages, ISBN 0130160938 7.Secrets and Lies: Digital Security in a Networked World by Bruce Schneier John Wiley, Published August 2000, 412 pages, ISBN 0471253111.Kruegel, and G. Vigna.

CST722 Advances in Data Mining (3-0-0) UNIT-I Data mining Overview Data mining tasks – mining frequent patterns, associations and correlations, classification and regression for predictive analysis, cluster analysis , outlier analysis; advanced pattern mining in multilevel, multidimensional space – mining multilevel associations, mining multidimensional associations UNIT-II Classification, Clustering, Association Rule Mining Classification by back propagation, support vector machines, classification using frequent patterns, other classification methods – genetic algorithms, roughest approach, fuzz>set approach; Density - based methods –DBSCAN, OPTICS, DENCLUE; Grid-Based methods – STING, CLIQUE; Exception – maximization algorithm; clustering High- Dimensional Data; Clustering Graph and Network Data. Frequent Pattern matching, Association Rule Mining UNIT-III Web and Text Mining Introduction, web mining, web content mining, web structure mining, we usage mining, Text mining – unstructured text, episode rule discovery for texts, hierarchy of categories, text clustering. UNIT-V Temporal and Spatial Data Mining Introduction; Temporal Data Mining – Temporal Association Rules, Sequence Mining, GSP algorithm, SPADE, SPIRIT Episode Discovery, Time Series Analysis, Spatial Mining – Spatial Mining Tasks, Spatial Clustering. Data Mining Applications. TEXT BOOKS: 1. Data Mining Concepts and Techniques, Jiawei Han Micheline Kamber, Jian pei, Morgan Kaufmann. 2. Data Mining Techniques – Arun K pujari, Universities Press. REFERENCE BOOKS: 1. Introduction to Data Mining – Pang-Ning Tan, Vipin kumar, Michael Steinbach, Pearson. 2. Data Mining Principles & Applications – T.V Sveresh Kumar, B.Esware Reddy, Jagadish S Kalimani, Elsevier.

CST724 Web Security (3-0-0) PRE-REQUISITES: Computer Networks, Operating System, Web Application Development COURSE OUTCOMES: 3.Describe the

browser security model including same-origin policy and threat models in web security. 4. Discuss the concept of web sessions, secure communication channels such as TLS and importance of secure certificates, authentication including single sign-on such as OAuth and SAML. 5. Describe common types of vulnerabilities and attacks in web applications, and defenses against them. 6. Use client-side security capabilities in an application. COURSE OUTLINE: Web Security Model: Browser security model including same-origin policy, Client-server trust boundaries Session Management and Authentication: Single sign-on, HTTPS and certificates Application Vulnerabilities and Defenses: SQL Injection, Cross Site Scripting (XSS), CSRF, Insecure Direct Object References, Security Misconfiguration, Sensitive Data Exposure, Missing Function Level Access Control, Using Components with Known Vulnerabilities, Invalidated Redirects and Forwards (OWASP Top 10) Client-Side Security: Cookies security policy, HTTP security extensions, Plugins, and web apps; Web user tracking Server-Side Security: Tools, Web Application Firewalls (WAFs) and Fuzzers TEXT BOOKS: 1. Dafydd Stuttard and Marcus Pinto, The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws, II Edition, Wiley Publishing Inc, 2011 2. Vincent Liu, Web Application Security - A Beginner's Guide, McGraw-Hill Osborne, 2012 3. Mike Shema, Seven Deadliest Web Application Attacks, Syngress, 2010 4. Jeremiah Grossman, Robert "RSnake" Hansen, Petko "pdp" D. Petkov, Anton Rager, Cross Site Scripting Attacks: XSS Exploits and Defense, 2007 5. Justin Clarke, SQL Injection Attacks and Defense, II Edition, Syngress, 2012 CST726 Quantum Cryptography (3-0-0) Preliminaries: Quantum Information Theory, Quantum Information Theory, Unconditional Secure Authentication and , Entropy. Quantum Key Distribution: Quantum Channel, Public Channel, QKD Gain , Finite Resources, Adaptive Cascade: Introduction, Error Correction and the Cascade Protocol, Adaptive Initial Block- Size Selection, Fixed Initial Block-Size, Dynamic Initial Block-Size. Attack Strategies on QKD Protocols: Attack Strategies in an Ideal Environment , Individual Attacks in an Realistic Environment. QKD Systems, Statistical Analysis of QKD Networks in

Real-Life Environment: Statistical Methods, Results of the Experiments, Statistical Analysis. QKD Networks Based on Q3P : QKD Networks, PPP, Q3P, Routing and Transport. Quantum- Cryptographic Networks from a Prototype to the Citizen. The Ring of Trust Model, Model of the Point of Trust Architecture, Communication in the Point of Trust Model, Exemplified Communications, A Medical Information System Based on the Ring of Trust. Text books: 1. Quantum Cryptography and Secret-Key Distillation, Gilles van Assche, Cambridge University Press, 2006. Paul Kaye, Raymond Laflamme, and Michele Mosca, An Introduction to Quantum Computing, Oxford University Press (2007). 2. Michael A. Nielsen and Isaac L. Chuang, Quantum Computation and Quantum Information, Cambridge University Press (2000). CST728 Trust Management System (3-0-0) Introduction: Definition – Sociological perspective, technical perspective; Concept of Trust Evolution, Trust over Security and Privacy; Important of trust in future networks; properties of trust. Traditional Trust Management: Identification and Authentication mechanism; Overview of Public Key Infrastructure (PKI), Entities, Standards, design issues, implementation and

deployment, Trust management challenges. Re-invention of “Trust” paradigm on future internet: Social Psychology to Social Network; Sociology of the Internet and Digital Sociology; Digital Personality; Trust origin, types, properties, models. Trust and Social Network: Overview of Social network, social agents, importance of trust, social capital and social trust, information collection, evaluation of trust. Trust and Internet of Things: Overview of Internet of Things, importance of trust, objective, frameworks, types of trust for IoT, evaluation models. Social IoT, trust in social IoT. Attacks on Trust: Classification criteria, system model, classification of trust attacks. Attack’s assumptions, characteristics, setup, effect in trust evaluation. Text and References: 1.Roles, Trust, and Reputation in Social Media Knowledge Markets: Theory and Methods, Elisa Bertino, Sorin Adam Matei, Springer. 2.The Internet of Things: Key Applications and Protocols, David Boswarthick, Olivier Hersent, and Omar Elloumi, Wiley. 3.Latest research articles. CST730 Cloud Security (3-0-0) PRE-REQUISITES: Computer Networks, Operating System COURSE OUTCOMES: 7.Understand the characteristics in terms of the systems, protocols and mechanisms in Cloud 8.Examine virtualization & its types, hypervisors and various aspects of VM management

9.Comprehend the design of Cloud Architectures with reference to scalability 10.Understand the vulnerabilities, threats and attacks in Cloud Environment and the defense mechanisms 11.Realize the post attack scenario and evaluate investigation and forensic techniques for Cloud COURSE OUTLINE: Introduction of Cloud Computing: Taxonomy and related technologies, Essential Characteristics, Service and Deployment Models Virtualization: Types of Virtualization and Hypervisors, Virtualization at Storage, Compute and Network, Hypervisors (Types and Case studies), Virtual Machine Provisioning, Virtual Machine Migration Architectures: Standards, Orchestration, Provisioning, Portability, Interoperability, Federated Cloud, Security: CIA Triad, Vulnerabilities in Cloud, Threats to Infrastructure, Data and Access Control; Identity Management; Multi Tenancy Issues; Attack taxonomy; Intrusion Detection, VM Specific attacks, VM Introspection, Management; Trusted Cloud Initiative of Cloud Security Alliance (CSA). Forensics: NIST Forensics Reference Architecture, Forensic Science Challenges, Architectural Issues, Evidence Collection and Analysis, Anti-Forensics, Incident Response, Standards and Framework TEXT BOOKS: 1.K. Hwang, G. C. Fox, and J. Dongarra, Distributed and Cloud Computing, 1st ed.: Morgan Kaufmann, 2011 2.R. Buyya, J. Broberg, and A. M. Goscinski, Cloud Computing: Principles and Paradigms: Wiley-Blackwell, 2011 3.S. Dinkar and G. Manjunath, Moving to the Cloud: Developing Apps in the New World of Cloud Computing Syngress Media, U.S., 2012. 4.W. Stallings, Foundations of Modern Networking: SDN, NFV , QoE, IoT, and Cloud, 1st ed.: Addison-Wesley Professional, 2015 5.T. Erl, Z. Mahmood, and R. Puttini, Cloud Computing: Concepts, Technology & Architecture: Prentice Hall/Pearson PTR, 2014 6.R. L. Krutz and R. D. Vines, Cloud Security - A Comprehensive Guide to Secure Cloud Computing, Wiley Publishing, 2010 7.T. Mather, S. Kumaraswamy, and S. Latif, Cloud Security and Privacy - An Enterprise Perspective on Risks and Compliance, O Reilly Publishers, 2009 8.V . (J. R.) Winkler, G. Speake, P . Foxhoven, Securing the Cloud: Cloud Computer Security



Techniques and Tactics, Syngress, 2011

CST732 Database Security (3-0-0) Security and Information Technology, Database Security Architecture, Profiles, Password policies, Privileges and Roles, Virtual Private Databases, and Database Auditing. SQL Injections- Identification and Defense. Security Testing. Database Management Security Issues such as Administration of Users, Enforcing Access Controls, and related Issues. Security Issues in New-generation Database Systems like Distributed, Frame-based and Object-oriented Databases. Text: 1.Alfred Basta, Melissa Zgola, Database Security, Course Technology (Cengage Learning). 2.Hassan A. Afyduni, Database Security and Auditing: Protecting Data Integrity and Accessibility, Course Technology (Cengage Learning). 3.Ron Ben Natan, Implementing Database Security and Auditing, Elsevier.

CST734 Secure Software (3,0,0) Unit 1: Introduction: Secure Software, assets, stakeholders, threats, security requirements, confidentiality, authentication, authorization, integrity. Unit 2: Secure Software Development Life Cycle: Security practices, Common criteria, built-in security, Agile Processes, Security Development Lifecycle (SDL), Secure Software Development Methodology (SecSDM), Security Design Patterns. Unit 3: Requirements Engineering: Functional and Non-functional requirements, security requirements, reliability, maintainability, portability, trustworthiness, robustness, usability, use cases, mis-use cases. Unit 4: Threat Modeling and Secure Design: Asset, Threat, Attack, Dataflow Diagram (DFD), Attack Tree, STRIDE, DREAD, Security Principles, Guidelines for Secure Software Development, Access Control. SecUML, model based security engineering with UML Unit 5: Secure Coding and Secure Testing: Secure Coding Practices, Vulnerabilities, Vulnerability Patterns, Code Checking Tools, Cross Site Scripting, Injection Flaws. Use of formal methods and verification for security, techniques for software protection. Test Cases, Security Test Plan, White Box Testing, Black Box Testing, Penetration Testing, Code Reviews, Regression Testing, Performance Testing. Recommended Books: 1.John Musa D, "Software Reliability Engineering", 2nd Edition, Tata McGraw-Hill, 2005 (Units I, II and III) 2.Jan Jürjens, "Secure Systems Development with UML", Springer; 2004 (Unit IV and V) 3.Frank Swiderski, Window Snyder, "Threat Modeling", Microsoft Press, First Edition, 2005. 4.J. Viega and G. McGraw, "Building Secure Software: How to Avoid Security Problems the Right Way", Addison-Wesley, 2002

5.A. Cockburn, "Writing Effective Use Cases", Addison- Wesley, Boston, MA, 2001

CST-736 Fault Tolerant Computing (3-0-0) Introduction to Fault Tolerant Paradigm: Fault Classification, Byzantine Failures, Basic Measures of Fault Tolerance. Failure Rate, Reliability and Mean Time to Failure. Redundancy in Hardware, Software, Time and Information. Software Fault Tolerance : Acceptance Tests, Single- Version Fault Tolerance, N-Version Programming, Recovery Block Approach, Preconditions, Post conditions and Assertions, Exception-Handling, Software Reliability Models, Fault-Tolerance Remote Procedure Calls. Fault Tolerance Strategies in Distributed Systems: Fault detection and Prediction, Location, Masking, Containment, Reconfiguration, Self-Repairing, Self-Healing and Recovery. Simulation Techniques .

Reference Books 1.Fault-Tolerant Systems, Israel Koren and C. Mani Krishna, Morgan Kaufmann Publishers, 2007 2.Fault Tolerance in Distributed Systems, Pankaj Jalote, PTR Prentice Hall, 1994. 3.Fault Tolerant Computer System design by D. K. Pradhan, Prentice Hall. CST738 Pattern Classification (3-0-0) Introduction to Pattern Recognition: Clustering vs. Classification; Applications; Linear Algebra, vector spaces, probability theory, estimation techniques. Classification:Tree Classifiers Getting our feet wet with real classifiers: Decision Trees: CART, C4.5, ID3. Random Forests. Bayes decision rule, Error probability, Error rate, Minimum distance classifier, Mahalanobis distance; K-NN Classifier, Linear discriminant functions and Non-linear decision boundaries. Parametric Techniques Generative Methods grounded in Bayesian Decision Theory, Maximum Likelihood Estimation, Bayesian Parameter Estimation, Sufficient Statistics Non-Parametric Techniques: Kernel Density Estimators, Parzen Window, Nearest Neighbor Methods Single and Multilayer perceptron, training set and test sets, standardization and normalization. Unsupervised Methods: Component Analysis and Dimension Reduction, The Curse of Dimensionality, Principal Component Analysis, Fisher Linear Discriminant Clustering: Different distance functions and similarity measures, Minimum within cluster distance criterion, K-means clustering, single linkage and complete linkage clustering, MST, medoids, DBSCAN, Visualization of datasets, existence of unique clusters or no clusters. Feature selection: Problem statement and Uses, Probabilistic separability based criterion functions, interclass distance based criterion functions, Branch and bound algorithm, sequential forward/backward selection algorithms, (l,r) algorithm. Feature Extraction: PCA, Kernel PCA. Recent advances in PR: Structural PR, SVMs, FCM References 1. Richard O. Duda, David G.Stork,Peter E. Hart, Pattern Classification, Wiley 2007 2. Bishop, C. M. Pattern Recognition and Machine Learning. Springer. 2007. 3. Dougherty, Pattern Recognition and Classification, Springer 2011. 4. Theodoridis, S. and Koutroumbas, K. Pattern Recognition. Edition 4. Academic Press, 2008.

5. Russell, S. and Norvig, N. Artificial Intelligence: A Modern Approach. Prentice Hall Series in Artificial Intelligence. 2003. 6. Bishop, C. M. Neural Networks for Pattern Recognition. Oxford University Press. 1995. 7. Andrew R. Webb, Kith D. Copsey, Statistical Pattern Recognition, Wiley 2011 CST740 Security Analysis of Protocols (3-0-0) Cryptographic background; Authentication; Key establishment and IP security; Denial of service; Anonymity and MIX networks; Fairness and contract signing; Privacy and protection of individual information; Wireless security (mobile phones, WiFi); Protocol analysis tools: Finite-state checking; Infinite-state symbolic analysis; Probabilistic model checking; Game-based verification; Process algebras (spi-calculus and applied pi- calculus); Protocol logics (BAN, DDMP, Isabelle); Introduction to Probabilistic polynomial- time calculus; Relating cryptographic and formal models; References: 1.Latest reputed conference and journal articles as chosen by the instructor. 2.Maximum Security, 2nd Edition , SAMS Books by Anonymous, 1998, ISBN: 0- 672-31341-3. Maximum Linux Security , SAMS Books by Anonymous, 2000, ISBN: 0-672- 31670-6. 3.The Cuckoo's Egg : Tracking a Spy Through the Maze of Computer Espionage ; by Clifford Stoll; Pocket Books; ISBN

0671726889 4.It's no secret: Measuring the security and reliability of authentication via 'secret' questions, by Schechter, Brush, and Egelman 5.10 Risks of PKI: What You're not Being Told about Public Key Infrastructure , by Ellison and Schneier 6.Computer Networks, a Systems Approach (3rd edition), by Peterson and Davie. 7.Network Security: Private Communication in a Public World" (2nd edition), by Kaufman, Perlman, and Speciner CST742 Biometrics (3-0-0) Introduction of Biometric traits and its aim, image processing basics, basic image operations, filtering, enhancement, sharpening, edge detection, smoothing, enhancement, thresholding, localization. Fourier Series, DFT, inverse of DFT. Biometric system, identification and verification. FAR/FRR, system design issues. Positive/negative identification. Biometric system security, authentication protocols, matching score distribution, ROC curve, DET curve, FAR/FRR curve. Expected overall error, EER, biometric myths and misrepresentations. Selection of suitable biometric. Biometric attributes, Zephyr charts, types of multi biometrics. Verification on multimodel system, normalization strategy, Fusion methods, Multimodel identification. Biometric system security, Biometric system vulnerabilities, circumvention, covert acquisition, quality control, template generation, interoperability, data storage. Leading technologies : Finger-scan –

Facial-scan – Iris-scan – Voice-scan – Hand Scan, Retina Scan - components, working principles, competing technologies, strengths and weaknesses. Recognition systems: Face,Signature, Fingerprint,Ear, Iris etc. Assessing the Privacy Risks of Biometrics – Designing Privacy-Sympathetic Biometric Systems – Need for standards – different biometric standards. References: 1. Introduction to Biometrics, Jain, Ross, Nandakumar, Springer 2011 2. Guide to Biometrics, Ruud M.Bolle,Sharath Pankanti, Nalini K. Ratha,Andrew W. Senior, Jonathan H. Connell,Springer 2009 3. Biometrics – Identity Verification in a Networked World, Samir Nanavati, Michael Thieme, Raj Nanavati, Wiley-dreamtech India Pvt Ltd, New Delhi, 2003 4. Biometric Technologies and Verification Systems, John R Vacca, Elsevier Inc, 2007 6. Digital Image Processing using MATLAB,By: Rafael C. Gonzalez, Richard Eugene Woods, 2nd Edition, Tata McGraw-Hill Education 2010 CST744 Digital Forensics (3-0-0) PRE-REQUISITES: Computer Networks, Network Security COURSE OUTCOMES: 6.Describe what digital investigation is, the sources of evidence, and the limitations of forensics. 7.Describe the legal requirements for use of seized data, data collection, and storage 8.Reconstruct application history from application artifacts and replay of attack 9.Capture and interpret network traffic, analyze mobile devices, and inspect for presence of malware 10.Apply forensics tools to investigate security breaches and identify anti-forensic methods. COURSE OUTLINE: Foundations: Basic Principles and methodologies for digital forensics, Design systems with forensic needs in mind Evidence Collection: Rules of Evidence, Jurisdictions, Chain of Custody; Search and Seizure of evidence: legal and procedural requirements; Digital Evidence methods and standards, Techniques and standards for Preservation of Data Evidence Analysis: OS / File System Forensics, Application Forensics, Web Forensics, Network Forensics, Mobile Device Forensics Investigation: Computer / Network / System attacks, Attack detection and investigation, Anti- forensics TEXT BOOKS: 1.Thomas J

Holt , Adam M Bossler, Kathryn C Seigfried-Spellar, Cybercrime and Digital Forensics: An Introduction, Routledge, 2015 2.Eoghan Casey, Handbook of Digital Forensics and Investigation, Academic Press, 2009 3.Eoghan Casey, Digital Evidence and Computer Crime: Forensic Science, Computers, and the Internet, III Edition, 2011 4.Angus McKenzie Marshall, Digital Forensics: Digital Evidence in Criminal Investigations, Wiley-Blackwell, 2008

CST746 Intrusion Detection (3-0-0) Overview of computer security solutions, Vulnerability assessment, firewalls, VPN's Review of Network protocol Vulnerabilities: buffer overflow, packet fragmentation, out-of-spec packets Overview of Intrusion Detection and Intrusion Prevention: Network and Host based IDS Classes of attacks: Network layer (scans, denial of service, penetration), Application layer (software exploits, code injection), Identity theft, root access, etc. Threats: Malware detection, Drones, Worms, Viruses, Botnets, Email/IM issues, Insider Threat issues IDS and IPS – Architecture and internals, tcpdump. Malicious and non-malicious traffic, IP headers, TDP, UPD and ICMP protocols and header formats, Header information to detect intrusion, logs and their analysis, Signature based Solutions, Snort, Snort rules Anomaly Detection Systems and Algorithms: Network Behavior Based Anomaly Detectors (rate based), Host based Anomaly Detectors, Attack trees and Correlation of alerts Collaborative Security Text & References: 1.Matt Fearnow, Stephen Northcutt, Karen Frederick, and Mark Cooper. Intrusion Signatures and Analysis, SAMS. 2.Carl Endorf, Gene Schultz, Jim Mellander, Intrusion Detection and Prevention , McGraw Hill. 3.Stephen Northcutt and Judy Novak. Network Intrusion Detection , SAMS. 4.Paul E. Proctor. The Practical Intrusion Detection Handbook , Prentice Hall. 5.Rebecca Gurley Bace: Intrusion Detection , CST748 Internet of Things (3-0-0) Introduction: Internet of Things and Connected Products, IoT paradigm, Smart objects, Goal orientation, Convergence of technologies; Business Aspects of the Internet of Things. Internet and "Things": Layers, Protocols, Packets, Services, Performance parameters of a packet network and applications: Web, Peer-to-peer, Sensor networks, and Multimedia. Hardware and Software: Hardware components, Microcontrollers and Software; Operating Systems. Protocols and Platforms: IoT Communication Protocols, Transport Protocols, Application Protocols; Cloud computing for IoT. Services and Attributes: Data creation, Data gathering and Data dependency; Robustness, Scaling, Privacy, Security, Trust. Application: Implications for the society, IoT case study. Text and References: 1.The Internet of Things: Key Applications and Protocols, David Boswarthick, Olivier Hersent, and Omar Elloumi, Wiley 2.Building the Internet of Things with IPv6 and MIPv6, Daniel Minoli, Wiley. 3.Latest research articles.

CST750 Ethical Hacking (3-0-0) PRE-REQUISITES: Computer Networks, Network Security COURSE OUTCOMES: 1.To know about hacking concept and apply it in ethical manner. 2.To provide awareness of security policies in defense field. 3.To learn about the tools and methods for hacking servers and Operating System. COURSE OUTLINE: Introduction & Overview: Ethical Hacking Terminology, Types, Different stages and phases in Ethical Hacking, Gaining Access, Hactivism,

Footprinting and Social Engineering, E-Mail Tracking, Common Types of Attacks, Identity Theft, Phishing Attack, Online Scams, URL obfuscation. Scanning and Enumeration: Scanning, types of scanning, Ping Sweep Techniques, Proxy Servers, HTTP Tunneling Techniques, IP Spoofing Techniques, Enumeration, Null Session, SNMP Enumeration, System Hacking: Understanding Password Cracking Techniques, Understanding the LanManager, Hash Cracking Windows passwords, Redirecting the SMB logon to Attacker. Attacks: Trojans, Backdoors, viruses, worms, sniffers, Denial of Service and Session Hijacking Hacking: Hacking Web Servers, Web Application Vulnerabilities and Web-Based Password Cracking Techniques, SQL Injection and buffer overflows. Penetration Testing : Penetration testing methodology, Steps of penetration testing, Legal Framework, Penetration Testing Tools: Manual and Automated Tools, Penetration Testing Deliverables. Text Books: 1.Hands■On Ethical Hacking and Network Defense – By Michael T. Simpson, Kent Backman, James Corley 2.Official Certified Ethical Hacker Review Guide – By Steven DeFino, Barry Kaufman, Nick Valenteen. 3.CEH Official Certified Ethical Hacking Review Guide, Wiley India Edition. 4.Certified Ethical Hacker: Michael Gregg, Pearson Education. 5.Certified Ethical Hacker: Matt Walker, TMH. 6.The Basics of Hacking and Penetration Testing: Ethical Hacking and Penetration Testing Made Easy (Syngress Basics Series) 7.Allen Harper, Shon Harris, Jonathan Ness, Chris Eagle, Gideon Lenkey, Terron Williams, Gray Hat Hacking: The Ethical Hackers Handbook, 3rd Edition. CST752 Parallel and Distributed Systems (3-0-0) Parallel and Distributed Computing: Concepts and issues in parallel and distributed computing. Multi-core and GP GPU computing, Distributed Systems models and enabling technologies, computer clusters for scalable parallel computing, Virtual machines and Virtualization. Grid Computing systems and resource management, Cloud computing and related issues. Reference Book 1.Distributed and Cloud computing, Kai Hawang, Geoffrey C. Fox and Jack J. Dongarra, Morgan Kaufmann Publishers, 2012.

CST754 Cyber Laws and IPR (3-0-0) Understanding Copy Right in Information Technology : Understanding the technology of Software software-copyright vs Patent debate Authorship , Assignment issues Commissioned work, Work for hire Idea/Expression dichotomy, Copy right in internet, Legal Issues in internet and Software Copyright Jurisdiction Issues, Copyright Infringe Remedies of Infringement Multimedia, Copyright issues Software Piracy, Patents understanding; Cyber Crimes: Understanding Cyber Crimes in context of Internet, Indian Penal Law & Cyber Crimes Fraud Hacking Mischief, International law, Obscenity and Pornography Internet, Potential of Obscenity Indian Law On Obscenity & Pornography Technical, Legal solutions International efforts Changes in Indian Laws, Ecommerce & Taxation, Security and Evidence in E-Commerce Dual Key encryption Digital signatures security issues, UNCITRAL model law of E- Commerce, Indian Legal Position on E-Commerce IT Act 2000/Indian Evidence Act/Draft law on E-Commerce Procedures and security Polices , Risk assessment methodologies, Risk management, DRP/BCP-Business impact analysis, Asset classification, process level strategy, information classification organization, Crisis management plan, Resources recovery strategy, Framework, audits benchmarks, compliance, communications; Data protection for

system designers : Evaluation criteria and security testing, International standards, Analysis and Logging, Recovery and data backs, Security policy development; Security Models: Frameworks, Standards, Security Certification ISO 17799/ ISO 27001, System Security Engineering Capacity Maturity Model, Laws and Legal Framework for Information Security, Recovery and risk analysis, Operating system and application specific auditing. Text Book: 1. V . D. Dudeja ,”Cyber Crime and Law Enforcement ”, Commonwealth Publishers, 2003 2. C. Davis,”IT Auditing: Using Controls to protect Information Assets ”, TMH, 2011 MTech\_2013\_CS\_FT.pdf

Department of Computer Engineering Malaviya National Institute of Technology MTech Full Time (Computer Engineering) (2012-13 onwards) I Semester (Autumn Semester) I Semester (Autumn Semester) Course Title Credit LTP CWS PRS MTE ETE PRE 1CP-501Topics in Algorithms PC3300220-3050- 2CP-513Topics in Databases PC3300220-3050- 3CP-523Topics in Computing PC3300220-3050- 4CP-505System Design Lab PC3103-60--40 5CP-509Programming Lab – I PC3103-60--40 6CP-506Security in Computing PC3300220-3050- Total 18 \* Typical distribution. Can be changed by Course Instructor/Coordinator by announcing at beginning of semester. II Semester (Spring Semester) II Semester (Spring Semester) Course Title\*\* Credit LTP CWS PRS MTE ETE PRE CWS 1Elective-I PE3300220-3050- 2Elective-II PE3300220-3050- 3Elective-III PE3300220-3050- 4Elective-IV PE3300220-3050- 5Elective-V PE3300220-3050- 6Lab Elective-I PE3103-60--40 Total 18 \* Typical distribution. Can be changed by Course Instructor/Coordinator by announcing at beginning of semester. \*\* Two Electives need to be taken from Department Elective List. 36S.NoCourse Code Subject AREA Exam DurationRelative Weightage\* S . N o 1 2 3 4 5 6 P E S.NoCourse Code Subject AREA Exam DurationRelative Weightage\* S . N o 1 2 4 3T o t a l TOTAL CREDITS (Sem I-II) TOTAL CREDITS (Sem I-II) Department of Computer Engineering Malaviya National Institute of Technology MTech Full Time (Computer Engineering) (2012-13 onwards) III Semester (Autumn Semester) Course Title Credit LTP CWS PRS MTE ETE PRE CWS 1CP-600Seminar PC4-----100- 2CP-601Dissertation PC16----- Total 20 IV Semester (Spring Semester) S.No Course Title Credit LTPRelative Weightage\*CWS PRS MTE ETE PRE CWS 1CP-602Dissertation PC16----- Total 16 TOTAL CREDITS (Sem III-IV) 36 TOTAL CREDITS (Sem V-VI) TOTAL CREDITS (Sem I-IV) 72 TOTAL CREDITS (Sem V-VI)S.NoCourse Code Subject AREA Exam DurationRelative Weightage\* S . N o 1 2T o t a l Course Code Subject AREA Exam Duration S . N o 1T o t a l CPT601 Topics in Algorithms 3-0-0 RAM model – Notations, Recurrence analysis - Master's theorem and its proof - Amortized analysis - Advanced Data Structures: B-Trees, Binomial Heaps, Fibonacci Heaps, A VL trees, Red-black trees, B- trees, Splay trees. Disjoint set – union and path compression, Amortized analysis Recurrence equations. Time and space complexity, NP, NPC and NP-Hard problems, undecidability. Convex hull and V oronoi diagrams, line segments, Optimal polygon triangulation. Primality testing, Integer factorization, Randomized algorithms, Probabilistic algorithms. Dynamic programming: Longest common subsequence. Chain of matrix multiplication, Approximate Algorithms: Vertex-cover, set-covering problems, Travelling Salesman problem. Combinatorial algorithms, Randomized algorithms: Use of probabilistic inequalities in analysis, applications using examples.

Graph algorithms: Matching and Flows. Parallel algorithms: Basic techniques for sorting, searching, merging.. Complexity classes - NP-Hard and NP-complete Problems - Cook's theorem NP completeness reductions. Texts/References: 1)Cormen, Leiserson, Rivest: Introduction to Algorithms, Prentice Hall of India. 2)Horowitz and Sahani: Fundamental of Computer algorithms . 3)Aho A.V , J.D Ullman: Design and analysis of Algorithms , Addison Wesley 4)Brassard : Fundamental of Algorithmics , PHI. 5)Sara Baase: Computer Algorithms: Introduction to Design and Analysis , Pearson Education. 6)Papadimitriou, Steiglitz: Combinatorial Optimization: Algorithms and Complexity , PHI. 7)Motwani and Raghavan: Randomized Algorithms , Cambridge University Press 8)Joseph Ja'Ja': Introduction to Parallel Algorithms , Addison-Wesley 9)Vaizirani: Approximation Algorithms , Springer Verlag 10)N. Deo: Graph Theory with Application to Engineering and Computer Science , Prentice-Hall. 11)N. Deo: Combinatorial Algorithms: Theory and Practice , Prentice-Hall.

**CPT602 Parallel and Distributed Computing 3-0-0** Introduction to parallel computing. Parallel processing terminology, Pipelining Vs Data parallelism, Control parallelism, Scalability, Control parallel approach, Data parallel approach, Data parallel approach with I/O Parallel reduction, Prefix sums, List ranking, Preorder tree traversal, Merging two sorted lists, Graph coloring, Reducing the number of processors, Problems defying fast solutions on PRAMS Thread and process level parallel architectures: MIMD, multi-threaded architectures. Distributed and shared memory MIMD architectures. Dynamic interconnection networks. Mapping and scheduling: Mapping data to processors on processor arrays and multicomputers, Dynamic Load Balancing on multicomputers, Static scheduling on UMA multiprocessors, Deadlock. Parallel programming and parallel algorithms: Programming models, parallel programming on multiprocessors and multicomputers. Parallel algorithm structure, analyzing parallel algorithm. Elementary parallel algorithms, Matrix algorithms, sorting, Graph algorithms. Text & References: 1)Quinn, Parallel computing – theory and practice , Tata McGraw Hill. 2)Sima and Fountain, Advanced Computer Architectures , Pearson Education. 3)Mehdi R. Zargham, Computer Architectures single and parallel systems , PHI. 4)Ghosh, Moona and Gupta, Foundations of parallel processing , Narosa publishing. 5)Ed. Afonso Ferreira and Jose' D. P. Rolin, Parallel Algorithms for irregular problems - State of the art, Kluwer Academic Publishers. 6)Selim G. Akl, The Design and Analysis of Parallel Algorithms , PH International.

**CPT603 Selected Topics in Operating System 3-0-0** Introduction: Goals, Functions, Design issues of Distributed OS, Distributed v/s network operating system. Communication: Client Server, RPC Distributed OS: Issues, process management, inter-process communication, scheduling, deadlocks Design and implementation of distributed file systems, distributed shared memory Security: Concepts and Distributed Systems Distributed Concurrency, Transactions. Case study: Unix, Amoeba. Text/References: 1)Tanenbaum: Distributed Operating Systems, Pearson Education. 2)Bach, Design of Unix O/S. 3)Coulouris et al, Distributed Systems: Concepts and Design , Addison Wesley. 4)Mullender: Distributed Systems , Addison Wesley. 5)Tanenbaum and Steen: Distributed Systems: Principles and Paradigms , Pearson Education

**CPT627 Information System Security 3-0-0** Number theory: Prime numbers, modular arithmetic, Fermat's theorem,

Euler's theorem, Chinese remainder theorem, Discrete logarithms, Random number generation, factoring, prime number generation, one-way hash functions – MD5, SHA (Secure Hash Algorithm). Cryptography: Need, conventional techniques, stream ciphers, block cipher, steganography. Public v/s private key cryptography. Stream Ciphers: Caesar Cipher, mono-alphabetic and poly-alphabetic ciphers, Playfair Cipher, Hill Cipher, Rotor machines, One time pad,. Steganography: Visual, Textual, Cipher hiding, False errors. Private-key cryptography: Feistel structure, DES (Data encryption standard), design of S-boxes, AES, Triple DES, Public key cryptography: Key management, Key exchange – Diffie-Hellman, Authentication, Signatures, Deniability, RSA. Digital Signature: DSA and its variants, discrete logarithm based digital signatures. Cryptanalysis: Differential and linear cryptanalysis - cracking DES. Rabin, ElGamal, Goldwasser-Micali, Blum-Goldwasser cryptosystems. Digests: Message authentication, digital signature algorithms. Security handshake pitfalls, Strong password protocols. Text & References: 1.Stallings, Cryptography and Network Security , Pearson Education. 2.B Schneier, Applied Cryptography , Wiley. ISBN 0-471-11709-9 3.D Kahn. The Codebreakers, Sphere books. ISBN 0-7221-51497 4.A.J. Menezes, P.C. van Oorschot and S.A. Vanstone, Applied Cryptography , CRC Press. 5.D.R. Stinson, Cryptography - Theory and practice , CRC Press. CPT611Advanced Topics in Computer Graphics 3-0-0 Visibility: Polygon Meshes, Depth Sorting. Triangle decomposition, Geometric Sort, Warnock's Methods Hidden Lines and Surfaces : Special cases, Surfaces defined by a function  $y=f(x,y)$ , Grid surfaces, visible surface determination . Colour in Computer Graphics : Color Vision, Measuring Color, Color Models, Color output, color usage. Object Lighting and Shading : Illumination and shading models, Local reflection models, shading surfaces, Texture and transparency, Forward & backward Ray-tracing Global Illumination and classical radiosity. Modeling natural phenomena : Fractals and chaos. Animation Techniques : Position, speed or orientation. Animation by hierarchic control, scenario-based systems, movement control. Shadows, Morphing, Texture mapping Text/References: 1)J. Foley et al : Computer Graphics-Principles and Practice, Addison Wesley. 2)Alan Watt- 3D Computer Graphics . 3)A. Watt, M. Watt: Advanced Animation & Rendering Techniques , Addison-Wesley. 4)D. Rogers and Adams: Mathematical Elements of Computer Graphics , Mc Graw Hill. 5)Thomas Moller: Real-time Rendering , Eric Haines, A.K Peters Ltd CPT613Topics in Databases 3-0-0 Issues in Implementation of Database Systems, Query Processing, Query Optimization, Transaction Processing, Concurrency, Recovery Management. Database System Architectures, Distributed Databases, Distributed Transactions, Distributed Query Processing, Parallel Databases, Times in Databases, Multimedia Databases. Text/References 1)Silberschatz A, Korth HF, Sudarshan S, Database System Concepts, McGrall Hill. 2)Elmasri R and Navathe SB, Fundamentals of Database Systems, 3rd Edition, Addison Wesley,2000. This book covers most of the material on the course. 3)Ceri S, Pelagatti G, Distributed Databases – Principles and Systems, McGraw Hill. 4)Date CJ, An Introduction to Database Systems , 7th Edition, Addison Wesley. 5)Khashafian S and Baker AB, Multimedia and Imaging Databases , Morgan Kaufmann. CPT615Network Performance Modeling 3-0-0 Networking as resource sharing: current practices, Traffic Multiplexing, Traffic analysis, Stochastic



Traffic Models, Multiple Access: Wireless Networks. Routing: Virtual path routing and Elastic Aggregates, Routing of Stream Type sessions, Routing in Ad-hoc and Sensor Networks. Introduction to High Performance Switching and Routing. QoS and Modeling issues of the Networks. Text & References: 1)Communication Networking: An Analytical Approach, Anurag Kumar, D.Manjunath, Joy Kuri, Elsevier 2)High Performance Communication Networks, Jean Walrand, P.Vaiya, Elsevier 3)Selected papers and online references. CPT617Software Testing and Validation 3-0-0 Basic software testing principles – Software Quality, Software testing and test management. Acceptance Testing: User acceptance testing, alpha and beta testing. Functional and Non-functional system testing Static and dynamic testing, Black-box or functional testing, structural, white box or glass box testing. Integration testing, component testing. Software testing tools. Software Validation: Issues and Challenges. Books/References: 1)Selected papers and online references. CPT619Topics in SOC Design 3-0-0 Methodologies and design flows of front end and back end designs. Introduction to intellectual property core types and their design issues. Integration issues of IPs on SOC designs. Low power design issues and methodologies. Testing standards and architecture of SOC. Text/Reference: 1)Farzad Nekoogar , F .Nekooqar, From ASICs to SOC: A Practical Approach, Pearson. 2)Steve B. Furber, ARM System-on-Chip Architecture (2nd Edition), AWL 3)Recent papers from conferences and journals. CPT621Advances in Compiler Design 3-0-0 A Tour of Compiler Design, LR Parsers, Lex and Yacc Tools, Control-flow Analysis, Control-flow Graphs, Basic Blocks, Data-flow Analysis, Dependence Analysis, Global Optimizations, Loop Optimizations, Peephole Optimization and Optimal Code Generation, Data Dependence Analysis in Loops, Loop Scheduling, Static Single Assignment, Just-In-Time (JIT) and Adaptive Compilation, Runtime System Architectures and Automatic Memory Management Techniques. Text/Reference: 1)Aho, Alfred V ., Sethi, Ravi, Ullman, Jeffrey D., Compilers: Principles, Techniques and Tools , Addison-Wesley. 2)Steven Muchnick, Advanced Compiler Design & Implementation , Morgan Kaufmann. 3)Keith Cooper and Linda Torczon, Engineering a Compiler , Morgan Kaufmann. CPT623Topics in Computing 3-0-0 Advanced Architectures relevant to Modern OS. Multi core architectures (Power performance issues, virtualisation etc.). GPU Architecture. Architecture for cloud computing. Advanced concepts for multi media OS and scheduling. Disk management. MLFQ scheduling, Linux kernel features, hardware abstraction layer, Completely fair scheduling. Virtualisation and Cloud computing. Mobile OS. DVM and ART. Comparative study of mobile and desktop OS. Advanced topics on Networking: flow control in Networks. Software Defined Networks. QoS issues at transport and application layer of networks. Special and emerging topics in different areas of CSE. Text and References: 1. Recent papers from Journals 2. Computer Networks: Peterson and Davie 3. Linux kernel Internals CPT625Wireless Sensor Networks 3-0-0 Wireless Sensor Networks: Introduction, Overview and Applications. Sensor node – Design issues, power consumption, operating environment, sensor examples. Architecture - Single node, Network, Single hop v/s multi-hop, Performance metrics, QoS Wireless communication – Fundamentals, spread spectrum techniques, CDMA Protocols – Physical layer, MAC, link layer, Routing, middleware. Network

management, Topology, operating system. Security in sensor networks. Open issues and Challenges. Texts/References: 1)Holger Karl, Andreas Willig. Protocols and Architectures for Wireless Sensor Networks , Wiley Interscience. 2)Kazem Sohraby, Daniel Minoli, and Taieb Znati: Wireless Sensor Networks: Technology, Protocols, and Applications , Wiley Interscience. 3)Selected papers and online reference material. CPT641 Digital Image Analysis 3-0-0 Digital Image Fundamentals, Point operations. Smoothing, Sharpening, Crispening, Image Enhancement in Spatial Domain, Image Enhancement in Frequency Domain Image Transforms: Hotelling, Hit and Miss transform. Color Image Processing, Multiview Image Processing, Epipolar geometry Image Warping and Restoration. Image Segmentation, Representation and Description Morphological Operators, Erosion, Dilation, Medial Axis, Thining, Skeleton. Image Matching and Classification Texts/References: 1)Rafael C Gonzalez, Richard E Woods, Digital Image Processing , Addison-Wesley. 2)Milan Sonka, Vaclav Hlavac, Roger Boyale, Image Processing, Analysis and Machine Vision : PWS Publishing (ITP-International Thomson Publishing). 3)Anil K Jain: Fundamentals of Digital Image Processing , Printice Hall of India (PHI). CPT643 Data Mining and Data Warehousing 3-0-0 Introduction to Decision Support Systems, Data Warehouse and Online Analytical Processing. Data Warehouse Architecture: System Processes, Process Architecture: Load Warehouse, Query, Detailed and Summarized Information. Design: Data Base Schema Facts, Dimensions and Attributes. Data Base and Metadata. Data Mining : Introduction and need, Descriptive and Predicative Data Mining. Data Processing : Data Cleaning, Data Integration and Transformation, Data Reduction. Data Mining Primitives:, Language DMQL and its Preliminary Clauses. Data Mining Methods: Association – Single and Multilevel, Characterization and Comparison, Regression Analysis, Classification and Predication. Data Mining Algorithms: Clustering, Association, Regression, Decision Trees. Application and Trends in Data Mining. Data Warehouse Implementation. Text & References: 1)Data Warehousing in the Real World – Anahory and Murray, Pearson Education. 2)Data Mining – Concepts and Techniques – Jiawei Han and Micheline Kamber. 3)Building the Data Warehouse – WH Inmon, Wiley. CPT645Topics in High Speed Networking 3-0-0 Overview of Internet Technologies, Issues in next generation Internet - Routing, Multicasting, Packet Scheduling, Quality of Service etc. Admission control in Internet: Effective bandwidth, Differentiated services, Policy-based networking, Real time communications over Internet, Internet telephony, V oice over IP, Integrated services. Web QoS, Intelligent caching, Traffic measurement and characterization. Text/References: 1)Kurose: Computer Networking A Top Down Approach , Pearson. 2)Peterson and Davie: Computer Networks: A systems approach , Morgan Kaufman and Elsevier. 3)J.Walrand, High Performance Computer Networks , Elesevier 4)A.Kumar, D.Manjunath, Communication Network MKP. 5)Recent papers from conferences and journals. CPT647e-Commerce 3-0-0 Introduction and concepts: networks and commercial transactions, the Internet environment, online commerce solutions. A generic business model for e-commerce. Security technologies: Introduction to cryptography, key distribution and clarification. Architecture for e-commerce: online commerce environment, servers and commercial environments, strategies, techniques and tools. Electronic payment methods: Secure online

transaction models, digital payment system, cyber cash, digital currencies, Smart cash, digital purse, anonymity and authentication. Protocol for the public transport of private information: security protocols, secure socket layer. Open issues: legal and technical issues. Text & References: 1)Pete Loshin, Paul A Murphy: Electronic e-commerce , Jaico book. 2)Paul May: The Business of e-commerce , Cambridge University Press. 3)Recent papers from conferences and journals CPT649High Level Synthesis of Digital Systems 3-0-0 Overview. Design methodologies. Abstractions and views. Review of basic concepts in algorithms and graph theory Design representation and modeling, Modeling languages, Abstract models Synthesis at higher levels of abstraction Scheduling, Resource sharing Structural synthesis: Module selection. Pipeline. Control Synthesis at lower levels of abstraction, Logic synthesis Text/Reference: 1)G. D. Micheli. Synthesis and optimization of digital systems . 2)N.D. Dutt, D. D. Gajski. High level synthesis, Kluwer, 2000. 3)T. H. Cormen, C. E. Leiserson and R. L. Rivest, " Introduction to Algorithms ," McGraw-Hill, 1990. 4)Recent papers from journals and conferences. CPT651Parallelizing Compiler 3-0-0 Motivation and overview, structure of a parallelizing compiler. Review of code optimization techniques in compilers for sequential machines. Parallelism detection - data dependence analysis, direction vectors, loop carried and loop independent dependences; tests for data dependence and their applicability, construction of data dependence graph. Control dependence and control dependence graph. Restructuring transformations and automatic extraction of parallelism; representation of iteration spaces of multiply nested loops; loop based transformations such as loop distribution, loop coalescing, loop inter-change and cycle shrinking transformation. Texts/References 1)Selected papers and online reference material CPT653Quantum Cryptography 3-0-0 Finite Dimensional Hilbert Spaces – Tensor Products and Operators on Hilbert Space – Hermitian and Trace Operators - Basic Quantum Mechanics necessary for the course. Quantum Gates and operators and Measurement – Quantum Computational Model – Quantum Complexity – Schemes for Physical realization (Only peripheral treatment expected). Shor's Algorithm – Application to Integer Factorization – Grover's Algorithm – Quantum Cryptography: Encryption and decryption schemes. Texts/References 1)Nielsen M. A. and I. L. Chuang , Quantum Computation and Quantum Information , Cambridge University Press, 2002. 2)J. Gruska, Quantum Computing , McGraw Hill, 1999. 3)P. R. Halmos, Finite Dimensional Vector Spaces , Van Nostrand, 1958. 4)Selected papers and online material. CPT655Public Key Infrastructure and Trust Management 3-0-0 Public key infrastructure - components and architecture. PKI interoperability, deployment and assessment PKI data structures – certificates, validation, revocation, authentication, cross-certification. Repository, Certification Authority (CA) and Registration Authority (RA), trusted third party, digital certificates. PKI services – authentication, non-repudiation, privilege management, privacy, secure communication. Key management – certificate revocation list, root CA, attacks on CA, key backup. PKI standards – SSL, LDAP, IPSec, X.500, X.509, S/MIME Trust models – strict v/s loose hierarchy, four corner, distributed. Certificate path processing – path construction and path validation. Texts/References 1)Ashutosh Saxena, Public Key Infrastructure , Tata McGraw Hill 2)Carlisle Adams, Steve Lloyd. Understanding PKI: Concepts,

Standards, and Deployment Considerations, Addison Wesley. 3)John R. Vacca. Public Key Infrastructure: Building Trusted Applications and Web Services , AUERBACH. 4)Messaoud Benantar, Introduction to the Public Key Infrastructure for the Internet , Pearson Education. CPT606Selected Topics in Cryptography 3-0-0 Elliptic Curve Cryptography Secret Sharing, Threshold cryptography – Robust ElGamal system Visual Cryptography Interactive zero knowledge proofs, witness hiding protocols. Group encryption, decryption. Group signatures, ring signatures. EVoting: requirements, issues and challenges, existing solutions, write-in ballots. Pair based cryptography – Weil and Tate pairing. Text & References: 1)Selected paper and online reference material. CPT612Robotics and Control 3-0-0 Robotics: Introduction to robotics, advantages, applications. Robotic kinematics and dynamics: Direct and inverse kinematics problem. Axis transformations; DH matrix; forward and reverse kinematics, trajectory planning. manipulators and their control. Robot sensors: Active and passive robot sensors, Construction of tactile, touch and vision sensors; interpretation of sensory information; vision processing; kinematic information from sensory data. Robot Intelligence: Robot learning, State space search, robotics in computer vision applications. Robotic end effectors: Stable grip; constraints; types of contact; mathematical representation of stable grip; use of screw twist, and wrench gripper design; tools as end effectors. Problems of implementation of automatic systems. Text & References: 1)Fu K, Gonzalez R and Lee C, Robotics - Control Sensing Vision & Intelligence , McGraw Hill. 2)Craig J J, Introduction to Robotics, Mechanics and Control , Addison Wesley, 1993. 3)McKerrow P J, Introduction to Robotics , Addison Wesley, 1993. 4)Selig M, Introductory Robotics , Prentice Hall, 1992. CPT614FPGA based System Design 3-0-0 Introduction to FPGA Architectures. FPGA design flow, partitioning, placement and routing algorithms. Technology mapping for FPGAs, case studies. Text/References: 1)Brown, Francis, Rose and Vranesic. Field programmable Gate arrays . Kluwer. 2)Betz, Rose, Marquardt, Architecture and CAD for Deep-submicron FPGAs . Kluwer. 3)Trimberger, FPGA Technology. Kluwer, 1992. 4)Oldfield, Dorf. FPGAs: Reconfigurable logic for rapid prototyping and implementation of digital systems. John Wiley. 5)Recent papers from conferences and journals. CPT616 Network Security 3-0-0 Review of wired/wireless network protocols, intrusion detection systems, malicious software. Review of cryptographic algorithms, protocols, cryptanalysis, authentication and signature protocols. Kerberos, PKI, real-time communication security, IPsec: AH, ESP, IKE . SSL/TLS, e-mail security, PEM and S/MIME, PGP, web security, network management security, wireless security. Threats in networks, network security controls, firewalls, intrusion detection, administering security Honeypots, password management, malicious software, viruses and countermeasures Text/References: 1)C. Kaufman, R. Perlman, Network Security, Prentice Hall. 2)Kurose & Ross, Computer Networking , Pearson Education. 3)Schiller J., Mobile Communications , Pearson Education. 4)W. Stallings, Cryptography and Network Security Principles and practice , Pearson Education. CPT618Security in Computing 3-0-0 Computer security, threats, attacks, computer criminals, defense methods, information and network policies, cryptography, symmetric and public-key encryption, uses of encryption. Secure file systems and database security. Program security, secure programs,

viruses and other malicious code, control against program threats, protection in general-purpose OS, protected resources and methods of protection, user authentication. Binding programs to machines. Language based security, Integrating security in compilers. Designing trusted OS, models of security, database security, security requirements, reliability and integrity, inference. Administering security, legal, privacy, and ethical issues in computer security. Texts/References 1)Pfleeger and Pfleeger, Security in Computing , Pearson Education. 2)M. Bishop and S. S. Venkatramanayya, Introduction to Computer Security , Pearson Education. 3)Stallings W., Cryptography and Network Security Principles and Practice , Pearson Education. 4)Stallings W., Network Security Essentials: Applications and Standards , Pearson Education.

CPT620Intelligent Agents 3-0-0 Introduction to agent-based computing , Motivations for agent-based computing Key concepts and models, Agent architectures (deliberative, reactive, hybrid), Rational decision making (decision theoretic, belief-desire-intention) Mobile agents, Agent Interactions, Coordination (organisation models, social laws, social dependencies), Cooperation (team-oriented problem solving, coalition formation) Negotiation (mechanism design, heuristic models, argumentation) Computational markets (auctions, competition) Agent-Oriented Software Engineering, Benefits and Potential Drawbacks, Agent Methodologies, Application Case Studies (agent-mediated electronic commerce, business process management, telecommunications network management) Texts/References 1)M.J.Wooldridge, An introduction to multi-agent systems . Wiley (2002)

CPT624Critical Systems 3-0-0 Introduction to time critical systems, Issues, Components, Classification and terminology. Misconceptions about Real-time computing. Real-time System requirements. Specification of timing constraints. Real-time scheduling: Requirements and Issues, Terminology, modeling, Introduction static and dynamic scheduling schemes, cyclic scheduling, priority driven scheduling of periodic tasks, schedulability tests, Aperiodic task scheduling: server/non-server based scheduling algorithms. Practical factors/overheads. Task Synchronization: Need and priority inversion problem, Priority Inheritance protocol, priority ceiling protocol and stack-based priority ceiling protocol. Introduction to multiprocessor real-time systems, problems and issues. An overview of an operating system Text & References: 1)J.W.S.Liu: Real-Time Systems, Pearson Education Asia 2)S.T.Lavi, A.K.Agrawala: Real-time system Design, McGraw Hill 3)Laplante: Real-time Systems Design and Analysis, An Engineer's Handbook, IEEE Press 4)Laurence, K.Mauch: Real-time Microcomputer system design, An introduction, McGraw Hill

CPT626Pattern Recognition 3-0-0 Introduction to statistical, syntactic and descriptive approaches, features and feature extraction. Bayes Decision theory- continuous case, 2-category classification, minimum error rate classification, discriminant functions and decision surfaces, discrete case. Parameter estimation, supervised learning- Maximum likelihood, Bayes, general bayesian learning. Nonparametric - density estimation, parzen windows, k-nearest Neighbor, estimation posterior probability. Linear discriminant functions- decision surfaces, generalized linear discriminant functions, 2- category linearly separable case, non-separable behavior, linear programming procedures, SVMs. Supervised learning: Feed forward Neural networks, Backpropagation algorithm, error surfaces. Clustering - data description and

clustering, Hierarchical clustering, self organizing maps. Texts/References 1)Duda and Hart P.E, and David G Stork, Pattern classification , John Wiley & Sons. 2)Duda and Hart P.E, Pattern classification and scene analysis , John Wiley and sons.. 3)Earl Gose, Richard Johnsonbaugh, and Steve Jost; Pattern Recognition and Image Analysis, PHI. 4)Fu K.S., Syntactic Pattern recognition and applications , Prentice Hall.s

CPT628Security Analysis of Protocols 3-0-0 Mathematical models of computer security – Abstract state machines, belief logics, provable security, spi-calculus, Communicating Sequential Processes (CSP). Needham Schroeder – public key, shared key, attacks; security analysis of Kerberos and Shoup Rupin protocol Time-stamping and its incorporation in modeling Authentication protocols, Access control – policies and mechanism , Nominal calculi for security and mobility, classification of security properties. Protocol verification – case studies. Texts/References 1)Peter Ryan, Steve Schneider, Michael Goldsmith, and Gavin Lowe. Modelling & Analysis of Security Protocols, Addison Wesley. 2)Giampaolo Bella. Formal Correctness of Security Protocols , Springer. 3)Riccardo Focardi and Roberto Gorrieri. Foundations of Security Analysis and Design: Tutorial Lectures, Springer. 4)Riccardo Focardi and Roberto Gorrieri. Foundations of Security Analysis and Design II , Springer.

CPT691 Object Oriented Systems 3-0-0 Abstractions, Objects, Classes and Methods, Inheritance and Reuse, Replacement and Refinement, Contracts, Design by Contract, Reuse: code vs. design reuse, Design patterns – classification, pattern descriptions, Creational patterns: Singleton, Factory, Prototype, Structural patterns: Adapter, Proxy, Composite, Decorator, Facade, Behavioral patterns: Strategy, State, Observer, Template method, Iterator. Text/References: 1)Timothy Budd, An Introduction to Object-oriented Programming, Pearson Education. 2)Erich Gamma, Richard Helm, Ralph Johnson and John Vlissides, Design Patterns, Pearson Education.

CPT693Data Compression 3-0-0 Compression: Need, Lossless v/s lossy compression, review of information theory, prefix codes, uniquely decodable code. Huffman coding – minimum variance, optimal, non-binary, extended, adaptive. Applications and limitations of Huffman codes. Run length encoding, Arithmetic coding, Predictive coding – Burrows-Wheeler transform, Delta modulation, Adaptive delta modulation Lossy Compression Techniques – JPEG and its application, MPEG Error detection and correction: Parity, 1,2,n dimensions, Hamming codes, p-out-of-q codes Dictionary based compression - Lempel-Ziv-Welch, LZ77 and LZ-78 Quantization – Scalar and Vector Quantization. Video compression, Audio Compression, Fractal techniques. Texts/References: ■■Khalid Sayood, Introduction to Data Compression, Morgan Kaufman ■■Greg A. Harris, Darrel R. Hankerson, Peter D. Jr. Johnson, Introduction to Information Theory and Data Compression, Second Edition , Chapman and Hall. ■■Saloman, Data Compression, Springer Verlag. ■■Nelson, The Data Compression book, Hungry Minds. ■■Stephen Welstead, Fractal and wavelet Image Compression techniques , PHI, NewDelhi-1, 1999.

CPT695Biometric Security 3-0-0 Biometrics: Need, Conventional techniques of authentication, challenges - legal and privacy issues. Biometrics: DNA, fingerprint, Iris, Face, hand geometry, ear. Behavioral: Human gait, speech, thermal imaging, infra-red spectrum, signature, keystroke dynamics Combining biometrics, scaling issues. Privacy, legal and ethical issues. Texts/References: 1)Julian D. M. Ashbourn,

Biometrics: Advanced Identify Verification: The Complete Guide 2)Davide Maltoni (Editor), et al, Handbook of Fingerprint Recognition 3)L.C. Jain (Editor) et al, Intelligent Biometric Techniques in Fingerprint and Face Recognition 4)John Chirillo, Scott Blaul, Implementing Biometric Security 5)Nalini Ratha (Editor), Ruud Bolle 6)Authentication: From Passwords to Public Keys, Richard E. Smith

CPT697 Digital Forensics 3-0-0 File System Forensics : Duplicating hard disks for "dead analysis", reading hidden data on a disk's Host Protected Area (HPA), Direct versus BIOS access, dead versus live acquisition, Disk partitions - DOS, Apple, and GPT partitions, BSD disk labels, Sun Volume; multiple disk volumes - RAID and disk spanning; Analyzing FAT, NTFS, Ext2, Ext3, UFS1, and UFS2 file systems, Finding evidence: File metadata, recovery of deleted files, Using The Sleuth Kit (TSK), Autopsy Forensic Browser, and related open source tools Web Forensics: network-based evidence in Windows and Unix environments, Reconstructing Web browsing, e-mail activity, Tracing domain name ownership and the source of e-mails System Forensics: Windows Registry changes, Duplicating and analyzing the contents of PDAs and flash memory devices Electronic document, computer image verification and authentication

Texts/References: 1)Brian Carrier. File System Forensic Analysis , Addison Wesley. 2)Chris Prosise, Kevin Mandia. Incident Response and Computer Forensics , McGraw Hill. 3)Linda Volonino, Reynaldo Anzaldua, and Jana Godwin. Computer Forensics: Principles and Practices, Prentice Hall. 4)Keith J. Jones, Richard Bejtlich, and Curtis W. Rose. Real Digital Forensics: Computer Security and Incident Response , Addison Wesley 5)Vacca, John R., Computer Forensics Computer Crime Scene Investigation , Charles River Media. 6)Nelson, Phillips, Enfinger, Stuart. Guide to computer Forensics and Investigation , Course Technology.

CPT692 Semantic Web 3-0-0 Introduction to semantic web, architecture, languages and tools for knowledge management. XML, RDF, OIL, DAML, OWL for semantic web. Semantic Web Technologies: Ontology-based Systems: Ontology based knowledge management; ontology construction; generating, storing, aligning and maintaining ontologies for semantic web; information retrieval from natural language based documents; ontology evolution; ontological indexing and searching techniques for Searching web

Texts/References 1)John Davies, Rudi Studer, and Paul Warren. Semantic Web Technologies: Trends and Research in Ontology-based Systems, Wiley. 2)John Davies, Dieter Fensel, Frank van Harmelen, and Frank van Harmelen. Towards the Semantic Web: Ontology-Driven Knowledge Management, Wiley.

CPT694 Intrusion Detection 3-0-0 Introduction- Intrusion detection system (IDS), intrusion prevention system (IPS), Unauthorized access – buffer overflow, packet fragmentation, out-of-spec packets Review of Network protocol – TCP/IP, Intrusion detection through tcpdump. IDS and IPS – Architecture and internals. Malicious and non-malicious traffic, IP headers, TDP, UDP and ICMP protocols and header formats, Header information to detect intrusion, logs and their analysis, IDS through reaction and response Intrusion analysis – data correlation, tools, SNORT. Text & References: 1)Matt Fearnow, Stephen Northcutt, Karen Frederick, and Mark Cooper. Intrusion Signatures and Analysis, SAMS. 2)Carl Endorf, Gene Schultz, Jim Mellander, Intrusion Detection and Prevention , McGraw Hill. 3)Stephen Northcutt and Judy Novak. Network Intrusion Detection , SAMS. 4)Paul E. Proctor. The Practical Intrusion

Detection Handbook , Prentice Hall. CPT696Intellectual Property Rights 3-0-0 Introduction to Intellectual property, Patents, Trademark, Copyright Patents – process, patentable entities, scope of patent system, patents and free enterprise; cost considerations; antitrust law, patent institutions, infringement, limitations of patents Copyright – protection, eligibility, fair use; works and rights protection; limitations Trademark – history, concepts, scope, computer software copyrights, copyright in databases and electronic publishing. Design protection Computer contracts, liability for defective hardware and software, software contracts, web and hardware contracts, electronic contracts and torts, liabilities. Introduction to Cyber laws in India, IT Act 2000, data subjects' rights, ethical issues in computer security. Case studies. Texts/References 1)Robert P. Merges and Jane C. Ginsburg. Foundations of Intellectual Property, Foundation Press. 2)Tom Greaves. Intellectual Property Rights for Indigenous Peoples: A Source Book, 3)Susan K. Sell. Private Power, Public Law: The Globalization of Intellectual Property Rights, Cambridge University Press. 4)D. Bainbridge, Introduction to Computer Law, Pearson Education. 5)P. Duggal, Cyber law: the Indian Perspective, 2005 CPT698Internet Security 3-0-0 Security protocols: naming and addressing, IPv6, Network address translation, SNMP, remote login, file transfer protocol, RPC based protocol, peer-to-peer communication Web architecture and protocols, buffer overflow and hacking Internet threats – password stealing, Trojans, phishing, viruses, worms, DOS attack, backdoors, Botnets, port scanning, hacking techniques. Security mechanisms – passwords, one-time password – time based, Lamport's, authentication – smart card, biometrics, RADIUS, SASL framework, host to host authentication, PKI. Firewalls, VPNs, tunneling, Intrusion detection. Server and client security, Text & References: 1)John Chirillo. Hack attacks denied, Wiley. 2)McClure. Web Hacking, Pearson Education. 3)John R. Vacca. Practical Internet Security , Springer. 4)William R. Cheswick, Steven M. Bellovin, and Aviel D. Rubin. Firewalls and Internet Security: Repelling the Wily Hacker , Addison-Wesley. 5)Kenneth Einar Himma. Internet Security: Hacking, Counterhacking ,and Security , Jones & Bartlett Publishers CPT634Malware Analysis and Detection 3-0-0 Malware: Types – Virus, Worms, Trojans, Logic Bombs, etc., infection modes, payload and its delivery mechanisms. Analysis Tools and their design: Disassemblers, Unpackers, Scanners, Decompilers, Emulators, Virtualization techniques Anti-analysis techniques: Obfuscation techniques, Packing, Encryption, Polymorphism, metamorphism. Analysis Techniques: Signature based, Non-signature based, Static, dynamic, behavioral, anomaly detection. Case Study: Android Malware Text/Reference Books 1. Peter Szor: The Art of Computer Virus Research and Defense, Addison Wesley Professional. 2. Eric Filiol: Computer Viruses: from theory to applications, Springer. 3. Michael Sikorski and Andrew Honig: Practical Malware Analysis: The Hands-On Guide to Dissecting Malicious Software, No Starch Press 4. Christopher Elisan: Advanced Malware Analysis, McGraw-Hill Osborne Media. 5. Michael Hale Ligh, Andrew Case: The Art of Memory Forensics: Detecting Malware, Wiley. 6. Bruce Dang, Alexandre Gazet: Practical Reverse Engineering, Wiley. CPT699 Modelling and Simulation 3-0-0 Analytical v/s simulation modeling, performance measurement and benchmarking, Workload modeling, random variables, commonly used distributions, Stochastic Processes, Performance



evaluation methods, Evaluation Metrics Markov chains, Birth and Death Processes, Markov chain models of Computer systems, Steady- state and transient analysis Queuing models, M/M systems and their steady state analysis, Single server and multi-server queues, open and closed queuing networks Petri Net based Performance Modeling : Classical Petri Nets, Timed Petri Nets, Discrete Petri Nets, Modeling multiprocessor systems Discrete event simulation – Simulation languages, random number generation and testing, model verification and validation, analysis of simulation results, confidence intervals, variance reduction techniques, Case studies of analytical and simulation studies of computer systems Text/Reference Books 1. Law and Kelton, Simulation Modeling and Analysis, Mcgraw Hill 2. Raj Jain, The Art of Computer System Performance Analysis, John Wiley 3. K.S.Trivedi, Probability and Statistics with Reliability, Queuing and Computer Science Applications, PHI 4. Kant, Introduction to Computer System Performance Evaluation, Mcgraw Hill

MTEch\_2013\_CS\_PT.pdf Department of Computer Engineering Malaviya National Institute of Technology MTEch Part-Time (Computer Engineering) (2012-13 onwards)

I Semester (Autumn Semester) Course Title Credit LTP CWS PRS MTE ETE PRE

1CP-501Topics in Algorithms PC3300220-3050- 2 3CP-523Topics in Computing PC3300220-3050- 4 5CP-509Programming Lab – I PC3103-60--40 6 Total 9 \* Typical distribution. Can be changed by Course Instructor/Coordinator by announcing at beginning of semester.

II Semester (Spring Semester) Course Title\*\* Credit LTP CWS PRS MTE ETE PRE

1Elective-I PE3300220-3050- 2Elective-II PE3300220-3050- 3 4 5 6Lab Elective-I PE3103-60--40 Total 9 \* Typical distribution. Can be changed by Course Instructor/Coordinator by announcing at beginning of semester. \*\* Two Electives need to be taken from Department Elective List.

18S.NoCourse Code Subject AREA Exam DurationRelative Weightage\* S.NoCourse Code Subject AREA Exam DurationRelative Weightage\* TOTAL CREDITS (Sem I-II) Department of Computer Engineering Malaviya National Institute of Technology MTEch Part-Time (Computer Engineering) (2012-13 onwards)

III Semester (Autumn Semester) Course Title Credit LTP CWS PRS MTE ETE PRE

1 2CP-513Topics in Databases PC3300220-3050- 3 4CP-505System Design Lab PC3103-60--40 5 6CP-506Security in Computing PC3300220-3050- Total 9 \* Typical distribution. Can be changed by Course Instructor/Coordinator by announcing at beginning of semester.

IV Semester (Spring Semester) Course Title\*\* Credit LTP CWS PRS MTE ETE PRE

1 2 3Elective-III PE3300220-3050- 4Elective-IV PE3300220-3050- 5Elective-V PE3300220-3050- 6 Total 9 \* Typical distribution. Can be changed by Course Instructor/Coordinator by announcing at beginning of semester. \*\* Two Electives need to be taken from Department Elective List.

18S.NoCourse Code Subject AREA Exam DurationRelative Weightage\* S.NoCourse Code Subject AREA Exam DurationRelative Weightage\* TOTAL CREDITS (Sem III-IV) Department of Computer Engineering Malaviya National Institute of Technology MTEch Part-Time (Computer Engineering) (2012-13 onwards)

III Semester (Autumn Semester) Course Title Credit LTP CWS PRS MTE ETE PRE

1CP-600Seminar PC4-----100- 2CP-601Dissertation PC16----- Total 20

IV Semester (Spring Semester) Course Title Credit LTP CWS PRS MTE ETE PRE

1CP-602Dissertation PC16----- Total 16 36 72S.NoCourse Code Subject AREA Exam DurationRelative Weightage\* S.NoCourse Code Subject

AREA Exam Duration Relative Weightage\* TOTAL CREDITS (Sem III-IV) TOTAL CREDITS (Sem I-IV) CPT601 Topics in Algorithms 3-0-0 RAM model – Notations, Recurrence analysis - Master's theorem and its proof - Amortized analysis - Advanced Data Structures: B-Trees, Binomial Heaps, Fibonacci Heaps, AVL trees, Red-black trees, B- trees, Splay trees. Disjoint set – union and path compression, Amortized analysis Recurrence equations. Time and space complexity, NP, NPC and NP-Hard problems, undecidability. Convex hull and Voronoi diagrams, line segments, Optimal polygon triangulation. Primality testing, Integer factorization, Randomized algorithms, Probabilistic algorithms. Dynamic programming: Longest common subsequence. Chain of matrix multiplication, Approximate Algorithms: Vertex-cover, set-covering problems, Travelling Salesman problem. Combinatorial algorithms, Randomized algorithms: Use of probabilistic inequalities in analysis, applications using examples. Graph algorithms: Matching and Flows. Parallel algorithms: Basic techniques for sorting, searching, merging.. Complexity classes - NP-Hard and NP-complete Problems - Cook's theorem NP completeness reductions. Texts/References: 1)Cormen, Leiserson, Rivest: Introduction to Algorithms, Prentice Hall of India. 2)Horowitz and Sahani: Fundamental of Computer algorithms . 3)Aho A.V , J.D Ullman: Design and analysis of Algorithms , Addison Wesley 4)Brassard : Fundamental of Algorithmics , PHI. 5)Sara Baase: Computer Algorithms: Introduction to Design and Analysis , Pearson Education. 6)Papadimitriou, Steiglitz: Combinatorial Optimization: Algorithms and Complexity , PHI. 7)Motwani and Raghavan: Randomized Algorithms , Cambridge University Press 8)Joseph Ja'Ja': Introduction to Parallel Algorithms , Addison-Wesley 9)Vaizirani: Approximation Algorithms , Springer Verlag 10)N. Deo: Graph Theory with Application to Engineering and Computer Science , Prentice-Hall. 11)N. Deo: Combinatorial Algorithms: Theory and Practice , Prentice-Hall. CPT602 Parallel and Distributed Computing 3-0-0 Introduction to parallel computing. Parallel processing terminology, Pipelining Vs Data parallelism, Control parallelism, Scalability, Control parallel approach, Data parallel approach, Data parallel approach with I/O Parallel reduction, Prefix sums, List ranking, Preorder tree traversal, Merging two sorted lists, Graph coloring, Reducing the number of processors, Problems defying fast solutions on PRAMS Thread and process level parallel architectures: MIMD, multi-threaded architectures. Distributed and shared memory MIMD architectures. Dynamic interconnection networks. Mapping and scheduling: Mapping data to processors on processor arrays and multicomputers, Dynamic Load Balancing on multicomputers, Static scheduling on UMA multiprocessors, Deadlock. Parallel programming and parallel algorithms: Programming models, parallel programming on multiprocessors and multicomputers. Parallel algorithm structure, analyzing parallel algorithm. Elementary parallel algorithms, Matrix algorithms, sorting, Graph algorithms. Text & References: 1)Quinn, Parallel computing – theory and practice , Tata McGraw Hill. 2)Sima and Fountain, Advanced Computer Architectures , Pearson Education. 3)Mehdi R. Zargham, Computer Architectures single and parallel systems , PHI. 4)Ghosh, Moona and Gupta, Foundations of parallel processing , Narosa publishing. 5)Ed. Afonso Ferreira and Jose' D. P. Rolin, Parallel Algorithms for irregular problems - State of the art, Kluwer Academic Publishers. 6)Selim G. Akl, The Design and Analysis of Parallel

Algorithms , PH International. CPT603Selected Topics in Operating System 3-0-0  
Introduction: Goals, Functions, Design issues of Distributed OS, Distributed v/s  
network operating system. Communication: Client Server, RPC Distributed OS:  
Issues, process management, inter-process communication, scheduling, deadlocks  
Design and implementation of distributed file systems, distributed shared memory  
Security: Concepts and Distributed Systems Distributed Concurrency, Transactions.  
Case study: Unix, Amoeba. Text/References: 1)Tanenbaum: Distributed Operating  
Systems, Pearson Education. 2)Bach, Design of Unix O/S. 3)Coulouris et al,  
Distributed Systems: Concepts and Design , Addison Wesley. 4)Mullender:  
Distributed Systems , Addison Wesley. 5)Tanenbaum and Steen: Distributed  
Systems: Principles and Paradigms , Pearson Education CPT627Information System  
Security 3-0-0 Number theory: Prime numbers, modular arithmetic, Fermat's theorem,  
Euler's theorem, Chinese remainder theorem, Discrete logarithms, Random number  
generation, factoring, prime number generation, one-way hash functions – MD5, SHA  
(Secure Hash Algorithm). Cryptography: Need, conventional techniques, stream  
ciphers, block cipher, steganography. Public v/s private key cryptography. Stream  
Ciphers: Caesar Cipher, mono-alphabetic and poly-alphabetic ciphers, Playfair  
Cipher, Hill Cipher, Rotor machines, One time pad,. Steganography: Visual, Textual,  
Cipher hiding, False errors. Private-key cryptography: Feistel structure, DES (Data  
encryption standard), design of S-boxes, AES, Triple DES, Public key cryptography:  
Key management, Key exchange – Diffie-Hellman, Authentication, Signatures,  
Deniability, RSA. Digital Signature: DSA and its variants, discrete logarithm based  
digital signatures. Cryptanalysis: Differential and linear cryptanalysis - cracking DES.  
Rabin, ElGamal, Goldwasser-Micali, Blum-Goldwasser cryptosystems. Digests:  
Message authentication, digital signature algorithms. Security handshake pitfalls,  
Strong password protocols. Text & References: 1.Stallings, Cryptography and  
Network Security , Pearson Education. 2.B Schneier, Applied Cryptography , Wiley.  
ISBN 0-471-11709-9 3.D Kahn. The Codebreakers, Sphere books. ISBN  
0-7221-51497 4.A.J. Menezes, P.C. van Oorschot and S.A. Vanstone, Applied  
Cryptography , CRC Press. 5.D.R. Stinson, Cryptography - Theory and practice , CRC  
Press. CPT611Advanced Topics in Computer Graphics 3-0-0 Visibility: Polygon  
Meshes, Depth Sorting. Triangle decomposition, Geometric Sort, Warnock's Methods  
Hidden Lines and Surfaces : Special cases, Surfaces defined by a function  $y=f(x,y)$ ,  
Grid surfaces, visible surface determination . Colour in Computer Graphics : Color  
Vision, Measuring Color, Color Models, Color output, color usage. Object Lighting and  
Shading : Illumination and shading models, Local reflection models, shading surfaces,  
Texture and transparency, Forward & backward Ray-tracing Global Illumination and  
classical radiosity. Modeling natural phenomena : Fractals and chaos. Animation  
Techniques : Position, speed or orientation. Animation by hierarchic control, scenario-  
based systems, movement control. Shadows, Morphing, Texture mapping Text/  
References: 1)J. Foley et al : Computer Graphics-Principles and Practice, Addison  
Wesley. 2)Alan Watt- 3D Computer Graphics . 3)A. Watt, M. Watt: Advanced  
Animation & Rendering Techniques , Addison-Wesley. 4)D. Rogers and Adams:  
Mathematical Elements of Computer Graphics , Mc Graw Hill. 5)Thomas Moller:  
Real-time Rendering , Eric Haines, A.K Peters Ltd CPT613Topics in Databases 3-0-0

Issues in Implementation of Database Systems, Query Processing, Query Optimization, Transaction Processing, Concurrency, Recovery Management. Database System Architectures, Distributed Databases, Distributed Transactions, Distributed Query Processing, Parallel Databases, Times in Databases, Multimedia Databases. Text/References 1)Silberschatz A, Korth HF, Sudarshan S, Database System Concepts, McGrall Hill. 2)Elmasri R and Navathe SB, Fundamentals of Database Systems, 3rd Edition, Addison Wesley,2000. This book covers most of the material on the course. 3)Ceri S, Pelagatti G, Distributed Databases – Principles and Systems, McGraw Hill. 4)Date CJ, An Introduction to Database Systems , 7th Edition, Addison Wesley. 5)Khashafian S and Baker AB, Multimedia and Imaging Databases , Morgan Kaufmann.

CPT615Network Performance Modeling 3-0-0 Networking as resource sharing: current practices, Traffic Multiplexing, Traffic analysis, Stochastic Traffic Models, Multiple Access: Wireless Networks. Routing: Virtual path routing and Elastic Aggregates, Routing of Stream Type sessions, Routing in Ad-hoc and Sensor Networks. Introduction to High Performance Switching and Routing. QoS and Modeling issues of the Networks. Text & References: 1)Communication Networking: An Analytical Approach, Anurag Kumar, D.Manjunath, Joy Kuri, Elsevier 2)High Performance Communication Networks, Jean Walrand, P.Vaiya, Elsevier 3)Selected papers and online references.

CPT617Software Testing and Validation 3-0-0 Basic software testing principles – Software Quality, Software testing and test management. Acceptance Testing: User acceptance testing, alpha and beta testing. Functional and Non-functional system testing Static and dynamic testing, Black-box or functional testing, structural, white box or glass box testing. Integration testing, component testing. Software testing tools. Software Validation: Issues and Challenges. Books/References: 1)Selected papers and online references.

CPT619Topics in SOC Design 3-0-0 Methodologies and design flows of front end and back end designs. Introduction to intellectual property core types and their design issues. Integration issues of IPs on SOC designs. Low power design issues and methodologies. Testing standards and architecture of SOCs. Text/Reference: 1)Farzad Nekoogar , F .Nekooqar, From ASICs to SOCs: A Practical Approach, Pearson. 2)Steve B. Furber, ARM System-on-Chip Architecture (2nd Edition), AWL 3)Recent papers from conferences and journals.

CPT621Advances in Compiler Design 3-0-0 A Tour of Compiler Design, LR Parsers, Lex and Yacc Tools, Control-flow Analysis, Control-flow Graphs, Basic Blocks, Data-flow Analysis, Dependence Analysis, Global Optimizations, Loop Optimizations, Peephole Optimization and Optimal Code Generation, Data Dependence Analysis in Loops, Loop Scheduling, Static Single Assignment, Just-In-Time (JIT) and Adaptive Compilation, Runtime System Architectures and Automatic Memory Management Techniques. Text/Reference: 1)Aho, Alfred V ., Sethi, Ravi, Ullman, Jeffrey D., Compilers: Principles, Techniques and Tools , Addison-Wesley. 2)Steven Muchnick, Advanced Compiler Design & Implementation , Morgan Kaufmann. 3)Keith Cooper and Linda Torczon, Engineering a Compiler , Morgan Kaufmann.

CPT623Topics in Computing 3-0-0 Advanced Architectures relevant to Modern OS. Multi core architectures (Power performance issues, virtualisation etc.). GPU Architecture. Architecture for cloud computing. Advanced concepts for multi media OS and scheduling. Disk management. MLFQ

scheduling, Linux kernel features, hardware abstraction layer, Completely fair scheduling. Virtualisation and Cloud computing. Mobile OS. DVM and ART. Comparative study of mobile and desktop OS. Advanced topics on Networking: flow control in Networks. Software Defined Networks. QoS issues at transport and application layer of networks. Special and emerging topics in different areas of CSE.

Text and References: 1. Recent papers from Journals 2. Computer Networks: Peterson and Davie 3. Linux kernel Internals CPT625 Wireless Sensor Networks 3-0-0 Wireless Sensor Networks: Introduction, Overview and Applications. Sensor node – Design issues, power consumption, operating environment, sensor examples. Architecture - Single node, Network, Single hop v/s multi-hop, Performance metrics, QoS Wireless communication – Fundamentals, spread spectrum techniques, CDMA Protocols – Physical layer, MAC, link layer, Routing, middleware. Network management, Topology, operating system. Security in sensor networks. Open issues and Challenges. Texts/References: 1) Holger Karl, Andreas Willig. Protocols and Architectures for Wireless Sensor Networks , Wiley Interscience. 2) Kazem Sohraby, Daniel Minoli, and Taieb Znati: Wireless Sensor Networks: Technology, Protocols, and Applications , Wiley Interscience. 3) Selected papers and online reference material.

CPT641 Digital Image Analysis 3-0-0 Digital Image Fundamentals, Point operations. Smoothing, Sharpening, Crispening, Image Enhancement in Spatial Domain, Image Enhancement in Frequency Domain Image Transforms: Hotelling, Hit and Miss transform. Color Image Processing, Multiview Image Processing, Epipolar geometry Image Warping and Restoration. Image Segmentation, Representation and Description Morphological Operators, Erosion, Dilation, Medial Axis, Thining, Skeleton. Image Matching and Classification Texts/References: 1) Rafael C Gonzalez, Richard E Woods, Digital Image Processing , Addison-Wesley. 2) Milan Sonka, Vaclav Hlavac, Roger Boyale, Image Processing, Analysis and Machine Vision : PWS Publishing (ITP-International Thomson Publishing). 3) Anil K Jain: Fundamentals of Digital Image Processing , Printice Hall of India (PHI).

CPT643 Data Mining and Data Warehousing 3-0-0 Introduction to Decision Support Systems, Data Warehouse and Online Analytical Processing. Data Warehouse Architecture: System Processes, Process Architecture: Load Warehouse, Query, Detailed and Summarized Information. Design: Data Base Schema Facts, Dimensions and Attributes. Data Base and Metadata. Data Mining : Introduction and need, Descriptive and Predicative Data Mining. Data Processing : Data Cleaning, Data Integration and Transformation, Data Reduction. Data Mining Primitives:, Language DMQL and its Preliminary Clauses. Data Mining Methods: Association – Single and Multilevel, Characterization and Comparison, Regression Analysis, Classification and Predication. Data Mining Algorithms: Clustering, Association, Regression, Decision Trees. Application and Trends in Data Mining. Data Warehouse Implementation. Text & References: 1) Data Warehousing in the Real World – Anahory and Murray, Pearson Education. 2) Data Mining – Concepts and Techniques – Jiawei Han and Micheline Kamber. 3) Building the Data Warehouse – WH Inmon, Wiley.

CPT645 Topics in High Speed Networking 3-0-0 Overview of Internet Technologies, Issues in next generation Internet - Routing, Multicasting, Packet Scheduling, Quality of Service etc. Admission control in Internet: Effective bandwidth, Differentiated services, Policy-based networking, Real time

communications over Internet, Internet telephony, Voice over IP, Integrated services. Web QoS, Intelligent caching, Traffic measurement and characterization.

Text/References: 1)Kurose: Computer Networking A Top Down Approach , Pearson. 2)Peterson and Davie: Computer Networks: A systems approach , Morgan Kaufman and Elsevier. 3)J.Walrand, High Performance Computer Networks , Elsevier 4)A.Kumar, D.Manjunath, Communication Network MKP. 5)Recent papers from conferences and journals.

CPT647e-Commerce 3-0-0 Introduction and concepts: networks and commercial transactions, the Internet environment, online commerce solutions. A generic business model for e-commerce. Security technologies: Introduction to cryptography, key distribution and clarification. Architecture for e-commerce: online commerce environment, servers and commercial environments, strategies, techniques and tools. Electronic payment methods: Secure online transaction models, digital payment system, cyber cash, digital currencies, Smart cash, digital purse, anonymity and authentication. Protocol for the public transport of private information: security protocols, secure socket layer. Open issues: legal and technical issues. Text & References: 1)Pete Loshin, Paul A Murphy: Electronic e-commerce , Jaico book. 2)Paul May: The Business of e-commerce , Cambridge University Press. 3)Recent papers from conferences and journals

CPT649High Level Synthesis of Digital Systems 3-0-0 Overview. Design methodologies. Abstractions and views. Review of basic concepts in algorithms and graph theory Design representation and modeling, Modeling languages, Abstract models Synthesis at higher levels of abstraction Scheduling, Resource sharing Structural synthesis: Module selection. Pipeline. Control Synthesis at lower levels of abstraction, Logic synthesis Text/Reference: 1)G. D. Micheli. Synthesis and optimization of digital systems . 2)N.D. Dutt, D. D. Gajski. High level synthesis, Kluwer, 2000. 3)T. H. Cormen, C. E. Leiserson and R. L. Rivest, " Introduction to Algorithms ," McGraw-Hill, 1990. 4)Recent papers from journals and conferences.

CPT651Parallelizing Compiler 3-0-0 Motivation and overview, structure of a parallelizing compiler. Review of code optimization techniques in compilers for sequential machines. Parallelism detection - data dependence analysis, direction vectors, loop carried and loop independent dependences; tests for data dependence and their applicability, construction of data dependence graph. Control dependence and control dependence graph. Restructuring transformations and automatic extraction of parallelism; representation of iteration spaces of multiply nested loops; loop based transformations such as loop distribution, loop coalescing, loop inter-change and cycle shrinking transformation. Texts/References 1)Selected papers and online reference material

CPT653Quantum Cryptography 3-0-0 Finite Dimensional Hilbert Spaces – Tensor Products and Operators on Hilbert Space – Hermitian and Trace Operators - Basic Quantum Mechanics necessary for the course. Quantum Gates and operators and Measurement – Quantum Computational Model – Quantum Complexity – Schemes for Physical realization (Only peripheral treatment expected). Shor's Algorithm – Application to Integer Factorization – Grover's Algorithm – Quantum Cryptography: Encryption and decryption schemes. Texts/References 1)Nielsen M. A. and I. L. Chuang , Quantum Computation and Quantum Information , Cambridge University Press, 2002. 2)J. Gruska, Quantum Computing , McGraw Hill, 1999. 3)P. R. Halmos,

Finite Dimensional Vector Spaces , Van Nostrand, 1958. 4)Selected papers and online material. CPT655Public Key Infrastructure and Trust Management 3-0-0 Public key infrastructure - components and architecture. PKI interoperability, deployment and assessment PKI data structures – certificates, validation, revocation, authentication, cross-certification. Repository, Certification Authority (CA) and Registration Authority (RA), trusted third party, digital certificates. PKI services – authentication, non-repudiation, privilege management, privacy, secure communication. Key management – certificate revocation list, root CA, attacks on CA, key backup. PKI standards – SSL, LDAP, IPsec, X.500, X.509, S/MIME Trust models – strict v/s loose hierarchy, four corner, distributed. Certificate path processing – path construction and path validation. Texts/References 1)Ashutosh Saxena, Public Key Infrastructure , Tata McGraw Hill 2)Carlisle Adams, Steve Lloyd. Understanding PKI: Concepts, Standards, and Deployment Considerations, Addison Wesley. 3)John R. Vacca. Public Key Infrastructure: Building Trusted Applications and Web Services , AUERBACH. 4)Messaoud Benantar, Introduction to the Public Key Infrastructure for the Internet , Pearson Education. CPT606Selected Topics in Cryptography 3-0-0 Elliptic Curve Cryptography Secret Sharing, Threshold cryptography – Robust ElGamal system Visual Cryptography Interactive zero knowledge proofs, witness hiding protocols. Group encryption, decryption. Group signatures, ring signatures. EVoting: requirements, issues and challenges, existing solutions, write-in ballots. Pair based cryptography – Weil and Tate pairing. Text & References: 1)Selected paper and online reference material. CPT612Robotics and Control 3-0-0 Robotics: Introduction to robotics, advantages, applications. Robotic kinematics and dynamics: Direct and inverse kinematics problem. Axis transformations; DH matrix; forward and reverse kinematics, trajectory planning. manipulators and their control. Robot sensors: Active and passive robot sensors, Construction of tactile, touch and vision sensors; interpretation of sensory information; vision processing; kinematic information from sensory data. Robot Intelligence: Robot learning, State space search, robotics in computer vision applications. Robotic end effectors: Stable grip; constraints; types of contact; mathematical representation of stable grip; use of screw twist, and wrench gripper design; tools as end effectors. Problems of implementation of automatic systems. Text & References: 1)Fu K, Gonzalez R and Lee C, Robotics - Control Sensing Vision & Intelligence , McGraw Hill. 2)Craig J J, Introduction to Robotics, Mechanics and Control , Addison Wesley, 1993. 3)McKerrow P J, Introduction to Robotics , Addison Wesley, 1993. 4)Selig M, Introductory Robotics , Prentice Hall, 1992. CPT614FPGA based System Design 3-0-0 Introduction to FPGA Architectures. FPGA design flow, partitioning, placement and routing algorithms. Technology mapping for FPGAs, case studies. Text/References: 1)Brown, Francis, Rose and Vranesic. Field programmable Gate arrays . Kluwer. 2)Betz, Rose, Marquardt, Architecture and CAD for Deep-submicron FPGAs . Kluwer. 3)Trimberger, FPGA Technology. Kluwer, 1992. 4)Oldfield, Dorf. FPGAs: Reconfigurable logic for rapid prototyping and implementation of digital systems. John Wiley. 5)Recent papers from conferences and journals. CPT616 Network Security 3-0-0 Review of wired/wireless network protocols, intrusion detection systems, malicious software. Review of cryptographic algorithms, protocols, cryptanalysis, authentication and signature

protocols. Kerberos, PKI, real-time communication security, IPSec: AH, ESP, IKE . SSL/TLS, e-mail security, PEM and S/MIME, PGP, web security, network management security, wireless security. Threats in networks, network security controls, firewalls, intrusion detection, administering security Honeypots, password management, malicious software, viruses and countermeasures Text/References: 1)C. Kaufman, R. Perlman, Network Security, Prentice Hall. 2)Kurose & Ross, Computer Networking , Pearson Education. 3)Schiller J., Mobile Communications , Pearson Education. 4)W. Stallings, Cryptography and Network Security Principles and practice , Pearson Education.

CPT618Security in Computing 3-0-0 Computer security, threats, attacks, computer criminals, defense methods, information and network policies, cryptography, symmetric and public-key encryption, uses of encryption. Secure file systems and database security. Program security, secure programs, viruses and other malicious code, control against program threats, protection in general-purpose OS, protected resources and methods of protection, user authentication. Binding programs to machines. Language based security, Integrating security in compilers. Designing trusted OS, models of security, database security, security requirements, reliability and integrity, inference. Administering security, legal, privacy, and ethical issues in computer security. Texts/References 1)Pfleeger and Pfleeger, Security in Computing , Pearson Education. 2)M. Bishop and S. S. Venkatramanayya, Introduction to Computer Security , Pearson Education. 3)Stallings W., Cryptography and Network Security Principles and Practice , Pearson Education. 4)Stallings W., Network Security Essentials: Applications and Standards , Pearson Education.

CPT620Intelligent Agents 3-0-0 Introduction to agent-based computing , Motivations for agent-based computing Key concepts and models, Agent architectures (deliberative, reactive, hybrid), Rational decision making (decision theoretic, belief-desire-intention) Mobile agents, Agent Interactions, Coordination (organisation models, social laws, social dependencies), Cooperation (team-oriented problem solving, coalition formation) Negotiation (mechanism design, heuristic models, argumentation) Computational markets (auctions, competition) Agent-Oriented Software Engineering, Benefits and Potential Drawbacks, Agent Methodologies, Application Case Studies (agent-mediated electronic commerce, business process management, telecommunications network management) Texts/References 1)M.J.Wooldridge, An introduction to multi-agent systems . Wiley (2002)

CPT624Critical Systems 3-0-0 Introduction to time critical systems, Issues, Components, Classification and terminology. Misconceptions about Real-time computing. Real-time System requirements. Specification of timing constraints. Real-time scheduling: Requirements and Issues, Terminology, modeling, Introduction static and dynamic scheduling schemes, cyclic scheduling, priority driven scheduling of periodic tasks, schedulability tests, Aperiodic task scheduling: server/non-server based scheduling algorithms. Practical factors/overheads. Task Synchronization: Need and priority inversion problem, Priority Inheritance protocol, priority ceiling protocol and stack-based priority ceiling protocol. Introduction to multiprocessor real-time systems, problems and issues. An overview of an operating system Text & References: 1)J.W.S.Liu: Real-Time Systems, Pearson Education Asia 2)S.T.Lavi, A.K.Agrawala: Real-time system Design, McGraw Hill 3)Laplante: Real-time Systems



Design and Analysis, An Engineer's Handbook, IEEE Press 4) Laurence, K. Mauch: Real-time Microcomputer system design, An introduction, McGraw Hill

CPT626 Pattern Recognition 3-0-0 Introduction to statistical, syntactic and descriptive approaches, features and feature extraction. Bayes Decision theory- continuous case, 2-category classification, minimum error rate classification, discriminant functions and decision surfaces, discrete case. Parameter estimation, supervised learning- Maximum likelihood, Bayes, general bayesian learning. Nonparametric - density estimation, parzen windows, k-nearest Neighbor, estimation posterior probability. Linear discriminant functions- decision surfaces, generalized linear discriminant functions, 2- category linearly separable case, non-separable behavior, linear programming procedures, SVMs. Supervised learning: Feed forward Neural networks, Backpropagation algorithm, error surfaces. Clustering - data description and clustering, Hierarchical clustering, self organizing maps. Texts/References 1) Duda and Hart P.E, and David G Stork, Pattern classification , John Wiley & Sons. 2) Duda and Hart P.E, Pattern classification and scene analysis , John Wiley and sons.. 3) Earl Gose, Richard Johnsonbaugh, and Steve Jost; Pattern Recognition and Image Analysis, PHI. 4) Fu K.S., Syntactic Pattern recognition and applications , Prentice Hall.

CPT628 Security Analysis of Protocols 3-0-0 Mathematical models of computer security – Abstract state machines, belief logics, provable security, spi-calculus, Communicating Sequential Processes (CSP). Needham Schroeder – public key, shared key, attacks; security analysis of Kerberos and Shoup Rupin protocol Time-stamping and its incorporation in modeling Authentication protocols, Access control – policies and mechanism , Nominal calculi for security and mobility, classification of security properties. Protocol verification – case studies. Texts/References 1) Peter Ryan, Steve Schneider, Michael Goldsmith, and Gavin Lowe. Modelling & Analysis of Security Protocols, Addison Wesley. 2) Giampaolo Bella. Formal Correctness of Security Protocols , Springer. 3) Riccardo Focardi and Roberto Gorrieri. Foundations of Security Analysis and Design: Tutorial Lectures, Springer. 4) Riccardo Focardi and Roberto Gorrieri. Foundations of Security Analysis and Design II , Springer.

CPT691 Object Oriented Systems 3-0-0 Abstractions, Objects, Classes and Methods, Inheritance and Reuse, Replacement and Refinement, Contracts, Design by Contract, Reuse: code vs. design reuse, Design patterns – classification, pattern descriptions, Creational patterns: Singleton, Factory, Prototype, Structural patterns: Adapter, Proxy, Composite, Decorator, Facade, Behavioral patterns: Strategy, State, Observer, Template method, Iterator. Text/References: 1) Timothy Budd, An Introduction to Object-oriented Programming, Pearson Education. 2) Erich Gamma, Richard Helm, Ralph Johnson and John Vlissides, Design Patterns, Pearson Education.

CPT693 Data Compression 3-0-0 Compression: Need, Lossless v/s lossy compression, review of information theory, prefix codes, uniquely decodable code. Huffman coding – minimum variance, optimal, non-binary, extended, adaptive. Applications and limitations of Huffman codes. Run length encoding, Arithmetic coding, Predictive coding – Burrows-Wheeler transform, Delta modulation, Adaptive delta modulation Lossy Compression Techniques – JPEG and its application, MPEG Error detection and correction: Parity, 1,2,n dimensions, Hamming codes, p-out-of-q codes Dictionary based compression - Lempel-Ziv-Welch,

LZ77 and LZ-78 Quantization – Scalar and Vector Quantization. Video compression, Audio Compression, Fractal techniques. Texts/References: ■■Khalid Sayood, Introduction to Data Compression, Morgan Kaufman ■■Greg A. Harris, Darrel R. Hankerson, Peter D. Jr. Johnson, Introduction to Information Theory and Data Compression, Second Edition, Chapman and Hall. ■■Saloman, Data Compression, Springer Verlag. ■■Nelson, The Data Compression book, Hungry Minds. ■■Stephen Welstead, Fractal and wavelet Image Compression techniques, PHI, NewDelhi-1, 1999.

CPT695Biometric Security 3-0-0 Biometrics: Need, Conventional techniques of authentication, challenges - legal and privacy issues. Biometrics: DNA, fingerprint, Iris, Face, hand geometry, ear. Behavioral: Human gait, speech, thermal imaging, infra-red spectrum, signature, keystroke dynamics Combining biometrics, scaling issues. Privacy, legal and ethical issues. Texts/References: 1)Julian D. M. Ashbourn, Biometrics: Advanced Identify Verification: The Complete Guide 2)Davide Maltoni (Editor), et al, Handbook of Fingerprint Recognition 3)L.C. Jain (Editor) et al, Intelligent Biometric Techniques in Fingerprint and Face Recognition 4)John Chirillo, Scott Blaul, Implementing Biometric Security 5)Nalini Ratha (Editor), Ruud Bolle 6)Authentication: From Passwords to Public Keys, Richard E. Smith

CPT697 Digital Forensics 3-0-0 File System Forensics : Duplicating hard disks for "dead analysis", reading hidden data on a disk's Host Protected Area (HPA), Direct versus BIOS access, dead versus live acquisition, Disk partitions - DOS, Apple, and GPT partitions, BSD disk labels, Sun Volume; multiple disk volumes - RAID and disk spanning; Analyzing FAT, NTFS, Ext2, Ext3, UFS1, and UFS2 file systems, Finding evidence: File metadata, recovery of deleted files, Using The Sleuth Kit (TSK), Autopsy Forensic Browser, and related open source tools Web Forensics: network-based evidence in Windows and Unix environments, Reconstructing Web browsing, e-mail activity, Tracing domain name ownership and the source of e-mails System Forensics: Windows Registry changes, Duplicating and analyzing the contents of PDAs and flash memory devices Electronic document, computer image verification and authentication Texts/References: 1)Brian Carrier. File System Forensic Analysis, Addison Wesley. 2)Chris Prosise, Kevin Mandia. Incident Response and Computer Forensics, McGraw Hill. 3)Linda Volonino, Reynaldo Anzaldúa, and Jana Godwin. Computer Forensics: Principles and Practices, Prentice Hall. 4)Keith J. Jones, Richard Bejtlich, and Curtis W. Rose. Real Digital Forensics: Computer Security and Incident Response, Addison Wesley 5)Vacca, John R., Computer Forensics Computer Crime Scene Investigation, Charles River Media. 6)Nelson, Phillips, Enfinger, Stuart. Guide to computer Forensics and Investigation, Course Technology.

CPT692Semantic Web 3-0-0 Introduction to semantic web, architecture, languages and tools for knowledge management. XML, RDF, OIL, DAML, OWL for semantic web. Semantic Web Technologies: Ontology-based Systems: Ontology based knowledge management; ontology construction; generating, storing, aligning and maintaining ontologies for semantic web; information retrieval from natural language based documents; ontology evolution; ontological indexing and searching techniques for Searching web Texts/References 1)John Davies, Rudi Studer, and Paul Warren. Semantic Web Technologies: Trends and Research in Ontology-based Systems, Wiley. 2)John Davies, Dieter Fensel, Frank van Harmelen, and Frank van Harmelen. Towards the

Semantic Web: Ontology-Driven Knowledge Management, Wiley. CPT694

**Intrusion Detection 3-0-0** Introduction- Intrusion detection system (IDS), intrusion prevention system (IPS), Unauthorized access – buffer overflow, packet fragmentation, out-of-spec packets Review of Network protocol – TCP-/IP, Intrusion detection through tcpdump. IDS and IPS – Architecture and internals. Malicious and non-malicious traffic, IP headers, TDP, UDP and ICMP protocols and header formats, Header information to detect intrusion, logs and their analysis, IDS through reaction and response Intrusion analysis – data correlation, tools, SNORT. Text & References: 1)Matt Fearnow, Stephen Northcutt, Karen Frederick, and Mark Cooper. Intrusion Signatures and Analysis, SAMS. 2)Carl Endorf, Gene Schultz, Jim Mellander, Intrusion Detection and Prevention , McGraw Hill. 3)Stephen Northcutt and Judy Novak. Network Intrusion Detection , SAMS. 4)Paul E. Proctor. The Practical Intrusion Detection Handbook , Prentice Hall. CPT696

**Intellectual Property Rights 3-0-0** Introduction to Intellectual property, Patents, Trademark, Copyright Patents – process, patentable entities, scope of patent system, patents and free enterprise; cost considerations; antitrust law, patent institutions, infringement, limitations of patents Copyright – protection, eligibility, fair use; works and rights protection; limitations Trademark – history, concepts, scope, computer software copyrights, copyright in databases and electronic publishing. Design protection Computer contracts, liability for defective hardware and software, software contracts, web and hardware contracts, electronic contracts and torts, liabilities. Introduction to Cyber laws in India, IT Act 2000, data subjects' rights, ethical issues in computer security. Case studies. Texts/References 1)Robert P. Merges and Jane C. Ginsburg. Foundations of Intellectual Property, Foundation Press. 2)Tom Greaves. Intellectual Property Rights for Indigenous Peoples: A Source Book, 3)Susan K. Sell. Private Power, Public Law: The Globalization of Intellectual Property Rights, Cambridge University Press. 4)D. Bainbridge, Introduction to Computer Law, Pearson Education. 5)P. Duggal, Cyber law: the Indian Perspective, 2005 CPT698

**Internet Security 3-0-0** Security protocols: naming and addressing, IPv6, Network address translation, SNMP, remote login, file transfer protocol, RPC based protocol, peer-to-peer communication Web architecture and protocols, buffer overflow and hacking Internet threats – password stealing, Trojans, phishing, viruses, worms, DOS attack, backdoors, Botnets, port scanning, hacking techniques. Security mechanisms – passwords, one-time password – time based, Lamport's, authentication – smart card, biometrics, RADIUS, SASL framework, host to host authentication, PKI. Firewalls, VPNs, tunneling, Intrusion detection. Server and client security, Text & References: 1)John Chirillo. Hack attacks denied, Wiley. 2)McClure. Web Hacking, Pearson Education. 3)John R. Vacca. Practical Internet Security , Springer. 4)William R. Cheswick, Steven M. Bellovin, and Aviel D. Rubin. Firewalls and Internet Security: Repelling the Wily Hacker , Addison-Wesley. 5)Kenneth Einar Himma. Internet Security: Hacking, Counterhacking ,and Security , Jones & Bartlett Publishers CPT634

**Malware Analysis and Detection 3-0-0** Malware: Types – Virus, Worms, Trojans, Logic Bombs, etc., infection modes, payload and its delivery mechanisms. Analysis Tools and their design: Disassemblers, Unpackers, Scanners, Decompilers, Emulators, Virtualization techniques Anti-analysis techniques: Obfuscation techniques, Packing, Encryption, Polymorphism,

metamorphism. Analysis Techniques: Signature based, Non-signature based, Static, dynamic, behavioral, anomaly detection. Case Study: Android Malware

Text/Reference Books

1. Peter Szor: The Art of Computer Virus Research and Defense, Addison Wesley Professional.
2. Eric Filiol: Computer Viruses: from theory to applications, Springer.
3. Michael Sikorski and Andrew Honig: Practical Malware Analysis: The Hands-On Guide to Dissecting Malicious Software, No Starch Press
4. Christopher Elisan: Advanced Malware Analysis, McGraw-Hill Osborne Media.
5. Michael Hale Ligh, Andrew Case: The Art of Memory Forensics: Detecting Malware, Wiley.
6. Bruce Dang, Alexandre Gazet: Practical Reverse Engineering, Wiley.

CPT699 Modelling and Simulation 3-0-0

Analytical v/s simulation modeling, performance measurement and benchmarking, Workload modeling, random variables, commonly used distributions, Stochastic Processes, Performance evaluation methods, Evaluation Metrics Markov chains, Birth and Death Processes, Markov chain models of Computer systems, Steady- state and transient analysis Queuing models, M/M systems and their steady state analysis, Single server and multi-server queues, open and closed queuing networks Petri Net based Performance Modeling : Classical Petri Nets, Timed Petri Nets, Discrete Petri Nets, Modeling multiprocessor systems Discrete event simulation – Simulation languages, random number generation and testing, model verification and validation, analysis of simulation results, confidence intervals, variance reduction techniques, Case studies of analytical and simulation studies of computer systems

Text/Reference Books

1. Law and Kelton, Simulation Modeling and Analysis, Mcgraw Hill
2. Raj Jain, The Art of Computer System Performance Analysis, John Wiley
3. K.S.Trivedi, Probability and Statistics with Reliability, Queuing and Computer Science Applications, PHI
4. Kant, Introduction to Computer System Performance Evaluation, Mcgraw Hill

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Semester	S.No.	Semester	Course Code	Course Name	Category	Type	Credit	L-T-P
III	1	III	CST201	Logic in Computing	PC	Theory	3	3-0-0
III	2	III	CST203	Data Structures and Algorithms	PC	Theory	4	3- 1-0
III	3	III	CST205	Digital Logic Design	PC	Theory	4	3-1-0
III	4	III	CST207	Programming Methodology	PC	Theory	3	3-0-0
III	5	III	CST209	Introduction to Signals and Communication	PC	Theory	4	3-1-0
III	6	III	HST201	Effective Communication	PC	Theory	3	2-1-0
III	1	III	CSP211	Programming Lab	PC	Lab	2	0-0-4
III	2	III	CSP213	Digital Logic Design Lab	PC	Lab	2	0-0-3
25	29	Cont	act	Hour s				
Semester	S.No.	Semester	Course Code	Course Name	Category	Type	Credit	L-T-P
IV	1	IV	CST202	Computer Organization and Microprocessors	P C	Theory	3	3-0-0
IV	2	IV	CST204	Discrete Structures	PC	Theory	4	3-0-0
IV	3	IV	CST206	Formal Languages and Automata	Theory	PC Theo ry	4	3-1-0
IV	4	IV	CST208	Design and Analysis of Algorithms	PC	Theory	4	3-1-0
IV	5	IV	CST210	Systems Programming	PC	Theory	3	3-0-0
IV	6	IV	HST202	Economic Environment	PC	Theory	3	2-1-0
IV	1	IV	CSP212	Assembly Language Programming	Lab	PC Lab	2	0-0 -3
IV	2	IV	CSP214	Algorithms Lab	PC	Lab	2	0-0-3
IV	3	IV	CSP216	System Programming Lab	PC	Lab	2	0-0-3
27	29	Cont	act	Hour s				
Semester	S.No.	Semester	Course Code	Course Name	Category	Type	Credit	L-T-P
V	1	V	CST301	Computer Architecture	PC	Theory	3	3-0-0
V	2	V	CST303	Concurrent and Parallel Programming	PC	Theory	3	3-0-0
V	3	V	CST305	DBMS	PC	Theory	4	3-1-0
V	4	V	CST307	Computer Networks	PC	Theory	3	3-0-0
V	5	V	CST309					

Department of Computer Engineering Curricular Structure (B.Tech Computer Engg.)

Compiler Design PC Theory 3 3-0-0 6 V CST311 Software Engineering PC Theory 3 3-0-0 1 V CSP313 DBMS Lab PC Lab 2 0-0-3 2 V CSP315 Concurrent Programming Lab PC Lab 2 0-0-3 3 V CSP317 Computer Network Lab PC Lab 2 0-0-3 25 28 Contact Hours  
 Semester VI S.No. Semester Course Code Course Name Category Type Credit L-T-P  
 1 VI CST302 Operating System PC Theory 3 3-0-0 2 VI CST304 Embedded Systems PC Theory 3 3-0-0 3 VI CST306 Object Oriented Analysis and Design PC Theory 3 3-0-0 4 VI CST308 Computer and Network Security PC Theory 3 3-0-0 5 VI CST310 Computer Graphics PC Theory 3 3-0-0 6 VI CST312 AI and Expert System PC Theory 3 3-0-0 1 VI CSP314 OS and Security Lab PC Lab 2 0-0-3 2 VI CSP316 Graphics Lab PC Lab 2 0-0-3 3 VI CSP318 Advanced Programming Lab PC Lab 2 0-0-3 4 VI CSP320 Embedded System Design Lab PC Lab 2 0-0-3 26 30 Contact Hours \* Letter grades to be awarded.  
 Semester VII S.No. Semester Course Code Course Name Category Type Credit L-T-P  
 1 VII CSS401 Training Seminar PC Theory 2 0-2-0 2 VII Management PC Theory 3 VII Open Elective I OE Theory 4 VII Open Elective II OE Theory 5 VII Program Elective I PE Theory 4 3-0-2 6 VII Program Elective II PE Theory 4 3-0-2  
 Semester VIII S.No. Semester Course Code Course Name Category Type Credit L-T-P  
 1 VIII Management PC Theory 2 VIII CSD402 Major Project Project Theory 3 VIII Open Elective III OE Theory 4 VIII Open Elective IV OE Theory 5 VIII Advanced Program Elective I AEC Theory 4 3-0-2 6 VIII Advanced Program Elective II AEC Theory 4 3-0-2  
 Advanced Elective Courses S.No. Course Code Course Name  
 CST432 Topics in Data Structures and Algorithms  
 CST434 Parallel and Distributed Computing  
 CST436 Selected Topics in Operating System  
 CST438 Advanced Topics in Computer Graphics  
 CST440 Advanced Topics in Databases  
 CST442 Network Performance Modelling  
 CST444 Software Testing and Validation  
 CST446 Topics in SOC Design  
 CST448 Advances in Compiler Design  
 CST450 Wireless Sensor Networks  
 CST452 Digital Image Analysis  
 CST454 Data Mining and Data Warehousing  
 CST456 Topics in High Speed Networking  
 CST458 E-Commerce  
 CST460 High Level Synthesis of Digital Systems  
 CST462 Parallelizing Compiler  
 CST464 Public Key Infrastructure and Trust Management  
 CST466 Selected Topics in Cryptography  
 CST468 Robotics and Control  
 CST470 FPGA based System Design  
 CST472 Security in Computing  
 CST474 Intelligent Agents  
 CST476 Critical Systems  
 CST478 Pattern Recognition  
 CST480 Biometric Security  
 CST482 Computer Forensics  
 CST484 Semantic Web  
 CST486 Intrusion Detection  
 CST488 Internet Security  
 CST490 Malware Analysis and Detection  
 Program Electives S.No. Course Code Course Name  
 CST433 Wireless Communications  
 CST435 VHDL  
 CST437 Neural Networks  
 CST439 Speech Recognition  
 CST441 Software Project Management  
 CST443 Data Compression  
 CST445 Natural Language Processing  
 CST447 Wireless & Ad-hoc Networks  
 CST449 Real Time Systems  
 CST451 Cryptography  
 CST453 VLSI Algorithms  
 CST455 Digital Image Processing  
 CST457 Evolving Architectures  
 CST459 Topics in Computing  
 CST461 Machine Learning  
 CST463 Modelling and Simulation  
 CST431 Programming in Java  
 CST465 Python Programming  
 CST467 Multimedia Technology  
 CST469 Computer Human Interaction  
 UG/PG Department: Course Code: Course Credit: L-T-P: Version: Approved on:  
 Pre-requisite Course : Syllabus Books: Michael Huth, Mark Ryan: Logic in Computer Science : Modelling and Reasoning about Systems, Cambridge University Press .

DUGC Convener Curriculum committee Convener SUGB Chairman Date: 3 3-0-0

Logic: Introduction to Logic, Propositional Logic and Predicate Logic Propositional logic: Elements, Truth table, Declarative sentences, Construction of Proposition, Converse and Contrapositive, Reasoning with Propositions, Natural deduction – rules, Provable equivalence, Semantics, logical connectives, Soundness and completeness of propositional logic, Normal forms, Identities of Propositions and Dual, Use of Identities, Implications, Reasoning with Propositions, Proof of Identities, Proof of Implications, Semantic equivalence, satisfiability and validity, Conjunctive normal forms. Predicate logic: Terms, Formulas - Well Formed Formula (WFF) of Predicate Logic, Constructing Formulas; Free and bound variables, Reasoning with Predicate Logic, deduction rules, Quantifier, Semantics, Undecidability of predicate logic, Expressiveness, second-order logic. Verification: Linear-time temporal (LTL) logic, Syntax and Semantics, Model checking: systems, tools, properties, Branching-time temporal logic - Syntax and Semantics of CTL, Model-checking algorithms Program verification: Partial and total correctness, Proof calculus, Modal logic – syntax and semantics, Binary decision diagrams. B.Tech (Computer Engineering) - Semester III UG Computer Engineering CST201 Logic in Computing UG/PG Department: Course Code: Course Name: Credit: L-T-P: Version: Approved on: Pre-requisite Course : Syllabus Books: Date: Introduction to data structures, dynamic aspects of operations on data, analysis of algorithms. Creation and manipulation of data structures: arrays, lists, stacks, queues, trees – binary, threaded, multiway; heaps, height balanced trees, graphs, hashing and hash tables, dictionaries, tries. Algorithm approaches: greedy, dynamic programming, divide and conquer, branch and bound, introduction to complexity analysis and measures. Algorithms: sorting and searching, merging, tree and graph traversals, shortest path, minimum spanning tree, order statistics, string matching. Selected topics: computational geometry, emerging areas. 1. Kruse R.L., Data Structure and Program Design, PHI. 2. Rivest, Cormen, Introduction to Algorithms, MIT Press 3. Horowitz and Sahni: Data Structure in C++ , Galgotia 4. Ellis Horowitz, Sartaj Sahni, Fundamentals of Data Structures 5. Aaron M. Tenenbaum, Y. Langsam, Moshe J. Augenstein, Data Structures Using C DUGC Convener Curriculum committee Convener SUGB Chairman UG Computer Engineering CST203 Data Structures and Algorithms 4 3-1-0 B.Tech (Computer Engineering) - Semester III UG/PG Department: Course Code: Course Name: Credit: L-T-P: Version: Approved on: Pre-requisite Course : Syllabus Books: 1.Digital Systems and Hardware and Firmware Algorithms: M.Ercegovac and T. Lang, Pearson. 2.Hill & Peterson: Switching Theory and Logic Design, John Wiley 3.J.F.Wakerly: Digital Design, Principle and Practices, Pearson. 4 3-1-0 Boolean algebra: Binary connectives, Evaluation of truth functions, Duality, Simplification of Boolean expressions. Realisation of Logic Circuits: Minterm, Maxterm, Karnaugh maps, incompletely specified functions, simplification. Quine-McCluskey's tabular method, prime implicants, map and tabular minimization of multiple output circuits. Combinational and Sequential circuits: Adders - Ripple carry, Carry look ahead, Carry select, carry save; subtraction, encoder/decoder, multiplexer, demultiplexer, parity checker and generator. Latches, Flip Flops : JK, SR, D Type and T type Flip Flops; Shift registers, Counters - Ripple, decade, up- down counters, Mod- n counters, Multiplication - Add

and Shift method, Booth's Multiplier, m-Array Multiplier, Division - Restoring/Non restoring method.. Clock, pulse and level mode sequential circuits; Analysis and design of sequential circuit. Synthesis of state diagrams, finite memory circuits, equivalence relations, equivalent states and circuits, simplification by implicant tables. Mealy and Moore machines, state assignment and memory element input equation, General pulse-mode circuits, clock input counters, extended state tables. Asynchronous Mode Circuits: Analysis of a fundamental mode circuits, Synthesis of flow tables, minimization, transition tables, excitation maps and output maps, Cycles and Races, Race free assignments, Hazards in sequential circuits. Introduction to A/D and D/A converters. Sampling and Quantization. B.Tech (Computer Engineering) - Semester III UG Computer Engineering CST205 Digital Logic Design UG/PG Department: Course Code: Course Name: Credit: L-T-P: Version: Approved on: Pre-requisite Course : Syllabus Introduction to flow charts, programming paradigms. Abstractions in programming languages. Declarations, variables and constants, data types, arithmetic expressions, statements, precedence and associativity of operators. User-defined data types, data abstraction, array, records, character string, variable size data structure, pointer and reference types, design and implementation uses of these types, type checking and type conversion. Control constructs – branching and looping, relational and boolean expressions, conditional execution and iteration, exception handling. Sub-programs, procedures and functions, parameter passing mechanism, scope and lifetime of variables, environment, activations, and allocation. Recursion and recursive functions, Co-routines and scheduled subprograms, task and concurrent execution. Name and referencing environments, static dynamic and block structures. Dynamic and static scope of shared data. Block structure, parameters and their transmission. Dynamic memory management. Storage management: Static, Stack, Heap (Fixed/variable size), File processing, debugging strategies. UG Computer Engineering CST207 Programming Methodology 3 3-0-0 DUGC Convener Curriculum committee Convener SUGB Chairman Date: B.Tech (Computer Engineering) - Semester III Books: UG/PG Department: Course Code: Course Name: Credit: L-T-P: Version: Approved on: Pre-requisite Course : 4 3-1-0 Date: B.Tech (Computer Engineering) - Semester III UG Computer Engineering CST209 Introduction to Signals and Communication Ghezzi and Jazayeri: Programming Language Concepts, . Sethi Ravi: Programming Language Concepts & Constructs, Addison Wesley Louden: Programming Languages- Principles and Practice, Cengage Learning. Friedman and Wand: Essential of Programming Languages, PHI. Sebastia: Concept of programming language, Addison Wesley Pratt: Programming language design and implementation PHI. DUGC Convener Curriculum committee Convener SUGB Chairman Syllabus Books: UG/PG Department: Course Code: Course Name: Credit: L-T-P: B.Tech (Computer Engineering) - Semester III UG Computer Engineering HST201 Effective Communication 3 2-1-0 1. Oppenheim, Willsky: Signals and Systems, Prentice Hall. 2. Proakis: Digital Signal Processing, Maxwell Macmillan. 3. Oppenheim: Discrete-time Digital Signal Processing, PHI. 4. N K Sinha, Linear systems, John Wiley. 5. Haykins, Analog and Digital Communications, Wiley Publications. 6. Forouzan, Data Communications and Networking, McGraw Hill, . 7. B.P.Lathi : Modern Digital Communication, Oxford. 9. Taub: Introduction to

Communication Systems, McGraw Hill. 10. R. Coolen : Electronic Communication, PHI

DUGC Convener Curriculum committee Convener SUGB Chairman Date: Signals: representation, Sampling and aliasing; quantization, Review of Fourier, Laplace and z-transform; Linear Time Invariant System Filters: Transfer functions, FIR filters, IIR filters; Spectrograms; Spectral analysis: DFT for periodic and non-periodic signals, FFT. Analog Communication: Signal modulation, FM, PM, SSB, VSB. Frequency Division Multiplexing and Time Division Multiplexing. Digital Communication: Pulse transmission over Band limited signals, sampling theory; Pulse Modulation - PAM, PCM, DPCM, DM, ADM, metrics - bit transmission, signaling rate, error probability, S/N ratio, bandwidth requirement. Modulation: PSK, FSK, QPSK (QAM), MSK. Transmission Media: Guided and Unguided Media, Transmission Impairments, Multiplexing, Switching: Circuit, Message, Packet, Datagram, Virtual Networks, DSL. Fiber Optic Communication : Principles of light communication in fiber, losses in fiber, dispersion, light source and detectors, multiple access – TDMA, FDMA, CDMA. Codes : Information theory, Shannon's theorem, Source coding, error control coding, Block codes, Cyclic codes, Linear code, checksum. Version: Approved on: Pre-requisite Course : Syllabus Books: UG/PG Department: Course Code: Course Credit: L-T-P: Version: Approved on: Pre-requisite Course : Syllabus Books: Programming assignments for conceptual understanding of control constructs, scoping rules, functions, recursion, file handling, dynamic memory management.

B.Tech (Computer Engineering) - Semester III UG Computer Engineering CSP211 Programming Lab 2 0-0-3 Importance of Effective Communication Principles to Increase Clarity of Communication Technical Report Writing Soft Skills for the first Job (Time Mgmt, attitude, responsibility, self-confidence and courage, teamwork, consistency, ethics, integrity and values, etc.) Presentation skills (defining purpose, analysis of audience and locale, organizing contents, visual aids, and nuances of delivery) Resume', Group discussions and Job Interviews Avoiding Errors; Active Listening; Condensation Reading Comprehension Effective Speaking Guidelines Vocabulary Building (Root Words, Prefixes and suffixes, words often confused, and frequently used foreign phrases) 1. Technical Communication Principles and Practice : Raman and Sharma (Oxford) DUGC Convener Curriculum committee Convener SUGB Chairman Date: UG/PG Department: Course Code: Course Name: Credit: L-T-P: Version: Approved on: Pre-requisite Course : Syllabus Books: The following proposed coverage are broad guiding areas. The instructor offering the course in consultation with the theory offered can adopt further variations in tune with concerned theory courses.

1. Design and test a 2-bit and 4-bit half adder.
2. Design and test a 2-bit and 4-bit adder (ripple, carry look ahead).
3. Design and test of encoder/decoder (binary-gray, self-complementing).
4. Design and test of parity generator and detector.
5. Design and test of one bit error detecting and correcting circuit.
6. Design and test of a 2-bit multiplier.
7. Design and test of n-bit comparator.
7. Design and test of flip flops – RS/JK/D/T.
8. Design and test of SISO and PIPO shift registers.
9. Design and test of counters.

Programming Implementation and simplification of k-map (upto 3 variables. Implementation of Quine-Mccluskey's method. Design of a simulator. Text/Reference books for Digital Logic Design. Online reference material. UG Computer Engineering CSP213 Digital Logic Design Lab 2



0-0-3 Date: B.Tech (Computer Engineering) - Semester III DUGC Convener Curriculum committee Convener SUGB Chairman Date: DUGC Convener Curriculum committee Convener SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Computer Organization and Microprocessors Credit: L-T-P: 3-0-0 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman Organization of Computer Systems – CPU, Memory and I/O organization, Instruction encoding and addressing modes. Von-neum ann versus Harvard Architecture, RISC and CISC architectures. Introduction to microprocessors, control unit, and interrupt system design. Design of hardware and software for microprocessor applications. Assembly language programming. Microprocessor system case studies – x86, IA, ARM. 1. Patterson and Hennessy: Computer Organization and Design, Morgan Kaufmann. 2. Hamacher and Zaky: Computer Organization, McGraw Hill. 3. Pal Chaudhuri: Computer Organization and Design, PHI. 4. Hayes: Computer Architecture and Organization, McGraw Hill. 5. Barry B. Brey: The Intel microprocessors. Pearson 6. Douglas V. Hall: Microprocessors and Interfacing , McGraw Hill. DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Semester IV UG CST202 3 UG/PG Department: Computer Engineering Course Code: Course Name: Discrete Structures Credit: L-T-P: 3-0-0 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman 1. Kolman B., Busby R: Discrete Mathematical Structures for Computer Science, PHI. 2. Liu: Introduction to Discrete Mathematics, McGraw-Hill. 3. Graham, Knuth, Pratt: Concrete Mathematics. 4. Grimaldi: Discrete Mathematical Structures. 5. Rosen, Discrete Mathematics and Its Applications , McGraw Hill. 6. Koshy, Discrete Mathematics with Applications, Elsevier. 7. Foulds: Graph Theory Applications, Narosa. 8. Harary: Graph Theory, Narosa. 9. N. Deo: Graph Theory, PHI. DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Semester IV UG CST204 3 Mathematical Reasoning – Induction; Counting – Pigeonhole principle, permutation, combination, probability Sets, relations, functions, operations, and equivalence Relations, relation of partial order, partitions, binary relations, Equivalence relations. Recursion, Number-theoretic algorithms: Greatest Common Divisor, Chinese Remainder Theorem, Primality testing, polynomial representation of binary number, Galois fields, primitive roots, discrete logarithms. Graph Theory: Connectivity, Binary tree, Spanning tree, tree enumeration, cycles, Planarity, cut-set, coverings, colourings, matroid. B.Tech (Computer Engineering) - Semester IV UG/PG Department: Computer Engineering Course Code: Course Name: Formal Languages and Automata Theory Credit: L-T-P: 3-1-0 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Semester IV CST206 4 Introduction to automata theory, finite automata and regular languages, regular expressions, transition graphs. Non-determination, finite automata with output, regular languages, minimization of finite automata, pumping lemma for regular languages. Chomsky classification of languages, regular grammars, context free grammars, simplification of context free grammars, Normal forms of context free grammars. Push Down Automata Theory: push down automata and languages, push down automata and context free grammars, pumping lemma for context free

languages. Turing hypothesis, Turing machine, Minsky's theorem, TM variation and encoding, Post machines, computability and acceptability. Introduction to automata theory, finite automata and regular languages, regular expressions, transition graphs.

1. Hopcroft, Motwani and Ullman: Introduction to Automata Theory, languages and Computation, Pearson Education. 2. Cohen: Introduction to Computer Theory, Addison Wesley. 3. Martin: Introduction to Languages and Theory of Computation, TMH. 4. Papadimitriou, Introduction to Theory of Computing, Prentice Hall.

UG/PG Department: Computer Engineering Course Code: Course Name: Design and Analysis of Algorithms Credit: L-T-P: 3-1-0 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering B.Tech (Computer Engineering) - Semester IV UG 4 Algorithm Analysis: Asymptotic notation, solution of recurrence, model of computation, time and space complexities, average and worst case analysis, Amortized analysis. Algorithm Design Techniques: Greedy algorithm, dynamic programming, divide and conquer, backtracking, branch and bound. Graph Algorithms: Shortest path algorithms, Disjoint set operations, minimum spanning tree algorithm, network flow, matching, coverings, applications of DFS:- bi-connectivity, Euler circuits, strongly connected components, topological sort, and articulation point. Matrix Algorithms – Strassen Matrix multiplication, LUP decomposition. Construction of codes: Shannon Fano and Huffman codes. Dynamic Programming: Chained matrix multiplication, longest common subsequence. Divide and Conquer: Order Statistics – finding the median, exponentiation, matrix multiplication, LCS. Computational Geometry: Line segments, Optimal polygon triangulation. Approximate Algorithm: Travelling Salesman Problem, vertex-cover problem. Primality testing, Integer factorization, Randomized algorithms, Probabilistic algorithms. String Matching algorithms: Rabin Karp, KMP, Boyer Moore. Introduction to problem classes – NP, NPC, NP-Hard. 1.Cormen, Leiserson, Rivest: Introduction to Algorithms, Prentice Hall of India. 2.Horowitz and Sahani: Fundamental of Computer algorithms. 3.Aho A.V , J.D Ullman: Design and analysis of Algorithms, Addison Wesley 4.Brassard : Fundamental of Algorithmics, PHI. 5.W.W. Peterson and E. J. Weldon: Error correcting codes. 6.Sara Baase, Allen Van Gelder: Computer Algorithms : Introduction to Design and Analysis, Pearson Education

DUGC Convener Curriculum committee Convener UG CST208 Course Code: Course Name: Systems Programming Credit: L-T-P: 3-0-0 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Economic Environment Credit: L-T-P: 2-1-0 Version: Approved on: Pre-requisite Course : B.Tech (Computer Engineering) - Semester IV UG HST202 3Overview Of Systems Software, Language Processors. Concept Of Machine And Assembly Language, Representation Of Instruction And Data, Macro Processor, Macros And Macro Programming, Assemblers. Linker, Loader, Dynamic Link Library, relocation, Editors And Debuggers. Unix/ Linux Shell programming, Device Drivers, Kernel and Low Level Programming. 1. D. M. Dhamdhare ; Introduction to Systems Software ,TMH 2. Beck L.L. : System Software-An Introduction to Systems Programming, Addison Wesley 3. Rebecca Thomas : Adv. Programmer guide to Unix system V. MH 4. Glingaert : Assemblers, Loaders and Compilers, Prentice Hall 5. John R. Levine : Linkers and Loaders,

Harcourt India 6. Kanetkar : Unix Shell Programming. DUGC Convener Curriculum committee Convener CST210 3 Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Assembly Language Programming Lab Credit: L-T-P: 0-0-3 Version: Approved on: Pre-requisite Course : UG CSP212 2 Economic growth & development; primary, secondary and tertiary sectors; structural changes & emerging sectors of the Indian economy. National Income; concepts & measurement; circular flows of income. Review of five year plans in India, planning strategy and objectives. Current trends in industrial growth, industrial and licensing policy, growth of private sector, problems of public sector units, policy changes for industrial growth; environment for the SME sector. Design and strategy of economic reforms and liberalization: India's growth post liberalization. Main trends in imports and exports, balance of payments in recent years, environment for foreign capital and investment. Intellectual property rights and R & D environment. Banking reforms and challenges; business opportunities in the rural sector. Monetary & Fiscal Policies; meaning, importance & instruments. Global economic environment and opportunities. 1) Ishwar C. Dhingra, "The Indian Economy: Environment and Policy", Sultan Chand, New Delhi 2) H. L. Ahuja, "Economic Environment of Business: Macroeconomic Analysis", Sultan Chand, New Delhi 3) Amartya Sen & Jean Dreze, "INDIA: Development and Participation", Oxford University Press, India 4) S. K. Mishra & Puri, "Development Issues of Indian Economy", Himalaya 5) Ahluwalia, I.J. & IMD Little, "India's Economic Reform and Development", Oxford University Press, India DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Semester IV Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Algorithms Lab Credit: L-T-P: 0-0-3 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: System Programming Lab DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Semester IV UG CSP216 CSP214 2 The following proposed are broad guiding areas lab. The instructor offering the course can adopt further variations. Implementation of graph algorithms – DFS, Shortest Path, MST, articulation point, topological sorting, Network Flow, matching, covering; pattern matching algorithms; kth shortest number in a given sequence ; Dynamic programming; Approximation algorithms for NP problems; Randomized algorithms implementation. Text/Reference books of "Design and Analysis of Algorithms".. Text/Reference books of "Microprocessors and Computer Organization" Online material on Assembly Language programming. DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Semester IV UG Programming assignments on microprocessor kits (8085, 8086), FPGA programming, Programs on ARM processor, mini-emulator Credit: L-T-P: 0-0-3 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman 2 Programming lab assignments related to 1. Assemblers 2. Macro assembler 3. Loader 4. Linker 5. Editor 6. Interpreter 7. Device driver 8. Kernel mode programming Text books of "System Programming" DUGC Convener Curriculum committee Convener UG/PG Department: Computer Engineering Course Code: Course Name: Computer Architecture Credit: L-T-P: 3-0-0 Version: Approved on: Pre-requisite Course :

Syllabus Books: SUGB Chairman Flynn Classification, Stack machines, subroutine calls, allocation and evaluation of data in stack machines. SIMD, SPMD and MIMD. CPU Organization: Addressing techniques, Instruction formats: Instruction set design, Instruction types: example for zero address, one address, two address and three address machines, Stack, accumulator and general purpose register organization. Register Transfer Language: arithmetic, logic and shift micro operations and their hardware implementations as a simple ALU. Control Unit, Hardwired and Micro programmed control unit design. Memory Organization: device characteristics, RAM organization: 1D and 2D organization, Virtual memory - Paging and Segmentation, High speed memories: Associative and Cache memory. Input-Output Design: IO interface, Bus structure, Modes of data transfer, Interrupts, Input Output Processor, Serial Communication Pipelining: Pipeline structure, Pipeline types - Instruction and Arithmetic pipelines. Interleaved memory organization, instruction prefetch, data buffers, pipeline performance measures. Array processors : Routing mechanisms, Static v/s dynamic network. Multiprocessor systems, data flow concepts. Parallel processing languages. 1. J.L. Hennessy and D.A. Patterson, Computer Architecture: A Quantitative Approach, 4th Edition Elsevier. 2. Flynn : Computer Architecture, Narosa 3. David Culler: Parallel Computer Architecture: A Hardware/Software Approach, Morgan Kaufmann. 4. Hwang and Briggs: Computer Architecture and Parallel Processing, McGraw-Hill. DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Semester V UG CST301 3 UG/PG Department: Computer Engineering Course Code: Course Name: Concurrent and Parallel Programming Credit: L-T-P: 3-0-0 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman 1. Mordechai Ben-Ari. Principles of Concurrent and Distributed Programming, Prentice-Hall International. 2. Greg Andrews. Concurrent Programming: Principles and Practice, Addison Wesley. 3. Gadi Taubenfeld. Synchronization Algorithms and Concurrent Programming, Pearson. 4. M. Ben-Ari. Principles of Concurrent Programming, Prentice Hall. 5. Fred B. Schneider. On Concurrent Programming, Springer. 6. Brinch Hansen. The Origins of Concurrent Programming: From Semaphores to Remote Procedure Calls, 7. Introduction to Parallel Computing by Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar – Pearson 8. CUDA Programming – David Kirk 9. Parallel Algorithms – Joseph Ja Ja 10. Heterogeneous Computing with OpenCL by Ben Gastner, Lee Howes et al (Morgan Kaufmann) DUGC Convener Curriculum committee Convener UG CST303 3 Concurrent versus sequential programming. Concurrent programming constructs and race condition. Synchronisation primitives. Processes and threads. Interprocess communication. Livelock and deadlocks, starvation, and deadlock prevention. Issues and challenges in concurrent programming paradigm and current trends. Parallel algorithms – sorting, ranking, searching, traversals, prefix sum etc., Parallel programming paradigms – Data parallel, Task parallel, Shared memory and message passing, Parallel Architectures, GPGPU, pthreads, STM, OpenMP, OpenCL, Cilk++, Intel TBB, CUDA Heterogeneous Computing: C++AMP, OpenCL B.Tech (Computer Engineering) - Semester V UG/PG Department: Computer Engineering Course Code: Course Name: DBMS Credit: L-T-P: 3-1-0 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman DUGC Convener Curriculum committee Convener

CST305 4 Need, purpose and goal of DBMS, Three tier architecture, ER Diagram, data models- Relational, Network, Hierarchical and Object Oriented. Data Base Design: Conceptual data base design, Theory of Normalization, Primitive and Composite data types, concept of physical and logical databases, data abstraction and data independence, data aggregation, Relational Calculus. SQL : DDL and DML, Relational Algebra. Application Development using SQL : Host Language interface, embedded SQL programming, Stored procedures and triggers and views, Constraints assertions. Internal of RDBMS : Physical data organisation in sequential, indexed random and hashed files. Inverted and multilist structures , B trees, B+ trees, Query Optimisation, Join Algorithm, Statistics and Cost Base optimisation. Transaction Processing, concurrency control, and recovery management. Transaction model properties and state serialisability . Lock base protocols, two phase locking. 1. H.f. Korth and Silberschatz: Database Systems Concepts, McGraw Hill 2. Almasri and S.B. Navathe: Fundamentals of Database Systems, 3. C.J. Date: Data Base Design, Addison Wesley 4. Hansen and Hansen : DBM and Design, PHI B.Tech (Computer Engineering) - Semester V UG UG/PG Department: Computer Engineering Course Code: Course Name: Computer Networks Credit: L-T-P: 3-0-0 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Compiler Design Credit: L-T-P: 3-0-0 Version: Approved on: Date: B.Tech (Computer Engineering) - Semester V UG CST309 33 Computer Network Architecture, Circuit switching, Packet And Message Switching, Network Structure. OSI 7-layer architecture. Physical Layer, Data Link Layer, Framing, Error detection. Retransmission algorithms. Queueing models and introduction to Little's theorem, M/M/1 and M/M/m queues. Network of queues. Introduction to M/ G/1 queues, reservations and priority. Stability of queueing systems. Multiple access and Aloha. CSMA/CD and Ethernet. High Speed LANs and Token Ring. High speed switch scheduling. Broadcast routing and spanning trees. Shortest path routing. Distributed routing algorithms, optimal routing. Flow control – window/ credit schemes, rate control schemes. Transport layer and TCP/IP. Introduction to ATM networks and Network Management And Interoperability. Performance Issues Of LAN And WAN. 1. Data Networks: Bertsekas and Gallager, Phi. 2. Computer Networking A top down Approach: J.F.Kurose, Pearson. 3. Data & Computer Communication : W. Stallings , Phi 4. Computer Networks: L. Peterson and Davie, MKP 5. Computer Networks and Internet: D.E. Comer, Pearson DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Semester V UG CST307 Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Software Engineering Credit: L-T-P: 3-0-0 Version: Approved on: B.Tech (Computer Engineering) - Semester V UG CST311 3 Translators: Introduction to compilers, translators , and interpreters, compilation process. Lexical Analysis: Finite automata, Regular expressions, Design & implementation of lexical analysers. Syntax Analysis: Context Free Grammars, Derivation and Parse trees, Bottom- up and Top-down Parsing. Ambiguity, Shift Reduce Parser, Operator Precedence Parser, Predictive Parsers, canonical collection of items, LR parsers. Syntax directed translation: Syntax directed translation, Attributes, Intermediate codes, Three address codes. Symbol

table organization: Hashing, linked list, tree structures. Memory allocation: Static and dynamic structure allocation. Code optimization: Basic blocks, Flow graphs, DAG, Global data flow analysis – code-chaining, available expressions, Loop optimization. Code generation: Compilation of expression and control structures. Error detection and recovery. 1. Aho, Ullman and Sethi: Compilers – Principles, techniques and tools, Pearson Education. 2. Tremblay, Sorenson: The Theory and Practice of Compiler Writing, BSP. 3. Holub, Compiler Design in C, PHI. DUGC Convener Curriculum committee Convener Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: DBMS Lab Credit: L-T-P: 0-0-3 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman Text/Reference books for course on “DBMS” DUGC Convener Curriculum committee Convener UG CSP313 2 The following are broad guiding areas lab. The instructor offering the course can adopt further variations in tune with DBMS Conceptual designs using ER diagrams; Design and implementation of small DBMS; SQL queries. Engineering paradigms. System analysis: Feasibility study requirement analysis, Cost benefit analysis, Planning systems, Analysis tools and techniques. System Design: design fundamentals, Modular Design, Data and procedural design, object oriented design. System Development: Code documentation, Program design paradigms. Verification, Validation and Testing: testing methods, Formal Program Verification, Testing Strategies. Software Maintenance: Maintenance Characteristics, Maintainability, Maintenance tasks and side effects. 1. Pressman R.S: Software Engineering: A Practitioner approach, McGraw Hill. 2. Sommerville I: Software Engineering, Addison Wesley 3. Ghezzi C. Jazayeri M and Mandrioli: Fundamentals of Software Engg. , PHI. DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Semester V UG/PG Department: Computer Engineering Course Code: Course Name: Concurrent and Parallel Programming Lab Credit: L-T-P: 0-0-3 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Computer Network Lab Credit: L-T-P: 0-0-3 Version: Approved on: Pre-requisite Course : 2DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Semester V UG CSP317 CSP315 2 Programming exercises to implement synchronization primitives – semaphores and monitors. Parallel algorithm implementation (CUDA and OpenMP) Implementing solutions for Producer-Consumer problem – infinite buffer, bounded buffer; Reader – Writer problem; Sleeping Barber problem; Dining Philosopher problem lex(flex), yacc(bison) for lexical and parsing Design of a mini-compiler Text/Reference books for course on “Concurrent Programming” B.Tech (Computer Engineering) - Semester V UG Syllabus Books: SUGB Chairman The following proposed coverage are broad guiding areas lab. The instructor offering the course in consultation with the theory offered can adopt further variations in tune with CP-325. 1. Programming for data encoding, CRC detection and Correction. 2. Estimation of network delay through OS utilities . 3. Simulation and Emulation of Bus and Star topology, DLC, MAC protocols using Benchmark LAN trainer kits. 4. Packet measurement and observation using network sniffing tools. 5. Use of sniffers for protocol dynamics. 6. Introduction to Socket programming and application

development for internet. 7. ns-3 based assignments

1. Computer Networks and Internet: D.E. Comer, Pears on 2. TCP/IP Illustrated, W. Stevens, Vol 1-2, Pearson Eds DUGC Convener Curriculum committee Convener UG/PG Department: Computer Engineering Course Code: Course Name: Operating System Credit: L-T-P: 3-0-0 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman

Operating System and its evolution, batch, multiprogramming, time sharing systems, real time systems. Processes and processor management: process concept, Process scheduling, interprocess communication and synchronization, race condition, mutual exclusion, semaphores, monitors, messages. Deadlocks prevention, avoidance, detection and recovery. Processes and Threads, Concurrency control. Memory Management: Contiguous, partitioned – fixed and variable partitioning, Non contiguous allocation – Paging, segmentation. Virtual memory, page replacement, cache coherence. File management: disk space management directory structure, shared files, file system performance. File servers, security, protection mechanism, Directory and File structure, File sharing, NFS, Storage management. Input/Output Management: Device drivers, disk scheduling. Distributed OS: Issues, process management, inter-process communication, scheduling, deadlocks Design and implementation of distributed file systems, distributed shared memory, Distributed Concurrency, Transactions. Design issues of Distributed OS, Distributed v/s network operating system.

1. Silberschatz, Galvin: Operating System Concepts, Addison-Wesley. 2. Tanenbaum, Modern Operating Systems, Prentice Hall. 3. W. Stallings, Operating Systems, Prentice Hall. 4. Tanenbaum: Operating Systems: Design and Implementation. PHI. 5. Deitel, An introduction to operating systems. Addison-Wesley. 6. Sinha: Distributed Operating Systems: Concepts and Design, IEEE 7. Crowley: Operating System A Design Approach-, TMH. 8. Tanenbaum: Distributed Operating Systems, Pearson Education. 9. Bach, Design of Unix O/S. DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Semester VI UG CST302 3 UG/PG Department: Computer Engineering Course Code: Course Name: Embedded Systems Credit: L-T-P: 3-0-0 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Object Oriented Analysis and Design Credit: L-T-P: 3-0-0 Version: Approved on: CST306 31. Denial D. Gajski, Frank Vahid: Specification and design of embedded systems, PH 2. Jonathan W. Valvano: Embedded Microcomputer Systems, Thomson Learning 3. Myke Predko: Programming and Customizing the 8051 Micro Controller, TMH 4. Ayala: 8051 Micro controllers, Penram Press DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Semester VI UG UG CST304 3 Introduction to embedded systems., design representations, level of abstractions, design methodologies. Models and architectures, Taxonomy of models and architectures, Brief descriptions of specification languages, Specification requirement for embedded systems, Spec Chart and Spec Chart Description. Design challenges & issues, hardware and software design, co-design of software and hardware, ASIC. Design quality estimation : Quality matrix, software and hardware estimation. Introduction Sample design Specification of Answering machine/ Microcontroller 8051. B.Tech (Computer Engineering) - Semester VI Pre-requisite Course : Syllabus Books: SUGB Chairman

UG/PG Department: Computer Engineering Course Code: Course Name: Computer and Network Security Credit: L-T-P: 3-0-0 3DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Semester VI UG CST308 Object Oriented Programming and Design: Review of abstraction, objects and other basics, Encapsulation, Information hiding, method, Signature, Classes and Instances, Polymorphism and inheritance. C++ Programming Basics: Fundamentals, variables and assignments, Input and Output, Data types and expressions, flow of control, subprograms, top-down design, predefined functions, user defined functions, procedural abstractions, local variables, overloading function names, operator overloading, parameter passing, this pointer, destructors, copy constructor, overloading the assignment operator, virtual functions, function calling functions, friend functions, recursive functions, recursive member functions. Static member function. C++ Object oriented concepts: Objects and classes, use of file for I/O, formatting output with stream functions, Character I/O, inheritance, structures for diverse data, structures as function arguments, initializing structures, defining classes and member functions, public and private members, constructors for initialization, standard C++ classes, derived classes, flow of control, use of Boolean expressions, multiway branches, use and design of loops. Friend function and friend class. C++ Data structures and Advanced Topics: Arrays – programming with arrays, arrays of classes, arrays as function arguments, strings, Multidimensional arrays, Arrays of strings, pointers Dynamic arrays, Classes and dynamic arrays, Base classes, access control, Templates- generic classes and functions, namespaces. Standard Template Library. 1. Balaguruswamy: Object-oriented Programming with C++. 2. Robert Lafore: C++ Programming 3. Ashok N. Kamthane : Object Oriented with C++, Pearson Education Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering B.Tech (Computer Engineering) - Semester VI UG Computer Security: Threats and Countermeasures; Malware taxonomy, infection and propagation mechanisms, Countermeasures – Scanning, Anomaly detection, behavioural analysis; static and dynamic analysis Review of wired/wireless network protocols, intrusion detection systems, malicious software. Review of cryptographic algorithms, protocols, cryptanalysis, authentication and signature protocols. Kerberos, PKI, real-time communication security, IP Sec: AH, ESP, IKE. SSL/TLS, e-mail security, PEM and S/MIME, PGP, web security, network management security, wireless security. Threats in networks, network security controls, firewalls, intrusion detection, administering security Honeypots, password management, malicious software, viruses and countermeasures 1) C. Kaufman, R. Perlman, Network Security, Prentice Hall. 2) Kurose & Ross, Computer Networking, Pearson Education. 3) Schiller J., Mobile Communications, Pearson Education. 4) W. Stallings, Cryptography and Network Security Principles and practice, Pearson Education. DUGC Convener Curriculum committee Convener Course Code: Course Name: Computer Graphics Credit: L-T-P: 3-0-0 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: AI and Expert Systems Credit: L-T-P: 3-0-0 Version: Approved on: Pre-requisite Course : B.Tech (Computer Engineering) - Semester VI UG CST312 3Basic raster and vector



graphics. Scan conversion algorithms for line, circle, and ellipse. Filling: seed fill and polygon filling. Clipping lines and polygons. Geometrical transformations: 2D and 3D transformations, homogeneous coordinates, composition of transformations, the Window-to-Viewport transformation. matrix representation of transformations. Projections: mathematics of planar geometric projections, implementation of planar geometric projections. Visible surface determination: object space and image space techniques for visible surface detection, algorithms, z-buffer, list priority, scan line, are a subdivision, back face removal, BSP tree and ray tracing algorithms. Illumination and shading: illumination models, shading for polygons, constant, Gouraud and Phong shading models. Curves: parametric cubic curves, Hermite, Bezier and B-spline curves.

1. Computer Graphics, principles and practice, Foley, VanDam, Feiner, Hughes, Addison Wesley. 2. Computer Graphics, Hearn and Baker, PHI 3. Mathematical Elements for Computer Graphics, David F. Rogers, Adams, McGraw Hill. 4. Procedural Elements for Computer Graphics, David F. Rogers, McGraw Hill.

DUGC Convener Curriculum committee Convener CST310 3 Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: OS and Security Lab Credit: L-T-P: 0-0-3 Version: Approved on: Pre-requisite Course : Syllabus UG CSP314 2 This lab shall cater to programming assignments in area of Operating System and Security. Overview of AI, Problems, Problem space and searching techniques, Definition production system, Control strategies, Heuristic search techniques. Introduction to AI languages: PROLOG and LISP. Knowledge representation, Representation, mappings, approaches and issues, Predicate logic, propositional logic, Resolution, Procedural and declarative knowledge, forward and backward reasoning, Matching, Logic Frames and Semantic Nets etc. Domain Exploration Knowledge elicitation, conceptualization, methods of knowledge acquisition, formalization Learning and learning systems: Introduction to Hopfield networks, introduction to neural networks, learning in neural networks, applications of neural networks, Recurrent network. Natural Language Processing, Perceptions and actions. Expert Systems: Introduction, Definition types, Component, development process. Learning Planning and Explanation in Expert Systems. Implementation Tools : Prolog, Study of existing expert systems, MYCIN & AM.

1. Artificial Intelligence: Elaine Rich, Kevin Knight, McGraw Hill. 2. Introduction to AI & Expert System: Dan W. Patterson, PHI. 3. Patterson : Introduction to AI Expert Systems, PHI 4. Jackson : Building Expert Systems, John Wiley

DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Semester VI Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Graphics Lab Credit: L-T-P: 0-0-3 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Advanced Programming Lab Credit: L-T-P: 0-0-3 Version: Approved on: Pre-requisite Course : 2DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Semester VI UG CSP318 CSP316 2 This lab shall cater to programming assignments in area of Computer Graphics. Text/Reference material as suggested in "Operating System" and "Computer Graphics" Text/Reference material as suggested in "Operating System" and "Computer and Network Security" DUGC Convener Curriculum committee Convener

B.Tech (Computer Engineering) - Semester VI UG Syllabus Books: SUGB Chairman  
 UG/PG Department: Computer Engineering Course Code: Course Name: Embedded  
 System Design Lab Credit: L-T-P: 0-0-3 Version: Approved on: Pre-requisite Course :  
 Syllabus Books: SUGB Chairman The topics selection covering the latest and relevant  
 topics related to the emerging areas in "Embedded System" Text/Reference  
 material as suggested in "Embedded Systems" DUGC Convener Curriculum  
 committee Convener B.Tech (Computer Engineering) - Semester VI UG CSP320  
 2 Programming exercises from the different paradigms mainly include  
 Procedure-oriented Programming, Object-Oriented Programming, Aspect- Oriented  
 Programming, and Functional programming (AI and expert system related  
 assignments) Text/Reference material as suggested in "Object Oriented Analysis and  
 Design" and "AI and Expert Systems" DUGC Convener Curriculum committee  
 Convener UG/PG Department: Computer Engineering Course Code: Course Name:  
 Seminar Credit: L-T-P: Version: Approved on: Pre-requisite Course : Syllabus Books:  
 SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course  
 Name: Program Elective I Credit: L-T-P: 3-0-0 Version: Approved on: Pre-requisite  
 Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer  
 Engineering Course Code: Course Name: Program Elective II Credit: L-T-P: 3-0-0  
 Version: Approved on: Pre-requisite Course : Syllabus 3 DUGC Convener Curriculum  
 committee Convener B.Tech (Computer Engineering) - Semester VII UG UG 3 DUGC  
 Convener Curriculum committee Convener B.Tech (Computer Engineering) -  
 Semester VII B.Tech (Computer Engineering) - Semester VII UG CSS401 3 Books:  
 SUGB Chairman DUGC Convener Curriculum committee Convener UG/PG  
 Department: Computer Engineering Course Code: Course Name: Project Credit:  
 L-T-P: 3-0-0 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB  
 Chairman UG/PG Department: Computer Engineering Course Code: Course Name:  
 Advanced Elective Course I Credit: L-T-P: 3-0-0 Version: Approved on: Pre-requisite  
 Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer  
 Engineering Course Code: Course Name: Advanced Elective Course II Credit: L-T-P:  
 3-0-0 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman  
 DUGC Convener Curriculum committee Convener 3 DUGC Convener Curriculum  
 committee Convener B.Tech (Computer Engineering) - Semester VIII UG UG 3 DUGC  
 Convener Curriculum committee Convener B.Tech (Computer Engineering) -  
 Semester VIII B.Tech (Computer Engineering) - Semester VIII UG CSD402 3 UG/PG  
 Department: Computer Engineering Course Code: Course Name: Program Elective III  
 Credit: L-T-P: 3-0-0 Version: Approved on: Pre-requisite Course : Syllabus Books:  
 SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course  
 Name: Program Elective IV Credit: L-T-P: 3-0-0 Version: Approved on: Pre-requisite  
 Course : Syllabus Books: SUGB Chairman DUGC Convener Curriculum committee  
 Convener B.Tech (Computer Engineering) - Semester VIII UG 33 DUGC Convener  
 Curriculum committee Convener B.Tech (Computer Engineering) - Semester VIII UG  
 UG/PG Department: Computer Engineering Course Code: Course Name: Wireless  
 Communications Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course :  
 Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course  
 Code: Course Name: VHDL Credit: L-T-P: 3-0-2 Version: Approved on: UG CST435

4History of wireless communication, and future trends. Wireless Generations and Standards. Cellular Concept and Cellular System Fundamentals. Trunking Cell Splitting and Sectoring. Mobile Radio signal propagation, path loss and channel models. Large Scale Path Loss. Small Scale Path Loss - Rayleigh and Rician Fading. Analog Modulation Schemes for Wireless Communication - AM/FM. Digital Modulation Techniques for Wireless Communication Preliminaries. Baseband Modulation Schemes Bandpass Modulation Techniques. Fading Counteraction – Diversity, Coding and Interleaving. Source and Channel Coding. Speech Coding for Wireless Communications. Adaptive Equalization. Multipath Propagation, Doppler. Multiplexing and Multiple Access techniques. TDMA, FDMA, ALOHA - Packet Radio, Spread Spectrum-CDMA, Frequency Hopped Spread Spectrum, Inter-Symbol Interference (ISI), ISI mitigation; Equalization, Random Access Protocols. Wireless Networking, Wireless Standard. Third generation systems and advanced topics Wideband-CDMA, MCDMA. OFDM principles: Comparison of OFDM and CDMA. WLAN and Bluetooth

1. Wireless Communications: Principles and Practice, 2nd edition, T. Rappaport, Prentice Hall, 2002  
2. K. Pahlavan & P. Krishnamurthy, Principles of Wireless Networks, Prentice Hall  
3. Wireless Communications Systems, A. Goldsmith, Cambridge. DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Program Elective B.Tech (Computer Engineering) - Program Elective UG CST433  
4 Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Neural Networks Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus CST437  
4 Neural Architecture: Neuron model, transfer function, hamming and Hopfield network, perceptron, learning rule, recurrent networks. Back propagation: generalized delta rule, limitations, modifications – momentum, variable learning rate, conjugate gradient. Learning: Supervised, associative, competitive, unsupervised learning. Unsupervised learning: Self-organizing maps, Adaptive Resonance Theory. Neural network applications: Pattern classification, function approximation. Peter J. Ashenden, "The Designer's Guide to VHDL", published by Morgan Kaufmann" Kaufmann Pub. 1.SS Limaye," Digital Design with VHDL", CMR  
2.Douglas Parry, "VHDL Programming by Example", Morgan Kaufmann  
3.Xilinx, "Programmable Logic Design Quick Start Handbook and Book II ed. 4.Xilinx," A CPLD VHDL Introduction Application Notes" DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Program Elective UG  
1. Overview of VHDL, fundamentals of VHDL, Lexical elements Data types and objects  
2. Data Flow style: Conditional and selected Concurrent assignment, block assignment If and wait statement, Design for synthesizability  
3. Structural style: Instantiation and component declaration, statement configuration declaration, generate statement, examples of structural design  
4. Behavioural Style : Signal assignment, statement like case, process and wait loop, exit etc., concurrent signal assignment statements, function and procedures, file I/O operations and Testbenches. Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Speech Recognition Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus  
4 Overview of Speech Recognition; What is Speech; Why is it important; Applications and issues. Speech Production; Mechanism of speech production;

Categories of sounds; Sound units in Indian languages. Nature of Speech Signal; Source-system characteristics; Segmental and suprasegmental features; Temporal and spectral parameters for sound units in Indian languages. Basics of Digital Signal Processing; Signals and systems; Discrete Fourier transform; Digital filtering; Stochastic processes. Speech Signal Processing Methods: Short-time spectral analysis; Spectrograms; Linear prediction analysis; Cepstrum analysis. Speech Recognition; Isolated word recognition; Connected word recognition Continuous Speech Recognition; Speech recognition problem; Hidden Markov models. Other Applications: Word spotting; Speaker recognition; Speech enhancement; Speech synthesis; Practical issues in speech Recognition. DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Program Elective UG CST439

- 1.Simon Haykin: Neural Networks: A Comprehensive Foundation (2nd Edition)
- 2.Christopher M. Bishop: Neural Networks for Pattern Recognition
- 3.James A. Freeman, David M. Skapura: Neural Networks, Pearson Education.
- 4.Martin T. Hagan: Neural Network Design, Thomson Learning.

Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Software Project Management Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus Books: Software Project Management Concept: The Management Spectrum, People, Product, Process & Project. Software Processes & Project Matrix: Software Measurement, Size Oriented Matrices, Function Oriented Matrices. Software Project Planning: Objectives, Decomposition Techniques and Empirical Estimation Model. Risk Analyses and Management: Risk Identification, Projection, Risk Identification, Projection, Risk Refinement, Risk Monitoring and Management. Project Scheduling & Tracking, Software Quality Assurance, Software Configuration Management

- 1.R. S. Pressman, Software Engineering
- 2.P. Jalote, Software Project Management in Practice.
- 3.B. Hughes & M. Cotterell, Software Project Management.

B.Tech (Computer Engineering) - Program Elective UG CST441

41. Spoken Language Processing: A Guide to Theory, Algorithm and System Development by Xuedong Huang, Alex Acero, Hsiao-Wuen Hon, Raj Reddy Prentice Hall PTR; ISBN: 0130226165
2. Speech Communications : Human & Machine by Douglas O'Shaughnessy, IEEE Press, Hardcover 2nd edition, 1999; ISBN: 0780334493.
3. Digital Processing of Speech Signals, Rabiner and Schafer, Prentice Hall, 1978.
4. Fundamentals of Speech Recognition, Rabiner and Juang, Prentice Hall, 1994.
5. Speech and Audio Signal Processing : Processing and Perception of Speech and Music by Nelson Morgan and Ben Gold, July 1999, John Wiley & Sons, ISBN: 0471351547
6. Discrete-Time Speech Signal Processing: Principles and Practice by Thomas F. Quatieri Publisher: Prentice Hall; ISBN: 013242942X; 1st edition (October 29, 2001)
7. Speech Processing and Synthesis Toolboxes by Donald G. Childers, John Wiley & Sons, September 1999; ISBN: 0471349593

DUGC Convener Curriculum committee Convener SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Data Compression Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Natural Language Processing UG CST445

Compression: Need, Lossless v/s lossy compression, review of information theory, prefix codes, uniquely decodable code. Lossless Compression:

Huffman coding – minimum variance, optimal, non-binary, extended, adaptive. Applications and limitations of Huffman codes, Run length encoding, Arithmetic coding, Predictive coding – Burrows-Wheeler transform, Delta modulation, Adaptive delta modulation Dictionary based compression - Lempel-Ziv-Welch, LZ 77 and LZ-78 Lossy Compression Techniques – JPEG and its application Error detection and correction: Parity, 1,2,n dimensions, Hamming codes, p-out-of-q codes Quantization: Scalar and Vector Quantization. 1. Khalid Sayood, Introduction to Data Compression, Morgan Kaufman 2. Greg A. Harris, Darrel R. Hankerson, Peter D. Jr . Johnson, Introduction to Information Theory and Data Compression, Second Edition, Chapman and Hall. 3. Saloman, Data Compression, Springer Verlag. 4. Nelson, The Data Compression book, Hungry Minds DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Program Elective B.Tech (Computer Engineering) - Program Elective UG CST443 4DUGC Convener Curriculum committee Convener Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Wireless & Ad-hoc Networks Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : CST447 41. Allen James, Natural Language Understanding, Second Edition, Benjamin/Cumming, 1995. Grosz, Sparck-Jones Webber 2. Readings in Natural Language Processing, Morgan Kaufmann, 1986. Winograd T. 3. Language as a Cognitive Process, Addison Wesley, 1972. Marcus M. 4. A Theory of Syntactic Recognition for Natural Language, MIT Press, 1980. DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Program Elective UG 4 Introduction; Goals of Natural Language Processing and Computational Linguistics. Finite State Automata and Transducers, Morphology. Parsing: Context Free Grammars, Generalized Phrase Structure Grammar, Earley Parsing Algorithm. Transformational Grammar, Computational Models and Knowledge Representation. Semantics; Interpretation , time, tense and lexical semantics. Machine Translation, Natural Language Interfaces, Natural Language Generation. Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Real Time Systems Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : 4DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Program Elective UG CST449 Fundamentals of Wireless Communication Technology The Electromagnetic Spectrum – Radio Propagation Mechanisms Characteristics of the Wireless Channel - IEEE 802. 11a,b Standard Origin Of Ad hoc: Packet Radio Networks , Technical Challenges, Driving Applications, Components of Packet Radios What Is an Ad Hoc Network? Types of Ad hoc Mobile Communications. Key definitions of ad-hoc, Advantages of ad-hoc/sensor networks, Unique constraints and challenges, Driving Applications, Media Access Control (MAC) Protocols, Issues in designing MAC protocols, Classifications of MAC protocols, MAC protocols Routing Protocol: Global State Routing (GSR), Dynamic State Routing (DSR), Fisheye State Routing (FSR), Ad hoc On-Demand Distance Vector (AODV), Destination Sequenced Distance – Vector Routing (DSDV). Transport Layer, Security Protocols :Introduction Issues in Designing a Transport Layer Protocol for Ad Hoc Wireless Networks - Design Goals of a Transport Layer Protocol for Ad Hoc Wireless Networks - Classification of Transport Layer Solutions, security in Ad Hoc Wireless Networks –

Network Security Requirements - Issues and Challenges in Security Provisioning -Network Security Attacks. 1. C. Siva Ram Murthy and B.S. Manoj "Ad Hoc Wireless Networks: 2. C.K. Toh, Ad Hoc Mobile Wireless Networks: Protocols and Systems, Prentice Hall PTR, 2001 Charles E. Perkins, Ad Hoc Networking, Addison Wesley, 2000 3. Wireless Communications: Principles and Practice, 2nd edition, T. Rappaport, Prentice Hall, 2002 4. K. Pahlavan & P. Krishnamurthy, Principles of Wireless Networks, Prentice Hall

Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Cryptography Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : B.Tech (Computer Engineering) - Program Elective UG CST451

4Introduction to Real-time systems, Issues in Real-time Systems, Real-time System Components, Classification of Real-time systems and Real-time tasks. Misconceptions about Real-time computing. Real-time System requirements: Speed, Predictability, reliability, adaptability. Specification of timing constraints. Real-time scheduling: Requirements and Issues, Terminology, modeling, Introduction static and dynamic scheduling schemes, cyclic scheduling, priority driven scheduling of periodic tasks, schedulability tests, Aperiodic task scheduling: fixed priority server/non-server based scheduling algorithms. Practical factors/overheads. Task Synchronization: Need and priority inversion problem, Priority Inheritance protocol, priority ceiling protocol and stack-based priority ceiling protocol for fixed priority preemptive system. Introduction to multiprocessor real-time systems, problems and issues. An overview of a real-time operating system 1. J.W.S.Liu: Real-Time Systems, Pearson Education Asia 2. S.T.Lavi, A.K.Agrawala: Real-time system Design, McGraw Hill 3. P.A.Laplante: Real-time Systems Design and Analysis, An Engineer's Handbook, IEEE Press 4. P.D.Laurence, K.Mauch: Real-time Microcomputer System Design, An Introduction, McGraw Hill

DUGC Convener Curriculum committee Convener Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: VLSI Algorithms Credit: L-T-P: 3-0-2 Version: Approved on: B.Tech (Computer Engineering) - Program Elective UG CST453

4Review of Number theory: Prime numbers, modular arithmetic, Fermat's theorem, Euler's theorem, Chinese remainder theorem, Discrete logarithms, Random number generation, factoring, prime number generation. Cryptography: Need, conventional techniques, stream ciphers, block cipher, steganography. Public v/s private key cryptography. Stream Ciphers: Caesar Cipher, mono-alphabetic and poly-alphabetic ciphers, Playfair Cipher, Hill Cipher, Rotor machines, One time pad,. Random Number Generation: Pseudo Random Number, PRNG, LFSR, Blum-Blum Shub generator Private-key cryptography: Feistel structure, DES (Data encryption standard), design of S-boxes, AES, Triple DES. Public key cryptography: Key management, Key exchange – Diffie-Hellman, El-Gamal, Merkle's Puzzle, Authentication, Signatures, Deniability, RSA. Threshold Cryptography: Sharing Secrets. Digital Signature: DSA and its variants, discrete logarithm based digital signatures. One-way hash functions – MD5, SHA (Secure Hash Algorithm). Cryptanalysis: Differential and linear cryptanalysis - cracking DES. 1. Stallings, Cryptography and Network Security: Principles and Practice, Pearson Education Asia. ISBN 981-403-589-0. 2. B Schneier, Applied Cryptography, Wiley. ISBN 0-471-11709-9 3. D Kahn. The Codebreakers, Sphere books. ISBN 0-7 221-51497 4. P

Wayner, Disappearing Cryptography, Academic Press. ISBN 0-12- 738671-8 5. Cracking DES, Electronic Frontier Foundation. ISBN 1-56592-520-3 6. A.J. Menezes, P.C. van Oorschot and S.A. Vanstone, Applied Cryptography, CRC Press, ISBN 0-8493-8523-7, 1997 7. D.R. Stinson, Cryptography - Theory and practice , CRC Press, ISBN 0- 8493-8521-0, 1995 DUGC Convener Curriculum committee Convener Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Digital Image Processing Credit: L-T-P: 3-0-2 UG CST455 41. Introduction of VLSI Technology, VLSI design cycle, design styles, basic Layout rules and circuit abstraction, introduction to standard Cell, Gate array, FPGA 2. Overview of basic graph algorithms, Graph algorithms for physical Design 3. Partitioning: Classification of partitioning algorithms, Kernighan-Lin Algorithm, FM Algorithm, Ratio cut algorithm 4. Floor-planning: Rectangular dual graph approach of floor-planning, hierarchical tree based approach, Integer programming based floor- planning. 5. Placement: placement by simulated annealing and force directed method 6. Routing: classification of routing algorithms, Global routing: Maze routing algorithms, line probe algorithms, Steiner tree based algorithms, Detailed Routing: Single layer and two layer routing algorithms, routing in FPGAs 1. Naveed Shervawani, " Algorithms for VLSI physical Design Automation " 3rd Ed Springer 2. Sarrafzadeh and Wong " An introduction to VLSI Physical design " MGH 3. Sze: VLSI Technology 4. Weste and Eshraghan, " Introduction to VLSI Design". Pearson Edu. 5. Sadiq M. Sait, Habib Youssef, "VLSI Physical Design Automation: Theory and Practice", World Scientific Publishing Company; 0. Cormen Leiserson, Rivest, " Introduction to Algorithms", Pearson Edu. DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Program Elective Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Evolving Architectures Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus CST457 4 Special, and emerging advanced topics in different areas of Computer Engineering will be covered under this course. 1. Gonzalez and Woods. Digital Image Processing, Addison Wesley. 2. Castleman. Digital Image Processing. Prentice Hall. 3. Duda and Hart. Pattern Classification. John Wiley . DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Program Elective UG Digital Image Fundamentals: Image Model, Sampling, Quantization, Neighborhood, connectivity of pixels, Labelling of connected components, Distance measures Image Transforms: Fourier Transform, Discrete Fourier Transform, Properties of 2D Discrete Fourier Transform, The fast Fourier Transform and its algorithm, number of operations, the inverse FFT. Discrete Cosine Transform and its applications, KL Transform, Convolution and correlation Image Enhancement: Enhancement by point processing, spatial filtering, enhancement in frequency domain, generation of spatial masks from frequency domain specifications Image Segmentation: Detection of discontinuities, edge linking and boundary detection, thresholding, region oriented segmentation Representation and Description: Representation schemes, boundary descriptors, regional descriptors. Morphology: Dilation, erosion, opening, closing, Hit-or-Miss Transform, some basic morphological algorithms like pruning, thinning and thickening Books: SUGB Chairman UG/PG

Department: Computer Engineering Course Code: Course Name: Topics in Computing Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman 4 Autonomic and Fault Tolerant Computing: Fault Tolerance Strategies - Fault detection, masking, containment, location, re configuration, self-repairing, self-healing and recovery. Fault Tolerant Design Techniques - Hardware redundancy, software, redundancy, time redundancy, and information redundancy. Parallel and Distributed Computing: Concepts and issues in parallel and distributed computing. Concepts and issues in quantum computing, Trusted Computing, Grid Computing, Multi-core and GPGPU computing Introduction to Cloud computing Any other contemporary and relevant issues. 1. P. Jalote, Fault Tolerance in Distributed Systems, Prentice-Hall Inc., 1994 2. D. K. Pradhan (editor), Fault-Tolerant Computing, Theory and Techniques, Prentice-Hall, 1998. 3. Los Alamitos, CA, "Fault-tolerant Software Systems: Techniques and Applications", IEEE Computer Society Press, 1992. 4. Design and Analysis of Fault Tolerant Digital Systems, Barry W. Johnson, Addison Wesley, 1989 (Chapters 1-5). 5. A.K. Somani and N.H. Vaidya, "Understanding fault-tolerance and reliability," IEEE Computer, vol.30, no.4, pp.45-50, Apr. 1997. 6. Research papers and internet resources. DUGC Convener Curriculum committee Convener DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Program Elective UG CST459 .1. Research reports and papers from journals UG/PG Department: Computer Engineering Course Code: Course Name: Machine Learning Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus Introduction: Definition of learning systems. Goals and applications of machine learning. Aspects of developing a learning system: training data, concept representation, function approximation. Inductive Classification: The concept learning task. Concept learning as search through a hypothesis space. General-to-specific ordering of hypotheses. Finding maximally specific hypotheses. Version spaces and the candidate elimination algorithm. Learning conjunctive concepts. The importance of inductive bias. Decision Tree Learning: Representing concepts as decision trees. Recursive induction of decision trees. Overfitting, noisy data, and pruning. Ensemble Learning Using committees of multiple hypotheses. Bagging, boosting, and DECORATE. Active learning with ensembles. Experimental Evaluation of Learning Algorithms: Measuring the accuracy of learned hypotheses. Comparing learning algorithms: cross-validation, learning curves, and statistical hypothesis testing. Rule Learning: Propositional and First-Order: Translating decision trees into rules. Heuristic rule induction using separate and conquer and information gain. First-order Horn-clause induction (Inductive Logic Programming) and Foil. Learning recursive rules. Inverse resolution. Artificial Neural Networks: Neurons and biological motivation. Linear threshold units. Perceptrons: representational limitation and gradient descent training. Multilayer networks and back propagation. Hidden layers and constructing intermediate, distributed representations. Overfitting, learning network structure, recurrent networks. Bayesian Learning: Probability theory and Bayes rule. Naive Bayes learning algorithm. Parameter smoothing. Generative vs. discriminative training. Logistic regression. Bayes nets and Markov nets for representing dependencies. Instance-Based Learning: Constructing explicit generalizations versus comparing to past specific examples. k-Nearest-neighbor



algorithm. Case-based learning. B.Tech (Computer Engineering) - Program Elective UG CST461 4 Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Modelling and Simulation Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite : Course B.Tech (Computer Engineering) - Program Elective UG CST463 41. Bishop, C. (2006) Mitchell, T. M. (1997) Machine Learning. McGraw-Hill 2. Pattern Recognition and Machine Learning. Berlin : Springer-Verlag. 3. Richard O. Duda, Peter E. Hart and David G. Stork. Pattern Classification. Wiley-Interscience, second edition, 2001. 4. Thomas Mitchell. Machine Learning. McGraw Hill Higher Education, First edition, 1997. 5. Stuart Russell and Peter Norvig. Artificial Intelligence: A Modern Approach. Prentice Hall, second edition, 2003. (Machine-learning related chapters.) 6. Information Theory, Inference and Learning Algorithms by David MacKay. DUGC Convener Curriculum committee Convener Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Programming in Java Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : UG CST431 4 Analytical v/s simulation modeling, performance measurement and benchmarking, Workload modeling, random variables, commonly used distributions, Stochastic Processes, Performance evaluation methods, Evaluation Metrics' Markov chains, Birth and Death Processes, Markov chain models of Computer systems, Steady-state and transient analysis Queuing models, M/M systems and their steady state analysis, Single server and multi-server queues, open and closed queueing networks Petri Net based Performance Modeling : Classical Petri Nets, Timed Petri Nets, Discrete Petri Nets, Modeling multiprocessor systems Discrete event simulation – Simulation languages, random number generation and testing, model verification and validation, analysis of simulation results, confidence intervals, variance reduction techniques, Case studies of analytical and simulation studies of computer systems 1. Law and Kelton, Simulation Modeling and Analysis , McGraw Hill 2. Raj Jain, The Art of Computer System Performance Analysis, John Wiley 3. K.S.Trivedi, Probability and Statistics with Reliability, Queuing and Computer Science Applications, PHI 4. Kant, Introduction to Computer System Performance Evaluation, McGraw Hill DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Program Elective Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Python Programming Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : CST465 44. Herbert Schildt: JAVA 2 - The Complete Reference, TMH, Delhi 5. U.K. Chakraborty and D.G. Dastidar: Software and Systems - An Introduction, Wheeler Publishing, Delhi. 6. Joseph O'Neil and Herb Schildt: Teach Yourself JAVA, TMH, Delhi. DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Program Elective UG Introduction: Internet, Java as a tool for internet applications, Byte Code and its advantages. Object Oriented Programming and Design: Review of Abstraction, Objects and other basics, Encapsulation, Information hiding , Method, Signature, Classes and Instances, Polymorphism, Inheritance, Exceptions and Exception Handling with reference to object modeling, Coupling and Cohesion in object oriented software. Object Oriented Design – Process, Exploration and Analysis. Java Programming Basics: Fundamentals: Variables and assignments, Input and Output, Data Types and Expressions, Flow of control, Local variables,

Overloading Parameter passing, this pointer, Java Object Oriented Concepts: Objects and Classes: Use of file for I/O, Formatting output with stream functions, Character I/O, Inheritance, Public and private members, Constructors for initializations, Derived classes, Flow of Control Java Data Structures and Advanced Topics Arrays – Programming with arrays, arrays of classes, arrays as function arguments, Strings, Multidimensional arrays, Arrays of strings, vectors, Base classes. Introduction to Java Applets

Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Multimedia Technology Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus 4 Introduction to Multimedia, Graphics and Image data representations, Color in image and video CIE, RGB, CMY, HSL color models Fundamental concepts in video, NTSC, PAL and Digital video Compression methods: Lossy and Lossless compression techniques.: Huffman coding, Arithmetic coding, LZW Image compression standards: DCT Transform and Fourier transforms, JPEG coding Video representation and compression techniques Motion vector search: sequential, 2D logarithmic search. I, P and B frames, MPEG Video coding, MPEG-1, MPEG-2 and MPEG-3: video coding and decoding Basic Audio compression: Fletcher-Munson curves, Critical Bands, Psychoacoustic phenomenon, MPEG Layer 3 (MP3) Audio DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Program Elective UG CST467

Introduction to Python: Data types, variables, expressions, operators. Sequence, set, dictionary, print statement, control-flow statements, functions. Objects and classes, metaclasses. Decorators, special methods. Exception handling. Modules sys, os, etc. Strings and regular expressions. File operations. Working with processes and threads. Pipes and signals Graphical user interface design in Python (including the Tkinter module), Widgets and basic components, Layout options, Event handling Network scripting (sockets, FTP, and e-mail clients), Server-side scripting Databases and persistence in Python (including pickled objects and shelf files) Custom and built-in data structures in Python C integration with Python (including the SWIG module), Embedding Python calls within C

1. Programming Python by Mark Lutz, O'Reilly. 2. Learning Python, 3rd Edition by Mark Lutz, O'Reilly 3. Python in a Nutshell by Alex Martelli, O'Reilly. 4. An Introduction to Python by Guido van Rossum and Jr. Fred L. Drake, Network Theory Ltd. Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Computer Human Interaction Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: GUI Programming Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : B.Tech (Computer Engineering) - Program Elective UG CST471

4 Human factors issues in the development of software, use of database systems, and design of user interfaces for interactive systems. Science base (theories, models, usability studies, and controlled experimentation), and software engineering with user interface development environments. Issues include: command languages, menus, forms, and direct manipulation, graphical user interfaces, computer supported cooperative work, information search and visualization, World Wide Web design, input/output devices, and display design. 1. B. Shneiderman, Designing the User Interface, 3rd Edition, Addison-Wesley, (1998) 2. Interaction Design by Jenny Preece, Yvonne Rogers, and

Helen Sharp. John Wiley & Sons: New York, 2002. ISBN: 0471492787 . 3. User Centered Web Site Design, by D.D. McCracken and R.J. Wolfe. Pearson Prentice Hall: Upper Saddle River, NJ, 2004 . ISBN: 013041161-2. 4. The Web Wizard's guide to Web Design, J.G. Lenge I, Addison-Wesley, 2002. ISBN: 0201745623.

DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Program Elective UG CST469 41. J H McClellan, R W Schafer & M A Yoder, DSP First: a Multimedia Approach, Prentice-Hall International 1998 DUGC Convener Curriculum committee Convener Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Wireless and Mobile Computing Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus UG CST473 4 Wireless communication fundamentals: Introduction, wireless transmission, frequencies for radio transmission, signals, antennas, signal propagation, multiplexing, modulations, spread spectrum, MAC, SDMA, FDMA, TDMA, CDMA, cellular wireless networks. Telecommunication networks: Telecommunication systems :GSM,GPRS, DECT, UMTS, IMT-2000, Satellite networks - basics – parameters and configurations – capacity allocation: FAMA and DAMA . Wireless LAN: IEEE-802.11, architecture, services, MAC, physical layer, IEEE 802.11a, 802.11b standards, HIPERLAN, BLUE TOOTH. Mobile network layer: mobile ip, dynamic host configuration protocol, routing, DSDV, DSR . Transport and application layers : traditional TCP, classical TCP improvements – WAP, WAP 2.0. Issues and Challenges in GUI design. Overview of intelligent interface design. Graphics versus web interface. Principles of good interface. System Menu and Navigation schemes. Interaction devices. Screen based controls. Usability, testing, design for web, humans. Colors. 1. Wilbert O. Galitz. The Essential Guide to User Interface Design. Wiley. 2. Susan Weinschenk, Pamela Jamar, Sarah C. Yeo. GUI Design Essentials (Paperback) 3. Jenifer Tidwell. Designing Interfaces: Patterns for Effective Interaction Design, O'Reilly. 4. B. Shneiderman, Designing the User Interface, 3rd Edition, Addison- Wesley. DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Program Elective Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Implementation of Data Bases Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman DUGC Convener Curriculum committee Convener CST479 4 Issues in Implementation of Centralized Database Systems - Query Processing, Query Optimization, Transaction Processing, Concurrency, Recovery Management. Database System Architectures – Centralized and Client-Server architecture, Parallel Systems, Distributed Database Systems. Implementation of Distributed Database Systems- Distributed Data Storage, Distributed Transactions, Concurrency control in Distributed Database Systems, Distributed Query Processing. 1. Silberschatz A, Korth HF, Sudarshan S, Database System Concepts, McGraw Hill. 2. Elmasri R and Navathe SB, Fundamentals of Database Systems, 3rd Edition, Addison Wesley, 2000. 3. Ceri S, Pelagatti G, Distributed Databases – Principles and Systems, McGraw Hill. 1. Jochen Schiller, "Mobile Communications", PHI/Pearson Education, Second Edition, 2003. 2. William Stallings, "Wireless Communications and Networks", PHI/Pearson Education, 2002. 3. Kaveh Pahlavan, Prasanth Krishnamoorthy, "Principles of Wireless Networks", PHI/Pearson Education, 2003. 4.

Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, "Principles of Mobile Computing", Springer, New York, 2003. 5. Hazysztotf Wesolowshi, "Mobile Communication Systems", John Wiley and Sons Ltd, 2002

DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Program Elective UG UG/PG Department: Computer Engineering Course Code: Course Name: Information Retrieval Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Digital Watermarking Credit: L-T-P: 3-0-2 Version: Approved on: B.Tech (Computer Engineering) - Program Elective UG CST483 44

INTRODUCTION- Information storage and retrieval systems, Data Structures and Algorithms Related to Information Retrieval RETRIEVAL STRATEGIES - Vector Space Model, Probabilistic Retrieval Strategies, Language Models, Inference Network, Extended Boolean retrieval, Latent Semantic Indexing RETRIEVAL UTILITIES - Relevance Feedback, Clustering, Passage-Based Retrieval, N-grams, Regression Analysis, Thesauri, Stemming, Semantic Networks, Parsing, Ranking EFFICIENCY- Inverted Index, Query Processing, Signature Files, Duplicate Document Detection INTEGRATING STRUCTURED DATA AND TEXT - Review of the Relation Model, A Historic Progression, Information Retrieval as a Relational Application, Semi-Structured Search using a Relational Schema, Multi-dimensional Data Model

1. Information Retrieval Data Structures & Algorithms by William B. Frakes, Ricardo Baeza-Yates 2. Information retrieval- by D A Grossman, Ophir Frieder, Springer International Edition

DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Program Elective UG CST481 Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Multi-Core Architectures Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman Multiple core programming models. GPGPU programming and streaming data processing. Issues related with coherency, languages and communication overheads in multi-core programming Art of Multiprocessor Programming: Nir Shavit, Elsevier

DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Program Elective UG CST475 44

Watermarking: Applications, techniques, models, detection techniques. Visible and invisible watermarks. Embedding. Robust watermarking, watermark security. Steganography – Least Bit, DCT, Spread spectrum. Audio steganography. Steganalysis techniques. 1. Ingemar Cox, Matthew Miller, Jeffrey Bloom, and Jessica Fridrich. Digital Watermarking and Steganography, 2nd Ed, (The Morgan Kaufmann Series in Multimedia Information and Systems). 2. Frank Y. Shih. Digital Watermarking and Steganography: Fundamentals and Techniques, CRC Press. 3. Stefan Katzenbeisser, Fabien, and A.P. Petitcolas. Information Hiding Techniques for Steganography and Digital Watermarking, Artech House. 4. Neil F. Johnson; Zoran Duric; Sushil Jajodia. Information Hiding: Steganography and Watermarking - Attacks and Countermeasures, Springer. 5. Gregory Kipper. Investigator's Guide to Steganography, Auerbach Publications.

DUGC Convener Curriculum committee Convener UG/PG Department: Computer Engineering Course Code: Course Name: Distributed Systems Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus

Books: SUGB Chairman 1. Distributed Systems: Concepts and Design, 4rd e d by Coulouris, G, Dollimore, J., and Kindberg, T., Addison-Wesley, 20 06. ISBN: 0321263545 2. Distributed Systems: Principles and Paradigms, 2nd ed by Tanenbaum, A. and van Steen, M., Prentice Hall, 200 7. ISBN: 0132392275. DUGC Convener Curriculum committee Convener UG CST477 4 Introduction to distributed system: characteristics . Advantages, Disadvantages. Design goals. Issues, Models of dist ributed systems. Communication in Distributed Systems: Message passi ng, client/server model. Remote Procedure Call. Group Communication. Time in distributed systems. Logical clocks. Vector clocks. Causal ordering of messages. Global state and state recording. Distributed Mutual Exclusion: Non-token based algo rithms. Token based algorithms. Distributed elections. Transaction and concurrency control, Nested transactions, Locks, Timestamp ordering. Con currency control in distributed transactions, Distributed deadlocks. Tr ansaction recovery Replication: Motivation, Consistency and ordering. Total and causal ordering. Update protocols and voting; Distributed File Systems: Recovery and Fault Tolerance: Transaction recovery. Checkpointing and recovery. Fault tolerance in distributed systems. H ardware and software redundancy. Byzantine agreement. B.Tech (Computer Engineering) - Program Elective UG/PG Department: Computer Engineering Course Code: Course Name: Topics in Data Structures and Algorithms Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman RAM model – Notations, Recurrence analysis - Maste r's theorem and its proof - Amortized analysis - Advanced Data Structur es: B-Trees, Binomial Heaps, Fibonacci Heaps, AVL trees, Red-black trees , B-trees, Splay trees. Disjoint set – union and path compression, Amortize d analysis Recurrence equations. Time and space complexity, NP , NPC and NP-Hard problems, undecidability. Convex hull and Voronoi diagrams, line segments, Op timal polygon triangulation. Primality testing, Integer factorization, Randomize d algorithms, Probabilistic algorithms. Dynamic programming: Longest common subsequence. Ch ain of matrix multiplication, Approximate Algorithms: Vertex-cover, set-covering problems, Travelling Salesman problem. Combinatorial algorithms, Randomized algorithms: Use of probabilistic inequal ities in analysis, applications using examples. Graph algorithms: Matc hing and Flows. Parallel algorithms: Basic techniques for sorting, seraching, merging.. Complexity classes - NP-Hard and NP-complete Proble ms - Cook's theorem NP completeness reductions. 1) Cormen, Leiserson, Rivest: Introduction to Algor ithms, PHI. 2) Horowitz and Sahani: Fundamental of Computer alg orithms. 3) Aho, Ulman: Design and analysis of Algorithms, A ddison Wesley 4) Brassard : Fundamental of Algorithmics, PHI. 5) Sara Baase: Computer Algorithms, Pearson Educati on. 6) Papadimitriou, Steiglitz: Combinatorial Optimiza tion: Algorithms and Complexity, PHI. 7) Motwani: Randomized Algorithms, Cambridge Univer sity Press 8) Joseph Ja'Ja': Introduction to Parallel Algorit hms, Addison-Wesley 9) Vaizirani: Approximation Algorithms, Springer Ve rlag 10) N. Deo: Graph Theory with Application to Engine ering and Computer Science, PHI. 11) N. Deo: Combinatorial Algorithms: Theory and Pr actice, PHI. DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Advanced Elective C ourse UG CST432 4 UG/PG Department: Computer Engineering Course Code: Course Name: Parallel and Distributed

Computing Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman 1) Quinn, Parallel computing – theory and practice, Tata McGraw Hill. 2) Sima and Fountain, Advanced Computer Architectures, Pearson Education. 3) Mehdi R. Zargham, Computer Architectures single and parallel systems, PHI. 4) Ghosh, Moona and Gupta, Foundations of parallel processing, Narosa publishing. 5) Ed. Afonso Ferreira and Jose' D. P. Rolin, Parallel Algorithms for irregular problems - State of the art, Kluwer Academic Publishers. 6) Selim G. Akl, The Design and Analysis of Parallel Algorithms, PH International.

DUGC Convener Curriculum committee Convener UG CST434 4 Introduction to parallel computing. Parallel processing terminology, Pipelining Vs Data parallelism, Control parallelism , Scalability, Control parallel approach, Data parallel approach, Data parallel approach with I/O Parallel reduction, Prefix sums, List ranking, Preorder tree traversal, Merging two sorted lists, Graph coloring, Reducing the number of processors, Problems defying fast solutions on PRAM S Thread and process level parallel architectures: MIMD, multi-threaded architectures. Distributed and shared memory MIMD architectures. Dynamic interconnection networks. Mapping and scheduling: Mapping data to processors on processor arrays and multicomputers, Dynamic Load Balancing on multi computers, Static scheduling on UMA multiprocessors, Deadlock. Parallel programming and parallel algorithms: Programming models, parallel programming on multiprocessors and multicomputers. Parallel algorithm structure, analyzing parallel algorithm. Elementary parallel algorithms, Matrix algorithms, sorting, Graph algorithms.

B.Tech (Computer Engineering) - Advanced Elective Course UG/PG Department: Computer Engineering Course Code: Course Name: Selected Topics in Operating System Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Advanced Topics in Computer Graphics Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : 4DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Advanced Elective Course UG CST438 CST436 4 Introduction: Goals, Functions, Design issues of Distributed OS, Distributed v/s network operating system. Communication: Client Server, RPC Distributed OS: Issues, process management, inter-process communication, scheduling, deadlocks Design and implementation of distributed file systems, distributed shared memory Security: Concepts and Distributed Systems Distributed Concurrency, Transactions. Case study: Unix, Amoeba. 1) Tanenbaum: Distributed Operating Systems, Pearson Education. 2) Bach, Design of Unix O/S. 3) Coulouris et al, Distributed Systems: Concepts and Design, Addison Wesley. 4) Mullender: Distributed Systems, Addison Wesley. 5) Tanenbaum and Steen: Distributed Systems: Principles and Paradigms, Pearson Education

B.Tech (Computer Engineering) - Advanced Elective Course UG Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Advanced Topics in Databases Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus Issues in Implementation of Database Systems, Query Processing, Query Optimization, Transaction Processing, Concurrency, Recovery Management. Database System Architectures, Distributed Databases, Distributed Transactions, Distributed Query Processing, Parallel Databases, Times in Databases, Multimedia

Databases B.Tech (Computer Engineering) - Advanced Elective Course UG CST440

4 Visibility: Polygon Meshes, Depth Sorting. Triangle decomposition, Geometric Sort, Warnock's Methods Hidden Lines and Surfaces: Special cases, Surfaces defined by a function  $y=f(x,y)$ , Grid surfaces, visible surface determination. Colour in Computer Graphics: Color Vision, Measuring Color, Color Models, Color output, color usage. Object Lighting and Shading: Illumination and shading models, Local reflection models, shading surfaces, Texture and transparency, Forward & backward Ray-tracing Global Illumination and classical radiosity. Modeling natural phenomena: Fractals and chaos. Animation Techniques: Position, speed or orientation. Animation by hierarchic control, scenario-based systems, movement control. Shadows, Morphing, Texture mapping

- 1) J. Foley et al : Computer Graphics-Principles and Practice, Addison Wesley.
- 2) Alan Watt- 3D Computer Graphics.
- 3) A. Watt, M. Watt: Advanced Animation & Rendering Techniques, Addison-Wesley.
- 4) D. Rogers and Adams: Mathematical Elements of Computer Graphics, McGraw Hill.
- 5) Thomas Moller: Real-time Rendering, Eric Haines, A.K Peters Ltd

DUGC Convener Curriculum committee Convener Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Network Performance Modeling Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Software Testing and Validation Credit: L-T-P: 0-0-3 Version: Approved on: UG CST444

2 Networking as resource sharing: current practices, Traffic Multiplexing, Traffic analysis, Stochastic Traffic Models, Multiple Access: Wireless Networks. Routing: Virtual path routing and Elastic Aggregates, Routing of Stream Type sessions, Routing in Ad-hoc and Sensor Networks. Introduction to High Performance Switching and Routing. QoS and Modeling issues of the Networks.

- 1) Communication Networking: An Analytical Approach , Anurag Kumar, D.Manjunath, Joy Kuri, Elsevier
- 2) High Performance Communication Networks, Jean Walrand, P.Vaiya, Elsevier
- 3) Selected papers and online references.

DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Advanced Elective Course B.Tech (Computer Engineering) - Advanced Elective Course UG CST442

- 41) Silberschatz A, Korth HF, Sudarshan S, Database System Concepts, McGraw Hill.
- 2) Elmasri R and Navathe SB, Fundamentals of Database Systems, 3rd Edition, Addison Wesley, 2000. This book covers most of the material on the course.
- 3) Ceri S, Pelagatti G, Distributed Databases – Principles and Systems, McGraw Hill.
- 4) Date CJ, An Introduction to Database Systems, 7th Edition, Addison Wesley.
- 5) Khashafian S and Baker AB, Multimedia and Imaging Databases, Morgan Kaufmann.

DUGC Convener Curriculum committee Convener Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Topics in SOC Design Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Advanced Elective Course UG CST446

4 Methodologies and design flows of front end and back end designs. Introduction to intellectual property core types and their design issues. Integration issues of IPs on SOC designs. Low power design issues and methodologies. Testing standards and architecture of SOC. 1)

Farzad Nekoogar , F.Nekooqar, From ASICs to SOCs: A Practical Approach, Pearson.

2) Steve B. Furber, ARM System-on-Chip Architecture (2nd Edition), AWL

3) Recent papers from conferences and journals.

1) Selected papers and online references.

. DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Advanced Elective C course UG Basic software testing principles – Software Quality, Software testing and test management. Acceptance Testing: User acceptance testing, alpha and beta testing. Functional and Non-functional system testing Static and dynamic testing, Black-box or functional testing, structural, white box or glass box testing. Integration testing, component testing. Software testing tools. Software Validation: Issues and Challenges. Course Code: Course Name: Advances in Compiler Design Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Wireless Sensor Networks Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus Wireless Sensor Networks: Introduction, Overview and Applications. Sensor node – Design issues, power consumption, operating environment, sensor examples. Architecture - Single node, Network, Single hop v/s multi-hop, Performance metrics, QoS Wireless communication – Fundamentals, spread spectrum techniques, CDMA Protocols – Physical layer, MAC, link layer, Routing, middleware. Network management, Topology, operating system. Security in sensor networks. Open issues and Challenges. B.Tech (Computer Engineering) - Advanced Elective C course UG CST450 44 A Tour of Compiler Design, LR Parsers, Lex and Yacc Tools, Control-flow Analysis, Control-flow Graphs, Basic Blocks, Data-flow Analysis, Dependence Analysis, Global Optimizations, Loop Optimizations, Peephole Optimization and Optimal Code Generation, Data Dependence Analysis in Loops, Loop Scheduling, Static Single Assignment, Just-In-Time (JIT) and Adaptive Compilation, Runtime System Architectures and Automatic Memory Management Techniques. 1) Aho, Alfred V., Sethi, Ravi, Ullman, Jeffrey D., Compilers: Principles, Techniques and Tools, Addison-Wesley. 2) Steven Muchnick, Advanced Compiler Design & Implementation, Morgan Kaufmann. 3) Keith Cooper and Linda Torczon, Engineering a Compiler, Morgan Kaufmann. DUGC Convener Curriculum committee Convener CST448 Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Digital Image Analysis Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Data Mining and Data Warehousing Credit: L-T-P: 3-0-2 UG CST454 4 Digital Image Fundamentals, Point operations. Smoothing, Sharpening, Crispening, Image Enhancement in Spatial Domain, Image Enhancement in Frequency Domain Image Transforms: Hotelling, Hit and Miss transform . Color Image Processing, Multiview Image Processing, Epipolar geometry Image Warping and Restoration. Image Segmentation, Representation and Description Morphological Operators, Erosion, Dilation, Medial Axis, Thinning, Skeleton. Image Matching and Classification 1) Rafael C Gonzalez, Richard E Woods, Digital Image Processing, Addison-Wesley. 2) Milan Sonka, Vaclav Hlavac, Roger Boyale, Image Processing, Analysis and Machine Vision: PWS Publishing (ITP-International Thomson Publishing). 3) Anil K Jain: Fundamentals of Digital Image Processing, Printice Hall of India (PHI). DUGC



Convener Curriculum committee Convener B.Tech (Computer Engineering) - Advanced Elective C course B.Tech (Computer Engineering) - Advanced Elective C course UG CST452 41) Holger Karl, Andreas Willig. Protocols and Architectures for Wireless Sensor Networks, Wiley Interscience. 2) Kazem Sohraby, Daniel Minoli, and Taieb Znati: Wireless Sensor Networks: Technology, Protocols, and Applications, Wiley Interscience. 3) Selected papers and online reference material. DUGC Convener Curriculum committee Convener Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Topics in High Speed Networking Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus CST456 4 Overview of Internet Technologies, Issues in next generation Internet - Routing, Multicasting, Packet Scheduling, Quality of Service etc. Admission control in Internet: Effective bandwidth, Differentiated services, Policy-based networking, Real time communications over Internet, Internet telephony, Voice over IP, Integrated services. Web QoS, Intelligent caching, Traffic measurement and characterization. 1) Data Warehousing in the Real World – Anahory and Murray, Pearson Education. 2) Data Mining – Concepts and Techniques – Jiawei Han and Micheline Kamber. 3) Building the Data Warehouse – WH Inmon, Wiley. DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Advanced Elective C course UG Introduction to Decision Support Systems, Data Warehouse and Online Analytical Processing. Data Warehouse Architecture: System Processes, Process Architecture: Load Warehouse, Query, Detailed and Summarized Information. Design: Data Base Schema Facts, Dimensions and Attributes. Data Base and Metadata. Data Mining : Introduction and need, Descriptive and Predicative Data Mining. Data Processing : Data Cleaning, Data Integration and Transformation, Data Reduction. Data Mining Primitives:, Language DMQL and its Preliminary Clauses. Data Mining Methods: Association – Single and Multi level, Characterization and Comparison, Regression Analysis, Classification and Predication. Data Mining Algorithms: Clustering, Association, Regression, Decision Trees. Application and Trends in Data Mining. Data Warehouse Implementation. Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: e-Commerce Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman B.Tech (Computer Engineering) - Advanced Elective C course 4 Introduction and concepts: networks and commercial transactions, the Internet environment, online commerce solutions. A generic business model for e-commerce. Security technologies: Introduction to cryptography , key distribution and clarification. Architecture for e-commerce: online commerce environment, servers and commercial environments, strategies, techniques and tools. Electronic payment methods: Secure online transaction models, digital payment system, cyber cash, digital currencies, Smart cash, digital purse, anonymity and authentication. Protocol for the public transport of private information: security protocols, secure socket layer. Open issues: legal and technical issues. 1) Pete Loshin, Paul A Murphy: Electronic e-commerce, Jaico book. 2) Paul May: The Business of e-commerce, Cambridge University Press. 3) Recent papers from conferences and journals DUGC Convener Curriculum committee Convener DUGC Convener Curriculum committee Convener B.Tech

(Computer Engineering) - Advanced Elective Course UG CST458 1) Kurose: Computer Networking A Top Down Approach, Pearson. 2) Peterson and Davie: Computer Networks: A systems approach, Morgan Kaufman and Elsevier. 3) J.Walrand, High Performance Computer Networks, Elsevier 4) A.Kumar, D.Manjunath, Communication Network MKP. 5) Recent papers from conferences and journals UG/PG Department: Computer Engineering Course Code: Course Name: High Level Synthesis of Digital Systems Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Parallelizing Compiler Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus Motivation and overview, structure of a parallelizing compiler. Review of code optimization techniques in compilers for sequential machines. Parallelism detection - data dependence analysis, direction vectors, loop carried and loop independent dependences; tests for data dependence and their applicability, construction of data dependence graph. Control dependence and control dependence graph. Restructuring transformations and automatic extraction of parallelism; representation of iteration spaces of multiply nested loops; loop based transformations such as loop distribution, loop coalescing, loop inter-change and cycle shrinking transformation. B.Tech (Computer Engineering) - Advanced Elective Course UG CST462 4 Overview. Design methodologies. Abstractions and views. Review of basic concepts in algorithms and graph theory Design representation and modeling, Modeling languages, Abstract models Synthesis at higher levels of abstraction Scheduling, Resource sharing Structural synthesis: Module selection. Pipeline. Control Synthesis at lower levels of abstraction, Logic synthesis 1) G. D. Micheli. Synthesis and optimization of digital systems. 2) N.D. Dutt, D. D. Gajski. High level synthesis, Kluwer, 2000. 3) T. H. Cormen, C. E. Leiserson and R. L. Rivest, "Introduction to Algorithms," McGraw-Hill, 1990. 4) Recent papers from journals and conferences. DUGC Convener Curriculum committee Convener UG CST460 4 Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Public Key Infrastructure and Trust Management Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Selected Topics in Cryptography Credit: L-T-P: 3-0-2 CST466 41) Ashutosh Saxena, Public Key Infrastructure, Tata McGraw Hill 2) Carlisle Adams, Steve Lloyd. Understanding PKI: Concepts, Standards, and Deployment Considerations, Addison Wesley. 3) John R. Vacca. Public Key Infrastructure: Building Trusted Applications and Web Services, AUERBACH. 4) Messaoud Benantar, Introduction to the Public Key Infrastructure for the Internet, Pearson Education. DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Advanced Elective Course UG UG CST464 4 Public key infrastructure - components and architecture. PKI interoperability, deployment and assessment PKI data structures – certificates, validation, revocation, authentication, cross-certification. Repository, Certification Authority (CA) and Registration Authority (RA), trusted third party, digital certificates. PKI services – authentication, non-repudiation, privilege management, privacy, secure communication. Key management – certificate revocation list, root CA, attacks on CA, key backup. PKI standards – SSL, LDAP,

IPSec, X.500, X.509, S/MIME Trust models – strict v/s loose hierarchy, four corner, distributed. Certificate path processing – path construction and path validation. 1) Selected papers and online reference material DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Advanced Elective Course Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Robotics and Control Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus Books: 4 Robotics: Introduction to robotics, advantages, applications. Robotic kinematics and dynamics: Direct and inverse kinematics problem. Axis transformations; DH matrix; forward and reverse kinematics, trajectory planning. manipulators and their control. Robot sensors: Active and passive robot sensors, Construction of tactile, touch and vision sensors; interpretation of sensory information; vision processing; kinematic information from sensory data . Robot Intelligence: Robot learning, State space search, robotics in computer vision applications. Robotic end effectors: Stable grip; constraints; types of contact; mathematical representation of stable grip; use of screw twist, and wrench gripper design; tools as end effectors. Problems of implementation of automatic systems. 1) Fu K, Gonzalez R and Lee C, Robotics - Control Sensing Vision & Intelligence, McGraw Hill. 2) Craig J J, Introduction to Robotics, Mechanics and Control, Addison Wesley, 1993. 3) McKerrow P J, Introduction to Robotics, Addison Wesley, 1993. 4) Selig M, Introductory Robotics, Prentice Hall, 1992. DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Advanced Elective Course UG CST468 Elliptic Curve Cryptography Secret Sharing, Threshold cryptography – Robust ElGamal system Visual Cryptography Interactive zero knowledge proofs, witness hiding protocols. Group encryption, decryption. Group signatures, ring signatures. EVoting: requirements, issues and challenges, existing solutions, write-in ballots. Pair based cryptography – Weil and Tate pairing. 1) Selected paper and online reference material. SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: FPGA based System Design Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Security in Computing Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : B.Tech (Computer Engineering) - Advanced Elective Course UG CST472 4Introduction to FPGA Architectures. FPGA design flow, partitioning, placement and routing algorithms. Technology mapping for FPGAs, case studies. 1) Brown, Francis, Rose and Vranesic. Field programmable Gate arrays. Kluwer. 2) Betz, Rose, Marquardt, Architecture and CAD for Deep-submicron FPGAs. Kluwer. 3) Trimberger, FPGA Technology. Kluwer, 1992. 4) Oldfield, Dorf. FPGAs: Reconfigurable logic for rapid prototyping and implementation of digital systems. John Wiley. 5) Recent papers from conferences and journals. DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Advanced Elective Course UG CST470 4DUGC Convener Curriculum committee Convener Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Intelligent Agents Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : UG CST474 4Computer security, threats, attacks, computer criminals, defense methods,

information and network policies, cryptography, symmetric and public-key encryption, uses of encryption. Secure file systems and database security. Program security, secure programs, viruses and other malicious code, control against program threats, protection in general-purpose OS, protected resources and methods of protection, user authentication. Binding programs to machines. Language based security, Integrating security in compilers. Designing trusted OS, models of security, database security, security requirements, reliability and integrity, inference. Administering security, legal, privacy, and ethical issues in computer security. 1) Pfleeger and Pfleeger, Security in Computing, Pearson Education. 2) M. Bishop and S. S. Venkatramanayya, Introduction to Computer Security, Pearson Education. 3) Stallings W., Cryptography and Network Security Principles and Practice, Pearson Education. 4) Stallings W., Network Security Essentials: Applications and Standards, Pearson Education.

DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Advanced Elective Course Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Critical Systems Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus CST476

4 Introduction to time critical systems, Issues, Components, Classification and terminology. Misconceptions about Real-time computing. Real-time System requirements. Specification of timing constraints. Real-time scheduling: Requirements and Issues, Terminology, modeling, Introduction static and dynamic scheduling schemes, cyclic scheduling, priority driven scheduling of periodic tasks, schedulability tests, Aperiodic task scheduling: server/non-server based scheduling algorithms. Practical factors/overheads. Task Synchronization: Need and priority inversion problem, Priority Inheritance protocol, priority ceiling protocol and stack-based priority ceiling protocol. Introduction to multiprocessor real-time systems, problems and issues. An overview of an operating system 1) M.J.Wooldridge, An introduction to multi-agent systems. Wiley DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Advanced Elective Course UG Introduction to agent-based computing, Motivations for agent-based computing Key concepts and models, Agent architectures (deliberative, reactive, hybrid), Rational decision making (decision theoretic, belief-desire-intention) Mobile agents, Agent Interactions, Coordination (organisation models, social laws, social dependencies), Cooperation (team-oriented problem solving, coalition formation) Negotiation (mechanism design, heuristic models, argumentation) Computational markets (auctions, competition) Agent-Oriented Software Engineering, Benefits and Potential Drawbacks, Agent Methodologies, Application Case Studies (agent-mediated electronic commerce, business process management, telecommunications network management) Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Pattern Recognition Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman

4 Introduction to statistical, syntactic and descriptive approaches, features and feature extraction. Bayes Decision theory- continuous case, 2-category classification, minimum error rate classification, discriminant functions and decision surfaces, discrete case. Parameter estimation, supervised learning- Maximum likelihood, Bayes, general bayesian learning. Nonparametric - density estimation, parzen windows, k-nearest Neighbor,

estimation posterior probability. Linear discriminant functions- decision surfaces, generalized linear discriminant functions, 2-category linearly separable case, non-separable behavior, linear programming procedures, SVMs. Supervised learning: Feed forward Neural networks, Backpropagation algorithm, error surfaces. Clustering - data description and clustering, Hierarchical clustering, self organizing maps. 1) Duda and Hart P.E, and David G Stork, Pattern classification, John Wiley & Sons. 2) Duda and Hart P.E, Pattern classification and scene analysis, John Wiley and sons.. 3) Earl Gose, Richard Johnsonbaugh, and Steve Jost; Pattern Recognition and Image Analysis, PHI. 4) Fu K.S., Syntactic Pattern recognition and applications, Prentice Hall.s DUGC Convener Curriculum committee Convener DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Advanced Elective Course UG CST478 1) J.W.S.Liu: Real-Time Systems, Pearson Education Asia 2) S.T.Lavi, A.K.Agrawala: Real-time system Design, McGraw Hill 3) Laplante: Real-time Systems Design and Analysis, An Engineer's Handbook, IEEE Press 4) Laurence, K.Mauch: Real-time Microcomputer system design, An introduction, McGraw Hill UG/PG Department: Computer Engineering Course Code: Course Name: Biometric Security Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Computer Forensics Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : B.Tech (Computer Engineering) - Advanced Elective Course UG CST482 4Biometrics: Need, Conventional techniques of authentication, challenges - legal and privacy issues. Biometrics: DNA, fingerprint, Iris, Face, hand geometry, ear. Behavioral: Human gait, speech, thermal imaging, in fra-red spectrum, signature, keystroke dynamics Combining biometrics, scaling issues. Privacy, legal and ethical issues. 1) Julian D. M. Ashbourn, Biometrics: Advanced Identity Verification: The Complete Guide 2) Davide Maltoni (Editor), et al, Handbook of Fingerprint Recognition 3) L.C. Jain (Editor) et al, Intelligent Biometric Techniques in Fingerprint and Face Recognition 4) John Chirillo, Scott Blaul, Implementing Biometric Security 5) Nalini Ratha (Editor), Ruud Bolle 6) Authentication: From Passwords to Public Keys, Richard E. Smith DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Advanced Elective Course UG CST480 4 Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Semantic Web Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : UG CST484 4File System Forensics: Duplicating hard disks for "dead analysis", reading hidden data on a disk's Host Protected Area (HPA), Direct versus BIOS access, dead versus live acquisition, Disk partitions - DOS, Apple, and GPT partitions, BSD disk labels, Sun Volume; multiple disk volumes - RAID and disk spanning; Analyzing FAT, NTFS, Ext2, Ext3, UFS 1, and UFS2 file systems, Finding evidence: File metadata, recovery of deleted files, Using The Sleuth Kit (TSK), Autopsy Forensic Browser, and related open source tools Web Forensics: network-based evidence in Windows and Unix environments, Reconstructing Web browsing, e-mail activity, Tracing domain name ownership and the source of e-mails System Forensics: Windows Registry changes, Duplicating and analyzing the contents of PDAs and flash memory devices Electronic document, computer image verification and authentication 1) Brian Carrier. File System Forensic Analysis, Ad

dition Wesley. 2) Chris Prosise, Kevin Mandia. Incident Response and Computer Forensics, McGraw Hill. 3) Linda Volonino, Reynaldo Anzaldúa, and Jana Godwin. Computer Forensics: Principles and Practices, Prentice Hall. 4) Keith J. Jones, Richard Bejtlich, and Curtis W. Rose. Real Digital Forensics: Computer Security and Incident Response, Addison Wesley 5) Vacca, John R., Computer Forensics Computer Crime Scene Investigation, Charles River Media. 6) Nelson, Phillips, Enfinger, Stuart. Guide to Computer Forensics and Investigation, Course Technology. DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Advanced Elective Course Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Intrusion Detection Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus CST486 4 Introduction- Intrusion detection system (IDS), intrusion prevention system (IPS), Unauthorized access – buffer overflow, packet fragmentation, out-of-spec packets Review of Network protocol – TCP/IP, Intrusion detection through tcpdump. IDS and IPS – Architecture and internals. Malicious and non-malicious traffic, IP headers, TCP, UDP and ICMP protocols and header formats, Header information to detect intrusion, logs and their analysis, IDS through reaction and response Intrusion analysis – data correlation, tools, SNORT1) John Davies, Rudi Studer, and Paul Warren. Semantic Web Technologies: Trends and Research in Ontology-based Systems, Wiley. 2) John Davies, Dieter Fensel, Frank van Harmelen, and Frank van Harmelen. Towards the Semantic Web: Ontology-Driven Knowledge Management, Wiley. DUGC Convener Curriculum committee Convener B.Tech (Computer Engineering) - Advanced Elective Course UG Introduction to semantic web, architecture, languages and tools for knowledge management. XML, RDF, OIL, DAML, OWL for semantic web. Semantic Web Technologies: Ontology-based Systems: Ontology based knowledge management; ontology construction; generating, storing, aligning and maintaining ontologies for semantic web; information retrieval from natural language based documents; ontology evolution; ontological indexing and searching techniques for Searching web Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Internet Security Credit: L-T-P: 3-0-2 Version: Approved on: Pre-requisite Course : Syllabus Books: SUGB Chairman UG/PG Department: Computer Engineering Course Code: Course Name: Malware Analysis and Detection Credit: L-T-P: 3-0-2 B.Tech (Computer Engineering) - Advanced Elective Course UG CST490 44 Security protocols: naming and addressing, IPv6, Network address translation, SNMP, remote login, file transfer protocol, RPC based protocol, peer-to-peer communication Web architecture and protocols, buffer overflow and hacking Internet threats – password stealing, Trojans, phishing, viruses, worms, DOS attack, backdoors, Botnets, port scanning, hacking techniques. Security mechanisms – passwords, one-time password – time based, Lamport's, authentication – smart card, biometrics, RADIUS, SASL framework, host to host authentication, PKI. Firewalls, VPNs, tunneling, Intrusion detection. Server and client security, 1) John Chirillo. Hack attacks denied, Wiley. 2) McClure. Web Hacking, Pearson Education. 3) John R. Vacca. Practical Internet Security, Springer. 4) William R. Cheswick, Steven M. Bellovin, and Avi El D. Rubin. Firewalls and Internet Security: Repelling the Wily Hacker, Addison-Wesley. 5) Kenneth Einar Himma.

Internet Security: Hacking, Counterhacking ,and Security, Jones & Bartlett Publishers  
DUGC Convener Curriculum committee Convener DUGC Convener Curriculum  
committee Convener B.Tech (Computer Engineering) - Advanced Elective C ourse  
UG CST488 1) Matt Fearnow, Stephen Northcutt, Karen Frederick , and Mark Cooper.  
Intrusion Signatures and Analysis, SAMS. 2) Carl Endorf, Gene Schultz, Jim  
Mellander, Intrusion Detection and Prevention, McGraw Hill. 3) Stephen Northcutt  
and Judy Novak. Network Intrusion Detection, SAMS. 4) Paul E. Proctor. The  
Practical Intrusion Detection Handbook, Prentice Hall. Version: Approved on:  
Pre-requisite Course : Syllabus Books: SUGB Chairman Malware Taxonomy,  
Infection and Propagation mechanisms, Payload delivery, obfuscation, Detection  
mechanisms: scanning, anomaly detection, behavioural analysis; polymorphic and  
metamorphic malware, signature, static and dynamic analysis, generic decryptor, dis  
infection, system vulnerabilities and exploits. 1) Peter Szor. The Art of Computer Virus  
Research and Defense, Addison Wesley. 2) Eric Filliol: Computer Viruses from  
Theory to Applications, Springer. 3) M. Sikorski and A. Honig: Practical Malware Anal  
ysis, No Starch Press. DUGC Convener Curriculum committee Convener  
BTech\_CSE.pdf CP Page 1B.Tech (Computer Engineering)  
Semester12345678CreditsCHICPCPEOETotal I & II  
4545451HS-200CP-221CP-223CP-225CP-227CP-251CP-253 III Data Structures  
Abstract AlgebraLSD Lab 22216422 (3-0-0)(3-0-0)(3-0-0)(3-0-0)(0-0-3)(0-0-3)233332  
24CP-222CP-224CP-226CP-228CP-250CP-252 IVDBMS DBMS Lab  
Discipline23217423 (3-0-0)(3-0-0)(3-0-0)(3-1-0)(0-0-3)(0-0-3)  
333422411CP-321CP-323CP-325CP-351CP-353CP-355 VCompiler Design OS Lab  
23154423 (3-0-0)(3-0-0)(3-0-0)(0-0-3)(0-0-3)(0-0-3)33322244CP-322CP-324CP-350  
CP-352CP-354 VI Algorithms LabSeminar Discipline231144423  
(3-0-0)(3-0-0)(0-1-3)(0-0-3)(0-3-0) 3332344 1CP-451 CP-453 VII Design Elective  
25318425 (0-3-0) 344464CP-452 VIIIProject Discipline191108019 1044 1 Total  
Credits 18051753420180Discipline /NSS Social Science and EconomicsLogic System  
DesignProbability and StatisticsData Structure LabOpen Elective I Microprocessor  
and MicrocontrollersComputer ArchitectureTheory of ComputationAssembly  
Language Programming LabOpen Elective II Creative Arts/ Sports/ NSS/ Hindi  
Operating SystemComputer NetworkSystem Programming LabNetwork Programming  
LabProgram Elective IOpen Elective III Software Engg. Design and Analysis of  
AlgorithmsFree and Open Source LabProgram Elective IIOpen Elective IV Industrial  
TrainingProgram Elective IIIProgram Elective IVProgram Elective VOpen Elective V  
Program Elective VIProgram Elective VII CP Page 2Program Elective I CP-371Object  
Oriented Programming CP-373Logical and Functional Programming  
CP-375Programming in Java CP-377Concurrent Programming Program Elective II  
CP-372Digital Signal Processing CP-374Wireless Communications CP-376VHDL  
CP-378Neural Networks Program Elective III Program Elective IV Program Elective V  
CP-471Computer Graphics CP-481Advances in Compiler Design  
CP-491Cryptography CP-473Speech Recognition CP-483Natural Language  
Processing CP-493Embedded Systems CP-475Mobile Computing  
CP-485Programming Paradigms CP-495Data Mining CP-477Software Project  
Management CP-487 CP-497VLSI Algorithms CP-479Data Compression CP-489Real

Time Systems Program Elective VI Program Elective VII CP-470Network Security CP-480Evolving Architectures CP-472Biometrics CP-482Topics in Advanced Computing CP-474High Level Synthesis of Digital Systems CP-484Software Testing and Validation CP-476Selected Topics in Cryptography CP-486Machine Learning CP-478Digital Image Processing CP-488Wireless & Ad-hoc Networks Modelling and Simulation B.Tech (Computer Engineering) Semester III HF-201 Humanities and Social Sciences (X-X-X)2 Please refer to Department of Humanities and Social Sciences. CP-221 Logic System Design (3-0-0)3 Introduction to Boolean algebra : Binary connectives, Evaluation of truth functions, Truth – function calculus as Boolean Algebra, Duality, Fundamental theorems of Boolean Algebra and simplification of Boolean expressions. Realisation of Logic Circuits : Standard forms of Boolean Functions, Minterm and Maxterm, designation of functions. Simplification of functions on Karnaugh maps, incompletely specified functions. Combinational circuits : Adder, subtract, encoder, decoder, multiplexer, demultiplexer, parity checker and generator.Cubical representation of Boolean functions and determination of prime implicants. Selection of an optimal set of prime implicants, multiple output circuits and map minimization of multiple output circuits. Tabular determination of multiple output prime implicants. Latches, Flip Flops : JK, SR, D Type and T type Flip Flops and their working principals. Counters and shift registers: Ripple, decade, up-down counters, Mod-n counters and series, parallel registers. General characteristic of sequential circuits, clock, pulse and level mode sequential circuits. Analysis and design of sequential circuit. Synthesis of state diagrams, finite memory circuits, equivalence relations, equivalent states and circuits, determination of classes of in distinguishable states and simplification by implicant tables. Mealy and Moore machines, state assignment and memory element input equation, Partitioning and state assignment. General pulse-mode circuits, clock input counters, extended state tables. Asynchronous Mode Circuits : Analysis of a fundamental mode circuits, Synthesis of flow tables, minimization, transition tables, excitation maps and output maps, Cycles and Races, Race free assignments, Hazards in sequential circuits. Introduction to A/D and D/A converters. Text/References: 1.Digital Systems and Hardware and Firmware Algorithms: M.Ercegovac and T. Lang, Pearson. 2.Morris-Mano : Logic System and Design, McGraw Hill 3.Hill & Peterson: Switching Theory and Logic Design, John Wiley 4.J.F.Wakerly: Digital Design, Principle and Practices, Pearson. 5.Malvino leech: Digital Electronics CP-223 Data Structures (3-0-0)3 Introduction to Data structures. Arrays: Representation – row-major, column-major, sparse matrix –implementation, addition, multiplication; polynomial – Representation, addition, evaluation and multiplication. Strings: Representation, operations, string matching - Brute force or naïve, Robin-Karp, Knuth-Morris- Pratt. Linked List: Static and dynamic implementation, single, double, circular, multiple linked list. Stack: Static and dynamic implementation, expression evaluation, prefix (polish), infix, postfix (inverse polish) expressions, application, multiple stacks, recursion. Queues: Static and dynamic implementation, applications, circular queue, multiple queue. Tree: Binary tree, binary search tree, static and dynamic implementation, tree operations - insertion, deletion and search, tree traversal, Binary heaps. Introduction to A VL trees and B trees. Sorting: Insertion sort, selection sort, Bubble sort, quick sort, merge sort, heap-sort,



radix sort (bucket sort). Searching: Linear and binary search, hashing. Graph: Representation of graphs, BFS, DFS, topological sort. Text/References: 1.Aho A.V ., J.E. Hopcroft, J.D. Ullman, Data Structures and algorithms, Addison Wesley. 2.Kruse R.L., Data Structure and Program Design, PHI. 3.Horowitz and Sahni: Data Structure in C++ , Glagotia 4.Ellis Horowitz, Sartaj Sahni, Fundamentals of Data Structures 5.Aaron M. Tenenbaum, Y . Langsam, Moshe J. Augenstein, Data Structures Using C 6.Niklaus Wirth, Algorithms + Data Structures = Programs (Prentice-Hall Series in Automatic Computation) 7.Sartaj Sahni, Data Structures, Algorithms, and Applications in C++ 8.Mark Allen Weiss, Data Structures and Algorithm Analysis in C++ (2nd Edition) CP-225 Probability and Statistics (3-0-0)3 Probability Theorem : Properties of probability, Conditional probability, Independence, Bayes theorem Discrete Distributions : Probability distribution functions and cumulative distribution functions Mean and variance; moment-generating functions, Marginal and conditional probability distributions, Some specific discrete distributions Continuous Distributions : Probability density functions and cumulative distribution functions, Mean and variance; moment generating functions, Marginal and conditional probability distributions, Some specific continuous distributions Functions of Random Variables : Distribution function technique, Transformation technique, Moment- generating function techniques Text/References: 1.DeGroot, Morris H., and Mark J. Schervish. Probability and Statistics. 3rd ed. Boston, MA: Addison-Wesley, 2002. ISBN: 0201524880. 2.Feller, William. An Introduction to Probability Theory and Its Applications. 3rd ed., rev. printing. New York, NY: Wiley, 1968. ISBN: 0471257087. 3.Freund, W.J., Mathematical Statistics, 5th Ed., Prentice-Hall, Inc., Englewood Cliffs, N.J., 1994. 4.Hoel, P.G., Mathematical Statistics, 5th Ed., John Wiley & Sons, Inc., New York, 1984. 5.Hogg, R.V ., & Craig, A.T., Introduction to Mathematical Statistics, 5th Ed.,Prentice-Hall, Inc., Englewood Cliffs, N.J., 1995. 6.Mood, A.M., Graybill, F.A., Boes, D.C., Introduction to the Theory of Statistics, 3rd Ed. McGraw Hill, Inc., New York, 1974. CP-227 Abstract Algebra (3-0-0)3 Number Systems: Natural numbers. Counting. Cardinality of finite sets. Laws, Mathematical induction. Prime numbers. Fundamental theorem of arithmetic. Well-ordering principle. Number bases. Modulo arithmetic. Greatest Common Divisor, Euler's extended algorithm, Chinese Remainder Theorem, Primality testing, Integers. Laws of arithmetic. Integer powers and logarithms. Recurrence relations. Number sieves. Group Theory: Groups, Semi groups and Monoids, Cyclic semi groups and sub monoids, Subgroups and cosets, Congruence relations on Semi groups, Factor groups and homomorphisms, Morphisms Normal sub groups. Structure of cyclic groups, Permutation groups, dihedral groups, Sylow theorems, abelian groups; solvable groups, Nilpotent groups; groups of small order, elementary applications in coding theory. Rings: Rings, Subrings, Morphism of rings, ideal and quotient rings, Euclidean domains, Commutative rings; integral domains, noncommutative examples, Structure of Noncommutative Rings, Ideal Theory of Commutative Rings Field Theory: Integral domains and Fields, polynomial representation of binary number, Galois fields, primitive roots, discrete logarithms, split search algorithm. Modules: Sums and products; chain conditions, Composition series; tensor products. Text/ References: 1.John Fraleigh. First Course in Abstract Algebra , Pearson Education. 2.Michael

Artin. Algebra, Pearson Education. 3. John A. Beachy and William D. Blair. Abstract Algebra, Second Edition, Waveland Press. 4. John A. Beachy. Abstract Algebra II, Cambridge University Press, London Mathematical Society Student Texts #47, 1999.

CP-251 LSD Lab (0-0-3)<sup>2</sup> The following proposed coverage are broad guiding areas lab. The instructor offering the course in consultation with the theory offered can adopt further variations in tune with CP-221.

1. Truth table verification – NAND gate, NOR gate, OR gate, AND gate, NOT gate.
2. Verifying if NAND gate is a universal gate.
3. Constructing XOR gate using NOR gate only.
4. Realizing given truth table using SOP form.
5. Realizing given truth table using POS form.
6. Design of combinational circuits – half adder, full adder, multiplier.
7. Design of binary-gray encoder.
8. Design of parity generator and detector.
9. Design of one bit error detecting and correcting circuit.
10. Design of flip flops – RS, JK, D and T flip flops.
11. Design of sequential circuits – counters.

Text/References: 1. Digital Systems and Hardware and Firmware Algorithms: M. Ercegovic and T. Lang, Pearson. 2. Morris-Mano : Logic System and Design, Mc Graw Hill 3. Hill & Peterson: Switching Theory and Logic Design, John Wiley 4. J.F. Wakerly: Digital Design, Principle and Practices, Pearson. 5. Malvino leech: Digital Electronics

CP-253 Data Structure Lab (0-0-3)<sup>2</sup> The following proposed coverage are broad guiding areas lab. The instructor offering the course in consultation with the theory offered can adopt further variations in tune with CP-223.

Programs in C or C++ for following:

1. Sorting programs: Bubble sort, Merge sort, Insertion sort, Selection sort, and Quick sort.
2. Searching programs: Linear Search, Binary Search.
3. Array implementation of Stack, Queue, Circular Queue, Linked List.
4. Implementation of Stack, Queue, Circular Queue, dynamic memory allocation.
5. Infix to postfix (prefix) conversion.
6. Program for expression evaluation.
7. Implementation of Binary tree. Program for Tree Traversals (preorder, inorder, postorder).
8. Program for graph traversal (BFS, DFS).
9. Program for minimum cost spanning tree, shortest path.

Text/References: 1. Aho A.V ., J.E. Hopcroft, J.D. Ullman, Data Structures and algorithms, Addison Wesley. 2. Kruse R.L., Data Structure and Program Design, PHI. 3. Horowitz and Sahni: Data Structure in C++ , Glagotia 4. Ellis Horowitz, Sartaj Sahni, Fundamentals of Data Structures 5. Aaron M. Tenenbaum, Y . Langsam, Moshe J. Augenstein, Data Structures Using C 6. Niklaus Wirth, Algorithms + Data Structures = Programs (Prentice-Hall Series in Automatic Computation) 7. Sartaj Sahni, Data Structures, Algorithms, and Applications in C++ 8. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++ (2nd Edition)

Open Elective I (X-X-X)<sup>3/4</sup> Please refer to concerned Department.

B.Tech (Computer Engineering) Semester IV CP-222 Data Base Management System (3-0-0)<sup>3</sup> Need, purpose and goal of DBMS, Three tier architecture, ER Diagram, data models- Relational, Network, Hierarchical and Object Oriented. Data Base Design: Conceptual data base design, Theory of Normalization Primitive and Composite data types, concept of physical and logical databases, data abstraction and data independence, data aggregation, Relational Calculus. SQL : DDL and DML, Relational Algebra. Application Development using SQL : Host Language interface, embedded SQL programming, Stored procedures and triggers and views, Constraints assertions. Internal of RDBMS : Physical data organisation in sequential, indexed random and hashed files. Inverted and multilist structures, B trees, B+ trees, Query Optimisation,

Join Algorithm, Statistics and Cost Base optimisation. Transaction Processing, concurrency control, and recovery management. Transaction model properties and state serialisability . Lock base protocols, two phase locking. Text/References: 1.H.f. Korth and Silberschatz: Database Systems Concepts , McGraw Hill 2.Almasri and S.B. Navathe: Fundamentals of Database Systems , 3.C.J. Date: Data Base Design, Addison Wesley 4.Hansen and Hansen : DBM and Design, PHI CP-224

Microprocessor and Microcontrollers (3-0-0)3 Introduction to 8085 microprocessor: CPU Architecture, CPU Specifications, CPU Pin Description, System Timing Diagrams, Instructions, Interrupts etc. Introduction to 8086/88 microprocessor: CPU Architecture, 8086 CPU Specifications, CPU Pin Description, System Timing Diagrams, Bus Standards, 8086 Address & Data Buses, Segmentation and Paging, Addressing Modes, Accessing Memory, RAM & Direct Memory Access, Memory Mapped I/O, Processor Registers, Data Organization. Software Architecture: Introduction to Assembly Language Programming, Instruction and timing: instruction classification, instruction formats, addressing modes, instruction timings and status, interrupts. I/O System Design: 8255 Programmable Peripheral Interface, 8259 Programmable Interrupt Controller, Direct Memory Access: basic concepts of DMA techniques, Description and interfacing of DMA controller 8257. Introduction to Microcontrollers. Text/References: 1.Douglas V . Hall : Microprocessors and Interfacing, McGraw Hill 2.Gaonkar ; 8085 Architecture, Programming and interfaces, Penram Press 3.John Uffenbeck : The 8086/8088 Family -Design, Programming & Interfacing, Prentice Hall of India Private Limited. 4.Brey : Intel Microprocessor, The 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium & Pentium Pro Processor: Architecture, Programming, and Interfacing, PHI. CP-226 Computer Architecture (3-0-0)3 Introduction to computer architecture and organization: Digital components, Von Neumann Machine Architecture, Flynn Classification Register Transfer Language : Micro operations - data transfer operations, arithmetic, logic and shift micro operations and their hardware implementations as a simple Arithmetic and logic unit. CPU Organization: Addressing techniques - Immediate, direct, indirect, register, register indirect, index, relative and stack addressing techniques. Instruction formats : Instruction set design, Instruction types: example for zero address, one address, two address and three address machines, Stack, accumulator and general purpose register organization Arithmetic Algorithms : Arithmetic and Logic Unit, Adders - Full adder, Ripple carry adder, Carry look ahead adder, Carry select adder, carry save adder, Multiplication - Add and Shift method, Booth's Multiplier, m -Array Multiplier, Division - Restoring and Non restoring method. Pipelining: Pipeline structure, pipeline performance measures, Pipeline types - Instruction and Arithmetic pipelines. Memory Organization: Memory device characteristics, RAM organization: 1D and 2D organization, Virtual memory - Paging and Segmentation, High speed memories: Associative and Cache memory Control Unit Design, Hardwired and Micro programmed control unit design implementation techniques. Memory hierarchies. Input-Output Design: IO interface, Bus structure, Modes of data transfer, Interrupts, Input Output Processor, Serial Communication Text/References: 1. Computer Architecture: A Quantitative Approach, J.L. Hennessy and D.A. Patterson, 4th Edition Elsevier. CP-228 Theory of Computation (3-1-0)4 Introduction to automata theory,

formal languages, recursive definitions, regular expressions, finite automata, transition graphs and Kleen's theorem. Non-determination, finite automata with output, regular languages, minimization of finite automata, pumping lemma for regular languages. Chomsky classification of languages, regular grammars, context free grammars, simplification of context free grammars, Normal forms of context free grammars. Push Down Automata Theory: push down automata and languages, push down automata and context free grammars, pumping lemma for context free languages. Turing hypothesis, Turing machine, Minsky's theorem, TM variation and encoding, Post machines, computability and acceptability. Elements of propositional logic and predicate calculus. Text/ References: 1.Hopcroft, Motwani and Ullman: Introduction to Automata Theory, Languages and Computation , Pearson Education. 2.Cohen: Introduction to Computer Theory , Addison Wesley. 3.Martin: Introduction to Languages and Theory of Computation, TMH. 4.Papadimitriou, Introduction to Theory of Computing , Prentice Hall. 5.K.Krishnamurthy: Theory of Computation .

CP-252 DBMS Lab (0-0-3)2 The following proposed coverage are broad guiding areas lab. The instructor offering the course in consultation with the theory offered can adopt further variations in tune with CP-222. 1. Conceptual designs using ER diagrams. 2. Design of databases. Based on templates, files and relational basis. 3. Development and implementation of DB system from the fundamentals. 4. Experiments on SQL queries. CP-254 Assembly Language Programming Lab (0-0-3)2GS The following proposed coverage are broad guiding areas lab. The instructor offering the course in consultation with the theory offered can adopt further variations in tune with CP-224. Programming the 8085: 8085 instruction set, data transfer instruction, arithmetic, logic & branch operations. Rotate and compare. Instruction related to stack operations. Programming Techniques: looping, counting and indexing, counters and time delays, subroutines. Interfacing microprocessors with the additional devices like ADC/DAC and plotting them onto CRO. Programming the 8086: Instruction types: Data Transfer, String, Arithmetic, Logical, Bit Manipulation, Program Transfer and Processor Control, the Processor Flags. Interfacing microprocessors with the additional devices like ADC/DAC and plotting them onto CRO. Stepper motor controller and PPI usages. Text/References: 1.Gaonkar ; 8085 Architecture, Programming and interfaces, Penram Press 2.John Uffenbeck : The 8086/8088 Family -Design, Programming & Interfacing, Prentice Hall of India Private Limited. Open Elective II (X-X-X)3/4 Please refer to concerned Department. B.Tech (Computer Engineering) Semester V CP-321 Operating System (3-0-0)3 Introduction: Need of Operating System, its evolution, types of operating systems, batch, multiprogramming, time sharing systems, real time systems. Processes and processor management : process concept, systems programmers view of processes, operating systems view of processes, Process scheduling, Schedulers, interprocess communication and synchronization, race condition, mutual exclusion, semaphores, monitors, messages. Deadlocks prevention , avoidance, detection and recovery. Memory Management : Contiguous allocation-partitioned memory allocation – fixed and variable partitioning, memory management with bit maps – swapping – relocation- protection and sharing. Non contiguous allocation – Paging – principles , page allocation, segmentation. Virtual memory concepts, address translation, management of virtual memory, page replacement

policies, protection and sharing, working set model, hardware support. File management: Command language users view of file system, file system design, disk space management directory structure, shared files, file system performance. File servers, security, protection mechanism. Input/Output Management : Device drivers, disk scheduling. Introduction to loaders, linkers and relocating loaders. Case study: UNIX/LINUX, Windows. Text/References: 1.Abraham Silberschatz, Peter B. Galvin, Greg Gagne, Operating System Concepts. Sixth edition. Addison-Wesley (2003). 2.Andrew Tanenbaum, Modern Operating Systems, Prentice Hall. 3.William Stallings, Operating Systems, Prentice Hall. 4.Andrew Tanenbaum & Albert Woodhull, Operating Systems: Design and Implementation. Prentice-Hall. 5.Harvey M. Deitel, An introduction to operating systems. Addison-Wesley. CP-323 Compiler Design (3-0-0)3

Translators: Introduction to compilers, translators, and interpreters, compilation process. Lexical Analysis: Finite automata, Regular expressions, Design & implementation of lexical analysers. Syntax Analysis: Context Free Grammars, Derivation and Parse trees, Bottom-up and Top-down Parsing. Ambiguity, Shift Reduce Parser, Operator Precedence Parser, Predictive Parsers, canonical collection of items, LR parsers. Syntax directed translation: Syntax directed translation, Attributes, Intermediate codes, Three address codes. Symbol table organization: Hashing, linked list, tree structures. Memory allocation: Static and dynamic structure allocation. Code optimization: Basic blocks, Flow graphs, DAG, Global data flow analysis – ud-chaining, available expressions, Loop optimization. Code generation: Compilation of expression and control structures. Error detection and recovery. Text/References: 1.Aho, Ullman and Sethi: Compilers – Principles, techniques and tools, Pearson Education. 2.Tremblay, Sorenson: The Theory and Practice of Compiler Writing, BSP. 3.Holub, Compiler Design in C, PHI. CP-325 Computer Network (3-0-0)3

1.Computer network architecture, Physical layer: Hardware, topology, data encoding, 2.Data Link Layer: Logical link Control: Error detection and Correction, ARQ protocols, Framing protocols( HDLC, LLC) Medium Access Control: Multiple access protocols, Channel Allocation, contention, reservation, round robin with Examples. 3.Network Inter connection: Generic switches, switch design issues, switching mechanism : virtual Circuit switching, datagram switching, source route switching, Bridge and bridge learning , Global Addressing scheme, fragmentation and reassembly, Address translation: ARP, RARP, ICMP, IP Scalability Issues, sub netting and super netting (CIDR) , IP Routing, EGP, BGP protocols 4.End to End protocols: End to end issues, UDP and TCP segment formats, connection establishment and termination, state transition sliding window protocol, TCP Flow control, Silly window syndrome, TCP retransmission, RTT Estimation, TCP Congestion Control and congestion avoidance protocols 5.Internet applications : Client server paradigm, DNS, SMTP, RPC, NFS and General network security issues. Text/References: 1.Data Networks: Bertsekas and Gallager, Phi. 2.Computer Networking A Top down Approach: J.F.Kurose, Pearson. 3.Computer Networks A Systems Approach: L. Peterson and B. Davie, Elsevier 4.Computer Networks and Internet: D.E. Comer, Pearson CP-351 OS Lab (0-0-3)2

The following proposed coverage are broad guiding areas lab. The instructor offering the course in consultation with the theory offered can adopt further variations in tune with CP-321. 1.Simple Unix-C programs: Programs

using system calls, library function calls to display and write strings 2.Concurrent Programming concepts using fork, semaphore and pipes. 3.Programs for error reporting using `errno`,`perror()` function. 4.Programs to simulate process scheduling like FCFS,shortest Jobs First and Round Robin. 5.Programs to simulate page replacement algorithms like FIFO, Optimal and LRU. 6.Programs to simulate Free space management. 7.Programs to simulate virtual memory. 8.Programs to simulate deadlock detection. 9.Any other as per curriculum. Text/References: 1.Unix concepts and applicaions by Sumitbha Das,TMH applications. 2.Unix Programming by stevens, Pearsons Education. 3.Shell Programming by Yashwant Kanetkar. 4.Operating System concepts by silberschatz, and Peter Galvin. CP-353 System Programming Lab (0-0-3)2 The following proposed coverage are broad guiding areas lab. The instructor offering the course in consultation with the theory offered can adopt further variations. Programming exercises to implement typical lexical analyzers, parsers, intermediate code generation. Assignments using LEX and YACC tools. Programming exercises to implement assemblers, editors, debuggers etc. Text/References: 1.Aho, Ullman and Sethi: Compilers, Pearson Education. 2.Levine, Mason and Brown: Lex and Yacc, O'Reilly. CP-355 Network Programming Lab (0-0-3) 2 The following proposed coverage are broad guiding areas lab. The instructor offering the course in consultation with the theory offered can adopt further variations in tune with CP-325. 1.Programming for data encoding, CRC detection and Correction. 2.Estimation of network delay through OS utilities. 3.Simulation and Emulation of Bus and Star topology, DLC, MAC protocols using Benchmark LAN trainer kits. 4.Packet measurement and observation using network sniffing tools. 5.Use of sniffers for protocol dynamics. 6.Introduction to Socket programming and application development for internet. Text/References: 1. Computer Networks and Internet: D.E. Comer, Pearson 2. TCP/IP Illustrated, W. Stevens, V ol 1-2, Pearson Eds. Program Elective I (3-0-2)4 One/More of the following courses as offered by Department. CP-371 Object Oriented Programming CP-373 Logical and Functional Programming CP-375 Programming in Java CP-377 Concurrent Programming Open Elective III (X-X-X)3/4 Please refer to concerned Department. B.Tech (Computer Engineering) Semester VI CP-322 Software Engg. (3-0-0)3 Introductory Concepts : Historical perspective, System Definition, Software Life Cycle, Software Engineering paradigms. System analysis: Feasibility study requirement analysis, Cost benefit analysis, Planning systems, Analysis tools and techniques. System Design: design fundamentals, Modular Design, Data and procedural design, object oriented design. System Development : Code documentation, Program design paradigms. Verification, Validation and Testing: testing methods, Formal Program Verification, Testing Strategies. Software Maintenance : Maintenance Characteristics, Maintainability, Maintenance tasks and side effects. Text/References: 1.Pressman R.S: Software Engineering: A Practitioner approach, McGraw Hill. 2.Sommerville I: Software Engineering, Addison Wesley 3.Ghezzi C. Jazayeri M and Mandrioli: Fundamentals of Software Engg. , PHI. CP-324 Design and Analysis of Algorithms (3-0-0)3 Algorithm Analysis : Asymptotic notation, solution of recurrence, model of computation, time and space complexities, average and worst case analysis, Amortized analysis. Algorithm Design Techniques : Greedy algorithm, dynamic programming, divide and conquer,

backtracking, branch and bound. Graph Algorithms: Shortest path algorithms, Disjoint set operations, minimum spanning tree algorithm, network flow, matching, coverings, applications of DFS:- bi-connectivity, Euler circuits, strongly connected components, topological sort, and articulation point. Dynamic Programming : Chained matrix multiplication, longest common subsequence. Divide and Conquer : Order Statistics – finding the median, exponentiation, matrix multiplication, LCS. Computational Geometry: Line segments, Optimal polygon triangulation. Approximate Algorithm : Travelling Salesman Problem, vertex-cover problem. Primality testing, Integer factorization, Randomized algorithms, Probabilistic algorithms. String Matching algorithms : Rabin Karp, KMP, Boyer Moore. Matrix Algorithms – Strassen Matrix multiplication, LUP decomposition. Construction of codes: Shannon Fano and Huffman codes. Introduction to problem classes – NP, NPC, NP-Hard.

Text/References: 1.Cormen, Leiserson, Rivest: Introduction to Algorithms , Prentice Hall of India. 2.Horowitz and Sahani: Fundamental of Computer algorithms . 3.Aho A.V , J.D Ulman: Design and analysis of Algorithms , Addison Wesley 4.Brassard : Fundamental of Algorithmics , PHI. 5.W.W. Peterson and E. J. Weldon: Error correcting codes . 6.Sara Baase, Allen Van Gelder: Computer Algorithms: Introduction to Design and Analysis , Pearson Education. CP-352 Algorithms Lab (0-0-3)2 The following proposed coverage are broad guiding areas lab. The instructor offering the course in consultation with the theory offered can adopt further variations.

- 1.Implementation of graph algorithms – DFS, Shortest Path, MST, articulation point, topological sorting.
- 2.Implementation of Network Flow, matching, covering.
- 3.Implementation of pattern matching algorithms.
- 4.Determination of kth shortest number in a given sequence.
- 5.Dynamic programming – Applications to problem solving.
- 6.Approximation algorithms for NP problems.
- 7.Randomized algorithms implementation.

Text/References: 1.Cormen, Leiserson, Rivest: Introduction to Algorithms , Prentice Hall of India. 2.Horowitz and Sahani: Fundamental of Computer algorithms . 3.Aho A.V , J.D Ulman: Design and analysis of Algorithms , Addison Wesley 4.Brassard : Fundamental of Algorithmics , PHI. 5.W.W. Peterson and E. J. Weldon: Error correcting codes . 6.Sara Baase, Allen Van Gelder: Computer Algorithms: Introduction to Design and Analysis , Pearson Education. CP-354 Seminar (0-2-0)2 The topics selection covering the latest and relevant topics related to the emerging areas. Ideally, some recent reputed journal papers abstraction and presentation shall be encouraged for presentation. The evaluation shall be continuous and through components evaluation viz. content, coverage, depth, presentation, response to the queries, and seminar report. In case of unsatisfactory performance, an X grade can be awarded for extension work during summer term. Program Elective II (3-0-2)4 One/More of the following courses as offered by Department. CP-372 Digital Signal Processing CP-374 Wireless Communications CP-376 VHDL CP-378 Neural Networks Open Elective IV (X-X-X)3/4 Please refer to concerned Department. Open Elective V (X-X-X)3/4 Please refer to concerned Department. B.Tech (Computer Engineering) Semester VII CP-451 Industrial Training (0-2-0)2 The evaluation shall be continuous and through components evaluation viz. content, coverage, depth, presentation, demonstration, response to the queries, and training report. In case of unsatisfactory performance, and failure extra credit course from the department

equivalent to CP-451 can be permitted through consent of DUGC. CP-453 Free and Open Source Lab (0-0-3)<sup>2</sup> The following proposed coverage are broad guiding areas lab. The instructor offering the course in consultation with the theory offered can adopt further variations. 1.Linux basics and installation and management of the Linux. 2.Different types of software development environment (Eclipse) 3.make and other software construction utilities on Linux. 4.Version control and managing project in open source. 5.Managing large software development through wiki or alike project management tools. 6.Introduction to scripting for system management. Program Elective III (3-0-2)<sup>4</sup> One/More of the following courses as offered by Department. CP-471 Computer Graphics CP-473 Speech Recognition CP-475 Mobile Computing CP-477 Software Project Management CP-479 Data Compression Program Elective IV (3-0-2)<sup>4</sup> One/More of the following courses as offered by Department. CP-481 Advances in Compiler Design CP-483 Natural Language Processing CP-485 Programming Paradigms CP-487 Wireless and Ad hoc Networks CP-489 Real Time Systems Program Elective V (3-0-2)<sup>4</sup> One/More of the following courses as offered by Department. CP-491 Cryptography CP-493 Embedded Systems CP-495 Data Mining CP-497 VLSI Algorithms CP-455 Project Lab (0-2-3)<sup>5</sup> Objective of this elective is to facilitate transfer of knowledge acquired by a student to a field of his own choice for application to solving a problem. Student is expected to collect and study relevant material under mentorship of a faculty member working in similar area; identify a suitable problem and propose methodology towards its solution. Alternately a student can explore hardware implementation of existing solution(s). This elective shall act as prequel to project work for next semester. The project coordinator(s) from the department for continuity shall coordinate this course. Grouping and division shall be applicable as defined in the major project of final semester. Open Elective VI (X-X-X)<sup>3/4</sup> Please refer to concerned Department. B.Tech (Computer Engineering) Semester VIII CP-452 Major Project (0-10-0)<sup>10</sup> The major project covers lab component of the final semester work. The evaluation of project shall be continuous and will be done through project coordinator(s). The evaluation mechanism shall be evolved based on the existing practices through DUGC rectified from time to time. Ideally the project should comprise with group size of two students shall be limited to maximum 4 students and the groups shall be evenly distributed among faculty through coordinator(s). Internal and external components shall not exceed 40% each of the overall marks. CP-454 Group Discussions (0-0-3)<sup>2</sup> This lab will remain only if Industrial training is given weightage of 02 credits. Program Elective VI (3-0-2)<sup>4</sup> One/More of the following courses as offered by Department. CP-470 Network Security CP-472 Biometrics CP-474 High Level Synthesis of Digital Systems CP-476 Selected Topics in Cryptography CP-478 Digital Image Processing Program Elective VII (3-0-2)<sup>4</sup> One/More of the following courses as offered by Department. CP-480 Evolving Architectures CP-482 Topics in Advanced Computing CP-484 Software Testing and Validation CP-486 Machine Learning CP-488 Modeling and Simulation Open Elective VII (X-X-X)<sup>3/4</sup> Please refer to concerned Department. Program Elective I (Semester V) CP-371 Object Oriented Programming (3-0-2)<sup>4</sup> Object Oriented Programming and Design : Review of abstraction, objects and other basics, Encapsulation, Information hiding, method, Signature, Classes and Instances,



Polymorphism and inheritance. C++ Programming Basics : Fundamentals, variables and assignments, Input and Output, Data types and expressions, flow of control, subprograms, top-down design, predefined functions, user defined functions, procedural abstractions, local variables, overloading function names, operator overloading, parameter passing, this pointer, destructors, copy constructor, overloading the assignment operator, virtual functions, function calling functions, friend functions, recursive functions, recursive member functions. Static member function. C++ Object oriented concepts : Objects and classes, use of file for I/O, formatting output with stream functions, Character I/O, inheritance, structures for diverse data, structures as function arguments, initializing structures, defining classes and member functions, public and private members, constructors for initialization, standard C++ classes, derived classes, flow of control, use of Boolean expressions, multiway branches, use and design of loops. Friend function and friend class. C++ Data structures and Advanced Topics : Arrays – programming with arrays, arrays of classes, arrays as function arguments, strings, Multidimensional arrays, Arrays of strings, pointers Dynamic arrays, Classes and dynamic arrays, Base classes, access control, Templates- generic classes and functions, namespaces. Standard Template Library. Text/References: 1.Balaguruswamy: Object-oriented Programming with C++. 2.Robert Lafore: C++ Programming 3.Ashok N. Kamthane : Object Oriented with C++, Pearson Education CP-373 Logical and Functional Programming (3-0-2)4 Introduction to logic programming, Prolog - Lists, cut operator, and sorting, Data structures, text strings, operators - extensions of SWI Prolog, Searching state space, clause management, and parsing in Prolog Introduction to functional programming, lambda calculus, Programming language Haskell - introduction, lists, User-defined data types, type classes, and arrays in Haskell. Input/Output in Haskell - type classes IO and Monad, Simple applications/programs in Haskell. Text/References: 1.Nilsson, Maluszynski: Logic, Programming and Prolog, John Wiley. 2.Thompson: Haskell, The Craft of Functional Programming, Addison-Wesley. CP-375 Programming in Java (3-0-2)4 Introduction: Internet, Java as a tool for internet applications, Byte Code and its advantages. Object Oriented Programming and Design: Review of Abstraction, Objects and other basics, Encapsulation, Information hiding, Method, Signature, Classes and Instances, Polymorphism, Inheritance, Exceptions and Exception Handling with reference to object modeling, Coupling and Cohesion in object oriented software. Object Oriented Design – Process, Exploration and Analysis. Java Programming Basics: Fundamentals: Variables and assignments, Input and Output, Data Types and Expressions, Flow of control, Local variables, Overloading Parameter passing, this pointer, Java Object Oriented Concepts: Objects and Classes: Use of file for I/O, Formatting output with stream functions, Character I/O, Inheritance, Public and private members, Constructors for initializations, Derived classes, Flow of Control Java Data Structures and Advanced Topics Arrays – Programming with arrays, arrays of classes, arrays as function arguments, Strings, Multidimensional arrays, Arrays of strings, vectors, Base classes. Introduction to Java Applets Text/References: 1.Herbert Schildt: JA V A 2 - The Complete Reference, TMH, Delhi 2.U.K. Chakraborty and D.G. Dastidar: Software and Systems - An Introduction, Wheeler Publishing, Delhi. 3.Joseph O'Neil and Herb Schildt: Teach Yourself JA VA, TMH,

Delhi. CP-377 Concurrent Programming (3-0-2)4 Concurrent versus sequential programming. Concurrent programming constructs and race condition. Synchronisation primitives. Processes and threads. Interprocess communication. Livelock and deadlocks, starvation, and deadlock prevention. Issues and challenges in concurrent programming paradigm and current trends. Text/References: 1.Mordechai Ben-Ari. Principles of Concurrent and Distributed Programming , Prentice-Hall International. 2.Greg Andrews. Concurrent Programming: Principles and Practice , Addison Wesley. 3.Gadi Taubenfeld. Synchronization Algorithms and Concurrent Programming, Pearson. 4.M. Ben-Ari. Principles of Concurrent Programming, Prentice Hall. 5.Fred B. Schneider. On Concurrent Programming, Springer. 6.Brinch Hansen. The Origins of Concurrent Programming: From Semaphores to Remote Procedure Calls, Program Elective II (Semester VI) CP-372 Digital Signal Processing (3-0-2)4 Introduction to Continuous time Systems ,idea about Linear Time Invariant System LTI systems. Fourier Transforms. Discrete Time Systems: Sampling and aliasing, LTIs , Representation of Sequences by Fourier Transform and properties of Fourier Transform. Z-Transform, Structures for discrete system, DFT, Computation of DFT. FIR Filters, frequency response of FIR filters. IIR Filters, spectrum analysis. FFT Algorithms Text/References: 1.Discrete Time Signal Processing by Alan V Oppenheim, Ronald W Schafer.- PHI 2.Digital Signal Processing Primer : K.Steiglitz, Pearson. 3.Signal and Systems: S.Haykin and Veen, Wiley 4.DSP First: A Multimedia Approach : J.F.McClellan, Schafer and Yodar, Pearson. CP-374 Wireless Communications (3-0-2)4 History of wireless communication, and future trends. Wireless Generations and Standards. Cellular Concept and Cellular System Fundamentals .Trunking Cell Splitting and Sectoring. Mobile Radio signal propagation, path loss and channel models. Large Scale Path Loss. Small Scale Path Loss - Rayleigh and Rician Fading. Analog Modulation Schemes for Wireless Communication - AM/FM. Digital Modulation Techniques for Wireless Communication Preliminaries. Baseband Modulation Schemes Bandpass Modulation Techniques. Fading Counteraction – Diversity, Coding and Interleaving. Source and Channel Coding. Speech Coding for Wireless Communications. Adaptive Equalization. Multipath Propagation, Doppler. Multiplexing and Multiple Access techniques. TDMA, FDMA , ALOHA - Packet Radio, Spread Spectrum-CDMA ,Frequency Hopped Spread Spectrum, Inter-Symbol Interference (ISI) , ISI mitigation; Equalization, Random Access Protocols. Wireless Networking, Wireless Standard. Third generation systems and advanced topics Wideband-CDMA, MCCDMA. OFDM principles: Comparison of OFDM and CDMA. WLAN and Bluetooth. Text/References: 1.Wireless Communications: Principles and Practice, 2nd edition, T. Rappaport, Prentice Hall, 2002 2.K. Pahlavan & P. Krishnamurthy, Principles of Wireless Networks, Prentice Hall: 3.Wireless Communications Systems, A. Goldsmith, Cambridge, 2005 4. CP-376 VHDL (3-0-2)4 1.Overview of VHDL, fundamentals of VHDL, Lexical elements Data types and objects 2. Data Flow style: Conditional and selected Concurrent assignment, block assignment If and wait statement, Design for synthesizability 3.Structural style: Instantiation and component declaration, statement configuration declaration, generate statement, examples of structural design 4.Behavioural Style : Signal assignment, statement like case, process and wait loop,

exit etc., concurrent signal assignment statements, function and procedures, file I/O operations and Testbenches. Text/References: 1. Peter J. Ashenden, "The Designer's Guide to VHDL", published by Morgan Kaufmann" Kaufmann Pub. 1.SS Limalaye," Digital Design with VHDL", CMR 2.Douglas Parry, "VHDL Programming by Example", MGH 3.Xilinx, "Programmable Logic Design Quick Start Hand Book II ed. 4.Xilinx," A CPLD VHDL Introduction Application Notes" CP-378 Neural Networks (3-0-2)4 Neural Architecture : Neuron model, transfer function, hamming and Hopfield network, perceptron, learning rule, recurrent networks. Back propagation: generalized delta rule, limitations, modifications – momentum, variable learning rate, conjugate gradient. Learning: Supervised, associative, competitive, unsupervised learning. Unsupervised learning : Self-organizing maps, Adaptive Resonance Theory. Neural network applications : Pattern classification, function approximation. Text/References: 1.Simon Haykin: Neural Networks: A Comprehensive Foundation (2nd Edition) 2.Christopher M. Bishop: Neural Networks for Pattern Recognition 3.James A. Freeman, David M. Skapura: Neural Networks, Pearson Education. 4.Martin T. Hagan: Neural Network Design, Thomson Learning. Program Elective III (Semester VII) CP-471 Computer Graphics (3-0-2)4 Introduction to computer graphics : Vector and Raster graphics, Graphic primitives and attributes. Computer graphics devices - CRT, plasma, LCD, plotters, Scan conversion of line, circle and ellipse. Viewing Transformations : Coordinate system - world, device and normalized device coordinates, Window and Viewport and viewing transformations Filling and Clipping - Flood fill and seed fill algorithms and scan line polygon filling algorithms, Cohen Sutherland clipping algorithms for Polygon Geometric transformations - 2D and 3D transformations: Translation, Scaling, rotation, Shearing, reflection etc., Transformations about an arbitrary axis Projections: Parallel - Orthographic, Plans and Elevations, Axonometric - Isometric, Diametric, trimetric, Perspective - One point, two point, three point. Hidden surface removal : Object space and image space algorithms, Back space removal, Z-buffer, scan line, area subdivision, painters, BSP tree, Floating horizon and ray tracing methods Curves: Spline representations, Curve representation techniques, Continuity constraints, Hermite Interpolation, Bezier curves, B-Spline curves Text/References: 1.Foley, Van Dam. Computer Graphics: Principles and Practic. Addison Wesley. 2.Hearn and Baker. Computer Graphics. PHI. 3.Rogers and Adams. Mathematical Elements of Computer Graphics. McGraw Hill. 4.Rogers and Adams. Procedural Elements of Computer Graphics. McGraw Hill. CP-473 Speech Recognition (3-0-2)4 Overview of Speech Recognition; What is Speech; Why is it important; Applications and issues. Speech Production; Mechanism of speech production; Categories of sounds; Sound units in indian languages. Nature of Speech Signal; Source-system characteristics; Segmental and suprasegmental features; Temporal and spectral parameters for sound units in indian languages. Basics of Digital Signal Processing; Signals and systems; Discrete fourier transform; Digital filtering; Stochastic processes. Speech Signal Processing Methods: Short-time spectrum analysis; Spectrograms; Linear prediction analysis; Cepstrum analysis. Speech Recognition; Isolated word recognition; Connected word recognition Continuous Speech Recognition; Speech recognition problem; Hidden markov models. Other Applications: Word spotting; Speaker recognition; Speech

enhancement; Speech synthesis; Practical issues in speech Recognition. Text/References: 1.Spoken Language Processing: A Guide to Theory, Algorithm and System Development by Xuedong Huang, Alex Acero, Hsiao-Wuen Hon, Raj Reddy Prentice Hall PTR; ISBN: 0130226165 2.Speech Communications : Human & Machine by Douglas O'Shaughnessy, IEEE Press, Hardcover 2nd edition, 1999; ISBN: 0780334493. 3.Digital Processing of Speech Signals, Rabiner and Schafer, Prentice Hall, 1978. 4.Fundamentals of Speech Recognition, Rabiner and Juang, Prentice Hall, 1994. 5.Speech and Audio Signal Processing : Processing and Perception of Speech and Music by Nelson Morgan and Ben Gold, July 1999, John Wiley & Sons, ISBN: 0471351547 6.Discrete-Time Speech Signal Processing: Principles and Practice by Thomas F. Quatieri Publisher: Prentice Hall; ISBN: 013242942X; 1st edition (October 29, 2001) 7.Speech Processing and Synthesis Toolboxes by Donald G. Childers, John Wiley & Sons, September 1999; ISBN: 0471349593

CP-475 Mobile Computing (3-0-2)4 Introduction to mobile computing: principles, classification & overview of devices, operating systems. Wireless transmission: brief overview, multipath propagation, hidden & exposed terminals. Medium access control & protocols: SDMA, FDMA, TDMA, DAMA, FAMA, PRMA, Reservation TDMA, polling, CSMA/CA, CDMA etc. Wireless LAN: infrastructure & ad-hoc networks, IEEE 802.11, HIPERLAN. Mobile network layer: mobile IP, DHCP, infrastructure & Ad-hoc routing. Mobile transport layer: indirect TCP, snooping TCP, mobile TCP etc. mobile support, WWW & mobility, WAP. Text/ References: 1.Principles of mobile computing Hansmann & Merk., Springer 2. Mobile communications Jochen Schiller , Pearson 3. 802.11 wireless networks Matthew S.Gast, O'REILLY . 4. Wireless LANs: Davis & McGuffin, McGraw Hill 5. Mobile Communications Handbook by Jerry D. Gybson 6. Mobile Communications Handbook by Raymond Steel

CP-477 Software Project Management (3-0-2)4 Software Project Management Concept: The Management Spectrum, People, Product, Process & Project. Software Process & Project Matrix: Software Measurement, Size Oriented Matrices, Function Oriented Matrices. Software Project Planning: Objectives, Decomposition Techniques and Empirical Estimation Model. Risk Analyses and Management: Risk Identification, Projection, Risk Identification, Projection, Risk Refinement, Risk Monitoring and Management. Project Scheduling & Tracking, Software Quality Assurance, Software Configuration Management. Text/References: 1.R. S. Pressman, Software Engineering 2.P. Jalote, Software Project Management in Practice. 3.B. Hughest & M. Cotterell, Software Project Management. CP-479 Data Compression (3-0-2)4 Compression: Need, Lossless v/s lossy compression, review of information theory, prefix codes, uniquely decodable code. Lossless Compression : Huffman coding – minimum variance, optimal, non-binary, extended, adaptive. Applications and limitations of Huffman codes, Run length encoding, Arithmetic coding, Predictive coding – Burrows-Wheeler transform, Delta modulation, Adaptive delta modulation Dictionary based compression - Lempel-Ziv-Welch, LZ77 and LZ-78 Lossy Compression Techniques – JPEG and its application Error detection and correction : Parity, 1,2,n dimensions, Hamming codes, p-out-of-q codes Quantization: Scalar and Vector Quantization. Texts/References: 1.Khalid Sayood, Introduction to Data Compression, Morgan Kauffman 2.Greg A. Harris, Darrel R. Hankerson, Peter

D. Jr. Johnson, Introduction to Information Theory and Data Compression, Second Edition , Chapman and Hall. 3.Saloman, Data Compression, Springer Verlag. 4.Nelson, The Data Compression book, Hungry Minds Program Elective IV (Semester VII) CP-481 Advances in Compiler Design (3-0-2)4 A Tour of Compiler Design, LR Parsers – SLR parsers, Canonical LR and LALR parsers, Lex and Yacc Tools, Control-flow Analysis, Control-flow Graphs, Basic Blocks, Data-flow Analysis, Dependence Analysis, Global Optimizations, Loop Optimizations, Dominators, Loop-invariant computations, Code motion, Data Dependence Analysis in Loops, Loop Scheduling, Runtime System Architectures and Automatic Memory Management Techniques. Text/References: 1.Aho, Alfred V ., Sethi, Ravi, Ullman, Jeffrey D., Compilers: Principles, Techniques and Tools, Addison-Wesley. 2.Steven Muchnick, Advanced Compiler Design & Implementation, Morgan Kaufmann. 3.Keith Cooper and Linda Torczon, Engineering a Compiler, Morgan Kaufmann. CP-483 Natural Language Processing (3-0-2)4 Introduction; Goals of Natural Language Processing and Computational Linguistics. Finite State Automata and Transducers, Morphology. Parsing: Context Free Grammars, Generalized Phrase Structure Grammar, Earley Parsing ALgorithm. Transformational Grammar, Computational Models and Knowledge Representation. Semantics; Interpretation, time, tense and lexical semantics. Machine Translation, Natural Language Interfaces, Natural Language Generation. Text/References: 1.Allen James, Natural Language Understanding, Second Edition, Benjamin/Cumming, 1995. Grosz, Sparck-Jones Webber 2.Readings in Natural Lnguage Processing, Morgan Kaufmann, 1986. Winograd T. 3.Language as a Cognitive Process, Addison Wesley, 1972. Marcus M. 4.A Theory of Syntactic Recognition for Natural Language, MIT Press, 1980. CP-485 Programming Paradigms (3-0-2)4 Introduction: History of Programming Languages, Syntax and Semantics, Paradigms. Procedure-oriented Programming : Procedures and Modularity, Built-in and User-defined Functions, Scope and Lifetime of Variables, Structures, Recursion, Pointers and Dynamic Memory Allocation. Case Study: C language. Object-Oriented Programming : Objects and Classes, Encapsulation, Information hiding, Method and Signature, Polymorphism and Inheritance. Case Study: C++ language. Aspect-Oriented Programming : Crosscutting concerns, Aspect , Joinpoint and Pointcuts, Advice and static crosscutting. Case Study: AspectJ language. Functional programming: I ntroduction, lists, User-defined data types, type classes, and arrays, Input/Ouput and Monad, Simple applications/programs. Case Study: Haskell language. Text/References: 1.Kerningham and Ritchie: The 'C' programming language, Pearson Education. 2.Robert Lafore: C++ Programming, Sams. 3.Laddad: AspectJ in Action, Dreamtech. 4.Thompson: Haskell, The Craft of Functional Programming, Addison-Wesley. CP-487 Wireless & Ad-hoc Networks (3-0-2)4 Fundamentals of Wireless Communication Technology The Electromagnetic Spectrum – Radio Propagation Mechanisms Characteristics of the Wireless Channel - IEEE 802.11a,b Standard Origin Of Ad hoc: Packet Radio Networks , Technical Challenges, Driving Applications, Components of Packet Radios What Is an Ad Hoc Network? Types of Ad hoc Mobile Communications. Key definitions of ad- hoc, Advantages of ad-hoc/sensor networks, Unique constraints and challenges, Driving Applications, Media Access Control (MAC) Protocols, Issues in designing MAC

protocols, Classifications of MAC protocols, MAC protocols Routing Protocol: Global State Routing (GSR), Dynamic State Routing (DSR), Fisheye State Routing (FSR), Ad hoc On-Demand Distance Vector (AODV), Destination Sequenced Distance – Vector Routing (DSDV). Transport Layer, Security Protocols :Introduction Issues in Designing a Transport Layer Protocol for Ad Hoc Wireless Networks - Design Goals of a Transport Layer Protocol for Ad Hoc Wireless Networks -Classification of Transport Layer Solutions, security in Ad Hoc Wireless Networks – Network Security Requirements - Issues and Challenges in Security Provisioning -Network Security Attacks. Text/References: 1.C. Siva Ram Murthy and B.S. Manoj “Ad Hoc Wireless Networks: Architectures and Protocols”, Prentice Hall PTR,2004 2.C.K. Toh, Ad Hoc Mobile Wireless Networks: Protocols and Systems, Prentice Hall PTR ,2001 Charles E. Perkins, Ad Hoc Networking, Addison Wesley, 2000 3.Wireless Communications: Principles and Practice, 2nd edition, T. Rappaport, Prentice Hall, 2002 4.K. Pahlavan & P. Krishnamurthy, Principles of Wireless Networks, Prentice Hall CP-489 Real Time Systems (3-0-2)4 Introduction to Real-time systems, Issues in Real-time Systems, Real-time System Components, Classification of Real-time systems and Real-time tasks. Misconceptions about Real-time computing. Real-time System requirements: Speed, Predictability, reliability, adaptability. Specification of timing constraints. Real-time scheduling: Requirements and Issues, Terminology, modeling, Introduction static and dynamic scheduling schemes, cyclic scheduling, priority driven scheduling of periodic tasks, schedulability tests, Aperiodic task scheduling: fixed priority server/non-server based scheduling algorithms. Practical factors/overheads. Task Synchronization: Need and priority inversion problem, Priority Inheritance protocol, priority ceiling protocol and stack-based priority ceiling protocol for fixed priority preemptive system. Introduction to multiprocessor real-time systems, problems and issues. An overview of a real-time operating system Text/References: 1.J.W.S.Liu: Real-Time Systems, Pearson Education Asia 2.S.T.Lavi, A.K.Agrawala: Real-time system Design , McGraw Hill 3.P.A.Laplante: Real-time Systems Design and Analysis, An Engineer’s Handbook , IEEE Press 4.P.D.Laurence, K.Mauch: Real-time Microcomputer System Design, An Introduction , McGraw Hill Program Elective V (Semester VII) CP-491 Cryptography (3-0-2)4 Review of Number theory : Prime numbers, modular arithmetic, Fermat’s theorem, Euler’s theorem, Chinese remainder theorem, Discrete logarithms, Random number generation, factoring, prime number generation. Cryptography: Need, conventional techniques, stream ciphers, block cipher, steganography. Public v/s private key cryptography. Stream Ciphers: Caesar Cipher, mono-alphabetic and poly-alphabetic ciphers, Playfair Cipher, Hill Cipher, Rotor machines, One time pad,. Random Number Generation: Pseudo Random Number, PRNG, LFSR, Blum-Blum Shub generator Private-key cryptography: Feistel structure, DES (Data encryption standard), design of S-boxes, AES, Triple DES. Public key cryptography: Key management, Key exchange – Diffie-Hellman, El-Gamal, Merkle's Puzzle, Authentication, Signatures, Deniability, RSA. Threshold Cryptography : Sharing Secrets. Digital Signature: DSA and its variants, discrete logarithm based digital signatures. One-way hash functions – MD5, SHA (Secure Hash Algorithm). Cryptanalysis: Differential and linear cryptanalysis - cracking DES. Text/References: 1.Stallings, Cryptography and Network Security: Principles and

Practice, Pearson Education Asia. ISBN 981-403-589-0. 2.B Schneier, Applied Cryptography, Wiley. ISBN 0-471-11709-9 3.D Kahn. The Codebreakers, Sphere books. ISBN 0-7221-51497 4.P Wayner, Disappearing Cryptography, Academic Press. ISBN 0-12-738671-8 5.Cracking DES, Electronic Frontier Foundation. ISBN 1-56592-520-3 6.A.J. Menezes, P.C. van Oorschot and S.A. Vanstone, Applied Cryptography, CRC Press, ISBN 0-8493-8523-7, 1997 7.D.R. Stinson, Cryptography - Theory and practice, CRC Press, ISBN 0-8493-8521-0, 1995

CP-493 Embedded Systems (3-0-2)4 Introduction to embedded systems., design representations, level of abstractions, design methodologies, Models and architectures, Taxonomy of models and architectures, brief descriptions of specification languages, Specification requirement for embedded systems, Spec Chart and Spec Chart Description. Design challenges & issues, hardware and software design, co-design of software and hardware, ASIC. Design quality estimation : Quality matrix, software and hardware estimation. Introduction Sample design Specification of Answering machine/ Microcontroller 8051. Text /References: 1.Denial D. Gajski , frank Vahid: Specification and design of embedded systems , PH 2.Jonathan W. Valvano: Embedded Microcomputer Systems , Thomson Learning 3.Myke Predko: Programming and Customizing the 8051 Micro Controller , TMH 4.Ayala : 8051 Micro controllers , Penram Press

CP-495 Data Mining (3-0-2)4 Introduction : Basic Data Mining Tasks, Data Mining Issues, Data Mining Metrics, Data Mining from a Database Perspective. Data Mining Techniques : A Statistical Perspective on Data Mining, Similarity Measures, Decision Trees, Neural Networks, Genetic Algorithms. Classification : Statistical-Based Algorithms, Distance-Based Algorithms, Decision Tree-Based Algorithms, Neural Network-Based Algorithms, Rule-Based Algorithms, Combining Techniques. Clustering : Similarity and Distance Measures, Hierarchical Algorithms, Partitional Algorithms, Clustering Large Databases, Clustering with Categorical Attributes. Association Rules : Basic Algorithms, Parallel and Distributed Algorithms, Incremental Rules, Advanced Association Rule Techniques, Measuring the Quality of Rules. Advanced Techniques : Web Mining, Spatial Mining, Temporal Mining. Text/References: 1.M. H. Dunham. Data Mining: Introductory and Advanced Topics. Pearson Education. 2001. 2.J. Han and M. Kamber. Data Mining: Concepts and Techniques. Morgan Kaufman. 2001. 3.I. H. Witten and E. Frank. Data Mining: Practical Machine Learning Tools and Techniques. Morgan Kaufmann. 2000. 4.D. Hand, H. Mannila and P. Smyth. Principles of Data Mining. Prentice-Hall. 2001.

CP-497 VLSI Algorithms (3-0-2)4 1.Introduction of VLSI Technology, VLSI design cycle, design styles, basic Layout rules and circuit abstraction, introduction to standard Cell, Gate array, FPGA 2.Overview of basic graph algorithms, Graph algorithms for physical Design 3.Partitioning: Classification of partitioning algorithms, Karnighan-Lin Algorithm, FM Algorithm, Ratio cut algorithm 4.Floor-planning: Rectangular dual graph approach of floor-planning, hierarchical tree based approach, Integer programming based floor-planning. 5.Placement: placement by simulated annealing and force directed method 6.Routing: classification of routing algorithms, Global routing: Maze routing algorithms, line probe algorithms, Steiner tree based algorithms, Detailed Routing: Single layer and two layer routing algorithms, routing in FPGAs Text/References: 1.Naveed Shervawani, “ Algorithms for VLSI physical

Design Automation “ III Ed Springer 2.Sarrafzadeh and Wong “ An introduction to VLSI Physical design “ MGH 3.Sze: VLSI Technology 4.Weste and Eshraghan, “ Introduction toVLSI Design”. Pearson Edu. 5.Sadiq M. Sait, Habib Youssef, "VLSI Physical Design Automation: Theory and Practice", World Scientific Publishing Company; 6.Cormen Leiserson, Rivest, “ Introduction to Algorithms”, Pearson Edu.

Program Elective VI (Semester VIII) CP-470 Network Security (3-0-2)4 Review of wired/wireless network protocols, intrusion detection systems, malicious software. Review of cryptographic algorithms, protocols, cryptanalysis, authentication and signature protocols. Kerberos, PKI, real-time communication security, IPSec: AH, ESP, IKE . SSL/TLS, e-mail security, PEM and S/MIME, PGP, web security, network management security, wireless security. Threats in networks, network security controls, firewalls, intrusion detection, administering security Honeypots, password management, malicious software, viruses and countermeasures Text/References: 1.C. Kaufman, R. Perlman, Network Security, Prentice Hall. 2.Kurose & Ross, Computer Networking , Pearson Education. 3.Schiller J., Mobile Communications , Pearson Education. 4.W. Stallings, Cryptography and Network Security Principles and practice , Pearson Education. CP-472 Biometrics (3-0-2)4 Biometrics: Need, Conventional techniques of authentication, challenges - legal and privacy issues. Biometrics: DNA, fingerprint, Iris, Retinal scan, Face, hand geometry, human gait, speech, ear. Handwriting, Keystroke dynamics, Signature Multimodal biometrics: Combining biometrics, scaling issues. Biometric template security. Texts/References: 1.Julian D. M. Ashbourn, Biometrics: Advanced Identify Verification: The Complete Guide 2.Davide Maltoni (Editor), et al, Handbook of Fingerprint Recognition 3.L.C. Jain (Editor) et al, Intelligent Biometric Techniques in Fingerprint and Face Recognition 4.John Chirillo, Scott Blaul, Implementing Biometric Security CP-474 High Level Synthesis of Digital Systems (3-0-2)3 Overview. Design methodologies. Abstractions and views. Review of basic concepts in algorithms and graph theory Design representation and modeling, Modeling languages, Abstract models Synthesis at higher levels of abstraction Scheduling, Resource sharing Structural synthesis: Module selection. Pipeline. Control Synthesis at lower levels of abstraction, Logic synthesis Text/Reference: 1.G. D. Micheli. Synthesis and optimization of digital systems . 2.N.D. Dutt, D. D. Gajski. High level synthesis, Kluwer, 2000. 3.T. H. Cormen, C. E. Leiserson and R. L. Rivest, “ Introduction to Algorithms ,” McGraw-Hill, 1990 . 4.Recent papers from journals and conferences. CP-476 Selected Topics in Cryptography (3-0-2)4 Elliptic Curve Cryptography Secret Sharing, Threshold cryptography – Robust ElGamal system Visual Cryptography. Interactive zero knowledge proofs, witness hiding protocols. Group encryption, decryption. Group signatures, ring signatures. EVoting: requirements, issues and challenges, existing solutions, write-in ballots. Pair based cryptography – Weil and Tate pairing. Contemporary Issues. Text/References: 1.Oded Goldreich. Foundations of Cryptography – V ol I & V ol II. 2.Selected paper and online reference material. CP-478 Digital Image Processing (3-0-2)4 Digital Image Fundamentals: Image Model, Sampling, Quantization, Neighborhood, connectivity of pixels, Labelling of connected components, Distance measures Image Transforms: Fourier Transform, Discrete Fourier Transform, Properties of 2D Discrete Fourier Transform, The fast Fourier



Transform and its algorithm, number of operations, the inverse FFT. Discrete Cosine Transform and its applications, KL Transform, Convolution and correlation Image Enhancement: Enhancement by point processing, spatial filtering, enhancement in frequency domain, generation of spatial masks from frequency domain specifications Image Segmentation: Detection of discontinuities, edge linking and boundary detection, thresholding, region oriented segmentation Representation and Description: Representation schemes, boundary descriptors, regional descriptors. Morphology: Dilation, erosion, opening, closing, Hit-or-Miss Transform, some basic morphological algorithms like pruning, thinning and thickening Text/References: 1.Gonzalez and Woods. Digital Image Processing, Addison Wesley. 2.Castleman. Digital Image Processing. Prentice Hall. 3.Duda and Hart. Pattern Classification. John Wiley. Program Elective VII (Semester VIII) CP-480 Evolving Architectures (3-0-2)4 Special, and emerging advanced topics in different areas of Computer Engineering will be covered under this course. Text and References: 1. Research reports and papers from journals. CP-482 Topics in Advanced Computing (3-0-2)4 Fault Tolerant Computing : Fault Tolerance Strategies - Fault detection, masking, containment, location, reconfiguration, and recovery. Fault Tolerant Design Techniques - Hardware redundancy, software redundancy, time redundancy, and information redundancy. Parallel and Distributed Computing : Concepts and issues in parallel and distributed computing. Concepts and issues in quantum computing, Trusted Computing, Grid Computing Any other contemporary and relevant issues. GPGPU and Multicore computing. Text and References: 1.P. Jalote, Fault Tolerance in Distributed Systems , Prentice-Hall Inc., 1994 2.D. K. Pradhan (editor), Fault-Tolerant Computing, Theory and Techniques, Prentice-Hall, 1998. 3.Los Alamitos, CA, "Fault-tolerant Software Systems: Techniques and Applications", IEEE Computer Society Press, 1992. 4.Design and Analysis of Fault Tolerant Digital Systems, Barry W. Johnson, Addison Wesley, 1989 (Chapters 1-5). 5.A.K. Somani and N.H. Vaidya, ``Understanding fault-tolerance and reliability," IEEE Computer, vol.30, no.4, pp.45-50, Apr. 1997. 6.Research papers and internet resources. CP-484 Software Testing and Validation (3-0-2)4 Basic software testing principles - Software Quality, Software testing, test generation and test management. Acceptance Testing: User acceptance testing, alpha and beta testing. Verification and Validation, Functional and Non-functional system testing. Static and dynamic testing, Black-box or functional testing, structural, white box or glass box testing. Integration testing, component testing. Software testing tools. Books/References: 1.Recent papers from conferences and journals. 2.A. P. Mathur, Fundamentals of software testing. CP-486 Machine Learning (3-0-2)4 Introduction: Definition of learning systems. Goals and applications of machine learning. Aspects of developing a learning system: training data, concept representation, function approximation. Inductive Classification: The concept learning task. Concept learning as search through a hypothesis space. General-to-specific ordering of hypotheses. Finding maximally specific hypotheses. Version spaces and the candidate elimination algorithm. Learning conjunctive concepts. The importance of inductive bias. Decision Tree Learning: Representing concepts as decision trees. Recursive induction of decision trees. Overfitting, noisy data, and pruning. Ensemble Learning Using committees of multiple hypotheses. Bagging, boosting, and

DECORATE. Active learning with ensembles. Experimental Evaluation of Learning Algorithms: Measuring the accuracy of learned hypotheses. Comparing learning algorithms: cross-validation, learning curves, and statistical hypothesis testing. Rule Learning: Propositional and First-Order: Translating decision trees into rules. Heuristic rule induction using separate and conquer and information gain. First-order Horn-clause induction (Inductive Logic Programming) and Foil. Learning recursive rules. Inverse resolution. Artificial Neural Networks: Neurons and biological motivation. Linear threshold units. Perceptrons: representational limitation and gradient descent training. Multilayer networks and back propagation. Hidden layers and constructing intermediate, distributed representations. Overfitting, learning network structure, recurrent networks. Bayesian Learning: Probability theory and Bayes rule. Naive Bayes learning algorithm. Parameter smoothing. Generative vs. discriminative training. Logistic regression. Bayes nets and Markov nets for representing dependencies. Instance-Based Learning: Constructing explicit generalizations versus comparing to past specific examples. k-Nearest-neighbor algorithm. Case-based learning. Clustering and Unsupervised Learning: Learning from unclassified data. Clustering. Hierarchical Agglomerative Clustering. k-means partitional clustering. Expectation maximization (EM) for soft clustering. Semi-supervised learning with EM using labeled and unlabeled data. Text/References: 1.Bishop, C. (2006) Mitchell, T. M. (1997) Machine Learning. McGraw-Hill 2.Pattern Recognition and Machine Learning. Berlin: Springer-Verlag. 3.Richard O. Duda, Peter E. Hart and David G. Stork. Pattern Classification. Wiley-Interscience, second edition, 2001. 4.Thomas Mitchell. Machine Learning. McGraw Hill Higher Education, First edition, 1997. 5.Stuart Russell and Peter Norvig. Artificial Intelligence: A Modern Approach. Prentice Hall, second edition, 2003. (Machine-learning related chapters.) 6.Information Theory, Inference and Learning Algorithms by David MacKay. CP-488 Modelling and Simulation (3-0-2)4 Analytical v/s simulation modeling, performance measurement and benchmarking, Workload modeling, random variables, commonly used distributions, Stochastic Processes, Performance evaluation methods, Evaluation Metrics' Markov chains, Birth and Death Processes, Markov chain models of Computer systems, Steady-state and transient analysis Queuing models, M/M systems and their steady state analysis, Single server and multi-server queues, open and closed queuing networks Petri Net based Performance Modeling : Classical Petri Nets, Timed Petri Nets, Discrete Petri Nets, Modeling multiprocessor systems Discrete event simulation – Simulation languages, random number generation and testing, model verification and validation, analysis of simulation results, confidence intervals, variance reduction techniques, Case studies of analytical and simulation studies of computer systems Text/References : 1.Law and Kelton, Simulation Modeling and Analysis, Mcgraw Hill 2.Raj Jain, The Art of Computer System Performance Analysis, John Wiley 3.K.S.Trivedi, Probability and Statistics with Reliability, Queuing and Computer Science Applications, PHI 4.Kant, Introduction to Computer System Performance Evaluation, Mcgraw Hill BTech\_IT.pdf

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 Credits 18051753420180 B.Tech (Information Technology) Discipline /NSS Discrete  
 Structures Data Structures and Algorithms Formal Languages and Automata  
 Theory Data Structure and Algorithm Lab Electronics Devices and Circuits Switching  
 Theory & Finite Automata Open Elective I Social Science and Economics Data Base  
 Modelling and Administration Operating System Computer Architecture Open Elective II  
 Creative Arts/ Sports/ NSS/ Hindi Information System Security E-Commerce and Web  
 Applications Computer Network & Administration Information System Security Lab Web  
 based Development Lab Network Programming & Administration Lab Program Elective  
 I Open Elective III Software Engg. Free and Open Source Lab Program Elective II Open  
 Elective IV Industrial Training Program Elective III Program Elective IV Program  
 Elective V Open Elective V Program Elective VI Program Elective VII IT Page  
 2 Program Elective I IT-371 Programming in Java IT-373 Python Programming  
 IT-375 Scripting Language IT-377 Management Information Systems Program Elective  
 II IT-370 Signals and Systems IT-372 Object Oriented System Design  
 IT-374 Multimedia Technology IT-376 Artificial Intelligence Program Elective III  
 Program Elective IV Program Elective V IT-471 Computer Graphics IT-481 Advanced  
 Compiler IT-491 Information Retrieval IT-473 Human Computer Interaction  
 IT-483 Design and Analysis of Algorithms IT-493 Wireless Sensor Networks IT-475 GUI  
 Programming IT-485 Semantic Web IT-495 Topics in High Speed Networking  
 IT-477 Selected Topics in OS IT-487 Data Mining and Data Warehousing IT-497  
 IT-479 Mobile and Wireless Computing IT-489 Implementation of Data Bases  
 IT-499 Software Project Management Program Elective VI Program Elective VII  
 IT-470 Digital Forensics IT-480 IT-472 Biometric Security IT-482 Software Testing  
 IT-474 VLSI Algorithms IT-484 Distributed Systems IT-476 Intrusion Detection  
 IT-486 Advanced Topics in Data Bases IT-478 Pattern Recognition IT-488 Expert  
 Systems Digital Watermarking and Steganography Multi-Core Architectures B.Tech  
 Information Technology Semester III IT-221 Discrete Structures (3-0-0)3 Logic:  
 Introduction to Logic, Propositional Logic and Predicate Logic Propositional Logic:  
 Elements of Propositional Logic, Truth Table, Connectives, Construction of  
 Proposition, Converse and Contrapositive, Reasoning with Propositions, Identities of  
 Propositions and Dual, Use of Identities, Implications, Reasoning with Propositions,  
 Proof of Identities, Proof of Implications. Predicate Logic: Well Formed Formula (Wff)  
 of Predicate Logic, Predicate, Quantification, Constructing Formulas, Reasoning with  
 Predicate Logic, Quantifiers and Connectives. Set and Functions : Sets, relations,  
 functions, operations, and equivalence Relations, relation of partial order, partitions,  
 binary relations, Equivalence relations . Recursion, Proof by Induction  
 Number-theoretic algorithms : Greatest Common Divisor, Chinese Remainder  
 Theorem, Primality testing, polynomial representation of binary number, Galois fields,

primitive roots, discrete logarithms. Text/ References: 1.Kolman B., Busby R: Discrete Mathematical Structures for Compute Science , PHI. 2.Liu: Introduction to Discrete Mathematics , McGraw-Hill. 3.Graham, Knuth, Pratschnik : Concrete Mathematics . 4.Grimaldi: Discrete Mathematical Structures . 5.Grossman P, Discrete Mathematics for Computing , Macmillan 1995 6.Ross KA & Wright CRB, Discrete Mathematics , Prentice-Hall 1999 7.Johnsonbaugh R, Discrete Mathematics , Macmillan. 8.Wiitala, Discrete Mathematics , McGraw Hill. 9.Biggs N L, Discrete Mathematics , Oxford. 10.Truss J, Discrete Mathematics for Computer Scientists , Addison Wesley.

IT-223 Data Structures and Algorithms (3-0-0)3 Introduction to data structures, dynamic aspects of operations on data, analysis of algorithms. Creation and manipulation of data structures: arrays, lists, stacks, queues, trees, graphs, heaps, hashing and hash tables, height balanced trees, tries. Algorithms and data structures for sorting and searching, merging, graph traversals, shortest path and minimum spanning tree, order statistics, data structures for images, greedy algorithms, dynamic programming, algorithms- data structures dependency, introduction to complexity analysis and measures. Special topics from problems in computational geometry and string matching Text/ Refernces: 1.Kruse R.L., Data Structure and Program Design, PHI. 2.Rivest, Cormen, Introduction to Algorithms, MIT Press 3.Horowitz and Sahni: Data Structure in C++ , Glagotia 4.Ellis Horowitz, Sartaj Sahni, Fundamentals of Data Structures 5.Aaron M. Tenenbaum, Y . Langsam, Moshe J. Augenstein, Data Structures Using C IT-225 Formal Languages and Automata Theory (3-0-0)3 Introduction to formal languages and their operations, abstract machines. Finite automata and regular expressions, Non-deterministic finite automata, Mealy and Moore machines, minimization of finite automata, Pumping lemma for regular languages. Chomsky classification of languages, regular grammars, context free grammars, simplification of context free grammars, Normal forms of context free grammars. Push Down Automata Theory: Push down automata and context free languages, Pumping lemma for context free languages. Turing hypothesis, Turing machine, Minsky's theorem, TM variation and encoding, computability and acceptability. Text/ References: 1.Hopcroft, Motwani and Ullman: Introduction to Automata Theory, Languages and Computation , Pearson Education. 2.Cohen: Introduction to Computer Theory , Addison Wesley. 3.Martin: Introduction to Languages and Theory of Computation, TMH.

IT-251 Data Structure and Algorithm Lab (0-0-3)2 The following proposed coverage are broad guiding areas in lab. The instructor offering the course in consultation with the theory offered can adopt further variations in tune with IT-223. 1.Implementation of experiments with, basic data structures and use in dynamic operations on data for different algorithms and problem domains; 2.Analysis of basic sorting and searching algorithms and their relationship to these data structures. Comparison of asymptotic complexity with real behaviour of algorithms; 3.Sorting programs: Bubble sort, Merge sort, Insertion sort, Selection sort, and Quick sort. 4.Searching programs: Linear Search, Binary Search. 5.Array implementation of Stack, Queue, Circular Queue, Linked List. 6.Implementation of Stack, Queue, Circular Queue, Linked List using dynamic memory allocation. 7.Implementation of Binary tree. 8.Program for Tree Traversals (preorder, inorder, postorder). 9.Program for graph traversal (BFS, DFS). 10.Program for minimum cost

spanning tree, shortest path. Text/ References: 1.Kruse R.L., Data Structure and Program Design, PHI. 2.Rivest, Cormen, Introduction to Algorithms, MIT Press 3.Horowitz and Sahni: Data Structure in C++ , Glagotia 4.Ellis Horowitz, Sartaj Sahni, Fundamentals of Data Structures 5.Aaron M. Tenenbaum, Y . Langsam, Moshe J. Augenstein, Data Structures Using C EC-251 Electronics Devices and Circuits (3-0-2)4- As offered by the ECE Department. EC-253 Switching Theory & Finite Automata (3-0-0)3- As offered by the ECE Department. Open Elective I (X-X-X)3/4 Please refer to concerned Department. B.Tech Information Technology Semester IV HF-201 Humanities and Social Sciences (X-X-X)2 Please refer to Humanities and Social Sciences Department. IT-222 Data Base Modelling and Administration (4-0-0)4 Design: Conceptual design, three tier architecture, ER Diagram – entity (strong and weak), Data aggregation, specialization, generalization. Data models: Relational, Network, Hierarchical and Object Oriented. Normalization: Constraints – integrity and domain, Primary key, Super key, foreign key, Alternate key, candidate key, normal forms 1NF, 2NF, 3NF, BCNF, 4NF. SQL: DDL and DML, Relational Algebra, SQL Queries, Triggers and views, Constraints assertions. Data Organization: Sequential, indexed random and hashed files. Inverted and multilist structures, B trees, B+ trees, Query Optimization, Join Algorithm, Statistics and Cost Base optimization. DBMS internals: Transaction Processing, concurrency control, and recovery management. Transaction model properties and state serialisability , Lock base protocols, two phase locking. Text/References: 1.Almasri and S.B. Navathe: Fundamentals of Database Systems , Addison Wesley. 2.Kevine Kline, SQL in Nutshell, O'Reilly & Associates. 3.Raghu Ramakrishnan, Johannes Gehrke Database Management Systems , McGraw Hill. 4.H.F. Korth, Silberschatz, Sudarshan: Database Systems Concepts , McGraw Hill 5.C.J. Date: Data Base Design, Addison Wesley 6.Hansen and Hansen : DBM and Design, PHI IT-224 Operating System (3-0-0)3 Operating System Overview: Operating Systems objectives & functions, the evolution of operating Systems, Major Achievements, Examples of Operating systems. Process Description & Control: Process states, Process Description, Process Control, and Processes & Threads. Concurrency: Mutual Exclusion & Synchronization Principles of Concurrency, Mutual Exclusion-Software Approaches. Graphical User Interface & OS: Introduction , Windowing Technology, GUI, Relationship between the OS & Windows, Components of GUI, and Requirement of a Windows based GUI, MS-WINDOWS & NT, and Windows 2000. Introduction to UNIX Operating system. Text/References: 1.Modern Operating Systems by Tanenbaum (PHI) 2.Operating System Concepts- Abraham Silberchatz, Peter B. Galvin, Greg Gagne 7th Edition, John Wiley. 3. Systems Programming & Operating Systems (Second Edition) by Dhamdhare (TMH) IT-226 Computer Architecture (3-0-0)3 Introduction to computer architecture and organization: Digital components, Von Neumann Machine Architecture, Flynn Classification Register Transfer Language : Micro operations - data transfer operations, arithmetic, logic and shift micro operations and their hardware implementations as a simple Arithmetic and logic unit. CPU Organization: Addressing techniques - Immediate, direct, indirect, register, register indirect, index, relative and stack addressing techniques. Instruction formats : Instruction set design, Instruction types: example for zero address, one address, two address and three address

machines, Stack, accumulator and general purpose register organization Arithmetic Algorithms : Arithmetic and Logic Unit, Adders - Full adder, Ripple carry adder, Carry look ahead adder, Carry select adder, carry save adder, Multiplication - Add and Shift method, Booth's Multiplier, m Array Multiplier, Division - Restoring and Non restoring method. Pipelining: Pipeline structure, pipeline performance measures, Pipeline types - Instruction and Arithmetic pipelines. Memory Organization: Memory device characteristics, RAM organization: 1D and 2D organization, Virtual memory - Paging and Segmentation, High speed memories: Associative and Cache memory Control Unit Design, Hardwired and Micro programmed control unit design implementation techniques Input-Output Design: IO interface, Bus structure, Modes of data transfer, Interrupts, Input Output Processor, Serial Communication Text/References: 1. Computer Architecture: A Quantitative Approach, J.L. Hennessy and D.A. Patterson, 4th Edition Elsevier. IT-252 DBMS Lab (0-0-3)2 The following proposed coverage are broad guiding areas lab. The instructor offering the course in consultation with the theory offered can adopt further variations in tune with IT-222. 1. Conceptual designs using ER diagrams. 2. Design of databases. Based on templates, files and relational basis. 3. Development and implementation of DB system from the fundamentals. 4. Experiments on SQL queries. IT-254 OS Lab (0-0-3)2 The following proposed coverage are broad guiding areas in lab. The instructor offering the course in consultation with the theory offered can adopt further variations in tune with IT-224. 1. Write shell scripts for (i) multiplication table generation, (ii) copying multiple files to a directory, (iii) counting the number of lines and words present in a given file, (iv) displays the list of all the files in a given directory. 2. Write a shell script to implement small calculator – addition, subtraction, multiplication and division of two integers. Division has two options: one returns the quotient and the other returns remainder. 3. Write a shell script to reverse the rows and column of a matrix. 4. Write a C program to implement CPU Scheduling. 5. Write a C program to page replacement algorithms. 6. Write a C program to implement virtual memory. 7. Write a C program using fork() to illustrate process management. 8. Write a C program to implement concurrent programming constructs through semaphores – dining philosophers' problem, consumer-producer, readers-writers etc. 9. Write a C program that illustrate how to execute two commands concurrently with a command pipe. 10. Write a C program to implement deadlock avoidance algorithms. Text/References: 1. Unix concepts and applications by Sumitbha Das, TMH applications. 2. Unix Programming by Stevens, Pearsons Education. 3. Shell Programming by Yashwant Kanetkar. 4. Operating System concepts by silberschatz, and Peter Galvin. Open Elective II (X-X-X)3/4 Please refer to concerned Department. B.Tech Information Technology Semester V IT-321 Information System Security (3-0-0)3 Review of Number theory : Prime numbers, modular arithmetic, Fermat's theorem, Euler's theorem, Chinese remainder theorem, Discrete logarithms, Random number, prime number, factoring, . Cryptography: Classical, stream and block cipher, steganography. Public v/s private key cryptography. Random Number Generation: Pseudo Random Number, PRNG, LFSR, Blum-Blum Shub generator Private-key cryptography: Feistel structure, DES, design of S-boxes, AES, Triple DES. Public key cryptography: Key management, Key exchange – Diffie-Hellman, El-Gamal, Merkle's Puzzle, Authentication, Signatures,

Deniability, RSA. Threshold Cryptography : Sharing Secrets. Digital Signature: DSA and its variants, discrete logarithm based digital signatures. One-way hash functions – MD5, SHA (Secure Hash Algorithm). Cryptanalysis: Differential and linear cryptanalysis - cracking DES. Text & References: 1.Stallings, Cryptography and Network Security: Principles and Practice, Pearson Education Asia. ISBN 981-403-589-0. 2.B Schneier, Applied Cryptography, Wiley. ISBN 0-471-11709-9 3.D Kahn. The Codebreakers, Sphere books. ISBN 0-7221-51497 4.P. Wayne, Disappearing Cryptography, Academic Press. ISBN 0-12-738671-8 5.Cracking DES, Electronic Frontier Foundation. ISBN 1-56592-520-3 6.A.J. Menezes, P.C. van Oorschot and S.A. Vanstone, Applied Cryptography, CRC Press, ISBN 0-8493-8523-7, 1997 7.D.R. Stinson, Cryptography - Theory and practice, CRC Press, ISBN 0-8493-8521-0, 1995

IT-323 E-Commerce and Web Applications (3-0-0)3 Electronic commerce environment and opportunities: Back ground – The Electronic commerce Environment – Electronic Market Place Technologies. Modes of electronic commerce: Overview – EDI – Migration to open EDI – E commerce with WWW/Internet – Commerce Net Advocacy – Web commerce going forward. Approaches to safe electronic Commerce – Overview – Source – Transport Protocols – Secure Transactions – Secure Electronic Payment Protocol – Secure Electronic Transaction – Certificates for Authentication – Security on Web Servers and enterprise networks. Electronic cash and electronic payment schemes – Internet Monetary Payment and Security requirements – payment and purchase order process – online electronic cash. Master card/ Visa Secure electronic transaction: Introduction – Business requirements - Concepts - Payment Processing. Email and Secure Email Technologies for Electronic Commerce: Introduction – The means of Distribution – A model for Message Handling – How Does a Email Work. Internet Resources for Commerce: Introduction – Technologies for Web Servers – Internet Applications for commerce – Internet Charges – Internet Access and Architecture – Searching the Internet. Text/ References: 1.Web Commerce Technology Hand Book Daniel Minoli, Emma Minoli McGraw Hill 2.Frontiers of Electronic Commerce Ravi Kalakotar, Andrew B.Whinston Addison-Wesley IT-325 Computer Networks & Administration (4-0-0)4 1.Computer network architecture, Physical layer: Hardware, topology, data encoding, 2.Data Link Layer: Logical link Control: Error detection and Correction, ARQ protocols, Framing protocols( HDLC, LLC) Medium Access Control: Multiple access protocols, Channel Allocation, contention, reservation, round robin with Examples. 3.Network Inter connection: Generic switches, switch design issues, switching mechanism : virtual Circuit switching, datagram switching, source route switching, Bridge and bridge learning , Global Addressing scheme, fragmentation and reassembly, Address translation: ARP, RARP, ICMP, IP Scalability Issues, sub netting and super netting (CIDR) , IP Routing, EGP, BGP protocols 4.End to End protocols: End to end issues, UDP and TCP segment formats, connection establishment and termination, state transition sliding window protocol, TCP Flow control, Silly window syndrome, TCP retransmission, RTT Estimation, TCP Congestion Control and congestion avoidance protocols 5.Internet applications: Client server paradigm, DNS, SMTP, RPC, NFS and General network security issues. 6.Introduction to Network management protocols. Tools and techniques for network monitoring authentication,

and administration. Text/References: 1.Data Networks: Bertsekas and Gallager, Phi. 2.Computer Networking A Top down Approach: J.F.Kurose, Pearson. 3.Computer Networks A Systems Approach: L. Peterson and B. Davie, Elsevier 4.Computer Networks and Internet: D.E. Comer, Pearson IT-351 Information System Security Lab (0-0-3)2 The following proposed coverage are broad guiding areas in lab. The instructor offering the course in consultation with the theory offered can adopt further variations in tune with IT-321. 1.Implementation of Classic Ciphers. 2.Extended Euclid algorithm implementation. 3.Implementation of DES encryption and decryption. 4.Implementation of Polynomial arithmetic, Galois Fields. 5.Implementation of AES encryption and decryption. 6.Implementation of hash function. 7.Solution of Equations through CRT. 8.Implementation of an authentication scheme. 9.RSA implementation. 10.Digital Signature implementation. Text/References: 1.B Schneier, Applied Cryptography, Wiley. ISBN 0-471-11709-9 2.A.J. Menezes, P.C. van Oorschot and S.A. Vanstone, Applied Cryptography, CRC Press, ISBN 0-8493-8523-7, 1997 3.D.R. Stinson, Cryptography - Theory and practice, CRC Press, ISBN 0-8493-8521-0, 1995 IT-353 Web based Development Lab (0-0-3)2 Topics to be covered in the lab: . Introduction to Web Programming . Installation of PHP/MySql and web server . Introduction to PHP programming . Writing PHP Programs . Loops, Control Structure and Arrays . PHP functions . String functions . Array functions . Mathematical function . Graphics functions . File system function . Date and time function . Miscellaneous Functions Error handling Object Oriented Features of PHP File and Directory handling . MySql database . Configuration of MySql server. Starting MySql server . MySql tables . Displaying MySql data . Adding and removing user access . Advance PHP programming . mail . PHP - generated PDF files . Web Servers . IIS web Server . Apache web server. Text/References: 1. Beginning PHP 4 Databases – Christopher Scollo, Harish Rawat, Dipak Thomas, Sanjay Abraham, Andrew Hill & Jim Hubbard; Wrox Press 2.PHP MySql Website Programming – Chris Bea, Mike Duzzard, Jessy White, Cinis & Dilip Thomas; Wrox Press 3.PHP Black Book – Peter Moulding, Coriolis Group 4.MySql – PHP Database Applications – Jay Greenspan & Brad Bulger; John Wiley & Sons 5.PHP MySql Website Programming: Problem-Design-Solutions – Chris Bea, Mike Duzzard, Jessy White, Cinis & Dilip Thomas; Apress 6.Essential PHP for Web Professionals – Christopher Cosentino; Prentice Hall 7.Sam's Teach Yourself PHP 4 in 24 Hours – Matt Zandstra; SAMS 8.PHP 5.1 For Beginners – Ivan Bayross, O'Reilly, Shroff Publishers & Distributors Pvt. Ltd IT-355 Network Programming & Administration Lab (0-0-3) 2 The following proposed coverage are broad guiding areas lab. The instructor offering the course in consultation with the theory offered can adopt further variations in tune with IT-325. 1.Programming for data encoding, CRC detection and Correction. 2.Estimation of network delay through OS utilities. 3.Simulation and Emulation of Bus and Star topology, DLC, MAC protocols using Benchmark LAN trainer kits. 4.Packet measurement and observation using network sniffing tools. 5.Use of sniffers for protocol dynamics. 6.Installation and working of RRD tool for logging administration data for networks. 7.Bandwidth and other network parameter mechanism through SNMP protocols. Program Elective I (3-0-2)4 One/More of the following courses as offered by Department. IT-371 Programming in Java IT-373 Python Programming



IT-375 Scripting Languages IT-377 Management Information Systems Open Elective III (X-X-X)3/4 Please refer to concerned Department. B.Tech Information Technology Semester VI IT-322 Software Engg. (3-0-0)3 Introductory Concepts: Historical perspective, System Definition, Software Life Cycle, Software Engineering paradigms. System analysis: Feasibility study requirement analysis, Cost benefit analysis, Planning systems, Analysis tools and techniques. System Design: design fundamentals, Modular Design, Data and procedural design, object oriented design. System Development: Code documentation, Program design paradigms. Verification, Validation and Testing: testing methods, Formal Program Verification, Testing Strategies. Software Maintenance: Maintenance Characteristics, Maintainability, Maintenance tasks and side effects. Text/References: 1.Pressman R.S: Software Engineering: A Practitioner approach, McGraw Hill. 2.Sommerville I: Software Engineering, Addison Wesley 3.Ghezzi C. Jazayeri M and Mandrioli: Fundamentals of Software Engg. , PHI. IT-324 Compiler Design (3-0-0)3 Introduction to translators, compilers versus interpreters, compilation process. Lexical Analysis: Finite automata and Regular expressions, Minimization of finite automata. Syntax Analysis: Context Free Grammars, Bottom-up and Top-down Parsing. Ambiguity, Shift Reduce Parser, Operator Precedence Parser, Predictive Parsers, LR parsers. Syntax directed translation: Syntax directed translation, Synthesized and Inherited attributes, Intermediate codes- Postfix, Quadruples, Triples. Code optimization: Basic blocks, Flow graphs, Local and Global data flow analysis – DAG, ud- chaining, available expressions, Loop optimization. Code generation: Compilation of expression and control structures. Error detection and recovery. Symbol table organization: Hashing, linked list, tree structures. Text/References: 1.Aho, Ullman and Sethi: Compilers – Principles, techniques and tools, Pearson Education. 2.Tremblay, Sorenson: The Theory and Practice of Compiler Writing, BSP. 3.Holub, Compiler Design in C, PHI.

IT-352 Compiler Lab (0-0-3)2 The following proposed coverage are broad guiding areas in lab. The instructor offering the course in consultation with the theory offered can adopt further variations in tune with IT-324. 1.Programming exercises to implement typical lexical analyzers, parsers, intermediate code generation. 2.Assignments using LEX and YACC tools. 3.Programming assignments on some of the concepts related to Code Optimization. Text/References: 1.Aho, Ullman and Sethi: Compilers, Pearson Education. 2.Levine, Mason and Brown: Lex and Yacc, O'Reilly

IT-354 Seminar (0-2-0)2 The topics selection covering the latest and relevant topics related to the emerging areas. Ideally, some recent reputed journal papers abstraction and presentation shall be encouraged for presentation. The evaluation shall be continuous and through components evaluation viz. content, coverage, depth, presentation, response to the queries, and seminar report. In case of unsatisfactory performance, an X grade can be awarded for extension work during summer term.

Program Elective II (3-0-2)4 One/More of the following courses as offered by Department. IT-372 Signals and Systems IT-374 Object Oriented System Design IT-376 Multimedia Technology IT-378 Artificial Intelligence Open Elective IV (X-X-X)3/4 Please refer to concerned Department. Open Elective V (X-X-X)3/4 Please refer to concerned Department. B.Tech Information Technology Semester VII IT-451 Industrial Training (0-2-0)2 The evaluation shall be continuous and through

components evaluation viz. content, coverage, depth, presentation, demonstration, response to the queries, and training report. In case of unsatisfactory performance, and failure extra credit course from the department equivalent to CP-451 can be permitted through consent of DUGC. IT-453 Free and Open Source Lab (0-0-3)<sup>2</sup> The following proposed coverage are broad guiding areas lab. The instructor offering the course in consultation with the theory offered can adopt further variations. 1.Linux basics and installation and management of the Linux. 2.Different types of software development environment (Eclipse) 3.make and other software construction utilities on Linux. 4.Version control and managing project in open source. 5.Managing large software development through wiki or alike project management tools. 6.Introduction to scripting for system management. Program Elective III (3-0-2)<sup>4</sup> One/More of the following courses as offered by Department. IT-471 Computer Graphics IT-473 Human Computer Interaction IT-475 GUI Programming IT-477 Selected Topics in OS IT-479 Mobile and Wireless Computing Program Elective IV (3-0-2)<sup>4</sup> One/More of the following courses as offered by Department. IT-481 Advanced Compiler IT-483 Design and Analysis of Algorithms IT-485 Semantic Web IT-487 Data Mining and Data Warehousing IT-489 Implementation of Data Bases Program Elective V (3-0-2)<sup>4</sup> One/More of the following courses as offered by Department. IT-491 Information Retrieval IT-493 Wireless Sensor Network IT-495 Topics in High Speed Networking IT-497 Digital Watermarking and Steganography IT-499 Software Project Management IT-455 Project Lab (0-2-3)<sup>5</sup> Objective of this elective is to facilitate transfer of knowledge acquired by a student to a field of his own choice for application to solving a problem. Student is expected to collect and study relevant material under mentorship of a faculty member working in similar area; identify a suitable problem and propose methodology towards its solution. Alternately a student can explore hardware implementation of existing solution(s). This elective shall act as prequel to project work for next semester. The project coordinator(s) from the department for continuity shall coordinate this course. Grouping and division shall be applicable as defined in the major project of final semester. Open Elective VI (X-X-X)<sup>3/4</sup> Please refer to concerned Department. B.Tech Information Technology Semester VIII IT-452 Project (X-X-X)<sup>10</sup> The major project covers lab component of the final semester work. The evaluation of project shall be continuous and will be done through project coordinator(s). The evaluation mechanism shall be evolved based on the existing practices through DUGC rectified from time to time. Ideally the project should comprise with group size of two students shall be limited to maximum 4 students and the groups shall be evenly distributed among faculty through coordinator(s). Internal and external components shall not exceed 40% each of the overall marks. IT-454 Group Discussions (0-0-3)<sup>2VL</sup> This lab will remain only if Industrial training is given weightage of 02 credits. Program Elective VI (3-0-2)<sup>4</sup> One/More of the following courses as offered by Department. IT-470 Digital Forensics IT-472 Biometric Security IT-474 VLSI Algorithms IT-476 Intrusion Detection IT-478 Pattern Recognition Program Elective VII (3-0-2)<sup>4</sup> One/More of the following courses as offered by Department. IT-480 Multi-Core Architectures IT-482 Software Testing IT-484 Distributed Systems IT-486 Advanced Topics in Databases IT-488 Expert Systems Open Elective VII (X-X-X)<sup>3/4</sup> Please refer to concerned Department. Program Elective

I (Semester V) IT-371 Programming in Java (3-0-2)4 Introduction: Internet, Java as a tool for internet applications, Byte Code and its advantages. Object Oriented Programming and Design: Review of Abstraction, Objects and other basics, Encapsulation, Information hiding, Method, Signature, Classes and Instances, Polymorphism, Inheritance, Exceptions and Exception Handling with reference to object modeling, Coupling and Cohesion in object oriented software. Object Oriented Design – Process, Exploration and Analysis. Java Programming Basics: Fundamentals: Variables and assignments, Input and Output, Data Types and Expressions, Flow of control, Local variables, Overloading Parameter passing, this pointer, Java Object Oriented Concepts: Objects and Classes: Use of file for I/O, Formatting output with stream functions, Character I/O, Inheritance, Public and private members, Constructors for initializations, Derived classes, Flow of Control Java Data Structures and Advanced Topics Arrays – Programming with arrays, arrays of classes, arrays as function arguments, Strings, Multidimensional arrays, Arrays of strings, vectors, Base classes. Introduction to Java Applets Text/References: 1.Herbert Schildt: JA V A 2 - The Complete Reference, TMH, Delhi 2.U.K. Chakraborty and D.G. Dastidar: Software and Systems - An Introduction, Wheeler Publishing, Delhi. 3.Joseph O'Neil and Herb Schildt: Teach Yourself JA VA, TMH, Delhi. IT-373 Python Programming (3-0-2)4 Introduction to Python: Data types, variables, expressions, operators. Sequence, set, dictionary, print statement, control-flow statements, functions. Objects and classes, metaclasses. Decorators, special methods. Exception handling. Modules sys, os, etc. Strings and regular expressions. File operations. Working with processes and threads. Pipes and signals Graphical user interface design in Python (including the Tkinter module), Widgets and basic components, Layout options, Event handling Network scripting (sockets, FTP, and e-mail clients), Server-side scripting Databases and persistence in Python (including pickled objects and shelf files) Custom and built-in data structures in Python C integration with Python (including the SWIG module), Embedding Python calls within C Text/References: 8.Programming Python by Mark Lutz, O'Reilly. 9.Learning Python, 3rd Edition by Mark Lutz, O'Reilly 10.Python in a Nutshell by Alex Martelli, O'Reilly. 11.An Introduction to Python by Guido van Rossum and Jr. Fred L. Drake, Network Theory Ltd. IT-375 Scripting Language (3-0-2)4 Shell and Scripting languages introduction. AWK, Perl, and Python programming paradigms. Text/References: 1. Relevant online material with the latest version of the scripting languages. IT-377 Management Information Systems (3-0-2)4 Interpretation and understanding of information, need and role of information technology in business and organization. Information system: Basic elements, data, information, knowledge, infrastructure and types and its development. Organizing data and information: Basics of data arrangement and access, data knowledge & decision support, DBMS – An overview. Introduction to management information system Hardware and software used for information systems, transaction processing, office automation. Decision making process, concepts of information, humans as information processors, system concepts, organizational structure and management concepts. Text/ References : 1.Management Information and System, Davis and Olson, Mc-graw Hill. 2.Recent papers from conferences and journals. Program Elective II (Semester VI) IT-372

Signals and Systems (3-0-2)4 Review of signal description Review of Fourier and Laplace transforms Spectrograms; frequency modulation Sampling and aliasing The z-transform Filters: Transfer functions, FIR filters, IIR filters Spectral analysis: DFT for periodic signals, DFT for non-periodic signals Texts/References: 1.J H McClellan, R W Schafer & M A Yoder, DSP First: a Multimedia Approach , Prentice-Hall International 1998 2.A V Oppenheim , R W Schafer & J R Back, Discrete-time Digital Signal Processing , Prentice Hall Int 1999. Third major revision of classic text 3.A V Oppenheim , A S Willsky & S H Nawab, Signals and Systems, Prentice Hall Int 1996. 4.N K Sinha, Linear systems, John Wiley 1991 5.J G Proakis and D G Hanolakis, Digital Signal Processing , Maxwell Macmillan Int 1992 IT-374 Object Oriented System Design (3-0-2)4 Object Oriented Programming and Design : Review of abstraction, objects and other basics, Encapsulation, Information hiding, method, Signature, Classes and Instances, Polymorphism and inheritance. C++ Programming Basics : Fundamentals, variables and assignments, Input and Output, Data types and expressions, flow of control, subprograms, top-down design, predefined functions, user defined functions, procedural abstractions, local variables, overloading function names, operator overloading, parameter passing, this pointer, destructors, copy constructor, overloading the assignment operator, virtual functions, function calling functions, friend functions, recursive functions, recursive member functions. Static member function. C++ Object oriented concepts : Objects and classes, use of file for I/O, formatting output with stream functions, Character I/O, inheritance, structures for diverse data, structures as function arguments, initializing structures, defining classes and member functions, public and private members, constructors for initialization, standard C++ classes, derived classes, flow of control, use of Boolean expressions, multiway branches, use and design of loops. Friend function and friend class. C++ Data structures and Advanced Topics : Arrays – programming with arrays, arrays of classes, arrays as function arguments, strings, Multidimensional arrays, Arrays of strings, pointers Dynamic arrays, Classes and dynamic arrays, Base classes, access control, Templates- generic classes and functions, namespaces. Standard Template Library. Text/References: 1.Balaguruswamy: Object-oriented Programming with C++. 2.Robert Lafore: C++ Programming 3.Ashok N. Kamthane : Object Oriented with C++, Pearson Education IT-376 Multimedia Technology (3-0-2)4 Introduction to Multimedia, Graphics and Image data representations, Color in image and video CIE, RGB, CMY , HSL color models Fundamental concepts in video, NTSC, PAL and Digital video Compression methods: Lossy and Loss less compression techniques.: Huffman coding, Arithmetic coding, LZW Image compression standards: DCT Transform and Fourier transforms, JPEG coding Video representation and compression techniques Motion vector search: sequential, 2D logarithmic search. I, P and B frames, MPEG Video coding, MPEG-1, MPEG-2 and MPEG-3: video coding and decoding Basic Audio compression: Fletcher- Munson curves, Critical Bands, Psychoacoustic phenomenon, MPEG Layer 3 (MP3) Audio Text/References: IT-378 Artificial Intelligence (3-0-2)4 Overview of AI, Problems, Problem space and searching techniques, Definition production system, Control strategies, Heuristic search techniques. Knowledge representation: Representation, mappings, approaches and issues, Predicate logic, prepositional logic, Resolution, Procedural and declarative

knowledge, forward and backward reasoning, Matching, Semantic nets, Frames scripts. Learning and learning systems: Introduction to Hopfield networks, introduction to neural networks, learning in neural networks, applications of neural networks, Recurrent network. Natural Language Processing, Perceptions and actions. Introduction to Expert Systems, Definition types, Component, development process. Introduction to AI languages: PROLOG and LISP. Text/References: 1.Artificial Intelligence: Elaine Rich, Kevin Knight, Mc-Graw Hill. 2.Introduction to AI & Expert System: Dan W. Patterson, PHI. Program Elective III (Semester VII) IT-471 Computer Graphics (3-0-2)4 Introduction to computer graphics : Vector and Raster graphics, Graphic primitives and attributes. Computer graphics devices - CRT, plasma, LCD, plotters, Scan conversion of line, circle and ellipse. Viewing Transformations : Coordinate system - world, device and normalized device coordinates, Window and Viewport and viewing transformations Filling and Clipping - Flood fill and seed fill algorithms and scan line polygon filling algorithms, Cohen Sutherland clipping algorithms for Polygon Geometric transformations - 2D and 3D transformations: Translation, Scaling, rotation, Shearing, reflection etc., Transformations about an arbitrary axis Projections: Parallel - Orthographic, Plans and Elevations, Axonometric - Isometric, Diametric, trimetric, Perspective - One point, two point, three point. Hidden surface removal : Object space and image space algorithms, Back space removal, Z-buffer, scan line, area subdivision, painters, BSP tree, Floating horizon and ray tracing methods Curves: Spline representations, Curve representation techniques, Continuity constraints, Hermite Interpolation, Bezier curves, B-Spline curves Text/References: 1.Foley, Van Dam. Computer Graphics: Principles and Practic. Addison Wesley. 2.Hearn and Baker. Computer Graphics. PHI. 3.Rogers and Adams. Mathematical Elements of Computer Graphics. McGraw Hill. 4.Rogers and Adams. Procedural Elements of Computer Graphics. McGraw Hill. IT-473 Human Computer Interaction (3-0-2)4 Human factors issues in the development of software, use of database systems, and design of user interfaces for interactive systems. Science base (theories, models, usability studies, and controlled experimentation), and software engineering with user interface development environments. Issues include: command languages, menus, forms, and direct manipulation, graphical user interfaces, computer supported cooperative work, information search and visualization, World Wide Web design, input/output devices, and display design. Text /References: 1.B. Shneiderman, Designing the User Interface, 3rd Edition , Addison-Wesley, (1998) 2.Interaction Design by Jenny Preece, Yvonne Rogers, and Helen Sharp. John Wiley & Sons: New York, 2002. ISBN: 0471492787. 3.User Centered Web Site Design , by D.D. McCracken and R.J. Wolfe. Pearson Prentice Hall: Upper Saddle River, NJ, 2004. ISBN: 013041161-2. 4.The Web Wizard's guide to Web Design , J.G. Lengel, Addison-Wesley, 2002. ISBN: 0201745623. IT-475 GUI Programming (3-0-2)4 Issues and Challenges in GUI design. Overview of intelligent interface design. Graphics versus web interface. Principles of good interface. System Menu and Navigation schemes. Interaction devices. Screen based controls. Usability, testing, design for web, humans. Colors. Text/ References: 1.Wilbert O. Galitz. The Essential Guide to User Interface Design. Wiley. 2.Susan Weinschenk, Pamela Jamar, Sarah C. Yeo. GUI Design Essentials (Paperback) 3.Jenifer Tidwell. Designing

Interfaces: Patterns for Effective Interaction Design, O'Reilly. 4.B. Shneiderman, Designing the User Interface, 3rd Edition, Addison-Wesley. IT-477 Selected Topics in OS (3-0-2)4 Processes and Threads, Concurrency control, Directory and File structure, File sharing, NFS, Storage management. Design issues of Distributed OS, Distributed v/s network operating system. Communication: Client Server, RPC Distributed OS: Issues, process management, inter-process communication, scheduling, deadlocks Design and implementation of distributed file systems, distributed shared memory Security: Concepts and Distributed Systems Distributed Concurrency, Transactions. Case study: Unix, Amoeba. Text/References: 1.Operating System A Design Approach-Crowley, TMH. 2.Tanenbaum: Distributed Operating Systems, Pearson Education. 3.Bach, Design of Unix O/S. 4.Coulouris et al, Distributed Systems: Concepts and Design, Addison Wesley. 5.Mullender: Distributed Systems, Addison Wesley. 6.Tanenbaum and Steen: Distributed Systems: Principles and Paradigms, Pearson Education IT-479 Mobile and Wireless Computing (3-0-2)4 Wireless communication fundamentals: Introduction, wireless transmission, frequencies for radio transmission, signals, antennas, signal propagation, multiplexing, modulations, spread spectrum, MAC, SDMA, FDMA, TDMA, CDMA, cellular wireless networks. Telecommunication networks: Telecommunication systems :GSM,GPRS, DECT, UMTS, IMT-2000, Satellite networks - basics – parameters and configurations – capacity allocation: FAMA and DAMA. Wireless LAN: IEEE- 802.11, architecture, services, MAC, physical layer, IEEE 802.11a, 802.11b standards, HIPERLAN, BLUE TOOTH. Mobile network layer: mobile ip, dynamic host configuration protocol, routing, DSDV, DSR. Transport and application layers : traditional TCP, classical TCP improvements – WAP, WAP 2.0. Text/References: 1.Jochen Schiller, "Mobile Communications", PHI/Pearson Education, Second Edition, 2003. 2.William Stallings, "Wireless Communications and Networks", PHI/Pearson Education, 2002. 3.Kaveh Pahlavan, Prasanth Krishnamoorthy, "Principles of Wireless Networks", PHI/Pearson Education, 2003. 4.Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, "Principles of Mobile Computing", Springer, New York, 2003. 5.Hazysztof Wesolowshi, "Mobile Communication Systems", John Wiley and Sons Ltd, 2002. Program Elective IV (Semester VII) IT-481 Advanced Compiler (3-0-2)4 A Tour of Compiler Design, LR Parsers – SLR parsers, Canonical LR and LALR parsers, Lex and Yacc Tools, Control-flow Analysis, Control-flow Graphs, Basic Blocks, Data-flow Analysis, Dependence Analysis, Global Optimizations, Loop Optimizations, Dominators, Loop-invariant computations, Code motion, Data Dependence Analysis in Loops, Loop Scheduling, Runtime System Architectures and Automatic Memory Management Techniques. Text/References: 1.Aho, Alfred V., Sethi, Ravi, Ullman, Jeffrey D., Compilers: Principles, Techniques and Tools, Addison-Wesley. 2.Steven Muchnick, Advanced Compiler Design & Implementation, Morgan Kaufmann. 3.Keith Cooper and Linda Torczon, Engineering a Compiler, Morgan Kaufmann. IT-483 Design and Analysis of Algorithms (3-0-2)4 Review of Algorithms : Searching and Sorting, Tree and Graph traversal. DFS and its applications. Shortest path algorithms, minimum spanning tree algorithm. Algorithm Design Techniques: Greedy algorithm, dynamic programming, divide and conquer, backtracking, branch and bound. Algorithm Analysis : Asymptotic notation, solution of

recurrence, model of computation, time and space complexities, average and worst case analysis, Amortized analysis. Master's theorem. Recurrence solving. Graph Algorithms: network flow, matching, coverings, applications of DFS:- bi-connectivity, Euler circuits, strongly connected components, topological sort, and articulation point. Network Flow. Greedy Algorithms: Knapsack problem. Dynamic Programming : Chained matrix multiplication, longest common subsequence. Divide and Conquer: Order Statistics – finding the median, exponentiation, matrix multiplication, LCS. Approximate Algorithm : Travelling Salesman Problem, vertex-cover problem. Randomized Algorithms: Matrix Algorithms – Strassen Matrix multiplication, LUP decomposition. Number Theoretic Algorithms: Primality Testing, Factorization. Miscellaneous: Introduction to approximate, randomized and probabilistic algorithms. Introduction to problem classes – NP, NPC, NP-Hard. Text / References: 1.Cormen, Leiserson, Rivest: Introduction to Algorithms , Prentice Hall of India. 2.Horowitz and Sahani: Fundamental of Computer algorithms . 3.Aho A.V , J.D Ullman: Design and analysis of Algorithms , Addison Wesley 4.Brassard : Fundamental of Algorithmics , PHI. 5.W.W. Peterson and E. J. Weldon: Error correcting codes . 6.Sara Baase, Allen Van Gelder: Computer Algorithms: Introduction to Design and Analysis , Pearson Education.

IT-485 Semantic Web (3-0-2)4 Basics of knowledge representation and informal introduction to OWL Description logics and classifiers - the ALC family and its extensions. Expressiveness versus tractability; highly expressive description logics; implemented description logic systems; description logics and the "Semantic Web". Practical issues in ontologies: Basic principles, normalisation and the "Ontoclean" methodology, upper ontologies, Common problems in ontology development: parts and wholes, time, space, fundamental limitations. Text/References: 1.The Description Logic Handbook, Baader et al, CUP, 2003. 2.Ian Pratt. Artificial Intelligence. Macmillan, 1994. 3.John Sowa. Principles of Semantic Networks: Explorations in the representation of knowledge. Morgan Kaufmann, 1991. 4.Russell and Norvig. Artificial Intelligence: A Modern Approach. Prentice Hall, 1995. 5.Han Reichgelt. Knowledge Representation: An AI Perspective. Ablex Publishing, 1991.

IT-487 Data Mining and Data Warehousing (3-0-2)4 Introduction to Decision Support Systems, Data Warehouse and Online Analytical Processing. Data Warehouse Architecture: System Processes, Process Architecture: Load Warehouse, Query, Detailed and Summarized Information. Design: Data Base Schema Facts, Dimensions and Attributes. Introduction to Data Base and Metadata. Data Warehouse Implementation. Data Mining : Introduction and need. Data Processing : Data Cleaning, Data Integration and Transformation, Data Reduction. Data Mining Primitives : Descriptive and Predicative Data Mining, Language DMQL and its Preliminary Clauses. Data Mining Methods: Association – Single and Multilevel, Characterization and Comparison, Regression Analysis, Classification and Predication. Data Mining Algorithms: Clustering, Association, Regression, Decision Trees. OLAP : OLAP Architecture, ROLAP, and MOLAP. Application and Trends in Data Mining. Text/References: 1.Data Warehousing in the Real World – Anahory and Murray, Pearson Education. 2.Data Mining – Concepts and Techniques – Jiawei Han and Micheline Kamber. 3.Building the Data Warehouse – WH Inmon, Wiley.

IT-489 Implementation of Data Bases (3-0-2)4 Issues in Implementation of Centralized Database Systems - Query

Processing, Query Optimization, Transaction Processing, Concurrency, Recovery Management. Database System Architectures – Centralized and Client-Server architecture, Parallel Systems, Distributed Database Systems. Implementation of Distributed Database Systems- Distributed Data Storage, Distributed Transactions, Concurrency control in Distributed Database Systems, Distributed Query Processing. Text & References: 1.Silberschatz A, Korth HF, Sudarshan S, Database System Concepts, McGrall Hill. 2.Elmasri R and Navathe SB, Fundamentals of Database Systems, 3rd Edition, Addison Wesley,2000. This book covers most of the material on the course. 3.Ceri S, Pelagatti G, Distributed Databases – Principles and Systems, McGraw Hill. Program Elective V (Semester VII) IT-491 Information Retrieval (3-0-2)4 INTRODUCTION- Information storage and retrieval systems, Data Structures and Algorithms Related to Information Retrieval RETRIEVAL STRATEGIES - Vector Space Model, Probabilistic Retrieval Strategies, Language Models, Inference Network, Extended Boolean retrieval, Latent Semantic Indexing RETRIEVAL UTILITIES - Relevance Feedback , Clustering, Passage-Based Retrieval, N-grams, Regression Analysis, Thesauri, Stemming, Semantic Networks, Parsing, Ranking EFFICIENCY- Inverted Index, Query Processing, Signature Files, Duplicate Document Detection INTEGRATING STRUCTURED DATA AND TEXT - Review of the Relation Model, A Historic Progression, Information Retrieval as a Relational Application, Semi-Structured Search using a Relational Schema, Multi-dimensional Data Model Text/References: 1.Information Retrieval Data Structures & Algorithms by William B. Frakes, Ricardo Baeza-Yates 2.Information retrieval- by D A Grossman , Ophir Frieder, Springer International Edition IT-493 Wireless Sensor Networks (3-0-2)4 Introduction – motivation, applications, sensors, architectures, platforms for WSN Actual Systems - Berkeley motes, TinyOS and nesC.Wireless Radio Realities – radio irregularities and impact on protocols. MAC protocols – S-MAC, multi-channel MAC. Routing –Geographic routing, DSR, AODV , Directed Diffusion, SPEED. Clock Synchronization - FTSP, TPSN. Localization – TDOA, Walking GPS, range free solutions .Power Management – per node, system-wide, sentry services, sensing coverage Data Services and Databases – architectures, queries (SQL), data dissemination. Programming Abstractions – programming models, EnviroTrack, new APIs Security and Privacy – problems, attacks, solutions, open research areas.Case Study: A Complete System – surveillance and tracking application. How to program actual WSN. Text/References 1.Protocols and Architectures for Wireless Sensor Networks . H. Karl and A. Willig. John Wiley & Sons, June 2005. 2.Wireless Sensor Networks: Technology, Protocols, and Applications . K. Sohraby, D. Minoli, and T. Znati. John Wiley & Sons, March 2007. 3.Wireless Sensor Networks . C. S. Raghavendra, K. M. Sivalingam, and T. Znati, Editors. Springer Verlag, Sep. 2006. 4.Wireless Sensor Networks: Architectures and Protocols . E. H. Callaway, Jr. AUERBACH, Aug. 2003. 5.Networking Wireless Sensors . B. Krishnamachari. Cambridge University Press, Dec. 2005. 6.Wireless Sensor Networks: An Information Processing Approach . F. Zhao and L. Guibas. Morgan Kaufmann, Jul. 2004. 7.Sensor Networks and Configuration: Fundamentals, Standards, Platforms, and Applications . N. P. Mahalik. Springer Verlag, Nov. 2006. 8.Wireless Sensor Networks: A Systems Perspective , N. Bulusu and S. Jha, Editors, Artech House,



August 2005. IT-495 Topics in High Speed Networking (3-0-2)4 Overview of Internet Technologies, Issues in next generation Internet - Routing, Multicasting, Packet Scheduling, Quality of Service etc. Admission control in Internet: Effective bandwidth, Differentiated services, Policy-based networking, Real time communications over Internet, Internet telephony, Voice over IP, Integrated services. Web QoS, Intelligent caching, Traffic measurement and characterization. Text/ References: 1.Kurose: Computer Networking A Top Down Approach , Pearson. 2.Peterson and Davie: Computer Networks: A systems approach , Morgan Kaufman and Elsevier. 3.J.Walrand, High Performance Computer Networks , Elsevier 4.A.Kumar, D.Manjunath, Communication Network MKP. 5.Recent papers from conferences and journals. IT-497 Digital Watermarking and Steganography (3-0-2)4 Watermarking: Applications, techniques, models, detection techniques. Visible and invisible watermarks. Embedding. Robust watermarking, watermark security. Steganography – Least Bit, DCT, Spread spectrum. Audio steganography. Steganalysis techniques. Text/References: 1.Ingemar Cox, Matthew Miller, Jeffrey Bloom, and Jessica Fridrich . Digital Watermarking and Steganography, 2nd Ed, (The Morgan Kaufmann Series in Multimedia Information and Systems). (Hardcover - Nov 16, 2007) 2.Frank Y . Shih. Digital Watermarking and Steganography: Fundamentals and Techniques , CRC Press. 3.Stefan Katzenbeisser, Fabien, and A.P. Petitcolas. Information Hiding Techniques for Steganography and Digital Watermarking, Artech House. 4.Neil F. Johnson; Zoran Duric; Sushil Jajodia. Information Hiding: Steganography and Watermarking - Attacks and Countermeasures , Springer. 5.Gregory Kipper. Investigator's Guide to Steganography , Auerbach Publications. IT-499 Software Project Management (3-0-2)4 Software Project Management Concept: The Management Spectrum, People, Product, Process & Project. Software Process & Project Matrix: Software Measurement, Size Oriented Matrices, Function Oriented Matrices. Software Project Planning: Objectives, Decomposition Techniques and Empirical Estimation Model. Risk Analyses and Management: Risk Identification, Projection, Risk Identification, Projection, Risk Refinement, Risk Monitoring and Management. Project Scheduling & Tracking, Software Quality Assurance, Software Configuration Management. Text /References: 5.R. S. Pressman, Software Engineering 6.P. Jalote, Software Project Management in Practice. 7.B. Hughes & M. Cotterell, Software Project Management. Program Elective VI (Semester VIII) IT-470 Digital Forensics (3-0-2)4 File System Forensics : Duplicating hard disks for "dead analysis", reading hidden data on a disk's Host Protected Area (HPA), Direct versus BIOS access, dead versus live acquisition, Disk partitions - DOS, Apple, and GPT partitions, BSD disk labels, Sun Volume; multiple disk volumes - RAID and disk spanning; Analyzing FAT, NTFS, Ext2, Ext3, UFS1, and UFS2 file systems, Finding evidence: File metadata, recovery of deleted files, Using The Sleuth Kit (TSK), Autopsy Forensic Browser, and related open source tools Web Forensics: network-based evidence in Windows and Unix environments, Reconstructing Web browsing, e-mail activity, Tracing domain name ownership and the source of e-mails System Forensics: Windows Registry changes, Duplicating and analyzing the contents of PDAs and flash memory devices Electronic document, computer image verification and authentication Texts/References: 1.Brian Carrier. File System

Forensic Analysis , Addison Wesley. 2.Chris Prosise, Kevin Mandia. Incident Response and Computer Forensics , McGraw Hill. 3.Linda V olonino, Reynaldo Anzaldua, and Jana Godwin. Computer Forensics: Principles and Practices, Prentice Hall. 4.Keith J. Jones, Richard Bejtlich, and Curtis W. Rose. Real Digital Forensics: Computer Security and Incident Response , Addison Wesley 5.Vacca, John R., Computer Forensics Computer Crime Scene Investigation , Charles River Media. 6.Nelson, Phillips, Enfinger, Steuart. Guide to computer Forensics and Investigation , Course Technology. 7.Papers from Journals/Conferences. IT-472 Biometric Security (3-0-2)4 Biometrics: Need, Conventional techniques of authentication, challenges - legal and privacy issues. Biometrics in use: DNA, fingerprint, Iris, Retinal scan, Face, hand geometry, human gait, speech, ear. Handwriting, Keystroke dynamics, Signature Multimodal biometrics: Combining biometrics, scaling issues. Biometric template security. Texts/References: 1.Julian D. M. Ashbourn, Biometrics: Advanced Identify Verification: The Complete Guide 2.Davide Maltoni (Editor), et al, Handbook of Fingerprint Recognition 3.L.C. Jain (Editor) et al, Intelligent Biometric Techniques in Fingerprint and Face Recognition 4.John Chirillo, Scott Blaul, Implementing Biometric Security IT-474 VLSI Algorithms (3-0-2)3 1.Introduction of VLSI Technology, VLSI design cycle, design styles, basic Layout rules and circuit abstraction, introduction to standard Cell, Gate array, FPGA 2.Overview of basic graph algorithms, Graph algorithms for physical Design 3.Partitioning: Classification of partitioning algorithms, Karnighan-Lin Algorithm, FM Algorithm, Ratio cut algorithm 4.Floor-planning: Rectangular dual graph approach of floor-planning, hierarchical tree based approach, Integer programming based floor-planning. 5.Placement: placement by simulated annealing and force directed method 6.Routing: classification of routing algorithms, Global routing: Maze routing algorithms, line probe algorithms, Steiner tree based algorithms, Detailed Routing: Single layer and two layer routing algorithms, routing in FPGAs Text/References: 1.Naveed Shervawani, " Algorithms for VLSI physical Design Automation " III Ed Springer 2.Sarrafzadeh and Wong " An introduction to VLSI Physical design " MGH 3.Sze: VLSI Technology 4.Weste and Eshraghan, " Introduction toVLSI Design". Pearson Edu. 5.Sadiq M. Sait, Habib Youssef, "VLSI Physical Design Automation: Theory and Practice", World Scientific Publishing Company; 6.Cormen Leiserson, Rivest, " Introduction to Algorithms", Pearson Edu. IT-476 Intrusion Detection (3-0-2)4 Introduction- Intrusion detection system (IDS), intrusion prevention system (IPS), Unauthorized access – buffer overflow, packet fragmentation, out-of-spec packets. Review of Network protocol – TCP/IP. Intrusion detection through tcpdump. IDS and IPS – Architecture and internals. Malicious and non-malicious traffic, IP headers, TDP, UDP and ICMP protocols and header formats, Header information to detect intrusion, logs and their analysis, IDS through reaction and response Intrusion analysis – data correlation, tools, SNORT. Text/References: 1.Matt Fearnow, Stephen Northcutt, Karen Frederick, and Mark Cooper. Intrusion Signatures and Analysis, SAMS. 2.Carl Endorf, Gene Schultz, Jim Mellander, Intrusion Detection and Prevention , McGraw Hill. 3.Stephen Northcutt and Judy Novak. Network Intrusion Detection , SAMS. 4.Paul E. Proctor. The Practical Intrusion Detection Handbook , Prentice Hall. IT-478 Pattern Recognition (3-0-2)4 Digital Image Fundamentals: Image Model, Sampling, Quantization, Neighborhood, connectivity of

pixels, Labelling of connected components, Distance measures Image Transforms: Fourier Transform, Discrete Fourier Transform, Properties of 2D Discrete Fourier Transform, The fast Fourier Transform and its algorithm, number of operations, the inverse FFT. Discrete Cosine Transform and its applications, KL Transform, Convolution and correlation Image Enhancement: Enhancement by point processing, spatial filtering, enhancement in frequency domain, generation of spatial masks from frequency domain specifications Image Segmentation: Detection of discontinuities, edge linking and boundary detection, thresholding, region oriented segmentation Representation and Description: Representation schemes, boundary descriptors, regional descriptors. Morphology: Dilation, erosion, opening, closing, Hit-or-Miss Transform, some basic morphological algorithms like pruning, thinning and thickening Text/References: 1.Gonzalez and Woods. Digital Image Processing, Addison Wesley. 2.Castleman. Digital Image Processing. Prentice Hall. 3.Duda and Hart. Pattern Classification. John Wiley. Program Elective VII (Semester VIII) IT-480 Multi-Core Architectures (3-0-2)4 Multiple core programming models. GPGPU programming and streaming data processing. Issues related with coherency, languages and communication overheads in multi-core programming. Text/References: 1. Art of Multiprocessor Programming: Nir Shavit, Elsevier. IT-482 Software Testing (3-0-2)4 Basic software testing principles - Software testing, test case generation and test management. Acceptance Testing: User acceptance testing, alpha and beta testing. Verification and Validation, Functional and Non-functional system testing. Software quality assurance. Static and dynamic testing, Black-box or functional testing, structural, white box or glass box testing. Integration testing, component testing. Text/References: 1.Recent papers from conferences and journals. 2.A. P. Mathur, Fundamentals of software testing. IT-484 Distributed Systems (3-0-2)4 Introduction: What is a distributed system? Main characteristics. Advantages/Disadvantages. Design goals. Main problems. Models of distributed systems. Communication in Distributed Systems: Message passing and the client/server model. Remote Procedure Call. Group Communication. Time and State in Distributed Systems: Time in distributed systems. Logical clocks. Vector clocks. Causal ordering of messages. Global state and state recording. Distributed Mutual Exclusion: Mutual exclusion in distributed systems. Non-token based algorithms. Token based algorithms. Distributed elections. Transaction and concurrency control: Introduction. Transactions. Nested transactions. Locks. Optimistic concurrency control. Timestamp ordering. Comparison method of concurrency control Distributed Transactions : Introduction. Flat and nested distributed transactions . Atomic commit protocols, Concurrency control in distributed transactions, Distributed deadlocks . Transaction recovery Replication: Motivation for replication. Consistency and ordering. Total and causal ordering. Update protocols and voting. Recovery and Fault Tolerance: Transaction recovery. Checkpointing and recovery. Fault tolerance in distributed systems. Hardware and software redundancy. Byzantine agreement. File Systems: Introduction, File Service Architecture. Sun network file system. The Andrew File system. Recent Advances Text/References: 1.Distributed Systems: Concepts and Design, 4rd ed by Coulouris, G, Dollimore, J., and Kindberg, T., Addison-Wesley, 2006. ISBN: 0321263545 2.Distributed Systems: Principles and Paradigms, 2nd ed by

Tanenbaum, A. and van Steen, M., Prentice Hall, 2007. ISBN: 0132392275. IT-486 Advanced Topics in Data Bases (3-0-2)4 Transaction Management - Transaction Processing, Concurrency Control, Recovery Management. Advanced SQL – Complex queries, Nested Subqueries, Views, Materialized Views, Triggers, Referential Integrity, Security and Authorization. Query Processing and Query Optimizations. Database System Architectures, Distributed Databases, Distributed Transactions, Distributed Query Processing. Text/References: 1.Silberschatz A, Korth HF, Sudarshan S, Database System Concepts, McGrall Hill. 2.Elmasri R and Navathe SB, Fundamentals of Database Systems, 3rd Edition, Addison Wesley,2000. This book covers most of the material on the course. 3.Date CJ, An Introduction to Database Systems , 7th Edition, Addison Wesley. IT-488 Expert Systems (3-0-2)4 Overview of AI, Problem space and searching techniques, Production system, Control strategies, Heuristic search techniques, Knowledge representation acquisition and learning. Introduction to Expert Systems, Definition types, Component, development process. Architecture of Expert System, Case studies and expert system development tools. Introduction to AI languages: PROLOG and LISP. Text/References: 1.Artificial Intelligence: Elaine Rich, Kevin Knight, Mc-Graw Hill. 2.Introduction to AI & Expert System: Dan W. Patterson, PHI. 3.Fundamentals of expert system, S.N. Sharan, CBS Publishers. Btech\_CP\_April\_oldscheme.pdf Ist year AUTUMN SEMESTER MA-101 Mathematics-I BS 4 3-1-0 PH-101 Physics-I BS 5 3-1-2 EE-101 Electrical Science\* ESA 43-1-2/2 HS-101 English (Basic/Advanced)\* HS 4 3-0-2 CH-101 Fundamentals of Bio-Tech\* ESA 2 2-0-0 ME-101 Basic Mechanical Engg. ESA 3 2-0-2 CE-101 Engineering Graphics I ESA 3 1-0-3 CY-101 Chemistry\* BS 5 3-1-2 IC-101Computer Systems & Programming\*ESA 4 3-0-2 SPRING SEMESTER MA-102 Mathematics-II BS 4 3-1-0 PH-102 Physics-II BS 5 3-1-2 EC-102 Electronics ESA 4 3-1-0 ME-102 Engineering Graphics II ESA 3 1-0-3 IC-101Computer Systems & Programming\*ESA 4 3-0-2 HS-101 English (Basic/Advanced)\* HS 4 3-0-2 EE-101 Electrical Science\* ESA 43-1-2/2 CH-101 Fundamentals of Bio-Tech\* ESA 2 2-0-0 CY-101 Chemistry\* BS 5 3-1-2

Department of Computer Engineering Malaviya National Institute of Technology  
Curricular Structure BTech (Computer Engg.) 2nd Year AUTUMN SEMESTER  
Teaching Scheme Contact Hrs/Week Exam Duration Relative  
WeightageS.No.Subject CodeCourse Title Subject AreaPr Credit Lecture Tutorial  
Practical Theory Practical CWS PRS MTE ETE PRE CH 1IC-201 Mathematics III BS  
4 3 1 0 3 -25 -25 50 - 4 2CP-201 Logic System Design DC EC-102 4 3 0 2 3 - -30 20  
50 - 6 3CP-203 Data Structures DC IC-101 5 3 1 2 3 -10 20 20 50 - 6 4CP-205  
Discrete Structures DC 4 3 1 0 3 -20 -30 50 - 4 5CP-207 Electronic Circuits and  
Design ESA EC-102 4 3 0 2 3 - -30 20 50 - 5 6 Institute Elective I IE 4 3 1 0 3 -25 -25  
50 - 4 25 18 4 6 29 SPRING SEMESTER Pr Cr CH 1IC-202 Social Science &  
Economics HS 4 3 1 0 25 -25 50 - 4 2CP-202Principles of Programming  
LanguagesDC CP-203 4 3 0 2 3 - -30 20 50 - 5 3CP-204 Microprocessor & Interfaces  
DC CP-201 4 3 0 2 3 - -30 20 50 - 5 4CP-206 Object Oriented Design DCIC-101, CP-  
2034 3 0 2 3 - -30 20 50 - 6 5CP-208Principles of Communication EngineeringESA  
EC-102 4 3 1 0 3 -20 -30 50 - 4 6 Institute Elective II IE 4 3 1 0 3 -25 -25 50 - 4 24 18 3

6 Creative Arts /Sports/NSS/Hindi ECA 2 28 Discipline ECA 2 Total Credits: 53

Department of Computer Engineering Malaviya National Institute of Technology  
Curricular Structure BTech (Computer Engg.) 3rd Year AUTUMN SEMESTER  
Teaching Scheme Contact Hrs/Week Exam Duration Relative  
WeightageS.No.Subject CodeCourse Title Subject AreaPr Credit Lecture Tutorial  
Practical Theory Practical CWS PRS MTE ETE PRE CH 1CP-301 Computer  
Architecture DCCP- 2014 3 1 0 3 -20 -30 50 - 4 2CP-303 Data Base Management  
Systems DC 4 3 0 2 3 - -30 20 50 - 6 3CP-305 Software Engineering DC 4 3 1 0 3 -20  
-30 50 - 4 4CP-307Design and Analysis of AlgorithmsDCCP- 2034 3 0 2 3 - -30 20 50  
- 6 5CP-309 Computer Networks DC 4 3 0 2 3 - -30 20 50 - 2 6CP-311 Group  
Discussion and Viva Voce DC 2 0 2 0 - - - - -100 4 7 Institute Elective III IE 4 3 1 0 3  
-25 -25 50 - 4 26 18 5 6 30 SPRING SEMESTER CH 1IC-301 Technical  
Communication HS 4 2 2 0 2 -25 -25 50 - 5 2CP-302 Operating System DCCP- 2034  
3 0 2 3 - -30 20 50 - 5 3CP-304 Digital Signal Processing ESA 4 3 1 0 3 -20 -30 50 - 4  
4CP-306 Theory of Computation DCCP- 2034 3 1 0 3 -20 -30 50 - 4 5CP-308  
Computer Graphics DC 4 3 0 2 3 - -30 20 50 - 5 6CP-310 Scripting Language DC 1 0  
0 2 - - -100 - - - 2 7 Department Elective I DE 4 3 1 0 3 -20 -30 50 - 25 17 5 6 3  
Creative Arts /Sports/NSS/Hindi ECA 0 Total Credits: 53 2 Discipline ECA 2 30  
Department Elective I CP-322 Optimization Techniques DE CP-324 Combinatorics  
DE CP-326 Advanced Microprocessors DECP- 204 CP-328 Neural Networks DE  
CP-330 Mathematical Programming DE CP-332 Information Theory and Coding DE  
Department of Computer Engineering Malaviya National Institute of Technology  
Curricular Structure BTech (Computer Engg.) Final Year AUTUMN SEMESTER  
Teaching Scheme Contact Hrs/Week Exam Duration Relative  
WeightageS.No.Subject CodeCourse Title Subject AreaPr Credit Lecture Tutorial  
Practical Theory Practical CWS PRS MTE ETE PRE CH 1CP-401 Principles of  
Compiler Design DC CP-308 4 3 0 2 3 - -30 20 50 - 5 2CP-403 AI and Expert Systems  
DC 4 3 0 2 3 - -30 20 50 - 5 3CP-405 Introduction to VLSI Design DC 4 3 0 2 3 - -30  
20 50 - 5 4CP-407 Real Time Systems DCCP-204, CP-3014 3 0 2 3 - -30 20 50 - 4 5  
Department Elective II DE 4 3 0 2 3 - -30 20 50 - 5 6 Department Elective III DE 4 3 0  
2 3 - -30 20 50 - 4 7 Industrial Field/Training DC 2 - - - - - - -100 26 18 012 28  
SPRING SEMESTER CH 1IC-401 Industrial Management HS 4 3 1 0 2 -25 -25 50 - 5  
2CP-402 Major Project DC 12 0 2 6 - -20 -20 -60 5 3 Department Elective IV DE 4 3 0  
2 3 - -30 20 50 - 4 4 Department Elective V DE 4 3 0 2 3 - -30 20 50 - 5 5 2 6 24 9 310  
Creative Arts /Sports/NSS/Hindi ECA 0 Total Credits: 52 21 Discipline ECA 2  
Department Elctive II (Semester VII)Department Elctive IV (Semester VIII)  
CP-421Advanced Topics in Computer GraphicsDE CP-206CP- 420Advanced Topics  
in OS DE CP-423 Advanced Topics in Networking DE CP-301CP- 422Parallel and  
Distributed Computing DE CP-425 Distributed Data Bases DE CP-304CP-  
424Computer Human Interaction DE CP-427 VHDL DE CP-303CP- 426 Software  
Project ManagementDE CP-429 Simulation and Modelling DECP- 428Advanced  
Topics in Databases DE Department Elctive III (Semester VII)CP-304,  
CP-425Department Elctive V (Semester VIII) CP-441 Embedded Systems DECP-  
440Robotics DE CP-443 Cryptography DE CP-429CP- 442Behavioural Synthesis DE

CP-445Advanced Data Structures and AlgorithmsDECP-303, CP-427CP-444Multimedia Systems DE CP-447Image Processing and Pattern RecognitionDECP-446Mobile Computing DE CP-449 Biometrics DECP- 448Advanced Computer Architecture DE Department of Computer Engineering Department of Computer Engineering Malaviya National Institute of Technology Malaviya National Institute of Technology BTech (Computer Engg.) Teaching Scheme BTech (Computer Engg.)Credits Lecture Tutorial Practical HS BS HS ESA DC DE IED+n+S/C TOTAL  
First year 54 4 23 4 23 2+2+2 56 Semester III 25 18 4 6 4 4 13 4 - 25 Semester IV 24 18 3 6 4 4 4 12 4 2+0+2 28 Semester V 26 18 5 6 22 4 - 26 Semester VI 25 17 5 6 4 4 4 13 4 2+0+0 27 Semester VII 26 18 0 12 18 8 - 26 Semester VIII 24 9 3 10 4 12 12 8 2+0+0 26 Total 204 16 27 24 35 90 20 12 8+2+4 214 214

Ist year AUTUMN SEMESTER MA-101 Mathematics-I BS 4 3-1-0 PH-101 Physics-I BS 5 3-1-2 EE-101 Electrical Science\* ESA 4 3-1-2/2 HS-101 English (Basic/Advanced)\* HS 4 3-0-2 CH-101 Fundamentals of Bio-Tech\* ESA 2 2-0-0 ME-101 Basic Mechanical Engg. ESA 3 2-0-2 CE-101 Engineering Graphics I ESA 3 1-0-3 CY-101 Chemistry\* BS 5 3-1-2 IC-101Computer Systems & Programming\*ESA 4 3-0-2 SPRING SEMESTER MA-102 Mathematics-II BS 4 3-1-0 PH-102 Physics-II BS 5 3-1-2 EC-102 Electronics ESA 4 3-1-0 ME-102 Engineering Graphics II ESA 3 1-0-3 IC-101Computer Systems & Programming\*ESA 4 3-0-2 HS-101 English (Basic/Advanced)\* HS 4 3-0-2 EE-101 Electrical Science\* ESA 4 3-1-2/2 CH-101 Fundamentals of Bio-Tech\* ESA 2 2-0-0 CY-101 Chemistry\* BS 5 3-1-2 2nd Year AUTUMN SEMESTER Teaching SchemeS.No.Subject Code Course Title Subject AreaPr Credit B.Tech (Computer Engineering) CP-201 Logic System Design Credits: 4 (3-0-2) Introduction to Boolean algebra : Binary connectives, Evaluation of truth functions, Truth – function calculus as Boolean Algebra, Duality, Fundamental theorems of Boolean Algebra and simplification of Boolean expressions. Realisation of Logic Circuits : Standard forms of Boolean Functions, Minterm and Maxterm, designation of functions. Simplification of functions on Karnaugh maps, incompletely specified functions. Combinational circuits : Adder, subtract, encoder, decoder, multiplexer, demultiplexer, parity checker and generator.Cubical representation of Boolean functions and determination of prime implicants. Selection of an optimal set of prime implicants, multiple output circuits and map minimization of multiple output circuits. Tabular determination of multiple output prime implicants. Latches, Flip Flops : JK, SR, D Type and T type Flip Flops and their working principals. Counters and shift registers: Ripple, decade, up-down counters, Mod-n counters and series, parallel registers. General characteristic of sequential circuits, clock, pulse and level mode sequential circuits. Analysis and design of sequential circuit. Synthesis of state diagrams, finite memory circuits, equivalence relations, equivalent states and circuits, determination of classes of in distinguishable states and simplification by implicant tables. Mealy and Moore machines, state assignment and memory element input equation, Partitioning and state assignment. General pulse-mode circuits, clock input counters, extended state tables. Asynchronous Mode Circuits : Analysis of a fundamental mode circuits, Synthesis of flow tables, minimization, transition tables, excitation maps and output maps, Cycles and Races, Race free assignments,

Hazards in sequential circuits. Introduction to A/D and D/A converters. Text/References: 1.Morris-Mano : Logic System and Design, Mc Graw Hill 2.Hill & Peterson: Switching Theory and Logic Design, John Wiley 3.J.F.Wakerly: Digital Design, Principle and Practices, Pearson. 4.Malvino leech: Digital Electronics 5.Digital Systems and Hardware and Firmware Algorithms: M.Ercegovac and T. Lang, Pearson. 11/09/2012 1 B.Tech (Computer Engineering) CP-203 Data Structures Credits 5 (3-1-2) Arrays: Representation – row-major, column-major, sparse matrix – implementation, addition, multiplication; polynomial – representation, addition, evaluation and multiplication. Strings: Representation, operations, string matching - Brute force or naïve, Robin-Karp, Knuth- Morris-Pratt. Linked List: Static and dynamic implementation,single, double, circular, multiple linked list. Stack: Static and dynamic implementation, expression evaluation, prefix (polish), infix, postfix (inverse polish) expressions, application, multiple stacks, recursion. Queues: Static and dynamic implementation,applications, circular queue, multiple queue. Tree: Binary tree, binary search tree, static and dynamic implementation, tree operations - insertion, deletion and search, tree traversal, Binary heaps. Introduction to AVL trees and B trees. Sorting: Insertion sort, selection sort, Bubble sort, quick sort, merge sort, heap-sort, radix sort (bucket sort). Searching: Linear and binary search, hashing. Graph: Representation of graphs, BFS, DFS, topological sort. Text/References: 1.Aho A.V., J.E. Hopcroft, J.D. Ullman, Data Structures and algorithms , Addison Wesley. 2.Kruse R.L., Data Structure and Program Design , PHI. 3.Horowitz and Sahni: Data Structure in C++ , Glagotia 4.Ellis Horowitz, Sartaj Sahni, Fundamentals of Data Structures 5.Aaron M. Tenenbaum, Y. Langsam, Moshe J. Augenstein, Data Structures Using C 6.Niklaus Wirth, Algorithms + Data Structures = Programs (Prentice-Hall Series in Automatic Computation) 7.Sartaj Sahni, Data Structures, Algorithms, and Applications in C++ 8.Mark Allen Weiss, Data Structures and Algorithm Analysis in C++ (2nd Edition) 11/09/2012 2 B.Tech (Computer Engineering) CP-205 Discrete Structures Credits 4 (3-1-0) Set and Functions : Sets, relations, functions, operations, and equivalence Relations, relation of partial order, partitions, binary relations, Equivalence relations . Monoids and Groups : Groups, Semi groups and Monoids, Cyclic semi graphs and sub monoids, Subgroups and cosets. Congruence relations on Semi groups. Morphisms Normal sub groups. Structure of cyclic groups, Permutation groups, dihedral groups, elementary applications in coding theory. Rings: Rings, Subrings, Morphism of rings, ideal and quotient rings, Euclidean domains. Number-theoretic algorithms : Greatest Common Divisor, Chinese Remainder Theorem, Primality testing. Field Theory: Integral domains and Fields, polynomial representation of binary number, Galois fields, primitive roots, discrete logarithms. Text/ References: 1.Kolman B., Busby R: Discrete Mathematical Structures for Compute Science , PHI. 2.Liu: Introduction to Discrete Mathematics , McGraw-Hill. 3.Graham, Knuth, Pratschnik : Concrete Mathematics . 4.Grimaldi: Discrete Mathematical Structures . 5.Grossman P, Discrete Mathematics for Computing , Macmillan 1995 6.Ross KA & Wright CRB, Discrete Mathematics , Prentice-Hall 1999 7.Johnsonbaugh R, Discrete Mathematics , Macmillan. 8.Wiitala, Discrete Mathematics , McGraw Hill. 9.Biggs N L, Discrete Mathematics , Oxford. 10.Truss J, Discrete Mathematics for Computer Scientists , Addison Wesley. 11/09/2012 3 B.Tech

(Computer Engineering) CP-207 Electronic Circuits And Design Credits: 4 (3-0-2)

1. Transistor Characteristics : the junction transistor, transistor current component, the transistor as an amplifier, transistor construction, the common base configuration, the common emitter configuration, the CE cut off region, the CE saturation region, typical transistor junction voltage values, common-emitter current gain, the common collector configuration. 2. Transistor Biasing & Thermal Stabilization : the operating point, bias stability, self-bias or emitter bias, stabilization against variation in  $I_{CO}$ ,  $V_{BE}$ , and  $\beta$ , bias compensation, biasing techniques, for linear integrated circuits, thermistor and sensor compensation, thermal runaway, thermal stability. 3. The transistor at low frequencies : graphical analysis of the CE configuration, two-port devices and the hybrid model, transistor hybrid model, the h-parameter, conversion formulas for the parameters of the three transistor configuration, analysis of a transistor amplifier circuit using h- parameters, the emitter follower, comparison of transistor amplifier configuration. Simplified calculations for common-collector configuration, the common-emitter amplifier with an emitter resistance, high input resistance transistor circuits. 4. High Frequency model of BJT amplifiers. 5. Introduction to switching devices : positive and negative logic of OR, AND, NOR, NAND, Exclusive OR and Exclusive NOR gates. RTL, DTL, DCTL, TTL, ECL, HTL, MOS and CMOS logic circuit and their realisation. Speed and Delay in logic circuit. 6. Field Effect Transistors : The junction field effect transistor, the pinch-off voltage, the JFET volt-ampere characteristics, the FET small signal model, the metal-oxide-semiconductor FET (MOSFET), the low frequency common source and common drain amplifiers, the FET as a voltage variable resistors (VVR). 7. Feedback Amplifiers and Oscillators : Concepts of feedback. Various topologies for amplifiers. Positive feedback, various oscillator circuits. 8. Multivibrators: Astable, Bistable and Monostable Multivibrators.

Text/References: 1. Integrated Electronics, Millman Halkias, TMH. 2. Solid state Electronics Devices, Streetman, PHI. 3. Microelectronic Circuits, Sedra Smith, Oxford Press, India. 11/09/2012

4 B.Tech (Computer Engineering) CP-202 Principles of Programming Languages Credits 4 (3-0-2) Importance of programming languages, brief history and features, attributes of good programming language. Introduction to language translator, binding and binding time. Language translation issues: Formal translation models-BNF grammars, regular grammar, FSA. Elementary and structured data types, their specifications, representations, and implementation of numbers, vectors and arrays, records, character string, variable size data structure, sets, input output files. Type checking and type conversion, type equivalence. Encapsulation and information hiding, sub programs. Implicit and explicit sequence control. Subprogram sequence control. Recursive sub programs, exception and exception handlers. Co-routines and scheduled subprograms, task and concurrent exception. Name and reference environments, static dynamic and block structure. Local data and local referencing environments. Dynamic and static scope of shared data. Block structure, parameters and their transmission. Task and shared data storage requirement for major runtime elements. Program and system controlled storage management. Static and stack based storage management. Fixed size and variable size heap storage management. Text / References: 1. Ghezzi: Programming Language Concepts, Addison Wesley 2. Pratt, Zelkowitz: Programming Language Design and



Implementation PHI. 3. Sebastia: Concept of Programming Language , Addison Wesley 4. Sethi Ravi: Programming language Concepts & Constructs , Addison Wesley. 11/09/2012 5 B.Tech (Computer Engineering) CP-204 Microprocessor And Interfaces Credits 4 (3-0-2) The 8085 Microprocessor: Block diagram, pins and their description, demultiplexing of buses, control signal and flags. Introduction to 8085 based microcomputer system. Instruction and timing: instruction classification, instruction formats, addressing modes, instruction timings and status, interrupts. Programming the 8085: 8085 instruction set, data transfer instruction, arithmetic logic & branch operations: Rotate and compare. Instruction related to stack operations. Programming Techniques: looping, counting and indexing, counters and time delays, subroutines. Interfacing concepts: basic interfacing concepts, memory mapped and peripheral mapped I/O. Interfacing peripherals: Descriptions, programming and interfacing of 8255, 8253, 8259A with 8085. Description of simple systems using above chips. Direct Memory Access: basic concepts of DMA techniques, Description, programming and interfacing of DMA controller 8257. Serial I/O: Basic concept of serial I/O, software controlled serial I/O. Basic Idea of Following Bus Standard: RS232C, IEEE-4888. Text/References: 1. Douglas V. Hall : Microprocessors and Interfacing, McGraw Hill 2. Gaonkar ; 8085 Programming, Penram Press 11/09/2012 6 B.Tech (Computer Engineering) CP-206 Object Oriented Design Credits 4 (3-0-2) Object Oriented Programming and Design : Review of abstraction, objects and other basics, Encapsulation, Information hiding, method, Signature, Classes and Instances, Polymorphism and inheritance. C++ Programming Basics : Fundamentals, variables and assignments, Input and Output, Data types and expressions, flow of control, subprograms, top-down design, predefined functions, user defined functions, procedural abstractions, local variables, overloading function names, operator overloading, parameter passing, this pointer, destructors, copy constructor, overloading the assignment operator, virtual functions, function calling functions, friend functions, recursive functions, recursive member functions. Static member function. C++ Object oriented concepts : Objects and classes, use of file for I/O, formatting output with stream functions, Character I/O, inheritance, structures for diverse data, structures as function arguments, initializing structures, defining classes and member functions, public and private members, constructors for initialization, standard C++ classes, derived classes, flow of control, use of Boolean expressions, multiway branches, use and design of loops. Friend function and friend class. C++ Data structures and Advanced Topics : Arrays – programming with arrays, arrays of classes, arrays as function arguments, strings, Multidimensional arrays, Arrays of strings, pointers Dynamic arrays, Classes and dynamic arrays, Base classes, access control, Templates- generic classes and functions, namespaces. Standard Template Library. Text/References: 1. Balaguruswamy: Object-oriented Programming with C++. 2. Robert Lafore: C++ Programming 3. Ashok N. Kamthane : Object Oriented with C++, Pearson Education 11/09/2012 7 B.Tech (Computer Engineering) CP-208 Principles Of Communication Engineering Credits: 4 (3-1-0) Transmission Media : Primary and secondary line constant, telephone lines and cables, Electronic Public Switch Telephone Network. Twisted pair, coaxial cable. Introduction and principles of light communication in fibers, losses in optical fiber, dispersion, light sources and photo

detectors, connectors. Modulation Of Signals : Introduction to Radio communications. Principles of Analog modulation techniques like FM, PM, SSB, Generation and detection. FDM, Pulse Modulation: Pulse transmission over band-limited signals, sampling theory, pulse amplitude modulation, Time division multiplexing. Digital Communication : Digital representation of information, characterization of communication channels: Time and frequency domain. Fundamental limits of digital transmission: Nyquist signalling rate and Shannon channel capacity. PCM, DPCM, DM, ADM, comparison of above systems on the basis of performance criterion such as bit transmission, signalling rate, error probability, S/N ratio, bandwidth requirements. Text/ References: 1. Simon Haykin, Comm. System 3/e ,Wiley Eastern Ltd. 3. Taub & Schilling, Principles of Comm. Systems. , McGraw Hill publications. 4. John D. Ryder: Network lines and fields, PHI 5. Communication Networks: Leon Garcia and Widjaja, Tata McgrawHill 6. Digital Telephony: John.C.Bellamy 11/09/2012 8 B.Tech (Computer Engineering) CP-301 Computer Architecture Credits 4 (3-1-0) Basic Structure of computer Hardware and Software, Basic computer organization and design, Von Neumann Architecture Processor Design: Some Fundamental Concepts, Instruction Sets: Characteristics and functions and formats. Computer Arithmetic: Fixed Point Arithmetic and Floating point Arithmetic, Fast Adders and Multipliers, ALU Design. Control Design: Execution of a complete Instruction. Instruction Sequencing, Instruction Interpretation. Control Unit Operations: Hardware Control and Micro programmed Control Memory Organization: Memory Technology, Virtual Memory: Hierarchies, Segments, Pages ,High Speed Memories, Interleaved, Internal Memory, External Memory, Cache. System Organization: Communication with I/O devices (Asynchronous, Synchronous) Input Output: I/O HW, Standard I/O Interfaces. Text / References: 1. Computer Organization and Architecture - William Stallings (Pearson Education Asia) 2. Computer Organization and Architecture -John P. Hayes (McGraw -Hill) 3. Computer Organization -V. Carl. Hamacher (McGraw-Hill) 4. Computer System Architecture -M. Morris Mano (PHI) 11/09/2012 9 B.Tech (Computer Engineering) C P-303 Data Base Management Systems Credits 4 (3-0-2) Need, purpose and goal of DBMS, Three tier architecture, ER Diagram, data models- Relational, Network, Hierarchical and Object Oriented. Data Base Design: Conceptual data base design, Theory of Normalization Primitive and Composite data types, concept of physical and logical databases, data abstraction and data independence, data aggregation, Relational Calculus. SQL : DDL and DML, Relational Algebra. Application Development using SQL : Host Language interface, embedded SQL programming, Stored procedures and triggers and views, Constraints assertions. Internal of RDBMS : Physical data organisation in sequential, indexed random and hashed files. Inverted and multilist structures, B trees, B+ trees, Query Optimisation, Join Algorithm, Statistics and Cost Base optimisation. Transaction Processing, concurrency control, and recovery management. Transaction model properties and state serialisability . Lock base protocols, two phase locking. Text/References: 1.H.f. Korth and Silberschatz: Database Systems Concepts , McGraw Hill 2.Almasri and S.B. Navathe: Fundamentals of Database Systems , 3.C.J. Date: Data Base Design, Addison Wesley 4.Hansen and Hansen : DBM and Design, PHI 11/09/2012 10 B.Tech (Computer Engineering) CP-305 Software Engineering Credits 4 (3-1-0) Introductory

Concepts : Historical perspective, System Definition, Software Life Cycle, Software Engineering paradigms. System analysis: Feasibility study requirement analysis, Cost benefit analysis, Planning systems, Analysis tools and techniques. System Design: design fundamentals, Modular Design, Data and procedural design, object oriented design. System Development : Code documentation, Program design paradigms, Efficiency Consideration. Verification, Validation and Testing : testing methods, Formal Program Verification, Testing Strategies. Software Maintenance : Maintenance Characteristics, Maintainability, Maintenance tasks and side effects. Text / References: 1.Pressman R.S: Software Engineering: A Practitioner approach, McGraw hill 2.Sommerville I: Software Engineering, Addison Wesley 3.Ghezzi C. Jazayeri M and Mandrioli: Fundamentals of software Engg. , PHI 11/09/2012 11

B.Tech (Computer Engineering) CP-307 Design and Analysis of Algorithms Credits 4 (3-0-2) Algorithm Analysis : Asymptotic notation, solution of recurrence, model of computation, time and space complexities, average and worst case analysis. Algorithm Design Techniques : Greedy algorithm, dynamic programming, divide and conquer, backtracking, branch and bound. Greedy Algorithms : Knapsack problem. Dynamic Programming : Chained matrix multiplication, longest common subsequence. Divide and Conquer: Order Statistics – finding the median, exponentiation, matrix multiplication. Graph Algorithms : Shortest path algorithms, minimum spanning tree algorithm, network flow, matching, coverings, applications of DFS:- biconnectivity, Euler circuits, strongly connected components, topological sort, and articulation point. Approximate Algorithm : Travelling Salesman Problem, vertex-cover problem. Set algorithms: Disjoint set operations. Matrix inversion – LUP decomposition. Construction of codes: Shannon Fano and Huffman codes. Introduction to problem classes – NP, NPC, NP-Hard. Text / References: 1.Cormen, Leiserson, Rivest: Introduction to Algorithms , Prentice Hall of India. 2.Horowitz and Sahani: Fundamental of Computer algorithms . 3.Aho A.V , J.D Ulman: Design and analysis of Algorithms , Addison Wesley 4.Brassard : Fundamental of Algorithmics , PHI. 5.W.W. Peterson and E. J. Weldon: Error correcting codes . 6.Sara Baase, Allen Van Gelder: Computer Algorithms: Introduction to Design and Analysis , Pearson Education. 11/09/2012 12

B.Tech (Computer Engineering) CP-309 Computer Networks Credits: 4 (3-0-2) Computer Network Architecture, Circuit switching, Packet And Message Switching, Network Structure. OSI 7-layer architecture. Physical Layer, Data Link Layer, Framing, Error detection. Retransmission algorithms. Queueing models and introduction to Little's theorem, M/M/1 and M/M/m queues. Network of queues. Introduction to M/G/1 queues, reservations and priority. Stability of queueing systems. Multiple access and Aloha. CSMA/CD and Ethernet. High Speed LANs and Token Ring. High speed switch scheduling. Broadcast routing and spanning trees. Shortest path routing. Distributed routing algorithms, optimal routing. Flow control – window/credit schemes, rate control schemes. Transport layer and TCP/IP. Introduction to ATM networks and Network Management And Interoperability. Performance Issues Of LAN And WAN. Text/ References: 1.Data Networks: Bertsekas and Gallager, Phi. 2.Computer Networking A top down Approach : J.F.Kurose, Pearson. 3.Data & Computer Communication : W. Stalling , Phi 4.Computer Networks : L. Peterson and Davie, MKP 5.Computer Networks and

Internet : D.E. Comer, Pearson 11/09/2012 13 B.Tech (Computer Engineering) CP-302 Operating System Credits: 4 (3-0-2) 1.Introduction: Need of Operating System, its evolution, types of operating systems, batch, multiprogramming, time sharing systems, real time systems. 2.Processes and processor management : process concept, systems programmers view of processes, operating systems view of processes, Process scheduling, Schedulers, interprocess communication and synchronization, race condition, mutual exclusion, semaphores, monitors, messages. Deadlocks prevention , avoidance, detection and recovery. 3.Memory Management : a.Contiguous allocation- partitioned memory allocation – fixed and variable partitioning, memory management with bit maps – swapping – relocation- protection and sharing. b.Non contiguous allocation – i.Paging – principles , page allocation, segmentation. ii.Virtual memory concepts, address translation, management of virtual memory, page replacement policies, protection and sharing, working set model, hardware support. 4.File management: Command language users view of file system, file system design, disk space management directory structure, shared files, file system performance. File servers, security, protection mechanism. 5.Input/Output Management : Device drivers, disk scheduling. 6.Introduction to loaders, linkers and relocating loaders. 7.Case study: UNIX. References/text: 1.A.Silberschatz and Peter B Galvin: Operating System concepts , Addison Wesley publishing Company. 2.Deitel H.M: Operating Systems , Addison Wesley. 3.Stalling W: Operating Systems , Prentice Hall. 4.Tanenbaum: Operating System Concepts , Prentice Hall. 11/09/2012 14 B.Tech (Computer Engineering) CP-304 Digital Signal Processing Credits: 4 (3-1-0) Introduction to Continuous time Systems ,idea about Linear Time Invariant System LTI systems. Fourier Transforms. Discrete Time Systems: Sampling and aliasing, LTIs , Representation of Sequences by Fourier Transform and properties of Fourier Transform. Z-Transform, Structures for discrete system, DFT, Computation of DFT. FIR Filters, frequency response of FIR filters. IIR Filters, spectrum analysis. FFT Algorithms Text/ References: 1.Discrete Time Signal Processing by Alan V Oppenheim, Ronald W Schafer.- PHI 2.Digital Signal Processing Primer : K.Steiglitz, Pearson. 3.Signal and Systems : S.Haykin and Veen, Wiley 4.DSP First: A Multimedia Approach : J.F.McClellan, Schafer and Yodar, Pearson. 11/09/2012 15 B.Tech (Computer Engineering) CP-306 Theory of Computation Credits 4 (3-1-0) Introduction to automata theory, languages, recursive definitions, regular expressions, finite automata, transition graphs and Kleen's theorem. Non-determination, finite automata with output, regular languages, minimization of finite automata. Chomsky classification of languages, regular grammars, context free grammars, simplification of context free grammars, Normal forms of CFG. Push Down Automata Theory: push down automata and context free languages. Turing hypothesis, Turing machine, Minsky's theorem, TM variation and encoding, computability and acceptability. Elements of propositional logic and predicate calculus. Text/ References 1.Aho, Hopcroft and Ullman, Introduction to Automata Theory, Formal Languages and Computation, Narosa 2.Cohen, Introduction to Computer Theory , Addison Wesley. 3.Papadimitriou, Introduction to Theory of Computing , Prentice Hall. 4.K.Krishnamurthy: Theory of Computation . 11/09/2012 16 B.Tech (Computer Engineering) CP-3 08 Computer Graphics Credits: 4 (3-0-2) Introduction to Interactive

Computer Graphics : Picture analysis, Overview of programmer's model of interactive graphics, Fundamental problems in geometry. Basic Raster Graphics : Scan Conversion, Aliasing, and Anti Aliasing, Polygon: Representation, Filling and Clipping. Geometric Manipulation : Transformations, Vectors, Matrices, and Homogeneous Co-ordinates. Elementary 3D Graphics : Planar Geometric Projections, Vanishing Points, Specification of 3-D View. Hidden Lines & Surfaces : Image and Object space, Depth Buffer Methods, Hidden Facets removal, Scan line algorithm, Area based algorithms, Floating horizon, Painters & BSP tree algorithms . Curves and Splines : Parametric and Non parametric Representations, Bezier and B-Spline Curves. Rendering: Color, Simple Light Illumination Model, Ray tracing, Gouraud and Phong Shading. Text/ References: 1.J. Foley, A. Van Dam, S. Feiner, J. Hughes: Computer Graphics-Principles and Practice , Addison Wesley. 2.D. Hearn and Baker: Computer Graphics , PHI 3.D. Rogers and Adams: Mathematical Elements of Computer Graphics , Mc Graw Hill. 4.D. Rogers : Procedural Elements of Computer Graphics , McGraw Hill. 11/09/2012 17 B.Tech (Computer Engineering) CP-322 Optimization Techniques Credits 4 (3-1-0) 1.Introduction: Introduction, Engineering applications (models) of optimization. 2.Linear Programming : Graphical, simplex method, Concept of duality, Dual simplex method,. 3.Dynamic Programming: 4.Transportation Problems : basic feasibility solution by different methods, optimal solution, Degeneracy in transportation problem, unbalanced transportation problems 5.Assignment Problems : Balanced and unbalanced assignment, assignments to given schedule. 6.Introduction to Non-linear programming :. Text/References 1.Rao S S, Optimization: Theory and Applications. 2.N.S. Kambo : Mathematical Programming Techniques , East West Press 3.Hamdy A. Taha : Operation Research an Introduction , PHI 4.Vasek Chvatal : Linear Programming , W.H. Freeman & Co. 5.Walsh G R, Methods of Optimisation 6.Williams H P, Model Building in Mathematical Programming 7.Williams H P, Model Solving in Mathematical Programming 8.Winston W L, Operations Research: Applications and Algorithms . 9.Papadimitriou, Steiglitz: Combinatorial Optimization: Algorithms and Complexity , PHI. 11/09/2012 18 B.Tech (Computer Engineering) CP-324 Combinatorics Credits 4 (3-1-0) Graph Theory: Graphs – Directed and Unidirected, Eulerian chains and Cycles. Hamiltonian chains and cycles. Trees, chromatic number, Connectivity and other graphical parameters. Applications. Polya's Theory of enumeration and its applications. Number Systems: Sums and Product rules, Permutation and combinations. Pigeon hole principle, Inclusion and Exclusion Principles, Ramsey, Catalan and Stirling numbers. Sequences and selections, Proofs, Induction, Relations, Combinatorial number theory. State Machines: Invariants and Termination Recursive Definitions and Structural Induction Sums, Products & Asymptotics Probability Theory: Introduction to Probability, Random Variables and Expectation Text/References: 1.Graham, Knuth, and Patashnik: Concrete Mathematics: A Foundation for Computer Science , Pearson 2.Kenneth H. Rosen: Discrete Mathematics and its Applications , Fourth Edition. 3.Tucker: Applied Combinatorics , Wiley. 4.Gibbons, A.: Algorithmic Graph Theory , Cambridge University Press. 5.Narsingh Deo:Graph Theory with Application to Engineering and Computer Science , Prentice- Hall. 6.Narsingh Deo: Com binatorial Algorithms: Theory and Practice , Prentice-Hall. 11/09/2012 19 B.Tech (Computer Engineering)

CP-326 Advanced Microprocessors Credits 4 (3-1-0) Architectural Features of X86 Microprocessors and Pentium Processors and comparison. Addressing Modes of x86, Instruction Sets, Instruction templates, Interrupts and interrupt handling, assembly language programming. Memory management: Real, Protected And Virtual Real Modes, segmentation and paging. Multitasking and task switching Features in x86. Text/ References : 1.Douglas V. Hall: Microprocessor and interfacing, Programming And Hardware, TMH 2.B.S. Chhabra: 8086 architecture and interfacing, DRP 3.Liu Gibson: Introduction to 8086/88 architecture and interfacing, PHI 4.James L. Antonakof: Introduction to Intel Family of Microprocessors, Pearson Edu. Asia Credits 4 (3-1-0) 11/09/2012 20 B.Tech (Computer Engineering) CP-328 Neural Networks Credits 4 (3-1-0) Neural Architecture : Neuron model, transfer function, hamming and hopfield network, perceptron, learning rule, recurrent networks. Backpropagation: generalized delta rule, limitations, modeifications – momentum, variable learning rate, conjugate gradient. Learning: Supervised, associative, competitive, unsupervised learning. Unsupervised learning : Self-organising maps, Adaptive Resonance Theory. Neural network applications : Pattern classification, function approximation. Text/ References: 1.Simon Haykin: Neural Networks: A Comprehensive Foundation (2nd Edition) 2.Christopher M. Bishop: Neural Networks for Pattern Recognition 3.James A. Freeman, David M. Skapura: Neural Networks, Pearson Education. 4.Martin T. Hagan: Neural Network Design, Thomson Learning . 5.N. Gupta, Optimization Techniques for Engineers , Ashirwad Publishers and Distributors 11/09/2012 21 B.Tech (Computer Engineering) CP-330 Mathematical Programming Credits 4 (3-1-0) Classical Optimization: Polyhedra; Extreme Points. Degeneracy; Optimality Conditions; The Simplex Method. Duality; Dual Simplex, Farkas Lemma, Separating Hyperplanes and Duality, Cones, Rays, Representation of Polyhedra, Dantzig-Wolfe Decomposition Non-linear Programming : Unconstrained and constrained optimization Integer programming Project Scheduling : CPM and PERT. Theory of Games: Two person zero sum game, solution of pure strategy game (with saddle point). Search Methods: Line search, steepest descent and Newton's method. Text/References: 1.D. Bertsimas and J. N. Tsitsiklis, Introduction to Linear Optimization, Athena Scientific, 1997. 2.Papadimitriou, Steiglitz: Combinatorial Optimization: Algorithms and Complexity , PHI. 3.Rao S S, Optimization: Theory and Applications. 4.N.S. Kambo : Mathematical Programming Techniques , East West Press 5.Hamdy A. Taha : Operation Research an Introduction , PHI 6.N. Gupta, Optimization Techniques for Engineers , Ashirwad Publishers and Distributors 11/09/2012 22 B.Tech (Computer Engineering) CP-332 Information Theory and Coding Credits 4 (3-1-0) Mathematical Theory of Foundation Of Information Theory in Communication system. Measures of Information- Self information, Mutual Information, Average Information, entropy and its properties. Source Model and Coding, channels Model and Coding. Problems of unique decipherable Codes, condition of Instantaneous codes, Code word length, Kraft Inequality. Noiseless Coding Theorem. Construction of codes: Shannon Fano, Shannon Binary and Huffman codes. Discrete Memory less channels: Classification of channels, calculation of channel capacity. Decoding scheme- the ideal observer. The fundamental theorem of Information theory. Error Correcting Codes: Minimum distance principle. Relation between distance and error correcting properties of codes,

The Hamming bound. Parity check Coding. Bounds on the error correcting ability of Parity Check Codes. Text /References 1.Information theory and Reliable Communication by R.G.Gallager 2.Information Theory by Robert Ash 3.An Introduction to Information Theory by F. M. Reza 4.Error correcting codes by W.W. Peterson and E. J. Weldon 11/09/2012 23 B.Tech (Computer Engineering) CP-401 Principles of Compiler Design Credits 4 (3-0-2) Translators: Introduction to compilers, translators, and interpreters, compilation process. Lexical Analysis: Finite automata, Regular expressions, Design & implementation of lexical analysers. Syntax Analysis: Context Free Grammars, Derivation and Parse trees, Bottom-up and Top-down Parsing. Syntax directed translation: Syntax directed translation, Intermediate codes, Quadruples, Triples. Symbol table organization: Hashing, linked list, tree structures. Memory allocation: Static and dynamic structure allocation. Code optimization: Basic blocks, Flow graphs, DAG, Global data flow analysis, Loop optimization. Code generation: Compilation of expression and control structures. Error detection and recovery. Text & References: 1.Aho, Ullman and Sethi: Compilers, Addison Wesley. 2.Holub, Compiler Design in C, PHI. 11/09/2012 24 B.Tech (Computer Engineering) CP-403 AI & Expert System Credits 4 (3-0-2) Overview of AI, Problems, Problem space and searching techniques, Definition production system, Control strategies, Heuristic search techniques. Knowledge representation: Representation, mappings, approaches and issues, Predicate logic, prepositional logic, Resolution, Procedural and declarative knowledge, forward and backward reasoning, Matching, Semantic nets, Frames scripts. Learning and learning systems: Introduction to Hopfield networks, introduction to neural networks, learning in neural networks, applications of neural networks, Recurrent network. Natural Language Processing, Perceptions and actions. Introduction to Expert Systems, Definition types, Component, development process. Introduction to AI languages: PROLOG and LISP. Text & References: 1.Artificial Intelligence: Elaine Rich, Kevin Knight, Mc-Graw Hill. 2.Introduction to AI & Expert System: Dan W. Patterson, PHI. 11/09/2012 25 B.Tech (Computer Engineering) CP-405 Introduction to VLSI Design Credits: 4 (3-0-2) •Introduction: IC system design options, CMOS processing, layout and design rules, Stick diagrams •CMOS Design and Characterization using SPICE: Inverter transfer characteristics, noise margins, SPICE simulation, Transient response and transistor sizing, SPICE simulation, Speed-area trade-off , Circuit Power Consumption, design tradeoffs speed- power, introduction to low power circuit design, Capacitance estimation, buffer design, area-speed design tradeoffs. Transistors, gates and wires fabrication. •CMOS Circuit Design and Layout: Static complementary gates, Transmission gates and tristate circuits, Storage elements, Pass transistor logic, Dynamic logic, Structured macros: PLAs etc •Introduction to Low power design Text/References: 1.Modern VLSI Design : Wayne Wolf, Pearson 2.Rabaey JM, Digital Integrated Circuits , Prentice-Hall/Pearson 3.Weste NHE, Eshraghian K, Principles of CMOS VLSI Design with Verilog/VHDL manual , Addison-Wesley/Pearson, 2000 . 11/09/2012 26 B.Tech (Computer Engineering) CP-407 : Real Time Systems Credits: 4 (3-0-2) Introduction to Real-time systems, Issues in Real-time Systems, Real-time System Components, Classification of Real-time systems and Real-time tasks. Misconceptions about Real-time computing. Real-time System requirements: Speed, Predictability,

reliability, adaptability. Specification of timing constraints. Real-time scheduling: Requirements and Issues, Terminology, modeling, Introduction static and dynamic scheduling schemes, cyclic scheduling, priority driven scheduling of periodic tasks, schedulability tests, Aperiodic task scheduling: fixed priority server/non-server based scheduling algorithms. Practical factors/overheads. Task Synchronization: Need and priority inversion problem, Priority Inheritance protocol, priority ceiling protocol and stack-based priority ceiling protocol for fixed priority preemptive system. Introduction to multiprocessor real-time systems, problems and issues. An overview of a real-time operating system Text & References: 1.J.W.S.Liu: Real-Time Systems , Pearson Education Asia 2.S.T.Lavi, A.K.Agrawala: Real-time system Design , McGraw Hill 3.P.A.Laplante: Real-time Systems Design and Analysis, An Engineer's Handbook , IEEE Press 4.P.D.Laurence, K.Mauch: Real-time Microcomputer System Design, An Introduction , McGraw Hill 11/09/2012 27 B.Tech (Computer Engineering) CP-421 Advanced Topics in Computer Graphics Credits: 4 (3-0-2) Visibility: Polygon Meshes, Depth Sorting. Triangle decomposition, Geometric Sort, Warnock's Methods Hidden Lines and Surfaces : Special cases, Surfaces defined by a function  $y=f(x,y)$ , Grid surfaces. Colour in Computer Graphics : Color Vision, Measuring Color, Color Models, Color output, color usage. Object Lighting and Shading : Local reflection models, shading surfaces, Texture and transparency, Forward & backward Ray-tracing Global Illumination and classical radiosity. Modeling natural phenomena: Fractals and chaos. Animation Techniques : Position, speed or orientation. Animation by hierarchic control, scenario- based systems, movement control. Shadows, Morphing. Efficiency and complexity issues in graphics algorithms Text/ References: 1.J. Foley, A. Van Dam, S. Feiner, J. Hughes: Computer Graphics-Principles and Practice, Addison Wesley.( 2nd edition in C) 2.Alan Watt- 3D Computer Graphics (3rd edition) 3.Alan Watt, Mark Watt: Advanced Animation & Rendering Techniques:Theory & Practice , Addison-Wesley. 4.D. Rogers and Adams: Mathematical Elements of Computer Graphics , Mc Graw Hill. 5.Thomas Moller: Real-time Rendering , Eric Haines, A.K Peters Ltd 11/09/2012 28 B.Tech (Computer Engineering) CP-423 Advanced Topics in Networking Credits: 4 (3-0-2) Review of MAC and LLC Issues: Techniques for multiple access, Adaptive LLC mechanisms for wireless links . Internet Routing Architecture: Internet Service Providers and Peering. Border Gateway Protocol (BGP). Review of Open Shortest Path First Border Gateway Protocol (continued), BGP instability. Fair queuing. TCP congestion control. TCP variants. Random Early Detect (RED). TCP RTT estimation. Fast retransmit, Fast recovery. Resource ReSerVation Protocol (RSVP). Differentiated Services. Wireless TCP Mobile IP. Multicast routing Scalable Multicast routing. Core Based Trees (CBT). Scalable Multicast routing Protocol Independent Multicast (PIM). Scalable Reliable Multicast. Overlay Networks. Peer-to-Peer Networks. Domain Name System (DNS). LDAP/NIS. DHCP/BOOTP Introduction to Web-server and redirection mechanisms. Web cache sharing: Summary-Cache. Traffic Engineering. Introduction to the Next generation IP, IPv6, IP Next Layer (IPNL)ng,. Multi-Protocol Label Switching (MPLS) Access technologies: xDSL. Text/ References: 1.Computer Networks : L. Peterson and Davie, MKP\ 2.Wireless communication and Networking : W. Stallings 3.Recent RFCs and suggested reading form SIGCOMM/ACM/IEEE. 11/09/2012 29 B.Tech (Computer



Engineering) CP-42 5 Distributed Databases Credits: 4 (3-0-2) Introduction To Distributed DBMS, Overview of Relational DBMS and Computer Networking. Distributed DBMS Architecture, Architecture Models for Distributed Data Base System, Client - Server Systems, Peer-to-Peer Distributed Systems. Distributed Data Base Design, Distribution Design Issues, Fragmentation and Allocation. Semantic Data Control, View Management, Data Security, Query Processing, Characterization of Query Processor, Layers of Query Processing, Query Decomposition, Localization of Distributed Data, Optimization Of Distributed Queries. Introduction To Transaction Management, Distributed Concurrency Control, Distributed DBMS Reliability. Text & References: 1.Distributed Database: Principles and System - Ceri Pelagatti (McGraw Hill) 2.Principles of Distributed Database Systems - M. Tamer Ozsu, Patrick Valduriez (Pearson Education) 3.Distributed Data Base Systems - David Bill, Jane Grimson (Addison - Wesley) 11/09/2012 30 B.Tech (Computer Engineering) CP-427 VHDL Credits 4 (3-0-2) Origins of VHDL. VHDL Design Cycle, the standardisation process. Register-Transfer Level Design: RTL design stages. Design of Combinational Logic blocks. Synthesis and simulation models. Types and operators. Standard packages. Sequential VHDL: Concept of processes, Registers : simulation model, synthesis model, templates and types of registers. Hierarchy of components within VHDL designs. Subprograms and special structures. Test benches, data and file handling. Libraries. Text/References: 1.Designer's Guide to VHDL : P.J.Ashenden, MKP 2.Digital system Design with VHDL : M.Zwolinski, Pearson. 3.VHDL coding style and methodologies : Ben Cohen 4.VHDL Primer; J.Bhaskar, Pearson 5.VHDL for logic synthesis : A. Rushton, Wiley 11/09/2012 31 B.Tech (Computer Engineering) CP-429: Simulation and Modelling Credits: 4 (3-0-2) Definition of a system, System concepts, type of system, continuous & discrete systems, modeling process verification & validation. Markov chains. Weak law of large numbers. Central limit theorem. Strong law of large numbers. Queuing models: Little's Theorem, M/M/1, M/M/m, M/M/  $\infty$ , M/M/m/m, M/G/1, and M/M/1/J queuing systems. Introduction, classification of simulation models, advantages and disadvantages of simulation. Discrete system simulation: Monte Carlo method, Random number generators. Probability Distributions. Element of inventory theory, more complex inventory models, finite and infinite delivery rate model with and without back ordering. Simulation of inventory systems. Text/ References: 1.System simulation, Gordon G., Prentice Hall of India 2.System simulation, Narsing Deo, McGraw Hill. 3.Simulation modeling and analysis , Law and Kelton, McGraw Hill. 11/09/2012 32 B.Tech (Computer Engineering) CP-44 1 Embedded Systems Credits: 4 (3-0-2) Introduction to embedded systems., design representations, level of abstractions, design methodologies, Models and architectures, Taxonomy of models and architectures, brief descriptions of specification languages, Specification requirement for embedded systems, Spec Chart and Spec Chart Description. Design challenges & issues, hardware and software design, co-design of software and hardware, ASIC. Design quality estimation : Quality matrix, software and hardware estimation. Introduction Sample design Specification of Answering machine/ Microcontroller 8051. Text / References: 1.Denial D. Gajski , Frank Vahid: Specification and design of embedded systems , PH 2.Jonathan W. Valvano: Embedded Microcomputer Systems , Thomson Learning

3. Myke Predko: Programming and Customizing the 8051 Micro Controller , TMH 3. Ayala : 8051 Micro controllers , Penram Press 11/09/2012 33 B.Tech (Computer Engineering) CP-443 Cryptography Credits: 4 (3-0-2) Number theory: Prime numbers, modular arithmetic, Fermat's theorem, Euler's theorem, Chinese remainder theorem, Discrete logarithms, Random number generation, factoring, prime number generation, one-way hash functions – MD5, SHA (Secure Hash Algorithm). Cryptography: Need, conventional techniques, stream ciphers, block cipher, steganography. Public v/s private key cryptography. Stream Ciphers: Caesar Cipher, mono-alphabetic and poly-alphabetic ciphers, Playfair Cipher, Hill Cipher, Rotor machines, One time pad,. Steganography: Visual, Textual, Cipher hiding, False errors. Private-key cryptography: Feistel structure, DES (Data encryption standard), design of S-boxes, AES, Triple DES, Public key cryptography: Key management, Key exchange – Diffie-Hellman, Authentication, Signatures, Deniability, RSA. Digital Signature: DSA and its variants, discrete logarithm based digital signatures. Algorithms: International data encryption algorithm (IDEA), PGP. Cryptanalysis: Differential and linear cryptanalysis - cracking DES. Text & References: 1.Stallings, Cryptography and Network Security: Principles and Practice, Pearson Education Asia. ISBN 981-403-589-0. 2.B Schneier, Applied Cryptography, Wiley. ISBN 0-471-11709-9 3.D Kahn. The Codebreakers, Sphere books. ISBN 0-7221-51497 4.P Wayner, Disappearing Cryptography, Academic Press. ISBN 0-12-738671-8 5.Cracking DES, Electronic Frontier Foundation. ISBN 1-56592-520-3 6.A.J. Menezes, P.C. van Oorschot and S.A. Vanstone, Applied Cryptography, CRC Press, ISBN 0-8493-8523-7, 1997 7.D.R. Stinson, Cryptography - Theory and practice, CRC Press, ISBN 0-8493-8521-0, 1995 11/09/2012 34 B.Tech (Computer Engineering) CP-445 Advanced Data Structures and Algorithms Credits 4 (3-0-2) Binary heaps, binomial heaps, Fibonaaci heaps. AVL trees, Red-black trees, B-trees, Splay trees. Disjoint set – union and path compression, Amortized analysis Recurrence equations. Time and space complexity, NP, NPC and NP-Hard problems, undecidability. Convex hull, line segments, Optimal polygon triangulation. Primality testing, Integer factorization, Randomized algorithms, Probabilistic algorithms. Dynamic programming: Longest common subsequence. Chain of matrix multiplication, Approximate Algorithms: Vertex-cover, set-covering problems, Travelling Salesman problem. Combinatorial algorithms, Randomized algorithms. Texts/References: 1.Cormen, Leiserson, Rivest: Introduction to Algorithms, Prentice Hall of India. 2.Horowitz and Sahani: Fundamental of Computer algorithms . 3.Aho A.V , J.D Ullman: Design and analysis of Algorithms , Addison Wesley 4.Brassard : Fundamental of Algorithmics , PHI. 5.W.W. Peterson and E. J. Weldon: Error correcting codes . 6.Sara Baase, Allen Van Gelder: Computer Algorithms: Introduction to Design and Analysis , Pearson Education. 7.Papadimitriou, Steiglitz: Combinatorial Optimization: Algorithms and Complexity , PHI. 11/09/2012 35 B.Tech (Computer Engineering) CP-447 Image Processing & Pattern Recognition Credits: 4 (3-0-2) Image processing: Image formation, Image acquisition - cameras, displays, frame grabbers, Sampling and quantisation. Image Transforms: Fourier transform, Discrete Fourier transform (DFT), fast Fourier transform (FFT), Discrete cosine transform (DCT), wavelet transform, Principal component analysis (PCA), independent

component analysis (ICA). Image Enhancement : Point and region operators, Image filtering, Convolution, Histogram. Morphological operations – dilation and erosion. Image Segmentation: Segmentation by thresholding, optimal thresholding, region – representation, split and merge regions, quadtree, shape number, boundary descriptors. Image Restoration: Direct, inverse, pseudo-inverse. Image Representation: 2-D Shape representation and matching, Recovering depth information, 3-D representation and matching. Image Interpretation: Edge detection, feature extraction, template matching, Hough transform. Image classification: Metric, k-NN classification, clustering. Case Studies: Ultrasound image analysis, Face recognition. Text & References: 1.Gonzalez et al., Digital Image Processing, Prentice Hall, 2001 2.Sonka M, Hlavac V and Boyle R, Image Processing, Analysis and Machine Vision, Chapman and Hall, 2nd Ed. 1999. 3.Jain A K, Fundamentals of Digital Image Processing, Prentice Hall, 1989. 4.Stockman and Shapiro, Computer Vision, Prentice Hall, 2001 5.Banks S J, Signal Processing, Image Processing and Pattern Recognition, Addison Wesley, 1991. 6.Rabiner L R and Gold B, Theory and Applications of digital Signal Processing, Prentice Hall, 1975. 7.Efford, N., Digital Image Processing Using Java, Addison Wesley, 2000

11/09/2012 36 B.Tech (Computer Engineering) CP-449 Biometrics Credits 4 (3-0-2) Biometrics: Need, Conventional techniques of authentication, challenges - legal and privacy issues. Biometrics: DNA, fingerprint, Iris, Face, hand geometry, human gait, speech, infra-red spectrum, ear. Combining biometrics, scaling issues. Texts/References: 1.Julian D. M. Ashbourn, Biometrics: Advanced Identify Verification: The Complete Guide 2.Davide Maltoni (Editor), et al, Handbook of Fingerprint Recognition 3.L.C. Jain (Editor) et al, Intelligent Biometric Techniques in Fingerprint and Face Recognition 4.John Chirillo, Scott Blaul, Implementing Biometric Security 5.Nalini Ratha (Editor), Ruud Bolle 6.Authentication: From Passwords to Public Keys, Richard E. Smith

11/09/2012 37 B.Tech (Computer Engineering) CP-420 Advanced topics in Operating Systems Credits 4: (3-0-2) Introduction: Goals, Functions, Design issues of Distributed OS, Distributed v/s network operating system. Communication: Client Server, RPC Distributed OS: Issues, process management, inter-process communication, scheduling, deadlocks Design and implementation of distributed file systems, distributed shared memory Security: Concepts and Distributed Systems Distributed Concurrency, Transactions. Case study: Unix, Amoeba. Text/References: 1.Tanenbaum: Distributed Operating Systems, Pearson Education. 2.Bach, Design of Unix O/S . 3.Coulouris, Dollimore and Kindberg, Distributed Systems: Concepts and Design , Addison Wesley. 4.Mullender: Distributed Systems , Addison Wesley. Tanenbaum and Steen: Distributed Systems: Principles and Paradigms , Pearson Education

11/09/2012 38 B.Tech (Computer Engineering) CP-422: Parallel and Distributed Computing Credits 4 (3-0-2) Introduction to parallel computing. Parallel processing terminology, Pipelining Vs Data parallelism, Control parallelism, Scalability, Control parallel approach, Data parallel approach, Data parallel approach with I/O Parallel reduction, Prefix sums, List ranking, Preorder tree traversal, Merging two sorted lists, Graph coloring, Reducing the number of processors, Problems defying fast solutions on PRAMS Thread and process level parallel architectures: MIMD, multi-threaded architectures. Distributed and shared memory MIMD

architectures. Dynamic interconnection networks. Mapping and scheduling: Mapping data to processors on processor arrays and multicomputers, Dynamic Load Balancing on multicomputers, Static scheduling on UMA multiprocessors, Deadlock. Parallel programming and parallel algorithms: Programming models, parallel programming on multiprocessors and multicomputers. Parallel algorithm structure, analyzing parallel algorithm. Elementary parallel algorithms, Matrix algorithms, sorting, Graph algorithms. Text & References: 1.Parallel computing – theory and practice, Quinn, Tata McGraw Hill. 2.Advanced Computer Architectures, Sima and Fountain, Pearson Education. 3.Computer Architectures single and parallel systems, Mehdi R. Zargham, PHI. 4FOUNDATIONS of parallel processing, Ghosh, Moona and Gupta, Narosa publishing. 5.Michael Quinn: Parallel Computing-Theory and Practice, MGH 6.Ed. Afonso Ferreira and Jose' D. P. Rolin, Parallel Algorithms for irregular problems - State of the art, Kluwer Academic Publishers. 7.Selim G. Akl, The Design and Analysis of Parallel Algorithms, PH International. 11/09/2012 39 B.Tech (Computer Engineering) CP-424 Computer Human Interaction Credits: 4(3-0-2) Goals of human Computer Interaction and its relevance to the applications of interactive computer graphics Psychological Aspects Cognitive psychology, visual perception, auditory perception, haptic perception, human memory, human error Devices for human computer interaction : Text input devices, positioning and pointing devices, 3D devices, Devices for visual, auditory, and haptic output, Interfaces and devices for disabled users Models and paradigms of HCI : Characterizing different phases of interaction. Ergonomic aspects of interaction. Interaction styles: from command language to 3D interfaces. Windows interfaces(WIMP). Menu and icon design. Interaction paradigms. HCI and software Lifecycle : Analysis of usability requirements, Usability principles. User-centered design. Usability engg, prototyping techniques, Environment, user, task Analysis Formal Methods in HCI : State transition Networks and other diagrammatic notations, Textual notations Guidelines and standard user interfaces: Definition choosing and using guidelines. ISO 9241 standard Tools for user interface implementation : windowing system, programming techniques, user interface management systems. Usability Evaluation : Goals, recording tools, predictive evaluation, interpretive evaluation Help: Requirement, Main approaches, adaptive and adaptable interfaces. Recent Paradigms of HCI : Virtual reality, Multi-sensory interfaces, information visualization, Hypertext, Multimedia and Hypermedia interfaces, WWW interfaces. Design of usable web pages. Text / References: 1. A.Dix, J.Finlay, G. Abowd and R. Beale, Human Computer Interaction, Second Edition, PHI, 1998 2. B. Schneiderman, Designing the User Interface, Addison Wesley, III ed. 3. Preece, Rodgers, Sharp, Benion, Holland and Carey, Human Computer Interaction, Addison Wesley 4. Dix A, Finlay J, Abowd G and Beale R, Human-Computer Interaction , 3rd Edition. Prentice Hall, 2003 5. Norman DA, The Design of Everyday Things , Doubleday, 1990 6. Preece J and Keller L, Human-Computer Interaction, Prentice Hall, 1989 7. Barfield L, The User Interface: Concepts & Design , Addison Wesley, 1993 8. Cox K & Walker D, User Interface Design , Prentice Hall, 1993 9. Preece J, Rogers Y, Sharp H Interaction Design: beyond human- computer interaction , Wiley, 2002. 11/09/2012 40 B.Tech (Computer Engineering) CP-426 Software Project Management Credits 4 (3-0-2) 1.Software

Project Management Concept: The Management Spectrum, People, Product, Process & Project. 2. Software Process & Project Matrix: Software Measurement Size Oriented Matrixes, Function Oriented Matrices. 3. Software Project Planning: Objectives, Decomposition Techniques, Empirical Estimation Model. 4. Risk Analyses And Management: Risk Identification, Projection, Risk Identification, Projection, Risk Refinement, Risk Monitoring And Management. 5. Project Scheduling & Tracking, Software Quality Assurance, Software Configuration Management. Text & References: 1. R. S. Pressman, Software Engineering 2. P. Jalote, Software Project Management In Practice. 3. B. Hughes & M. Cotterell, Software Project Management.

11/09/2012 41 B.Tech (Computer Engineering) CP-428 Advanced Topics in Databases Credits 4 (3-0-2) Real-time Database: Implementation and issues. Concurrency control and locking. Recovery. Transaction management. Design and implementation issues in Relational Databases, Object-Oriented Databases, Temporal databases, Spatial databases, Multi-media databases Data mining, Data warehouse Text/References 1) Elmasri R and Navathe SB, Fundamentals of Database Systems, 3rd Edition, Addison Wesley, 2000. This book covers most of the material on the course. 2) Connolly T, Begg C and Strachan A, Database Systems, 2nd Edition, Addison Wesley, 1999 3) Simon AR, Strategic Database Technology: Management for the Year 2000, Morgan Kaufmann, 1995 4) Gray J and Reuter A, Transaction Processing: Concepts and Techniques, Morgan Kaufmann, 1993 5) Date CJ, An Introduction to Database Systems, 7th Edition, Addison Wesley, 1999 6) Khashafian S and Baker AB, Multimedia and Imaging Databases, Morgan Kaufmann, 1996 7) McFadden FR, Hofer JA and Prescott MB, Modern Database Management 5th Edition, Addison-Wesley 1999

11/09/2012 42 B.Tech (Computer Engineering) CP-440 Robotics Credits: 4 (3-0-2) Robotics: Introduction to robotics, advantages, applications. Robotic kinematics and dynamics: Direct and inverse kinematics problem. Axis transformations as applied to robotics; application and definition of the DH matrix; forward and reverse kinematics, trajectory planning. Robot manipulators and their control. Robot sensors: Active and passive robot sensors Construction of tactile, touch and vision sensors; interpretation of sensory information; vision processing; use of sensory data to determine kinematic information. Robot Intelligence: State space search, Robot learning, Robot task planning, robotics in computer vision applications. Robotic end effectors: Stable grip; constraints; types of contact; mathematical representation of stable grip; use of screw twist, and wrench gripper design; tools as end effectors. Problems of implementation of automatic systems. Text & References: 1. Fu K, Gonzalez R and Lee C, Robotics - Control Sensing Vision & Intelligence, McGraw Hill. 2. Craig J J, Introduction to Robotics, Mechanics and Control, Addison Wesley, 1993. 3. McKerrow P J, Introduction to Robotics, Addison Wesley, 1993. 4. Selig M, Introductory Robotics, Prentice Hall, 1992.

11/09/2012 43 B.Tech (Computer Engineering) CP-442 Behavioural Synthesis Credits 4 (3-0-2) • Review of hardware description languages and behavioural synthesis of digital systems. • Behavioural synthesis data structures and algorithms: Data and control flow representations, Data flow graph (DFG) descriptions, Control data flow graph (CDFG) descriptions, Extended Petri-net models • Synthesis and design space: Design space exploration, Constructive vs. transformational/iterative

techniques, Behavioural optimization, Scheduling, allocation, module binding and controller synthesis •Scheduling algorithms – constructive: Unconstrained scheduling: ASAP and ALAP algorithms, Constrained scheduling: list scheduling and force-directed scheduling, Scheduling of multicycled and pipelined functional modules •Allocation and binding algorithms: Lifetime analysis of registers, Variable-to-register mapping using the left edge algorithm •Interconnect allocation and optimisation •Transformational/iterative approaches: Cost functions, Transformations, Simulated annealing, Genetic algorithms •Test synthesis for digital systems: Design for testability: scan-based and built-in-self- test (BIST) techniques, Test scheduling, Test controllers, On-line test •Related areas: Analogue synthesis, HW/SW codesign, Design confidence (design verification, online test), Optimisation with respect to power dissipation, routability, interconnect delay, testability, Logic optimisation

Text/References: 1.Giovanni De Micheli, Synthesis and optimisation of digital circuits, McGraw Hill. 2.Sabih Gerez, Algorithms for VLSI design automation, , Wiley 3.John P Elliott, Understanding behavioural synthesis, , Kluwer. 11/09/2012 44

B.Tech (Computer Engineering) CP-444: Multimedia Systems Credits 4 (3-0-2) Multimedia Systems Design : An introduction. Compression and Decompression. Data and file format standards : Overview of other image file formats as JPEG, GIF, TIFF, BMP, PNG etc. Multimedia Input/Output Technologies : Storage and retrieval technologies, Architectural and telecommunication consideration. Making still images ; editing and capturing images; scanning images; computer color models; color palettes; vector drawing; 3-D drawing and rendering; Multimedia application design, Multimedia authoring and user interface. Multimedia information networks, distributed multimedia systems, System design methodology and considerations, Multimedia applications. MPEG Audio; audio compression & decompression; brief survey of speech recognition and generation; audio synthesis; Musical Instrument Digital Interface (MIDI); digital video and image compression; MPEG motion video compression standard; DVI technology; time-based media representation and delivery. Introduction to Virtual Reality Text & References: 1.Multimedia Systems Design, Prabhat Andleigh and Thakkar, PHI. 2.Multimedia Information Networking, N.K.Sharda, PHI. 3.Villamil & Molina, Multimedia : An Introduction, PHI 4.Lozano, Multimedia : Sound & Video, PHI. 5.Tay Vaughan, Multimedia :Making it work, TMH 6.Sinclair, Multimedia on the PC, BPB. 7.Villamil & Molina, Multimedia : Production, Planning and Delivery, PHI. 11/09/2012 45

B.Tech (Computer Engineering) CP-446: Mobile Computing Credits: 4 (3-0-2) Introduction to mobile computing: principles, classification & overview of devices, operating systems. Wireless transmission: brief overview, multipath propagation, hidden & exposed terminals. Medium access control & protocols: SDMA, FDMA, TDMA, DAMA, FAMA, PRMA, Reservation TDMA, polling, CSMA/CA, CDMA etc, Wireless LAN: infrastructure & ad-hoc networks, IEEE 802.11, HIPERLAN. Mobile network layer: mobile IP, DHCP, infrastructure & Ad-hoc routing. Mobile transport layer: indirect TCP, snooping TCP, mobile TCP etc. mobile support, WWW & mobility, WAP. Text & References: 1.Principles of mobile computing Hansmann & Merk. , Springer 2.Mobile communications Jochen Schiller , Pearson 3.802.11 wireless networks Matthew S.Gast, O'REILLY. 4.Wireless LANs: Davis & McGuffin, McGraw Hill 5.Mobile Communications Handbook by Jerry D. Gybson 6.Mobile

Communications Handbook by Raymond Steel 11/09/2012 46 B.Tech (Computer Engineering) CP-448: Advanced Computer Architecture Fundamentals: Computational models, concept of computer architecture, Von Newmann architecture. Instruction level parallel processors: Pipelining (instruction and arithmetic), Pipeline scheduling (static and dynamic), Throughput improvement, VLIW architectures. RISC and CISC architectures: RISC design versus CISC design. Instruction level data-parallel architectures: SIMD, vector architectures. Interconnection networks: Network topology, Static NW, Interconnection design decisions. Multiprocessors and multicomputers, Common interconnection structures, Data Flow computers: Introduction, Data Flow Program Graph, Activity Template, Scheme, Implementation, Pipelining in Data Flow Programs, Basic Mechanism, Data Flow Multiprocessor, Token labeling, MIT architecture. Text & References: 1.Advanced Computer Architectures , Sima and Fountain, Pearson Education. 2.Computer Architectures single and parallel systems , Mehdi R. Zargham, PHI. 3.Advanced Computer Architectures , Hwang, Tata McGraw Hill. 11/09/2012 47 Btech\_IT\_April\_oldscheme.pdf 1st year AUTUMN SEMESTER MA-101 Mathematics-I BS 4 3-1-0 PH-101 Physics-I BS 5 3-1-2 EE-101 Electrical Science\* ESA 43-1-2/2 HS-101 English (Basic/Advanced)\* HS 4 3-0-2 CH-101 Fundamentals of Bio-Tech\* ESA 2 2-0-0 ME-101 Basic Mechanical Engg. ESA 3 2-0-2 CE-101 Engineering Graphics I ESA 3 1-0-3 CY-101 Chemistry\* BS 5 3-1-2 IC-101 Computer Systems & Programming\*ESA 4 3-0-2 SPRING SEMESTER MA-102 Mathematics-II BS 4 3-1-0 PH-102 Physics-II BS 5 3-1-2 EC-102 Electronics ESA 4 3-1-0 ME-102 Engineering Graphics II ESA 3 1-0-3 IC-101 Computer Systems & Programming\*ESA 4 3-0-2 HS-101 English (Basic/Advanced)\* HS 4 3-0-2 EE-101 Electrical Science\* ESA 43-1-2/2 CH-101 Fundamentals of Bio-Tech\* ESA 2 2-0-0 CY-101 Chemistry\* BS 5 3-1-2

Department of Computer Engineering Malaviya National Institute of Technology Curricular Structure BTech (Computer Engg.) 2nd Year AUTUMN SEMESTER Teaching Scheme Contact Hrs/Week Exam Duration Relative WeightageS.No.Subject CodeCourse Title Subject AreaPr Credit Lecture Tutorial Practical Theory Practical CWS PRS MTE ETE PRE CH 1IC-201 Mathematics III BS 4 3 1 0 3 -25 -25 50 - 4 2CP-201 Logic System Design DC EC-102 4 3 0 2 3 - -30 20 50 - 6 3CP-203 Data Structures DC IC-101 5 3 1 2 3 -10 20 20 50 - 6 4CP-205 Discrete Structures DC 4 3 1 0 3 -20 -30 50 - 4 5CP-207 Electronic Circuits and Design ESA EC-102 4 3 0 2 3 - -30 20 50 - 5 6 Institute Elective I IE 4 3 1 0 3 -25 -25 50 - 4 25 18 4 6 29 SPRING SEMESTER Pr Cr CH 1IC-202 Social Science & Economics HS 4 3 1 0 25 -25 50 - 4 2CP-202 Principles of Programming LanguagesDC CP-203 4 3 0 2 3 - -30 20 50 - 5 3CP-204 Microprocessor & Interfaces DC CP-201 4 3 0 2 3 - -30 20 50 - 5 4CP-206 Object Oriented Design DCIC-101, CP-2034 3 0 2 3 - -30 20 50 - 6 5CP-208 Principles of Communication EngineeringESA EC-102 4 3 1 0 3 -20 -30 50 - 4 6 Institute Elective II IE 4 3 1 0 3 -25 -25 50 - 4 24 18 3 6 Creative Arts /Sports/NSS/Hindi ECA 2 28 Discipline ECA 2 Total Credits: 53

Department of Computer Engineering Malaviya National Institute of Technology  
Curricular Structure BTech (Computer Engg.) 3rd Year AUTUMN SEMESTER  
Teaching Scheme Contact Hrs/Week Exam Duration Relative  
WeightageS.No.Subject CodeCourse Title Subject AreaPr Credit Lecture Tutorial  
Practical Theory Practical CWS PRS MTE ETE PRE CH 1CP-301 Computer  
Architecture DCCP- 2014 3 1 0 3 -20 -30 50 - 4 2CP-303 Data Base Management  
Systems DC 4 3 0 2 3 - -30 20 50 - 6 3CP-305 Software Engineering DC 4 3 1 0 3 -20  
-30 50 - 4 4CP-307Design and Analysis of AlgorithmsDCCP- 2034 3 0 2 3 - -30 20 50  
- 6 5CP-309 Computer Networks DC 4 3 0 2 3 - -30 20 50 - 2 6CP-311 Group  
Discussion and Viva Voce DC 2 0 2 0 - - - - -100 4 7 Institute Elective III IE 4 3 1 0 3  
-25 -25 50 - 4 26 18 5 6 30 SPRING SEMESTER CH 1IC-301 Technical  
Communication HS 4 2 2 0 2 -25 -25 50 - 5 2CP-302 Operating System DCCP- 2034  
3 0 2 3 - -30 20 50 - 5 3CP-304 Digital Signal Processing ESA 4 3 1 0 3 -20 -30 50 - 4  
4CP-306 Theory of Computation DCCP- 2034 3 1 0 3 -20 -30 50 - 4 5CP-308  
Computer Graphics DC 4 3 0 2 3 - -30 20 50 - 5 6CP-310 Scripting Language DC 1 0  
0 2 - - -100 - - - 2 7 Department Elective I DE 4 3 1 0 3 -20 -30 50 - 25 17 5 6 3  
Creative Arts /Sports/NSS/Hindi ECA 0 Total Credits: 53 2 Discipline ECA 2 30  
Department Elective I CP-322 Optimization Techniques DE CP-324 Combinatorics  
DE CP-326 Advanced Microprocessors DECP- 204 CP-328 Neural Networks DE  
CP-330 Mathematical Programming DE CP-332 Information Theory and Coding DE  
CP- 306 CP- 301 CP- 301 Department of Computer Engineering Malaviya National  
Institute of Technology Curricular Structure BTech (Computer Engg.) Final Year  
AUTUMN SEMESTER Teaching Scheme Contact Hrs/Week Exam Duration Relative  
WeightageS.No.Subject CodeCourse Title Subject AreaPr Credit Lecture Tutorial  
Practical Theory Practical CWS PRS MTE ETE PRE CH 1CP-401 Principles of  
Compiler Design DC CP-308 4 3 0 2 3 - -30 20 50 - 5 2CP-403 AI and Expert Systems  
DC 4 3 0 2 3 - -30 20 50 - 5 3CP-405 Introduction to VLSI Design DC 4 3 0 2 3 - -30  
20 50 - 5 4CP-407 Real Time Systems DCCP-204, CP-3014 3 0 2 3 - -30 20 50 - 4 5  
Department Elective II DE 4 3 0 2 3 - -30 20 50 - 5 6 Department Elective III DE 4 3 0  
2 3 - -30 20 50 - 4 7 Industrial Field/Training DC 2 - - - - - -100 26 18 012 28  
SPRING SEMESTER CH 1IC-401 Industrial Management HS 4 3 1 0 2 -25 -25 50 - 5  
2CP-402 Major Project DC 12 0 2 6 - -20 -20 -60 5 3 Department Elective IV DE 4 3 0  
2 3 - -30 20 50 - 4 4 Department Elective V DE 4 3 0 2 3 - -30 20 50 - 5 5 2 6 24 9 310  
Creative Arts /Sports/NSS/Hindi ECA 0 Total Credits: 52 21 Discipline ECA 2  
Department Elctive II (Semester VII)Department Elctive IV (Semester VIII)  
CP-421Advanced Topics in Computer GraphicsDE CP-206CP- 420Advanced Topics  
in OS DE CP-423 Advanced Topics in Networking DE CP-301CP- 422Parallel and  
Distributed Computing DE CP-425 Distributed Data Bases DE CP-304CP-  
424Computer Human Interaction DE CP-427 VHDL DE CP-303CP- 426 Software  
Project ManagementDE CP-429 Simulation and Modelling DECP- 428Advanced  
Topics in Databases DE Department Elctive III (Semester VII)CP-304,  
CP-425Department Elctive V (Semester VIII) CP-441 Embedded Systems DECP-  
440Robotics DE CP-443 Cryptography DE CP-429CP- 442Behavioural Synthesis DE  
CP-445Advaned Data Structures and AlgorithmsDECP-303, CP-427CP-  
444Multimedia Systems DE CP-447Image Processing and Pattern RecognitionDECP-



446 Mobile Computing DE CP-449 Biometrics DE CP- 448 Advanced Computer Architecture DE Department of Computer Engineering Department of Computer Engineering Malaviya National Institute of Technology Malaviya National Institute of Technology BTech (Computer Engg.) Teaching Scheme BTech (Computer Engg.) Credits Lecture Tutorial Practical HS BS HS ESA DC DE IED+n+S/C TOTAL  
 First year 54 4 23 4 23 2+2+2 56 Semester III 25 18 4 6 4 4 13 4 - 25 Semester IV 24 18 3 6 4 4 4 12 4 2+0+2 28 Semester V 26 18 5 6 22 4 - 26 Semester VI 25 17 5 6 4 4 4 13 4 2+0+0 27 Semester VII 26 18 0 12 18 8 - 26 Semester VIII 24 9 3 10 4 12 12 8 2+0+0 26 Total 204 16 27 24 35 90 20 12 8+2+4 214 214

Ist year AUTUMN SEMESTER MA-101 Mathematics-I BS 4 3-1-0 PH-101 Physics-I BS 5 3-1-2 EE-101 Electrical Science\* ESA 4 3-1-2/2 HS-101 English (Basic/Advanced)\* HS 4 3-0-2 CH-101 Fundamentals of Bio-Tech\* ESA 2 2-0-0 ME-101 Basic Mechanical Engg. ESA 3 2-0-2 CE-101 Engineering Graphics I ESA 3 1-0-3 CY-101 Chemistry\* BS 5 3-1-2 IC-101 Computer Systems & Programming\* ESA 4 3-0-2 SPRING SEMESTER MA-102 Mathematics-II BS 4 3-1-0 PH-102 Physics-II BS 5 3-1-2 EC-102 Electronics ESA 4 3-1-0 ME-102 Engineering Graphics II ESA 3 1-0-3 IC-101 Computer Systems & Programming\* ESA 4 3-0-2 HS-101 English (Basic/Advanced)\* HS 4 3-0-2 EE-101 Electrical Science\* ESA 4 3-1-2/2 CH-101 Fundamentals of Bio-Tech\* ESA 2 2-0-0 CY-101 Chemistry\* BS 5 3-1-2 2nd Year AUTUMN SEMESTER Teaching Scheme Contact Hrs/Week Exam Duration Relative Weightage S.No. Subject Code Course Title Subject Area Pr Credit Lecture Tutorial Practical Theory Practical CWS PRS MTE ETE PRE CH 1 IC-201 Mathematics III BS 4 3 1 0 3 - 25 -25 50 - 4 2 IT-201 Digital Electronics DC EC-102 4 3 0 2 3 - - 30 20 50 - 6 3 IT-203 Data Structures & Algorithms DC IC-101 5 3 1 2 3 - 10 20 20 50 - 6 4 IT-205 Mathematical Foundations of IT DC 4 3 1 0 3 - 20 -30 50 - 4 5 IT-207 Electronic Devices and Circuits ES AEC-102 4 3 0 2 3 - - 30 20 50 - 5 6 Institute Elective I IE 4 3 1 0 3 - 25 -25 50 - 4 25 18 4 6 29 B.Tech (Information Technology) IT-201 Digital Electronics Credits: 4 (3-0-2) Number Systems and Codes Introduction to positional number system, signed magnitude numbers, floating point numbers, binary arithmetic: addition, subtraction, multiplication and division, Base conversion, conversion formulas with examples, one's and two's complement arithmetic, Computer codes – BCD codes, gray codes, excess-3 codes, parity checks, Hamming and alphanumeric codes. Digital Logic Families Qualitative introduction to digital ICs, TTL, Schottky TTL, ECL, MOS Logic, CMOS Logic, Tri-state logic: Characteristics and properties. Combinational Logic Design Introduction, standard representations for logical functions, Karnaugh map representation, simplification of logical functions using K-map, minimization of logical functions specified in minterms/maxterms or Truth Table, minimization of logical functions not specified in minterms/maxterms, Don't care conditions, design examples, Ex-or and Ex-nor simplification of K-maps, five and six-variable K-maps, QM method, MEV method. Combinational Logic Design using MSI circuits Introduction, multiplexers and their use in combinational logic design, demultiplexers/decoders and their use in combinational logic design, adders and their use as subtractors, digital comparators, parity generators/checkers, code converters, priority encoders, 7-segment decoder/driver. Synchronous Sequential Circuits

Introduction, FSM model, memory elements and their excitation functions. Synthesis of synchronous sequential circuits, capabilities and limitation of FSM, state equivalence and minimization, simplification of incompletely specified machines. Asynchronous Sequential Circuits Fundamental mode circuits synthesis, state assignment, pulse mode circuits. A to D and D to A Converters Introduction, Study of different types of analog to digital and digital to analog converters, their resolution, conversion time, sensitivity accuracy and other parameters. Study of some commercially available ADC and DAC chips. Books/References: 1.R.P. Jain: Modern Digital Electronics, TMH. 2.Z Kohavi: Switching and Finite Automata Theory, TMH 3.M.M. Mano: Digital Logic Design, PHI. 30 April, 2004 1 B.Tech (Information Technology) IT-203 Data Structures and Algorithms Credits: 5 (3-1-2) Static/Linear: Various Implementation of linear data structures – arrays, strings. Searching and Sorting methods. Dynamic/Non-linear : List as dynamic structure, single v/s double, generalized lists, garbage collection. Stack: Implementation, expression evaluation using stacks, stacks and recursion. Queue: Implementation and applications of queue. Tree: Implementation, binary and multiway tree, tree traversal, BST and heap Graph: Representation of graphs, BFS, DFS. Algorithms: Techniques, Complexity, Shortest path, MST, Matrix inversion, String matching – KMP, Dynamic programming – Matrix multiplication. Text/ References: 1.Kruse R.L., Data Structure and Program Design , PHI. 2.Rivest, Cormen, Introduction to Algorithms , MIT Press 3.Horowitz and Sahni: Data Structure in C++ , Galgotia 4.Ellis Horowitz, Sartaj Sahni, Fundamentals of Data Structures 5.Aaron M. Tenenbaum, Y. Langsam, Moshe J. Augenstein, Data Structures Using C 30 April, 2004 2 B.Tech (Information Technology) IT-205 Mathematical Foundations of IT Credits 4 (3-1-0) Set Theory: Basic notation and examples, Venn diagrams. Union, intersection and complement, Disjoint sets. Subsets, Laws of set theory. Principle of duality, Pairs, tuples, cartesian products. Powersets, Finite and infinite sequences Functions: Extensional view. Equality of functions. Intensional view, Domain and range. Partial functions. Typed view, Composition and application, Identity and inverse functions, Polynomials. Exponential and log functions. Graphs of functions, Equivalence relations. Number Systems: Natural numbers. Counting. Cardinality of finite sets. Laws, Mathematical induction. Prime numbers. Fundamental theorem of arithmetic. Well- ordering principle. Number bases. Modulo arithmetic. Integers. Laws of arithmetic. Integer powers and logarithms. Recurrence relations Field Theory: Rings and fields, Application in coding, Discrete logarithms, Primitive root, Polynomial representation of binary strings. Variable lengths codes and Huffman's algorithm. Texts/References: 1)Velleman DJ, How To Prove It: A Structured Approach , Cambridge University Press 1994 2)Aho and Ullman, Foundations of Computer Science , Addison Wesley 1992 3)Grossman P, Discrete Mathematics for Computing , Macmillan 1995 4)Ross KA & Wright CRB, Discrete Mathematics , Prentice-Hall 1999 5)Johnsonbaugh R, Discrete Mathematics , Macmillan 1986 6)Biggs N L, Discrete Mathematics , Oxford 1985 7)Wiitala, Discrete Mathematics , McGraw Hill 1987 8)Truss J, Discrete Mathematics for Computer Scientists , Addison Wesley 1999 30 April, 2004 3 B.Tech (Information Technology) IT-207 Electronic Devices and Circuits Credits: 4 (3-0-2) Introduction: Concepts of Fermi level, band structure of insulators, Metals & Semiconductors, mobility,

conductivity, doping, continuity equation, injected minority carrier injection. Transistor Characteristics: the junction transistor, transistor current component, the transistor as an amplifier, transistor construction, the common base configuration, the common emitter configuration, the CE cut off region, the CE saturation region, typical transistor junction voltage values, common-emitter current gain, the common collector configuration, analytical expressions for transistors characteristics, maximum voltage rating, the photo transistor. Transistor Biasing & Thermal Stabilization: the operating point, bias stability, self-bias or emitter bias, stabilization against variation in  $I_{CO}$ ,  $V_{BE}$ , and  $\beta$ , bias compensation, biasing techniques, for linear integrated circuits, thermistor and sensor compensation, thermal runaway, thermal stability. The transistor at low frequencies: graphical analysis of the CE configuration, two-port devices and the hybrid model, transistor hybrid model, the h-parameter, conversion formulas for the parameters of the three transistor configuration, analysis of a transistor amplifier circuit using h- parameters, the emitter follower, comparison of transistor amplifier configuration, linear analysis of a transistor circuit, cascading transistor amplifiers, simplified calculations for common-collector configuration, the common-emitter amplifier with an emitter resistance, high input resistance transistor circuits. Field Effect Transistors: The junction field effect transistor, the pinch-off voltage, the JEFT volt-ampere characteristics, the FET small signal model, the metal-oxide-semiconductor FET (MOSFET), the low frequency common source and common drain amplifiers, the FET as a voltage variable resistors (VVR). Introduction to semiconductor devices: Construction and working principles of UJT, SCR, thyristor, diac, triac, phototransistor, HBT. Text/References: 1.Integrated Electronics, Millman Halkias, TMH. 2.Solid state Electronics Devices, Stretman, PHI. 3.Microelectronic Circuits, Sedra Smith, Oxford Press, India. 30 April, 2004 4 B.Tech (Information Technology) IT-202 Principles of Information Technology Credits: 4 (3-0-2) Interpretation and understanding of information, need and role of information technology in business and organisation. Information system: Basic elements, data, information, knowledge, infrastructure and types and its development. Information technology infrastructure: Computer Hardware, computer software, Telecommunications: Practical uses of communication & connectivity, telephone related communication. Fax & voice mail, video/voice communication: video conferencing, picture phones, online information services, the intranet and internet, introduction to web technologies, shared resources: workgroup computing, electronic data interchange & extranets, communication technology, tele-computing, virtual offices and mobile workspace. Organization data and information: Basics of data arrangement and access, data knowledge & decision support, DBMS – An overview, data warehouses, data mining, electronic commerce. Benefits of information revolution, information technology: Ethics, impact and security. Text/References: 1.Turban, Rainer : Introduction to Information Technology . 2.Dennis P. Curtin, Kim Foley: Information Technology . 3.Henry C. Lucas: Information Technology for Management . 4.Brain K. Williams, Stacey C. Sawyer: Using Information Technology . 30 April, 2004 5 B.Tech (Information Technology) IT-204 Microprocessor based System Design Credits: 4 (3-0-2) 8086 Microprocessor: Introduction 8086 based microcomputer system. Block diagram, pins and their description, demultiplexing of

buses, control signal and flags. Instruction and timing: instruction classification, instruction formats, instruction timings and status, addressing modes, and interrupts. Software model: instruction set, data transfer instruction, arithmetic logic & branch operations: Program directives, String manipulation. Control loop Techniques: IF then Else, While loop, For loop techniques in 8086 assembly language programming. Interfacing peripherals: Descriptions, programming and interfacing of 8255, 8257, 8253, 8259A with 8086. Basic Idea of Following Bus Standard: RS232C, IEEE-4888. Introduction to 80386, 80486 and Pentium processors. Multitasking, Task Switching and protection in 80386. Text/References: 1. Douglas V. Hall : Microprocessors and Interfacing, McGraw Hill 2. Gaonkar ; 8085 Programming, Penram Press 3. Uffenback; 80x86 family, design, programming and interfacing , Pearson Edu. 4. Bray; Intel Microprocessors, TMH 5. Intel MANUALS 30 April, 2004 6. B.Tech (Information Technology) IT-206 Internet Programming in Java Credits: 4 (3-0-2) Introduction: Internet, Java as a tool for internet applications, Byte Code and its advantages. Object Oriented Programming and Design: Review of Abstraction, Objects and other basics, Encapsulation, Information hiding, Method, Signature, Classes and Instances, Polymorphism, Inheritance, Exceptions and Exception Handling with reference to object modeling, Coupling and Cohesion in object oriented software. Object Oriented Design – Process, Exploration and Analysis. Java Programming Basics: Fundamentals: Variables and assignments, Input and Output, Data Types and Expressions, Flow of control, Local variables, Overloading Parameter passing, this pointer, Java Object Oriented Concepts: Objects and Classes: Use of file for I/O, Formatting output with stream functions, Character I/O, Inheritance, Public and private members, Constructors for initializations, Derived classes, Flow of Control Java Data Structures and Advanced Topics Arrays – Programming with arrays, arrays of classes, arrays as function arguments, Strings, Multidimensional arrays, Arrays of strings, vectors, Base classes. Introduction to Java Applets Books/References 1. Herbert Schildt: JAVA 2 - The Complete Reference, TMH, Delhi 2. U.K. Chakraborty and D.G. Dastidar: Software and Systems - An Introduction, Wheeler Publishing, Delhi. 3. Joseph O'Neil and Herb Schildt: Teach Yourself JAVA, TMH, Delhi. 4. Elliotte Rusty Harold, Java Network Programming, 2nd Edition , O'Reilly and Associates. 30 April, 2004 7. B.Tech (Information Technology) IT- 208 Communication Systems Credits 4 (3-1-0) Review of Representation of Signals: Fourier series, Fourier transform and its properties, spectral systems, transmission of signals through linear systems, ideal low-pass and high-pass filters, band-pass signals, spectral density and power spectral density. Analog Communication: Amplitude modulation- SSB, DSB, Vestigial side bands, frequency modulation and phase modulation, Comparison of these techniques in respect of SNR, AM and FM receivers, Pulse time modulation Multiplexing – TDMA, FDMA, CDMA, spread spectrum modulation. Digital Communication: Pulse digital modulation, PCM, differential PCM, delta and adaptive delta modulation. Digital passband transmission: ASK, FSK, QPSK, m-ary shift keying. Line codes: On-off (RZ/NRZ), Polar and Bipolar, Basics of Satellite communication and mobile communications. Texts/References: 1) Communication Systems, Simon Haykin, John Wiley. 2) Communication Systems Engineering, Prakas & Salehi, Pearson Education. 3) Analog and Digital Communications, B.P. Lathi.

4)Modern Digital & Analog Communications, B.P. Lathi, Wiley Eastern.

5)Communication Systems, Taub and Schilling. 30 April, 2004 8 B.Tech (Information Technology) IT-301 Computer Organization Credits 4 (3-1-0) 1.Introduction Basic Machine Principle, Structure and representation of real world data, Von-Newman Model and stored program concept, Subroutine, Branching & Macro facility. 2.Processor Design Processor Organization, Information representation and Number format, Instruction cycle and Instruction format, Addressing modes, Arithmetic operation, timed point addition, subtraction, multiplication and division, ALU design and floating point arithmetic, Parallel processing – Performance consideration, Pipeline processor and Multiunit processor. 3.Control Design Instruction sequencing and Interpretation, Hardware Control design method, Multiplier control unit and CPU control unit, Microprogrammed Control, Minimizing Instruction Size, Microprogrammed computer. 4.Memory organization Memory device characteristic, Random access and serial access memories, Virtual memory – memory hierarchies, Main Memory allocation & replacement policies, Segments, pages and file organization, High speed memories – Interlocked, cache and associative memory. 5.System Organization Local and long distance communication, Programmed I/O, DMA and interrupts, I/O processors & CPU – I/O interaction, Multiprocessor Introduction. Books/References 1.J.P. Hayes: Computer Architecture and Organization, 3rd Ed. TMH, 1999. 2.C.W. Gear: Computer organization and Programming, TMH. 3.T.C. Bartee: Digital Computer Fundamental, TMH. 4.M.M. Mano: Computer System Architecture, PHI. 5.A. S. Tanenbaum: Computer System Organization, PHI. 30 April, 2004 9 B.Tech (Information Technology) IT-303 Data Modelling and Design Credits: 4 (3-0-2) Design: Conceptual design, Three tier architecture, ER Diagram – entity (strong and weak), Data aggregation, specialization, generalization. Data models: Relational, Network, Hierarchical and Object Oriented. Normalization: Constraints – integrity and domain, Primary key, Super key, foreign key, Alternate key, candidate key, normal forms 1NF, 2NF, 3NF, BCNF, 4NF. SQL: DDL and DML, Relational Algebra. Applications. SQL Queries, Triggers and views, Constraints assertions. Data Organization: Sequential, indexed random and hashed files. Inverted and multilist structures, B trees, B+ trees, Query Optimisation, Join Algorithm, Statistics and Cost Base optimisation. DBMS internals: Transaction Processing, concurrency control, and recovery management. Transaction model properties and state serialisability . Lock base protocols, two phase locking. Text/References: 1.Almasri and S.B. Navathe: Fundamentals of Database Systems , Addison Wesley. 2.Kevine Kline, SQL in Nutshell, O'Reilly & Associates. 3.Raghu Ramakrishnan, Johannes Gehrke Database Management Systems , McGraw Hill. 4.H.F. Korth, Silberschatz, Sudarshan: Database Systems Concepts , McGraw Hill 5.C.J. Date: Data Base Design, Addison Wesley 6.Hansen and Hansen : DBM and Design, PHI 30 April, 2004 10 B.Tech (Information Technology) IT-305 System Analysis and Design Credits 4 (3-1-0) System concept : Definition and characteristics , elements and boundaries , types of system development lifecycle , recognition of needs , feasibility study , prototyping , role of system analyst . System planning and tools like DFD , data dictionary , decision trees, structured analysis and decision tables . Feasibility study and reports, Object Oriented Analysis and Data Modeling.

System Design methodology , structured design , from driven methodology ,IPO charts, structured walkthrough, input output from design , requirement and classification of forms , layout considerations form control, object oriented Design Concepts and methods. Text/Reference :- 1.Awad : System Analysis and design 2.pressman :software Engineering 3.Salzinger Jackson ,Burd: System Analysis and Desingn Course Technology. 30 April, 2004 11 B.Tech (Information Technology) IT-307 Data Compression Credits: 4 (3-0-2) Compression: Need, Lossless v/s lossy compression, review of information theory, prefix codes, uniquely decodable code. Huffman coding – minimum variance, optimal, non-binary, extended, adaptive. Applications and limitations of Huffman codes. Run length encoding, Arithmetic coding, Predictive coding – Burrows-Wheeler transform, Delta modulation, Adaptive delta modulation Lossy Compression Techniques – JPEG and its application Error detection and correction: Parity, 1,2,n dimensions, Hamming codes, p-out-of-q codes Dictionary based compression - Lempel-Ziv-Welch, LZ77 and LZ-78 Quantization – Scalar and Vector Quantization. Texts/References: 1)Khalid Sayood, Introduction to Data Compression, Morgan Kauffman 2)Greg A. Harris, Darrel R. Hankerson, Peter D. Jr. Johnson, Introduction to Information Theory and Data Compression, Second Edition , Chapman and Hall. 3)Saloman, Data Compression, Springer Verlag. 4)Nelson, The Data Compression book, Hungry Minds. 30 April, 2004 12 B.Tech (Information Technology) IT-309 Data Networks Credits: 4 (3-0-2) Definition of a Communications Network Concept of a node; Nodes connected by links to form networks; Names & Addresses; the idea of "address resolution" Types of Network Understanding of operation and examples of use. ■Point-to-point Connections Fixed configuration; dedicated capacity ■Circuit-switched Networks Circuit setup; reserved capacity; (e.g. telephony) ■Message-switched Networks Circuit set-up; store and forward; message headers; (e.g. telex) ■Packet-switched Networks Packet headers; pipelining; datagram networks; (e.g. Internet) Types of Equipment ■End Systems (ES) (e.g. client or server) ■Intermediate Systems (IS) (e.g. router, bridge) Types of Packet-Switched Network ■Wide Area Networks (WANs) ■Internet Service Providers (ISPs) ■Local Area Networks (LANs) Differences in ownership, speed, cost, number of nodes Types of Communication ■Client and Server Communication (e.g. DNS, arp, ping) ■Broadcast, Unicast and Multicast modes ■Simplex, Duplex and Half-Duplex Information Flow Open System Interconnection Definition of OSI; Reasons for using the Reference Model ■Protocol Layers ■The Seven Layers of the OSI Reference Model Knowledge of the seven layers and their BASIC functions, particularly of the four lowest layers. ■Communications between layers ■Protocols ■Peer to Peer Communication between Remote Layers ■Service Access Points ■Service Primitives and Communication Between Adjacent Layers ■Encapsulation of PDUs Addition of headers on transmission; Removal on reception ■Segmentation & reassembly by protocol layers TCP/IP Networks and protocol stack. Text/References: 1.Computer Network and Internet, D.Comer, Pearson 2.Computer Networks: A top down approach, Kurose and Ross, Pearson. 3.Data Networks: Bertsekas and Gallager, PhI. 30 April, 2004 13 B.Tech (Information Technology) IT-302 System Software Credits: 4 (3-0-2) Translators: Introduction to compilers, translators, and interpreters, compilation process. Assemblers: Two pass, one pass assemblers, macro

processors. Editors and Debuggers: Design and implementation. Linkers and Loaders : Relocation, static and dynamic linking. Compilers: Lexical, syntax, semantic analysis, LL v/s LR Parser, Predictive parsing, Symbol table management, Intermediate code generation, Brief overview of code optimization. Operating System: OS as a resource manager, I/O management – disk scheduling, CPU management – scheduling, Process management - deadlocks, Memory management – virtual memory, paging, segmentation. Text & References: 1.System Software and Operating Systems, Dhamdhere. 2.System Programming : Donovan. 3.Holub, Compiler Design in C, PHI. 30 April, 2004 14 B.Tech (Information Technology) IT-304 Signals and Systems Credits 4 (3-1-0) Review of signal description Review of Fourier and Laplace transforms Spectrograms; frequency modulation Sampling and aliasing The z-transform Filters: Transfer functions, FIR filters, IIR filters Spectral analysis: DFT for periodic signals, DFT for non-periodic signals Texts/References: 1)J H McClellan, R W Schafer & M A Yoder, DSP First: a Multimedia Approach , Prentice-Hall International 1998 2)A V Oppenheim , R W Schafer & J R Back, Discrete-time Digital Signal Processing , Prentice Hall Int 1999. Third major revision of classic text 3)A V Oppenheim , A S Willsky & S H Nawab, Signals and Systems, Prentice Hall Int 1996. Includes companion book with Matlab examples 4)N K Sinha, Linear systems, John Wiley 1991 5)J G Proakis and D G Hanolakis, Digital Signal Processing , Maxwell Macmillan Int 1992 30 April, 2004 15 B.Tech (Information Technology) IT-306 VLSI Algorithms Credits 4 (3-0-2) Introduction: The VLSI Design Problem. Design Domains. Design Actions Algorithmic and System Design. Structural and Logic Design.Transistor-level Design. Layout Design. Verification Methods Algorithmic Graph Theory and Computational Complexity: Data Structures for the Representation of Graphs. Computational Complexity. Depth-first Search. Breadth-first Search Dijkstra's Shortest-path Algorithm Prim's Algorithm for Minimum Spanning Trees Tractability Issues: Combinatorial Optimization Problems Decision Problems Complexity Classes NP-completeness and NP-hardness Combinatorial Optimization: The Unit-size Placement Problem.Backtracking and Branch-and-bound. Dynamic Programming Linear and Integer Linear Programming.Local Search Simulated Annealing Tabu Search Genetic Algorithms Design Problems and Algorithms: Layout Compaction Design Rules Symbolic Layout Applications of Compaction Informal Problem Formulation Graph-theoretical Formulation Maximum-distance Constraints Algorithms for Constraint-graph Compaction Longest-path Algorithm for DAGs The Longest Path in Graphs with Cycles The Liao- Wong Algorithm The Bellman-Ford Algorithm Placement and Partitioning: Circuit Representation Wire-length Estimation Types of Placement Problem Constructive Placement Iterative Improvement Partitioning The Kernighan-Lin Partitioning Algorithm Floorplanning: Floorplanning Concepts Terminology and Floorplan Representation Optimization Problems in Floorplanning Shape Functions and Floorplan Sizing Routing: Types of Local Routing Problems Area Routing Channel Routing Channel Routing Models The Vertical Constraint Graph Horizontal Constraints and the Left-edge Algorithm Channel Routing Algorithms Introduction to Global Routing Standard-cell Layout Building-block Layout and Channel Ordering Algorithms for Global Routing Efficient Rectilinear Steiner-tree Construction Local Transformations for Global Routing Simulation: General VLSI

Simulation Gate-level Modeling and Simulation Signal Modeling Gate Modeling Delay Modeling Connectivity Modeling Compiler-driven Simulation Event-driven Simulation Switch-level Modeling and Simulation Connectivity and Signal Modeling Simulation Mechanisms Logic Synthesis and Verification: Introduction to Combinational Logic Synthesis Basic Issues and Terminology Binary-decision Diagrams ROBDD Principles ROBDD Implementation and Construction ROBDD Manipulation Variable Ordering Applications to Verification Applications to Combinatorial Optimization Two-level Logic Synthesis Heuristic Based on ROBDDs Text/References: 1.Sabih H. Gerez, Algorithms for VLSI Design Automation, John Wiley & Sons 2.Introduction to Algorithms, Rivest, Korman et.al.,Pearson. 30 April, 2004 16 B.Tech (Information Technology) IT-308 Multimedia Techniques Credits: 4 (3-0-2) 1.Basics of multimedia technology Computers, Communication and Entertainment; Multimedia -An introduction; Framework for multimedia systems; multimedia devices, CD-Audio, CD-ROM,CD-I; presentation devices and the user interface; multimedia presentation and authoring; professional development tools; LANs & multimedia ;Internet, World Wide Web(World Wide Web) & multimedia ;distribution network-ATM & ADSL; multimedia servers & databases; vector graphics; 3-D graphics programs; animation techniques; shading; anti-aliasing; morphing ;video on demand 2.Image Compression & Standards Making still images; editing and capturing images; scanning images; computer color models; color palettes; vector drawing; 3-D drawing and rendering; JPEG-objectives and architecture; JPEG-DCT encoding and quantization, JPEG statistical coding; JPEG predictive lossless coding; JPEG performance; Overview of other image file formats as GIF, TIFF, BMP, PNG etc. 3.Audio & Video Digital representation of sound; time domain sampled representation; method of encoding the analog signals; subband coding; Fourier method; transmission of digital sound; digital audio signal processing; stereophonic & quadraphonic signal processing; editing sampled sound; MPEG Audio; audio compression & decompression; brief survey of speech recognition and generation; audio synthesis; Musical Instrument Digital Interface (MIDI); digital video and image compression; MPEG motion video compression standard; DVI technology; time-based media representation and delivery. 4.Virtual Reality Applications of multimedia, Intelligent multimedia system, Desktop Virtual Reality (VR), VR operating System, Virtual environment displays and orientation tracking; visually coupled system requirements; intelligent VR software systems. Applications of environments in various fields viz. Entertainment, manufacturing, business, education, etc. Books/References 1. Villamil & Molina, Multimedia : An Introduction, PHI. 2. Lozano, Multimedia : Sound & Video, PHI. 3. Villamil & Molina, Multimedia : Production, Planning and Delivery, PHI. 4. Sinclair, Multimedia on the PC, BPB. 5. Tay Vaughan, Multimedia :Making it work, TMH 30 April, 2004 17 B.Tech (Information Technology) IT-322 Operations Research Credits 4 (3-1-0) Project Management: Network models of Engineering projects, scheduling and monitoring of projects CPM and PERT methods. Queueing Theory: Review of necessary probability functions, Dynamics of a queueing system, Mathematical Models of a simple queue, Use and limitations of analytical approach. Discrete Event Simulation: Discrete event simulation as a modelling technique, activity flow diagrams and examples. Decision Analysis: Use of Decisions Trees for more complex situations



including those that require Bayes Theorem to revise probabilities. Case Study: Inventory Models Texts/References: 1)Michael Pidd, Computer Simulation in Management Science, Wiley. 2)Anderson, Sweeney and Williams, An Introduction to Management Science, West Publishing Co., (also an accompanying study guide). 3)System simulation, Gordon G., Prentice Hall of India 4)Discrete Event Simulation, Banks 5)System simulation, Narsing Deo, McGraw Hill. 6)Simulation modeling and analysis , Law and Kelton, McGraw Hill. 30 April, 2004 18 B.Tech (Information Technology) IT-324 Management Information System Credits 4 (3-1-0) Introduction to management information system Hardware and software used for information systems, transaction processing, office automation. Decision making process, concepts of information, humans as information processors, system concepts, organisational structure and management concepts. Support for planning and controlling. Organisation and management of the information resources function. Text/References : 1.Management Information and System , Davis and Olson, McGraw Hill. 30 April, 2004 19 B.Tech (Information Technology) IT-326 Natural Language Processing Credits 4 (3-1-0) Introduction Origin, imposition, representation, role of knowledge, use of prolog for Natural Language Processing (NLP), Finite State Transition Networks(FSTN), notation, representation and traversal of FSTN in Prolog, Finite State Transducers(FST), implementation in Prolog, limitation of SM. Recursive and Augmented Transition Networks (RTN) Modeling recursion, representation, traversal, implementation in Prolog, push down transducers, implementation, advantage and limitations of RTN, augmented transition networks. Grammar and Parsing Grammar as knowledge representation, words, rules, structures, representation in Prolog, subcategorization, definite clause grammars, classes of grammars and languages, top down and bottom up parsing, comparison strategies, BFS and DFS, storing intermediate results, ambiguity, determinism and lookahead. Well formed Sub-string tables and Charts Well formed substring tables, active charts, rules of chart parsing, initialization, rule invocation, house keeping, implementation of top down and bottom up chart parsers, search strategy, alternative rule invocation, implementing flexible control, efficiency. Features and the Lexicon Feature theoretic syntax, feature structures as graphs, feature structures in Prolog, subsumption and unification, the status of rules, implementing PATR in Prolog, chart parsing with feature- based grammars, representation of lexical knowledge, implementing a lexicon in Prolog, DAGs versus terms Semantics Compositionality, meaning as reference, translation to a meaning representation language, computational semantics as feature instantiation, transitive verbs and quantification, ambiguity, preferences and timing, building semantic checking in to the grammar. Question answering and Inference Question answering, evaluating DBQ formulae, standard logical inference, implementing forwards inference in Prolog, the pathological nature of logical inference, primitives and canonical forms, classes and inheritance, plausible inference and defaults Books/References 1)Gerald Gazdar and Chris Mellish: Natural Language Processing in Prolog, Addison Wesley 2)Allen James: Natural Language Understanding, Benjamin Cummins 3)Briscoe, Edward J., Boguraev and Branimir K.: Computation Lexicography for Natural Language Processing, Longman/Wiley 4)Schwartz, Steven C.: Applied Natural Language Processing, Petrocelli 5)Winograd,

Terry: Understanding Natural Language, Academic Press. 30 April, 2004 20 B.Tech (Information Technology) IT-328 e-Commerce Credits 4 (3-1-0) Introduction and concepts: networks and commercial transactions, the Internet environment, online commerce solutions. A generic business model for e-commerce. Security technologies: Introduction to cryptography, key distribution and clarification. Architecture for e-commerce: online commerce environment, servers and commercial environments, strategies, techniques and tools. Electronic payment methods: Secure online transaction models, digital payment system, cyber cash, digital currencies. Protocol for the public transport of private information: security protocols, secure socket layer. Open issues: legal and technical issues. Text & References: 1.Electronic e-commerce II Edition: Pete Loshin, Paul A Murphy, Jaico book. 2.The Business of e-commerce: Paul May, Cambridge University Press. 30 April, 2004 21 B.Tech (Information Technology) IT-330 Graph Theory Credits 4 (3-1-0) Introduction to graphs. Review of DFS. Applications of DFS – Topological Sort, Connected components, Articulation Points. Euler graphs, detection of cycles in graph. Max-flow Min-cut theorem. Algorithms for computing maximum flows in graphs. Algorithms for computing the minimum cut in a graph. Edge and vertex connectivity of graphs and Menger's theorem. Maximum matching, Planar graphs and algorithms for checking for planarity. Edge and vertex coloring of graphs. Independent sets and perfect graphs. Texts/References: 1.Rivest, Cormen – Introduction to Algorithms 2.West, Graph Theory 3.Narsingh Deo:Graph Theory with Application to Engineering and Computer Science , Prentice-Hall. 4.Narsingh Deo: Combinatorial Algorithms: Theory and Practice, Prentice-Hall. 30 April, 2004 22 B.Tech (Information Technology) IT-332 Information Theory and Coding Credits 4 (3-1-0) Mathematical Theory of Foundation Of Information Theory in Communication system. Measures of Information- Self information, Mutual Information, Average Information, entropy and its properties. Source Model and Coding, channels Model and Coding. Problems of unique decipherable Codes, condition of Instantaneous codes, Code word length, Kraft Inequality. Noiseless Coding Theorem. Construction of codes: Shannon Fano, Shannon Binary and Huffman codes. Discrete Memory less channels: Classification of channels, calculation of channel capacity. Decoding scheme- the ideal observer. The fundamental theorem of Information theory. Error Correcting Codes: Minimum distance principle. Relation between distance and error correcting properties of codes, The Hamming bound. Parity check Coding. Bounds on the error correcting ability of Parity Check Codes. Text /References 1.Information theory and Reliable Communication by R.G.Gallager 2.Information Theory by Robert Ash 3.An Introduction to Information Theory by F. M. Reza 4.Error correcting codes by W.W. Peterson and E. J. Weldon 30 April, 2004 23 B.Tech (Information Technology) IT-401 GUI Programming Credits: 4 (3-0-2) Architecture of GUI Applications: Model-GUI Separation, N-Tier Architectures, GUI as Frontend to Transactions (Forms-based GUIs) GUI Design Patterns: Modal Dialog, Inspector (Properties of Selected Element), Wizard (Step-by-Step), Palette/Roll-Up, Explorer (Tree/Table Combination) Windowing Systems: Microsoft Windows, X Window, MacOS GUI Frameworks: Java Swing, Microsoft Foundation Classes Components: Java Beans, ActiveX Controls Development Environments & GUI Builders: Principles, Application, Restrictions,

Evaluation Texts/References: 1. B. Schneiderman, Designing the User Interface, Addison Wesley, III ed. 2. Susan Weinschenk, GUI Design Essentials. 3. Barfield L, The User Interface: Concepts & Design, Addison Wesley, 1993 4. Cox K & Walker D, User Interface Design, Prentice Hall, 1993 5. Preece, Rodgers, Sharp, Benion, Holland and Carey, Human Computer Interaction, Addison Wesley 6. Dix A, Finlay J, Abowd G and Beale R, Human-Computer Interaction, 3rd Edition. Prentice Hall, 2003 7. Preece J, Rogers Y, Sharp H Interaction Design: beyond human-computer interaction, Wiley, 2002.

30 April, 2004 24 B.Tech (Information Technology) IT-403 AI and Neural Networks Credits: 4 (3-0-2) Overview of AI, Problems, Problem space and searching techniques, Definition production system, Control strategies, Heuristic search techniques. Knowledge representation: Representation, mappings, approaches and issues, Predicate logic, propositional logic, Resolution, Procedural and declarative knowledge, forward and backward reasoning, Matching, Semantic nets. Learning and learning systems: Introduction to Hopfield networks, introduction to neural networks, learning in neural networks, applications of neural networks, Recurrent network., Back propagation Algorithm. Introduction to AI languages: PROLOG and LISP. Text & References: 1.Artificial Intelligence: Elaine Rich, Kevin Knight, Mc-Graw Hill. 2.Introduction to AI & Expert System: Dan W. Patterson, PHI. 30 April, 2004 25 B.Tech (Information Technology) IT-405 Information System Security Credits: 4 (3-0-2) Security issues in information systems. Public v/s private key. Mathematical preliminaries: Discrete Logarithms, Galois Fields, one-way hash functions. Case Study: DES, IDEA, RSA, Key management, Key exchange. Related issues: Privacy, Authentication, Signatures, Deniability. Introduction to hacking. Text & References: 1.Stallings, Cryptography and Network Security: Principles and Practice, Pearson Education Asia. ISBN 981-403-589-0. 2.B Schneier, Applied Cryptography, Wiley. ISBN 0-471-11709-9 3.B Schneier, Practical Cryptography, Wiley. ISBN 0-471-11709-9 30 April, 2004 26 B.Tech (Information Technology) IT-407 Wireless Technologies Credits: 4 (3-0-2) Issues in wireless networks, wireless multiple access protocols, cellular wireless networks, channel allocation in cellular system, wireless 802.11 LAN, HyperLAN, type of wireless networks. Wireless network layer, Ad-hoc network, tunneling and encapsulation, routing protocol, global state routing, dynamic state routing, fisheye routing, ad-hoc on-demand distance vector routing, destination sequence distance vector routing, dynamic source routing. Wireless transport layer problems, solutions & protocols. Wireless application protocol, goals, issues, architecture, wireless datagram protocol, wireless transport layer security, wireless transaction protocol, wireless session protocol, wireless application environment. Introduction to Blue tooth, GSM, GPRS & CDMA technologies. Text & References: 1.Mobile communications Jochen Schiller, Pearson 2.802.11 wireless networks Matthew S.Gast, O'REILLY. 3.Wireless LANs: Davis & McGuffin, McGraw Hill 4.Mobile Communications Handbook by Jerry D. Gybson 5.Mobile Communications Handbook by Raymond Steel 6.Research papers and Internet material. 30 April, 2004 27 B.Tech (Information Technology) IT-421 3D Computer Graphics Credits: 4 (3-0-2) Review of 2-D techniques: World coordinates, 2D transformations, Anti-aliasing 3-D techniques: Transformations in 3D Visible surface determination Illumination and shading models Texture mapping Ray tracing Fractals

case studies Texts/References 1)J D Foley, A Van Dam, S K Feiner, J F Hughes and R L Phillips, Introduction to Computer Graphics, Addison-Wesley, 1994 2)D Hearn and M S Baker, Computer Graphics, 2nd Ed, Prentice-Hall, 1994 3)J D Foley and A Van Dam, Computer Graphics, Principles and Practice , 2nd Ed in C, Addison Wesley, 1996 4)A Watts, Fundamentals of Three-Dimensional Computer Graphics , Addison Wesley, 1989 30 April, 2004 28 B.Tech (Information Technology) IT-423 Network Services and Management Credits: 4 (3-0-2) Overview of Internet Technologies, Issues in next generation Internet - Routing, Multicasting, Packet Scheduling, Quality of Service etc. Admission control in Internet: Effective bandwidth, Differentiated services, Policy-based networking, Real time communications over Internet, Internet telephony, Voice over IP, Integrated services. Web QoS, Intelligent caching, Traffic measurement and characterization. Structure and protocols for Network management, agents. Directory services and protocols. Text/References: 1.Computer Networks: A Top Down Approach, Kurose and Ross, Pearson. 2.SNMP, SNMPv2, SNMPv3, and RMON 1 and 2, W. Stallings, Pearson. 3.The practice of system and network administration, T.Limocelli, Pearson. 30 April, 2004 29 B.Tech (Information Technology) IT-425 Data Mining and Warehousing Credits: 4 (3-0-2) Introduction to Decision Support Systems, Data Warehouse and Online Analytical Processing. Data Warehouse Architecture: System Processes, Process Architecture: Load Warehouse, Query, Detailed and Summarized Information. Design: Data Base Schema Facts, Dimensions and Attributes. Introduction to Data Base and Metadata. Data Warehouse Implementation. Data Mining : Introduction and need. Data Processing : Data Cleaning, Data Integration and Transformation, Data Reduction. Data Mining Primitives : Descriptive and Predicative Data Mining, Language DMQL and its Preliminary Clauses. Data Mining Methods: Association – Single and Multilevel, Characterization and Comparison, Regression Analysis, Classification and Predication. Data Mining Algorithms: Clustering, Association, Regression, Decision Trees. OLAP : OLAP Architecture, ROLAP, and MOLAP. Application and Trends in Data Mining. Text & References: 1.Data Warehousing in the Real World – Anahory and Murray, Pearson Education. 2.Data Mining – Concepts and Techniques – Jiawei Han and Micheline Kamber. 3.Building the Data Warehouse – WH Inmon, Wiley. 30 April, 2004 30 B.Tech (Information Technology) IT-427 Digital Hardware Design Credits: 4 (3-0-2) Asynchronous State Machines: Analysis and design of fundamental mode circuits. Hardware Description Languages: VHDL, Verilog Register Transfer-Level Design: Controller/datapath partitioning Built in Test: Principles, structures, signature analysis Texts/References: 1)Zwolinski M, Digital Design with VHDL, Addison Wesley Longman 2000. 2)Rushton A, VHDL for Logic Synthesis, John Wiley, 1998. 3)Abramovici M, Breuer M A and Friedman A D, Digital System Testing and Testable Design,(Revised Printing) IEEE Press, 1990 4)Wilkins B R, Testing Digital Circuits, Chapman and Hall, 1990 5)Wakerly J F, Digital Design Principles and Practices, 2nd Edn, Prentice-Hall, 1994 6)De Micheli G, Synthesis and Optimization of Digital Circuits, McGraw-Hill, 1994 30 April, 2004 31 B.Tech (Information Technology) IT-429 Performance Analysis of Computer Systems Credits: 4 (3-0-2) Performance evaluation methods, Evaluation Metrics, Analytical v/s simulation modeling, performance measurement and benchmarking, Workload modeling, random

variables, commonly used distributions, Stochastic Processes Markov chains, Birth and Death Processes, Markov chain models of Computer systems, Steady- state and transient analysis Queuing models, M/M systems and their steady state analysis, Single server and multi-server queues, open and closed queuing networks Petri Net based Performance Modeling : Classical Petri Nets, Timed Petri Nets, Discrete Petri Nets, Modeling multiprocessor systems Discrete event simulation – Simulation languages, random number generation and testing, model verification and validation, analysis of simulation results, confidence intervals, variance reduction techniques, Case studies of analytical and simulation studies of computer systems

Text/References : 1.Raj Jain, The Art of Computer System Performance Analysis, John Wiley 2.K.S.Trivedi, Probability and Statistics with Reliability, Queuing and Computer Science Applications, PHI 3.Law and Kelton, Simulation Modeling and Analysis, Mcgraw Hill 4.Kant, Introduction to Computer System Performance Evaluation, Mcgraw Hill

30 April, 2004 32 B.Tech (Information Technology) IT-441 Embedded Systems and Appliances Credits: 4 (3-0-2) Embedded Systems: Introduction, hardware/software co-design, issues in deciding where to split the problem., examples of embedded systems, sensors and interfacing techniques. Real-time OS and concepts: introducing the problem domain and tools, RTOS services/capabilities (in contrast with traditional OS), Resource Management/scheduling paradigms: static priorities, static schedules, dynamic scheduling, best effort, current best practice in scheduling (eg Rate Monotonic vs. static schedules), Real-world issues: blocking, unpredictability, interrupts, caching, examples of OSs for embedded systems (RT Linux/ VRT), selected case studies. Programming Languages for Embedded Systems: tools for building embedded systems - with case studies. Esterel is good for control applications / Handel-C is good for casting algorithms into re-configurable hardware, Embedded Software Development Methodology. Embedded microcontrollers architecture. Appliances having embedded software and internet enables services and devices.

Text/References: 1.Programming for embedded systems, Prasad, Wiley. 2.Embedded microprocessor systems: Real World Design, S. Ball. 3.Embedded Systems Design: An Introduction to Processes, Tools and Techniques by Arnold S. Berger

30 April, 2004 33 B.Tech (Information Technology) IT-443 Automata Theory Credits: 4 (3-0-2)

1)Introduction Introduction to Finite State Machine, Binary counter, parity bit generator, Moore and Mealy FSMs, Equivalence, Isomorphism, Reduction of States, Regular Languages, Regular expressions, The memory required to recognize a language, Distinguishing one string from another, unions, Intersections and Complements, NFA, NFA with – transitions, Criterion for Regularity, Minimal Finite Automata, The pumping lemma, decision, problems, Finite automata, Nondeterminism and Kleen's Theorem, Regular and Non-regular languages.

2)Context-Free Language Context – Free Grammars, Definition of CFG, example of familiar languages, unions, concatenations and closures of CFLs, Derivation Tree, Ambiguity, unambiguous CFG for algebraic expressions, Simplified forms and normal forms. Push down automata, definition, deterministic PDA, PDA to CFG and Vice Versa, Parsing. Context Free and Non Context Free Languages, Pumping lemma for CFG, Intersection and complements of CFL, Decision Problems involving CFL.

3) Turing Machines Definition, Turing Machines as Language acceptors, combining TM, computing Partial Function with TM. Recursively Enumerable and Recursive Languages, Multitape TM, Nondeterministic TM, Universal TM, Other Grammars, Unrestricted grammars and TM, Unsolvability problems, Unsolvability Decision Problems, Halting Problem, Rice's Theorem and more unsolvable problems, Post's correspondence Problem, Unsolvability problems involving CFLs, Regular Grammars, context Sensitive grammars, Linear  $\epsilon$ -Bounded Automata, Chomsky Hierarchy.

4) Computability Primitive Recursive Functions, Primitive Recursive Predicates and some bounded operations, unbounded minimization and recursive functions, Godel Numbering, Non-numeric-functions. Growth rates of functions, Time and space complexity of TM, complexity Classes. P and NP. Polynomial-Time. Reductions and NP-Completeness, Cook's Theorem, other NP-Complete Problems. Computable Functions, Measuring and classifying complexity. Tractable and intractable problems.

Books/References: 1) John C. Martin: Introduction to Languages and the Theory of Computation, MGH. 2) Lewis & Papadimitriou: Elements of the Theory of Computation, PHI. 3) Daniel I.A. Cohen: Introduction to Computer Theory: John Wiley. 4) J.E. Hopcroft and J.D. Ullman: Introduction to Automata Theory Languages and Computation, Narosa. 30 April, 2004 34 B.Tech (Information Technology) IT-445

Speech Processing Credits: 4 (3-0-2) The speech chain: current capabilities in synthesis and recognition. Acoustic phonetics. Vocal tract physiology: voiced excitation, unvoiced excitation (bursts, frication). Acoustics of uniform tubes, of two- and three-tube models. Comparison to speech data. Synthesis: Formant synthesis (series, parallel), Articulatory synthesis, Concatenative Synthesis, Text-to-Speech (normalisation, linguistic units, rules) Articulatory parameters, shape-to-sound transformation, vocal tract imaging, revising the acoustic model. Letter-sound relations, phonology; prosody, intelligibility, quality assessment. Ear physiology. Auditory perception. Speech perception. Recognition: Template matching. (Training, distance measures, dynamic time warping), Stochastic models. (Hidden Markov models, Baum-Welch and Forward-Backward algorithms). Large-Vocabulary Recognition. (Phonemic baseforms, language models), Artificial Neural Networks. (Overview, hybrid systems). Assessing recognition performance; improving recognition performance; knowledge-based approaches, auditory models.

Texts/References J N Holmes and W. Holmes, Speech Synthesis and Recognition , 2nd ed., Taylor and Francis, 2001. 1.B. Gold and N. Morgan, Speech and Audio Signal Processing, Wiley and Sons, 2000. 2.D. G. Childers, Speech Processing and Synthesis Toolboxes, Wiley and Sons, 2000. 3.J. R. Deller, J. R. Proakis, J. H. L. Hansen, Discrete-Time Processing of Speech Signals , Prentice-Hall 1993. 4.P. B. Denes and E. N. Pinson, The Speech Chain, W. H. Freeman & Co 1993. 5.S Furui, Digital Speech Processing, Synthesis and Recognition , Marcel Dekker Inc 1989. 6.D O'Shaughnessy, Speech Communications: Human & Machine , IEEE Press 1999. 7.L R Rabiner and R W Schafer, Digital Processing of Speech Signals , Prentice-Hall 1978. 8.K. N. Stevens, Acoustic Phonetics, MIT 30 April, 2004 35 B.Tech (Information Technology) IT-447 Image Analysis and Classification Credits: 4 (3-0-2) Introduction: Image Processing Fourier Transform and Z-Transform, Causality and stability, Toeplitz and Circulant Matrices, orthogonal and unitary Matrices and Kronecker

product, Markov Processes, KL Transform, Mean square Estimates and Orthogonal Principles. Image sampling and quantization, Band Limited Image Sampling Versus Replication, Reconstruction of Image from samples Sampling Theorem, Image Quantization Uniform Optimal Quantizer, Properties of Mean Square Quantizer, Commander Design Visual Quantization Image Transforms: Two Dimensional Orthogonal and Unitary Transforms and their properties. One Dimensional and Two Dimensional DFT Cosine and Sine Transforms Hadamard, Slant, HARR Transforms and their properties, Wavelet transform, Hough Transform. Image Processing: Image smoothing, Sharpening, enhancement, thinning. Image Analysis: Spatial feature extraction, Edge detection and boundary extraction Boundary, region and moment representations structures, Texture, Image Segmentation. Image Classification: Bayes classifier, k-NN, neural network classification. Clustering techniques, template matching, image convolution. Books/References 1.Anil Jain: Digital Image Processing 2.Gonzalez Woods: Image Processing 30 April, 2004 36 B.Tech (Information Technology) IT-449 Bioinformatics Credits: 4 (3-0-2) What is bio-informatics? Significance. Role of computing in bio-informatics. Techniques for bio-informatics computing – Application of probabilistic, statistical and machine learning approach to bioinformatics computing, Modeling – Markov chains, Review of Data mining and visualization, review of pattern matching techniques, Search engines and their application to bioinformatics. DNA – structure, DNA matching. From genes to genomes. Future scope of bio-informatics. 1)Bryan Bergerson, Bioinformatics Computing , Pearson Education. 2)Pierre Baldi, Bioinformatics: The Machine Learning Approach, Second Edition (Adaptive Computation and Machine Learning) , MIT Press 3)David W. Mount, Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory 4)Warren J. Ewens & Gregory R. Grant, Statistical Methods in Bioinformatics, Springer Verlag 5)Andreas D. Baxevanis & B. F. Francis Ouellette, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Wiley Interscience 30 April, 2004 37 B.Tech (Information Technology) IT-420 Distributed Systems Credits: 4 (3-0-2) Introduction: What is a distributed systems? Goals. Hardware and software concepts, design issues. Issues in Communication: Client-server and RPC. Synchronization: Clock synchronization, mutual exclusion, deadlocks. Load Balancing: Process allocation and algorithms for load balancing. Scheduling. Fault Tolerance: Issues and solutions. File Systems: Design and implementation. Case Study. Shared Memory: Design and implementation. Case Study. Text/References: 1.Tanenbaum and Steen: Distributed Systems: Principles and Paradigms , Pearson Education. 2.Nancy Lynch, Distributed Algorithms, Morgan Kaufman. 3.Coulouris, Dollimore and Kindberg, Distributed Systems: Concepts and Design , Addison Wesley. 4.Mullender: Distributed Systems , Addison Wesley. 5.Tanenbaum: Distributed Operating Systems, Pearson Education. 30 April, 2004 38 B.Tech (Information Technology) IT-422 Client-Server Computing Credits: 4 (3-0-2) Evolution of PC, Introduction to LANs, PC LANs, and Mainframe Computers, PC connected to mainframes. Distributed systems and databases. Client-server computing model, client server hardware and software needs, issues in client-server computing – shared access, connectivity and security. Advantages of client-server computing. Case studies – UNIX, Windows NT. Client-server applications: Database

server networking, Gateway videos – conferencing and multimedia applications. Client-server architectures: Segmentation, switched FDDI, peer-to-peer architecture. Text & References: 1.Client-Server Computing, Robert O'Reilly, O'Reilly. 30 April, 2004 39 B.Tech (Information Technology) IT-424 Soft Computing Credits: 4 (3-0-2) Introduction: Background, uncertainty and impression, Statistics and Random Processes, Uncertainty in Information, Fuzzy sets and Membership, Chance versus Ambiguity, Classical Sets – Operations, Properties, mapping to classical sets to functions; Fuzzy Sets – Operations and Properties; Sets as points in Hypercubes. Relations and Functions: Cartesian Product, Crisp relations – cardinality operations, properties, composition, Fuzzy Relations – Cardinality operations, properties, Fuzzy Cartesian Product and Composition, Noninteractive Fuzzy Sets, Tolerance and Equivalence Relations, Crisp Equivalence Relation, Crisp Tolerance Relation, Fuzzy Tolerance and Equivalence Relations, Value Assignments, Cosine amplitude, Max-Min method, other similarity methods, Membership Functions – Features, Standard forms and biyearlies, Fuzzyfication, Membership value assignments, Intuitions, Inference, Rank Ordering, Angular Fuzzy sets, Neural Networks, Genetic Algorithm, Inductive Reasoning. Lambda-Cuts for Fuzzy Sets, Lambda-cuts for fuzzy relations, Defuzzification Methods. Arithmetic and Logic: Extension Principle, Crisp functions, Mapping and Relations, Functions of Fuzzy Sets, Fuzzy Transform Practical Considerations, Fuzzy Numbers, Interval Analysis in Arithmetic, Approximate Methods of extension, Vertex Method, DSW Algorithm, Restricted DSW Algorithms, Comparisons, Fuzzy Vectors, Classical predicate logic, Tautologies, Contradictions, Equivalence, Exclusive Or Exclusive Logical proofs, Deductive Proofs, Deductive Inferences, Fuzzy Logic, Approximate Reasoning, Fuzzy Tautologies, Contradictions, Equivalence and Logical Proofs, other forms of the implication operation, other forms of the composition operation. Books/References 1)Timothy J Ross, Fuzzy Logic with Engineering Applications, MGH. 2)Klir and Yuan, Fuzzy Sets & Fuzzy Logic-Theory and Applications, PHI. 3)Klir & Folger, Fuzzy Sets, Uncertainty and Information, PHI. 30 April, 2004 40 B.Tech (Information Technology) IT-426 Software Testing and Verification Credits: 4 (3-0-2) Basic software testing principles - Software Quality, Software testing and test management. Acceptance Testing: User acceptance testing, alpha and beta testing. Verification And Validation Functional and Non-functional system testing Static and dynamic testing, Black-box or functional testing, structural, white box or glass box testing. Integration testing, component testing. Software testing tools. Books/References: Recent papers from conferences and journals 30 April, 2004 41 B.Tech (Information Technology) IT-428 Data Engineering Credits: 4 (3-0-2) Overview of Relational DBMS and SQL. Real-time Database: Implementation and issues. Concurrency control and locking. Recovery. Transaction management. Distributed DBMS: Distribution Design Issues, Fragmentation and Allocation, Data Security, Architecture Models for Distributed Data Base System, Client - Server Systems, Peer-to-Peer Distributed Systems, Query Processing, Distributed Transactions, Concurrency Control, Reliability, Advances: Introduction to Object-Oriented Databases, Spatial databases, Temporal databases, Databases in multimedia. Text/References 1)Elmasri R and Navathe SB, Fundamentals of Database Systems, 3rd Edition, Addison Wesley,2000. This book



covers most of the material on the course. 2)Connolly T, Begg C and Strachan A, Database Systems, 2nd Edition, Addison Wesley, 1999 3)Ceri Pelagatti , Distributed Database: Principles and System - (McGraw Hill) 4)Simon AR, Strategic Database Technology: Management for the Year 2000 , Morgan Kaufmann, 1995 5)Gray J and Reuter A, Transaction Processing: Concepts and Techniques , Morgan Kaufmann, 1993 6)M. Tamer Ozsu, Patrick Valduriez, Principles of Distributed Database Systems - (Pearson Education) 7)David Bill, Jane Grimson Distributed Data Base Systems - (Addison - Wesley) 8)Date CJ, An Introduction to Database Systems , 7th Edition, Addison Wesley, 1999 9)Khashafian S and Baker AB, Multimedia and Imaging Databases , Morgan Kaufmann,1996 10)McFadden FR, Hofer JA and Prescott MB, Modern Database Management 5th Edition, Addison-Wesley 1999

30 April, 2004 42 B.Tech (Information Technology) IT-440 Computer Vision Credits: 4 (3-0-2) Feature Extraction and description: parametric and non-parametric feature extraction including advance Hough transform techniques and active contour models. Image Interpretation: Syntactic and symbolic image interpretation and analysis. Image Restoration: Weiner filter. Least mean squares and extensions and maximum entropy restoration. 3D Imaging: Calibration, epipolar constraint, coordinate systems. Active and passive ranging systems. Morphology: Binary image processing and image geometry. Texts/References: 1)Nixon, M S and Aguado, A S, Feature Extraction and Image Processing Butterworth Heinmann (Newnes), 2002, Book website <http://www.ecs.soton.ac.uk/~msn/book> 2)Sonka, M, Hlavac, V, and Boyle R., Image Processing, Analysis and Machine Vision (2nd Ed., Thompson, 1999) 3)Jain, R., Kasturi, R., and Schunck, B. G. Machine Vision (McGraw Hill, 1996) 4)D.H. Ballard and C.M. Brown, Computer Vision, Prentice Hall, 1982. 5)S.E. Umbaugh, Computer vision and Image Processing: A Practical Approach using CVIP tools, Prentice Hall PTR, 1998. 6)Blake, A., and Isard, M.m Active Contours (Springer, 1998) 7)Rabiner L R and Gold B, Theory and Application of Digital Signal Processing (Prentice Hall, 1975) 8)Jain A K, Fundamentals of Digital Image Processing, (Prentice Hall, 1989) 9)Teuber J, Digital Image Processing (Prentice Hall, 1992)

30 April, 2004 43 B.Tech (Information Technology) IT-442 High Level Synthesis Credits: 4 (3-0-2) Various abstraction levels of synthesis, Need of high level synthesis, Overview of hardware description languages and High level synthesis of digital systems: Advantages, Data Structures used, algorithms, DFG and CDFG. Transformations in high-level synthesis, Transform based design space exploration. Design Optimisation: Design space, constraints on optimization, heuristics, simulated annealing. Scheduling – constrained, unconstrained, allocation and module binding. Trade-off in high level synthesis. Cost-function based optimization techniques. BIST: Role and significance in high level synthesis. Texts/References 1)Andrew Rushton, VHDL for logic synthesis, Wiley, ISBN 0-471-98352-X 2)Mark Zwolinski, Digital system design with VHDL, Prentice-Hall, ISBN 0-201-360362 3)Giovanni De Micheli, Synthesis and optimisation of digital circuits, McGraw Hill, ISBN 0-07016333-2 4)Sabih Gerez, Algorithms for VLSI design automation, , Wiley, ISBN 0-471-98489-2 5)John P Elliott, Understanding behavioural synthesis, , Kluwer, ISBN 0-7923-8542-X

30 April, 2004 44 B.Tech (Information Technology) IT-440 Web based Application Development Credits: 4 (3-0-2) Intoroduction to Internet and Intranet, The Server/Client Architecture

of the World Wide Web, HTML, DHTML. Forms: HTML tags and production of HTML forms, Types of data that can be accepted by web forms, Getting the data back - canned solutions and transition to CGI. CGI: Introduction to CGI, CGI processing using csh, Perl – an introduction, Decoding a form step-by-step using Perl and CGI. Database design using mySQL Java Scripting, Overview of Javascript and Dynamic HTML, Javascript as a language, Javascript in action - check the fields of a form for blanks. PHP Programming Active Server Pages Web Information System : porting database applications to web, uploading, document management and web technologies, security issues Interactive web based application design

Text/References : 1.John Desborough, Intranet Web Development, New Riders 2.Patrik Naughton, The Complete Reference Java, Tata Mcgraw Hill 3.Communications of the ACM, July 1998-Volume 41, Number 7 4. Stephen R. Schach, Software Engineering with Java, Tata Mcgraw Hill 30 April, 2004 45 B.Tech (Information Technology) IT-446 Critical System design Credits: 4 (3-0-2) Introduction to time critical systems, Applications, Design Issues, Characterization and classification of time-critical systems and tasks, release time, deadlines & timing constraints, reference model, priority assignment & scheduling, clock driven approach, weighted round robin approach, priority driven approaches, resources & resource access control, assumption on resources & their uses, protocols. Scheduling flexible computations and tasks with temporal distance constraints. Introduction to clock synchronization. Case studies. Text & References: 1.J.W.S.Liu: Real-Time Systems, Pearson Education Asia 2.P.A.Laplante: Real-time Systems Design and Analysis, An Engineer's Handbook, IEEE Press 3.S.T.Lavi, A.K.Agrawala: Real-time system Design, McGraw Hill 4.P.D.Laurence, K.Mauch: Real-time Microcomputer system design, An introduction, McGraw Hill 30 April, 2004 46 B.Tech (Information Technology) IT-448 Parallel Computing Credits: 4 (3-0-2) 1.Introduction Parallel processing terminology, Pipelining Vs Data parallelism, Control parallelism, Scalability, Control parallel approach, Data parallel approach, Data parallel approach with I/O 2.PRAM Algorithm Parallel reduction ,Prefix sums, List ranking, Preorder tree traversal, Merging two sorted lists, Graph coloring, Reducing the number of processors, Problems defying fast solutions on PRAMS 3.Parallel Programming Languages Programming parallel processes, Example and application, C\* programmers model, Language features, Sample program, OCCAM, programmer's model, Language constructs, Sample program, C-LINDA, Programmers model, Language constructs, Sample program 4.Mapping and Scheduling Mapping data to processors on processor arrays and multicomputers, Dynamic Load Balancing on multicomputers, Static scheduling on UMA multiprocessors, Deadlock. 5.Elementary Parallel Algorithms Classifying MIMD algorithms, Reduction, Hypercube SIMD model, Shuffle-Exchange SIMD model, 2-D Mesh SIMD model, UMA Multiprocessor model, Broadcast, Prefix sums 6.Matrix Multiplication Sequential matrix multiplication, Algorithms for processor array, Algorithms for multiprocessors, Algorithms for multicomputers 7.Sorting Enumeration sort, lower bound on parallel sorting, Odd-even transposition sort. Bitonic merge, Quick sort based algorithms, Random read and random write. Books/References 1.Michael Quinn: Parallel Computing-Theory and Practice, MGH. 2.Ed. Afonso Ferreira and Jose' D. P. Rolin, Parallel Algorithms for

irregular problems - State of the art, Kluwer Academic Publishers. 3.Selim G. Akl, The Design and Analysis of Parallel Algorithms, PH International. 4.Brassard and Bratley, Fundamentals of Algorithms, PHI, New Delhi 30 April, 2004 47 PG2022-23.pdf CompaniesCOMPUTER SCIENCE AND ENGINEERING Amazon 3 Bajaj Auto 1 Bel Ghaziabad 6 CDOT 1 Galgotia university 1 GLA University 1 HCL 3 Hitachi Energy 1 IBM 1 Itron 2 Mangalam Cement Marvell 2 Mercedes Benz 4 Nokia 1 Oracle 1 P P Savani University 1 Short Hills 1 Span Idea 1 Tata Motors 1 Tera Data 2 Truminds 1 Grand Total 35PG Total Offers by the Companies PG2021-22.pdf S.No.Name College ID Company Package Company Package Company Package 12020PIS5649 JAGRITI MAURYA Ingnious 7 22020PIS5647 ALISHA RANJAN Iquati 9.5 32020PIS5665 KUMAR SAHAB mediatek 16.65 42020PCP5584 SHREYA CHOWDHURY mediatek 30 52020pis5645 KARAN GUPTA Deloitte 8.1 62020pis5669 SATYANSH MISHRA Micron 18.65 72020pcp5536 KARTIKEY JAIN Tata Digital 10.5 82020pis5657 SHUBHAM SHARMA SCA 12 92020pis5667 AKUL KRISHNAN K Optum 14.7 MAQ Software 10 102020pis5655 AMANDEEP Optum 14.7 MAQ Software 10 112020pis5644 NISHANT CHAUDHARY MAQ Software 10 122020pcp5576 RAJAT KUMAR Evosys 6 132020pcp5594 RAVI KUMAR Optum 14.7 142020pcp5546 AVINASH Optum 14.7 152020pcp5572 DHEERAJ YADAV Optum 14.7 152020pcp5572 DHEERAJ YADAV Optum 14.7 162020pcp5605 KUMARI RASHMI VERMA Optum 14.7 172020pcp5516 AREEN GAUR Optum 14.7 182020pcp5551 PRIYANKA LUBAL Optum 14.7 192020PCP5507 PULKIT CHANDEL Optum 14.7 202020PIS5654 PANYAM MEENAKSHI Optum 14.7 212020PIS5661 DEEPAK YADAV Optum 14.7 222020PCP5577 SHADAB KHAN Optum 14.7 232020PCP5580 DEEPAK SINGH PAL LnT Infotech 9.5 Capgemini 7.5 242020pcp5573 SHIVAM KUMAR LnT Infotech 9.5 252020PCP5587 DEEKSHA RATNAWAT Wissen Technology 11 262020PCP5582 SINCHIT BATHAM Parul University 5.04Dassault systemes 10.5 272020pis5670 SAURABH JAYASWAL Microchip 11 282020PIS5676 SAURABH SINGH Mini Orange 12 292020PIS5680 PALLAVI MOHAN WATURE Mini Orange 8 302020PCP5528 ADHITESH CHAUHAN Sapnidea 7 312020pcp5520 KAMAKHYA BANSAL Samsung 14.5IIFL 9 322020PIS5678 NIDHISH KUMAR IIFL 9congnizant 6.5 332020PIS5503 JYOTISHREE KANHAR IIFL 9 S.No.Name College ID Company Package Company Package Company Package 342020pcp5575 ROHIT KUMAR IIFL 9 352020PCP5511 KHUSHBOO KUMAR Genpect 11.4Factspan 7.5Innominds 6 362020pis5659 GOPALJI SINGH Qualcomm 29.1 372020PIS5650 BHUPENDRA KUMAR SAHU Tartan 12Deloitte 8.1 382020PCP5532 TOSHI RAWKA Mercedes-Benz 15 392020pis5498 VINODKUMAR SHIRGURI Qualcomm 29.1Kantar 7.15 402020PIS5663 ARVIND OKRAM Niyto Solutions 20Rebel Foods 12 412020PIS5672 SIDDHARTHA SINGH Cdot 13itron 14Capgemini 7.5 422020PCP5598 ADITYA KUMAR SINGH Cdot 13 PG2020-21.pdf S.No.Name College ID Company Package Company Package 12019pcp5028 SAKSHI PARASHAR Paytm 9 22019PCP5048 HARSHAL KAUSHIKBHAI KA. PATEL Maq Software 9 32019pcp5150 GHARAT SNEHAL RAJENDRA Halliburton 11 4 2019PCP5154 SHUBHANSHU KUMAR MISHRA Samsung Research Institute 13 CDOT 14.65 52019PCP5173 KULDEEP Adani Enterprises Ltd. 8 62019pcp5280 SHALIN KUMAR DEVAL MTX 14

72019PCP5282 RAHUL KUMAR CHAUBEY Micron 12.1 82019pcp5283 MANISH SUTHAR Snapdeal 10 92019pcp5333 SHABNAM ALI Nokia 7.5 102019PCP5420 SHIVAM SHARMA quovantis 3.35 112019PCP5422 SHIVENDRA SINGH BEL 10 122019PCP5456 AARADHANA SAHU Spanidea 5 132019pcp5460 ANKUSH KUMAR Samsung sds 12 142019PCP5471 SHIVAM SHARMA Adani Group 8 152019pcp5496 MOHAMMED ZABEER ALI Oracle 11.5 162019pcp5499 DEEPALI SINGH Nokia 7.5 172019pcp5505 RAJESH BISWAS miniOrange 12 182019pis5006 SAKSHI SHREE Nokia 7.5 182019pis5006 SAKSHI SHREE Nokia 7.5 192019PIS5182 ARISH Oracle 11.5 202019pis5351 OJASVI KHEMANI Oracle 11.5 212019pis5365 TUSHAR GAUTAM Deloitte 8.1 222019pis5384 KIRTI DUBEY Sciative Solutions 7 232019PIS5386 ASHOK RATHORE Sagacious IP 4.2 242019PIS5389 MANISH TOMAR BEL 10 252019pis5403 SUMEDH RANJAN BHAGAT Nokia 7.5 262019PIS5404 ROBIN SINGH Adani Group 8 272019pis5406 DHIRAJKUMAR SEKHANI Maq Software 9 282019PIS5414 KAJAL MEENA India Mart 10 292019PIS5417 KSHITIJ AGARWAL Interra Systems 9 302019PIS5472 SUSHIL KUMAR Spanidea 5 e2enetworks 5.5 312019pis5478 SHRUTI SAINI Maq Software 9 322019pis5479 RAHUL LAHRE Halliburton 11 332019PIS5490 DINESH SAINI Spanidea 5 342019PIS5498 DEEPIKA JASSAL Lava International 7 352019PIS5522 DEEKSHA NEELAM Oracle 11.5 362019PIS5525 MOHAN SINGH BEL 10 372019PIS5407 RATHOD RAHUL SANJAYBHAI e2enetworks 5.5 382019PIS5489 SAURABH SAGAR e2enetworks 5.5 392019pis5494 PRACHI SHRIKRUSHNA SUPE Research Wire 5 PG2019-20.pdf S.No.Name College ID Company Package Company Package 1Shweta Patidar 2018PCP5018 Deloitte 8.1 2Ram Vaishnav 2018PCP5047 Philips 11 3Sneha 2018PCP5055 MAQ Software 9 4neha kumari 2018PCP5070 Intel 17 5Kapil Mangal 2018PCP5112 Nokia 7.5 6Lilesh Jinger 2018pcp5123 BEL 10.34Oracle 9.5 7Mahendra Kumar Meena 2018pcp5186 Parul University 5 8Sonam Vyas 2018PCP5210 Nokia 7.5 9Vishal Teotia 2018PCP5212 Oracle 9.5 10Rishabh Sahu 2018PCP5344 Nokia 7.5 11Chandramani Adil 2018PCP5420 BEL 10.34Accops 8 12Mohammad Iqbal 2018PCP5500 Nokia 7.5 13Sai Sreekar 2018PIS5024 Walmart Labs 20.67 14Prateek Sharma 2018PIS5157 Societe Generale 13.13 15Pooja Kumari 2018PIS5159 Philips 11 15Pooja Kumari 2018PIS5159 Philips 11 16Pooja Goswami 2018PIS5352 BEL 10.34 17Prerana Kajla 2018PIS5368 Philips 11 18shivankshi khandelwal 2018PIS5393 Wissen 11 19Rashmi Raj 2018PIS5418 Ericsson Global 6.5 20Kawaldeep Kaur 2018PIS5431 Societe Generale 13.13 21 Vaibhav Kumar Srivastava 2018PIS5435 PVPSIT 5.4 22Anu Ayyappan 2018pis5474 BEL 10.34Oracle 9.5 23KARIMPANAPUITCHAYIL ANU AYYAPPAN 2018PIS5474 BEL 10.34 24PIYUSH MISHRA 2018PIS5487 MINI ORANGE 6 25Ram Vaishnav 2018PCP5047 BEL 10.34 26Shubham Joshi 2018PCP5099 BEL 10.34 UG2022-23.pdf Companies COMPUTER SCIENCE AND ENGINEERING 26 Miles Club Global Pvt. Ltd.1 Academor 1 Adani 1 Airtel 4 Amazon 2 Apple 2 Arcesium 1 Bright Champs 2 Carrier 1 CDOT 2 Celigo 1 Confluence Creditq 2 decision point 1 DEShaw 2 Deutsche 1 Eurofins 1 Ganit 1 Gap 4 Goldman Sachs 3 housing.com 1 IDBI 2 Informatica 3 Intuit 2 JPMC 2 Jubilant 3 Junglee Games 1 live your best life 1 magicbricks 2 Mercedes Benz 1 Micron 3 MMT 3 Nav Back Office 1 NHA 2 Niyo 1 Optum 8 Oracle 3 Paisabazaar 3 People Strong 1 Policybazaar 1 Q3

Technologies 1 Quadeye 1 Reliance Jio 1 Salesforce 8UG Total Offers by the Companies Samsung 3 Tata Motors 1 Truminds 1 UBS 2 Vodafone 1 Wells Fargo 1 wooqer 1 Zuora 1 Grand Total 109 UG2021-22.pdf S.No.Name College ID Company Package Company Package Company Package 12018ucp1460 DHRUV GOYAL Arcecium 37 Lowe's 19.34 22018UCP1386 DEVANSHI MITTAL Apple 60 32018UCP1700 ABHINAV AGGARWAL Apple 60 42018UCP1298 MOHIT MISHRA My Park Plus 16Apple 52018UCP1136 ROHIT KUMAR SAHU JPMC 14 UBS 10 62018UCP1438 KESHAV SONI JPMC 14 72018ucp1140 HARSHA Salesforce 35.37 JPMC 14 82018UCP1658 NIDHI HEMANT MITKARI JPMC 14JohnDheere 11 92018UCP1444 PRANSHU VYAS DeShaw 38.5 102018ucp1388 PRATEEK SHARMA Deutsche Bank 19.6 112018ucp1329 S KRISHNA KISHORE Deutsche Bank 19.6 122018ucp1489 MAYANK KALSAN Micron 17.75 132018UCP1691 SOMYA GUPTA Apple 64 John Dheere 11 142018UCP1349 TANMAY GUPTA Quadeye 20.4 152018ucp1385 TARUN KUMAR MISHRA Quadeye 20.4 2018ucp1385 TARUN KUMAR MISHRA Quadeye 20.4 162018ucp1411 PRANAY KANJOLIA Flipkart 26.57 172018UCP1325 NITIN SINGH BHADORIYA Salesforce 35.37 182018UCP1581 VAIBHAV AGARWAL Salesforce 35.37 192018UCP1464 NANDINI ROY Flipkart 26.57 202018ucp1154 AKASH SHARMA Flipkart 26.57 21 2018UCP1319 PARMAR ABHISHEK SANGHARSHBHAI Oracle 29.2 22 2018ucp1744 AKSHIT AGARWAL Oracle 29.2 23 2018ucp1466 PRATEEK MAHESHWARI Amazon 44 Oracle 29.2 24 2018ucp1097 RISHABH Amazon 44 Oracle 29.2 25 2018ucp1491 VINUSH VISHWANATH Oracle 29.2 262018UCP1398 ABHISHEK NARAIN DAS BHATIA Amazon 44 272018UCP1323 KARAN MAURYA Amazon 44 282018UCP1471 GUNJAN SHEKHAWAT Amazon 44 292018UCP1465 SONAL AGRAWAL Apple 64 JPMC 14 302018ucp1448 MOKSH AHUJA Amazon 32.16 Goldman Sachs 23 312018ucp1173 DEEPAK Barclays 11.73 322018ucp1436 RAHUL AMARWAL Barclays 11.73 332018ucp1456 AATESH Barclays 11.73 S.No.Name College ID Company Package Company Package Company Package 342018ucp1505 ASHUTOSH SONI Barclays 11.73 352018ucp1737 TRIYA BYADWAL ACKO 16 Fractal Analytics 10.5 362018UCP1497 TAVISH VIJAY Amazon 32.16 372018ucp1455 ANAND KUMAR Cevent 13.62 382018UCP1827 GAURAV SAINI Truminds 11 392018ucp1712 ABDULLAH JAMAL Paytm 16 402018ucp1265 SANSKAR SONI Paytm 16 412018ucp1287 AKSHAT SINGLA Paytm 16 422018ucp1270 RISHI ROSHAN SINGH Paytm 16 432018UCP1474 ADARSH KUMAR Celigo 16.5 442018UCP1451 NEETIN KUMAR Celigo 16.5 452018UCP1672 KAPIL KANSAL Sudrania 30 462018UCP1601 ANURAG JAIN Sudrania 30 472018UCP1478 DESHPRIYA Sudrania 30 Oracle 16 482018UCP1556 HEMANT BAJAJ Sudrania 30 2018UCP1556 HEMANT BAJAJ Sudrania 30 492018UCP1360 SHUBHAM MODI Oracle 16 502018UCP1502 SATYAJIT ROY Oracle 16 512018UCP1030 NITESH SHARMA IXIGO 22 522018UCP1490 YASH JAIN IXIGO 22 532018UCP1673 DIVYA KRIPLANI IXIGO 22 542018UCP1405 NIKHIL SAIN IXIGO 22 55 2018UCP1482 HEET VINOD SURANA LoadShare 17.5 56 2018UCP1620 PURVA DAGA LoadShare 17.5 57 2018UCP1479 SIDDHARTH SINGH LoadShare 17.5 58 2018UCP1427 SHUBHAM MEENA LoadShare 17.5 592018UCP1498 HIMANSHU VERMA Magicbricks 10 602018UCP1513 ANKIT

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GAP 9 Tredence 6.5 6 Akshita Agrawal 2016ucp1023 Fidelity 12.93 7 Akshay Rawat 2016UCP1026 Cubastion Consulting 7.19 8 Devendra Purohit 2016UCP1029 White Hat Jr 9 9 Birat Adhikari 2016UCP1033 Publicis Sapient 10 10 Pulkit 2016UCP1090 Samsung 13 11 Rishabh Kalakoti 2016UCP1098 ServiceNow 25 12 Ashish Goyal 2016ucp1100 Walmart Labs 19.27 13 Abhishek Tibrewal 2016UCP1103 Oracle 9 14 Mukul Kumar 2016UCP1116 Airtel 14 15 Shivanshu Vyas 2016UCP1121 Amazon India 28.75 16 Jaideep Sharma 2016UCP1126 Lowe's 19.17 17 Prashant Kumar 2016UCP1132 L&T; Infotech 9 18 Sankhya Kumar Mitra 2016UCP1145 People Strong 6.6 19 M. Satish Reddy 2016ucp1180 JP Morgan 14 20 Ronak Gadia 2016ucp1185 JP Morgan 14 21 Meedimale Yashwanth Reddy 2016ucp1216 Walmart Labs 19.27 22 Suraj Kumar 2016UCP1220 Publicis Sapient 10 23 Rohit Kumar bairwa 2016UCP1295 Samsung 13 24 Kapil Saini 2016UCP1297 ServiceNow 25 25 Sugam 2016UCP1305 Oracle 9 26 G Jahnvi VS 2016UCP1332 Oracle 9 27 Matli Mohan Tejeswar Reddy 2016UCP1338 Fidelity 12.93 28 Gaurav Bansal 2016UCP1345 Airtel 14 29 Shubham 2016UCP1350 QuadEye Security 17 30 Shreya Jain 2016UCP1360 Societe Generale 13.13 GAP 9 31 Amit Singh Jadaun 2016UCP1363 Walmart Labs 19.27 32 Varun Kumar Verma 2016UCP1368 Societe Generale 13.13 S.No.Name College ID Company Package Company Package 33 MD Saifullah 2016UCP1369 Societe Generale 13.13 34 Himnshu yadav 2016UCP1372 Samsung 13 35 Pankaj Tanwar Banna 2016UCP1381 Wissen 11 PaisaBazaar 9 36 Sanjay Kumar 2016UCP1382 PharmEasy 13.5 37 Shubham Arora 2016ucp1388 JP Morgan 14 38 Bhagwana Ram 2016UCP1389 Societe Generale 13.13 39 Aviral Mongra 2016UCP1392 Fidelity 12.93 40 Priyanshu Singh 2016UCP1393 Intellipaath 5.4 41 Priyanshu Singh 2016UCP1393 White Hat Jr 9 42 Rahul Jangir 2016UCP1396 Wipro 6.5 43 Kashyap Kumar Vishwakarma 2016ucp1400 Fidelity 12.93 44 Aashish Goel 2016ucp1404 Salesforce 30.82 45 Pooja Yadav 2016UCP1406 Nokia 7 46 Balwant Singh 2016ucp1411 Toshiba 8 Tally Solutions 7 47 Rahul Kumar 2016UCP1412 ServiceNow 25 48 Jagriti Aggarwal 2016ucp1413 Walmart Labs 19.27 49 Udit Arora 2016ucp1415 Goldman Sachs 22 50 Anmola kumari 2016ucp1422 Goldman Sachs 22 51 Gauri 2016UCP1425 Publicis Sapient 10 52 Pratibha Choudhary 2016UCP1426 Oracle 9 53 Ashish Pandey 2016UCP1432 Capgemini 6.8 54 Ajit Kumar Rai 2016UCP1433 NAV Back Office 7.5 55 Preet Yadav 2016UCP1436 Societe Generale 13.13 56 Shweta Mehroliya 2016UCP1438 Lowe's 19.17 GAP 9 57 Deepanshu Vijay 2016UCP1439 Nucleus software 6.5 58 Awadhesh Kumar 2016UCP1441 Incture 8 59 Tarishi Jain 2016ucp1443 Salesforce 30.82 60 Aditya Sinha 2016ucp1447 JP Morgan 14 61 Arvind Kumar 2016UCP1448 Incture 8 62 Adit Mathur 2016UCP1454 Oracle 9 63 Siddhant Gupta 2016UCP1455 Samsung 13 64 Aditya Bansal 2016ucp1456 Fidelity 12.93 S.No.Name College ID Company Package Company Package 65 Bhawana Sankhla 2016UCP1457 IBM 7.25 Capgemini 6.8 66 Aryan Sharma 2016ucp1458 Walmart Labs 19.27 67 Sumit Kumar 2016ucp1459 Walmart Labs 19.27 68 Shivani Khandelwal 2016UCP1462 Salesforce 30.82 69 Harsh Bansal 2016ucp1468 Fidelity 12.93 70 Khusboo Choudhary 2016UCP1469 Deutsche Bank 14.3 71 Shambhawi Varchasva 2016ucp1470 Commvault 24 JP Morgan 14 72 Gaurav Kabra 2016UCP1471 Salesforce 30.82 73 Divya Gupta 2016ucp1472 Salesforce 30.82 74 Narender Kumar Yadav



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Science & Engineering) programme was initiated whereas, M.Tech. (Computer Science & Information Security) was started in 2016. Faculty at Computer Science & Engineering believes in open interaction with students who are encouraged to participate in academic, research and extra-curricular activities. Students have never misplaced trust put in them by department and have done well in academic and industry alike. List of Programs offered by the Department: Program Title of the program B.Tech Computer Science and Engineering M.Tech Computer Science and Engineering Computer Science & Information Security Ph.D. Computer Science and Engineering Vision To be a Centre of Excellence in Computer Science and Engineering domain and work with industry on cutting edge technology to address current and emerging challenges in global perspective for the development of society. Mission To impart quality engineering education, enhance problem solving skills, foster research and innovation, encourage entrepreneurship and mold students of integrity and ethics to provide leadership with social sensitivity for the betterment of the country and humanity as a whole. Department of Computer Science and Engineering Course Structure and Syllabus for M.Tech CSE and M.Tech CS&IS; MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR DEPARTMENT of Computer Science and Engineering M.Tech. Computer Science and Engineering Semester. I S.No. Course Code Course Title Course Category Type Credit L T P 1. 21CST501 Advanced Data Structures and Algorithms PC Theory 3 3 0 0 2 21CST503 Parallel and Distributed Computing PC Theory 4 3 0 2 3. 21CST502 Advanced Databases PC Theory 3 3 0 0 4. 21CST813 Department Elective – 1 PE Theory 3 3 0 0 5. 21CST814 Department Elective – 2 PE Theory 3 3 0 0 6. 21CSP504 Programming Lab -1 PC Lab 2 0 1 2 Total 18 Semester. II S.No. Course Code Course Title Course Category Type Credit L T P 1. 21CST507 Research Methodology PC Theory 2 2 0 0 2 21CST842 Department Elective – 3 PE Theory 3 3 0 0 3. 21CST843 Department Elective – 4 PE Theory 3 3 0 0 4. 21CST844 Department Elective – 5 PE Theory 3 3 0 0 5. 21CST845 Department Elective – 6 PE Theory 3 3 0 0 6. 21CSP506 Programming Lab -2 PC Lab 2 0 1 2 7. 21CSP505 Design Lab /Computing Tools PC Lab 2 0 1 2 Total 18 Semester. III S.No. Course Code Course Title Course Category Type Credit L T P 1. 21CSS603 Technical Documentation and Presentation PC --- 2 0 1 2 2 21CSP602 Literature Review PC --- 2 0 1 2 3. 21CSD601 Dissertation – 1 PC --- 8 0 0 16 Total 12 Semester. IV S.No. Course Code Course Title Course Category Type Credit L T P 1. 21CSD604 Dissertation – 2 PC --- 12 0 0 24 Total 12 Total Credits: 60 MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST501 Course Name : Advanced Data Structures and Algorithms Credits : 3 L - 3 T - 0 P - 0 Course Type : Core Prerequisites: None Course Contents RAM model – Notations, Recurrence analysis - Master's theorem and its proof - Amortized analysis, Recurrence equations. Advanced Data Structures: B -Trees, Binomial Heaps, Fibonacci Heaps, AVL trees, Red -black trees, B -trees, Splay trees, Interval trees; Disjoint set – union and path compression, Amortized analysis Greedy Algorithms: shortest distance, minimum spanning tree, interval scheduling, interval partitioning; Divide and Conquer: sorting, integer and polynomial multiplication; Dynamic programming: Longest common subsequence. Chain of matrix multiplication,

sequence alignment, Bellman Ford Convex hull and Voronoi diagrams, line segments, Optimal polygon triangulation; Primality testing, Integer factorization; Graph algorithms: Matching and Flows; Parallel algorithms: Basic techniques for sorting, searching, merging. Intractability: Independent Set, Vertex Cover, Randomized algorithms, Probabilistic algorithms. Approximate Algorithms: Vertex -cover, set -covering problems, Travelling Salesman problem. Complexity classes - NP-Hard and NP -complete Problems - Cook's theorem NP completeness reductions, undecidability

Recommended Readings Text Books: - 1. Cormen, Leiserson, Rivest: Introduction to Algorithms, Prentice Hall of India. 2. AhoA.V , J.D Ulman: Design and analysis of Algorithms, Addison Wesley 3. Brassard : Fundamental of Algorithmics, PHI. 4. Sara Baase: Computer Algorithms: Introduction to Design and Analysis, Pearson Education. 5. Papadimitriou, Steiglitz: Combinatorial Optimization: Algorithms and Complexity, PHI 6. Motwani and Raghavan: Randomized Algorithms, Cambridge University Press 7. Vazirani: Approximation Algorithms, Springer Verlag 8. Joseph Ja'Ja': Introduction to Parallel Algorithms, Addison -Wesley 9. Kleinberg, Tardos: Algorithm Design, Addison Wesley. 10. Dexter Kozen: The Design and Analysis of Algorithms. Springer, 1992 11. SanjoyDasgupta, Christos Papadimitriou, and UmeshVazirani: Algorithms, McGraw Hill. 12. Robert Sedgewick and Kevin Wayne. Algorithms 4/e. Addison -Wesley. 13. Robert Tarjan: Data Structures and Network Algorithms, Society for Industrial and Applied Mathematics

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST503 Course Name : Parallel and Distributed Computing Credits : 4 L - 3 T - 0 P - 2 Course Type : Core Prerequisites: Programming in C, Data Structures, Operating Systems, Computer Architecture and Organization, Computer Networks Course Contents Parallel Computing, Sequential programs, Parallel Programs, Performance Metrics for Parallel Systems, Effect of Granularity on Performance, Scalability of Parallel Systems, Parallel Programming Platforms, Implicit Parallelism, SIMD & MIMD systems, Clusters, Single -Core and Multi -Core Processors, Physical Organization of Parallel Platforms, Cache Coherence, Interconnection Networks for Parallel Computers. Programming Using the Message -Passing Paradigm - MPI Principles of Message Passing Programming; Building blocks (Sending and Receiving Operations); Communication Library calls; Collective communication and Computation library calls, Programming Shared Address Space Platforms – OpenMP, Directive Parallel Programming; The OpenMP programming Model (Concurrent Tasks, Synchronization Constructs, Data Handling); Open libraries; OpenMP -Environment Variables; Parallel Programs, Matrix Computations, Matrix Vector Multiplication, Matrix - Matrix Multiplication, Solving system of Linear Equations; Parallel Implementation of Sparse Matrix Computations with Vector; Sorting algorithms, Issues in Sorting on Parallel Computers; Bubble Sort and its Variants, Quicksort; Parallelizing Quicksort; Sequential and Parallel Implementation of all -pairs of Shortest Paths Algorithms; Sequential & Parallel Search Algorithms; Depth -First Search Algorithms; Best - First Search Algorithms, Programming on Multi -Core Systems with GPU accelerators An Overview of Brief History of GPUs; An Overview of GPU Programming; An Overview of GPU Memory Hierarchy Features; An Overview of

CUDA enabled NVIDIA GPUs, Introduction to CUDA C, Parallel Programming using OpenACC, CUDA APIs, CUDA Libraries for Numerical and Non -Numerical Computations; The OpenCL – Heterogeneous Programming; OpenCL Libraries, The OpenCL Memory Model, Execution Model; Platform and Devices; An Overview of OpenCL API; An Overview of MapReduce, An Overview of MapReduce Programming, An Overview of Hadoop Architecture /Execution (Master/slave, Namenode/Datanode); Hadoop Distributed File System (HDFS), An Overview of Hadoop Components, Hadoop – Control Flow and Data Flow; An overview of Hive (Distributed Data Warehouse); Hbase (Distributed Column based database, Pig –(Data Flow Language); Recommended Readings Text Books: - 1. AnanthGrama, Anshul Gupta, George Karypis, Vipin Kumar: Introduction to Parallel Computing, Second Edition Pearson Education – 2007 2. Peter Pacheco, An Introduction to Parallel Programming, Morgan Kaufman Publishers, Elsevier (2011) 3. Jason Sanders, Edward Kandrot, CUDA By Example – An Introduction to General -Purpose GPU Programming, Addison Wesley (2011) 4. RohitChnadra, Leonardo Dagum, Dave Kohr, DrorMaydan, Jeff McDonald, Ramesh Menon, Parallel Programming in OpenMP, Academic Press (2001) 5. Benedict R Gaster, Lee Howes, David R KaeliPerhaad Mistry Dana Schaa, (2011), Heterogeneous Computing with OpenCL McGraw -Hill, Inc. Newyork 6. Michael J. Quinn, Parallel Programming in C with MPI and OpenMP McGraw -Hill International Ed (2003) 7. Aru C Murthy, Vinod Kumar Vavilapalli, Doug Eadline, Joseph Niemiec, and Jeff Markham, Apache Hadoop YARN Moving beyond MapReduce and Batch Processing with Apache Hadoop 2, Addison Wesley, 2014

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR**  
Department/Centre : Department of Computer Science & Engineering Course Code : 21CST502 Course Name : Advances in Databases Credits : 3 L - 3 T - 0 P - 0 Course Type : Core Prerequisites: Basic course in Database Management Systems Course Contents Query Processing and Optimization – Implementation of Database operations, External Sorting, Size Estimations, Equivalence Rules, Heuristic -based Optimization, Materialized Views, Incremental View Maintenance. Transaction Processing - Concurrency Control Management, Serializability, Two -phase Lock Protocol, Deadlock Prevention and Detection, Timestamp -based Ordering Protocol, Log -based Recovery Management. Modern Database Systems - Database System Architectures, Distributed Database Systems, Parallel Data bases, Times in Databases, Multimedia Databases Distributed Databases - Data Storage, Global Catalog, Distributed Transaction Processing, Two -Phase Commit Protocol, Distributed Query Processing. Recommended Readings Text Books: - 1. Silberschatz ,Korth, Sudarshan : Database System Concepts, McGraw Hill. 2. Elmasri and Navathe : Fundamentals of Database Systems, 3rd Edition, Addison

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR**  
Department/Centre : Department of Computer Science & Engineering Course Code : 21CSP504 Course Name : Programming Lab – 1 Credits : 2 L - 0 T - 1 P - 2 Course Type : Core Prerequisites: Course Contents Programming exercises and experiments in Algorithms Dynamic programming and Approximate Algorithms. Combinatorial algorithms, Randomized algorithms, Graph algorithms: Parallel algorithms: Basic techniques for sorting, searching, merging Programming exercises and experiments in Parallel and

Distributed Computing. Parallel processing terminology, Pipelining Vs Data parallelism, multi-threaded architectures. Parallel reduction, Prefix sums, List ranking, preorder tree traversal, Merging two sorted lists Distributed and shared memory, Hadoop and MapReduce Programming exercises and experiments in Advanced Data structure and database . Advanced Lists, Segment Tree, Trie, Binary indexed tree. Self-Balancing BSTs, N-ary Tree. Disjoint Set, Suffix Array and Tree. Recommended Readings Text Books: - 1. Cormen, Leiserson, Rivest: Introduction to Algorithms, Prentice Hall of India 2. N. Deo: Graph Theory with Application to Engineering and Computer Science, Prentice-Hall 3. Ghosh, Moona and Gupta, Foundations of parallel processing, Narosa publishing. 4. Ed. Afonso Ferreira and Jose' D. P. Rolin, Parallel Algorithms for irregular problems - State of the art, Kluwer Academic Publishers

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR**  
Department/Centre : Department of Computer Science & Engineering Course Code : 21CST507 Course Name : Research Methodology Credits : 2 L - 2 T - 0 P - 0 Course Type : Core Prerequisites: None Course Contents Unit I: Data Structures and Algorithms: Review of Data Structures, and most commonly used algorithms in Computer Science and Engineering – Sorting, DFS/BFS, Pattern Searching. Unit II: Linear Algebra: Vectors - linear vector spaces, linear independence, norms and inner products, Basis and dimension, Matrices, Matrix operations, Inverse of a matrix Orthogonalization, Properties of determinants, Eigenvalues and eigenvectors, SVD and pseudo inverse, KL or Hotelling transform. Unit III: Transforms Signals and representation, Convolution, Frequency Transforms, Properties of Fourier Transform, DFT, DCT and FFT, Introduction to wavelets, applications in Computer Science and Engineering Unit III: Probability and Statistics Statistics: Introduction to statistical analysis, hypothesis testing – null and alternate, statistical tests – chi-square, ANOVA, data validation Probability models and axioms, Bayes' rule, discrete and continuous random variables, Probability distributions: normal distribution and properties, conditional, marginal and joint probability distribution, PRNG (pseudo random number generators) - randomness tests, introduction to information theory and cryptography: an Introduction Unit IV: Machine Learning: Linear and non-linear regression, supervised learning – neural network, binary decision diagram, SVM, k-NN, unsupervised learning – Clustering, Hidden Markov Models, Introduction to deep learning. Unit V: Case Studies in Research Domains of CSE. Recommended Readings Text Books: - 1. Gilbert Strang: Linear Algebra, MIT Cambridge Press. 2. Sheldon Ross: First Course in Probability, Pearson. 3. Mark Girolami, Simon Rogers: First Course In Machine Learning, CRC Press. 4. Anirban Das Gupta: Probability and Statistics for Machine Learning, Springer. 5. The Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani, second ed, Springer 6. Ian Goodfellow: Deep learning, MIT Cambridge Press.

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR**  
Department/Centre : Department of Computer Science & Engineering Course Code : 21CSP506 Course Name : Programming Lab – 2 Credits : 2 L - 1 T - 0 P - 3 Course Type : Elective Prerequisites: Programming Skills, Data Structures, Computer Networks Course Contents 1) Programming exercises and experiments in Operating Systems a. Kernel compilation and configuration, kernel modules, system calls and in-line assembly. b. Memory management, process

management and scheduling c. Interrupts and interrupt handlers, synchronization etc.

2) Programming exercises and experiments in Advanced Database management systems. a. Cloud Databases: MongoDB/Cassandra etc. b. Transaction Processing: Practice on transaction processing 3) Programming assignments on NetSim and Libalium

Recommended Readings Text Books: - 1. Stevens, W. R., "Unix Network Programming: Vol. II", 2nd Ed., Pearson Education 2. Daniel P. Bovet, Marco Cesati, O'Reilly, "Understanding the Linux Kernel" Third Edition, 2005 3. Robert Love, "Linux Kernel Development", Pearson Education, Third Edition, 2010 4. LAN Trainer user Manual. 5. Lee Chao, "Cloud Database Development and Management", CRC Publisher, 2013

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAI PUR  
Department/Centre : Department of Computer Science & Engineering Course Code : 21CSP505 Course Name : Design Lab / Computing Tools Credits : 2 L - 0 T - 1 P - 2  
Course Type : Core Prerequisites: Students must have prior programming experience in C/C++ or any language; mathematics through differential equations, and numerical analysis

Course Contents Operating Systems and Unix Environments: features of UNIX/Linux for scientific and technical computing; languages, compilers, debuggers, performance tools, make files, build systems, shell scripting, file management, source code control. Research Documentation and Simple Data Visualization: tools for generating research and code documentation: LATEX, Dxygen, plotting tools. Software Best Practices: software design cycle, regression testing, defensive programming, verification, code coverage Scientific Libraries: availability of common math libraries and usage for scientific computing. High performance Computing (HPC): Tool and techniques.

Recommended Readings Text Books: - 1. Eric S. Raymond, The Art of Unix Programming, Addison-Wesley 2003 2. Heister, T. and Rebholz, L. G., Introduction to Scientific Computing for Scientists and Engineers. De Gruyter Press, 2015. 3. John Levesque, High Performance Computing: Programming and Applications

Electives Courses for PG -CSE 1. 21CST802 Advanced Computer Networks 2. 21CST824 Network on Chip 3. 21CST803 Advances in Compiler Design 4. 21CST804 Android Programming 5. 21CST806 Computer Vision 6. 21CST807 Cyber Physical Systems 7. 21CST808 Data Analytics 8. 21CST809 Data Compression 9. 21CST810 Data Mining 10. 21CST812 Deep Learning 11. 21CST815 Distributed Systems 12. 21CST816 E-Commerce 13. 21CST817 Hardware Software Codesign 14. 21CST818 Image Analysis 15. 21CST819 Information Retrieval 16. 21CST820 Internet of Things 17. 21CST822 Natural Language Processing 18. 21CST823 Nature Inspired Algorithms 19. 21CST825 Network Performance Modelling 20. 21CST826 Neural Networks 21. 21CST827 Parallel Processing & Algorithms 22. 21CST828 Parallelizing Compiler 23. 21CST830 Quantum Computing 24. 21CST831 Real Time Systems 25. 21CST832 Robotics and Control 26. 21CST801 5G Technology 27. 21CST834 Selected Topics in Operating System 28. 21CST833 Selected Topics in Computing 29. 21CST835 Social Media Mining 30. 21CST836 Social Network Analysis 31. 21CST837 Software Project Management 32. 21CST838 Software Testing and Validation 33. 21CST840 VLSI Algorithms 34. 21CST841 Wireless Sensor Networks 35. 21CST821 Machine Learning 36. 21CST829 Pattern Recognition 37. 21CST805 Big Data Analytics 38. 21CST811 Data Visualization 39. 21CST839 System on Chip 40. 21CSL760 Program Analysis

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST802 Course Name : Advanced Computer Networks Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Wireless networking: Bluetooth, 802.11 standards Information theory, bandwidth, multiple access Wireless Terahertz Networks 5G and 6G communication Intelligent Transportation Systems Emerging networking technologies: Host configuration and service discovery principles Future routing architectures IPv6 deployment scenarios and challenges, IPv6 transition/integration Advanced IP multicast, including IPv6 multicast and SSM Software -defined networking Delay - tolerant networking Future home network architectures IP network management and monitoring. Social Networks Recommended Readings Text Books: - 1. Tanenbaum A S and Wetherall D J (2010). Computer Networks. 2. Hagen S, (2006). IPv6 Essentials. 3. Recent publications on the relevant fields

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST824 Course Name : Network on Chip Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Computer Architecture, Logic System Design Course Contents The Concept of route packet not wires for On -Chip Interconnection Networks, Topology and design architecture of Network -on-Chip, Area and power trade off NoC protocols, Routing and Flow Control mechanism, Verification of Communications in Networks -on-Chips. Application Mapping on Network -on-Chip, Resource Allocation for QoS On -Chip Communication, routing techniques in different 2D/ 3D NoC topology, performance evaluation in terms of throughput, latency, jitter. Signal Integrity and Reliability of Network -on-Chip, Testing of Network -on- Chip Architectures, Test and Fault Tolerance for NoC Infrastructures, Reconfigurable Network -on-Chip Design, Security in NoCs. Energy and Power estimation techniques Network -on-Chips Recommended Readings Text Books: - 1. Giovanni De Micheli, Luca Benini, Davide Bertozzi, Networks on Chips: Technology and Tools, Morgan Kaufmann, 2006. 2. Fayez Gebali, Haytham Elmiligi, Mohamed Watheq El -Kharashi, Networks on - Chips: Theory and Practice, CRC Press, 2017. 3. Sudeep Pasricha, Nikil Dutt, On -Chip Communication Architectures: System on Chip Interconnect, Morgan Kaufmann, 2010.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST803 Course Name : Advances in Compiler Design Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Basic course in Compiler Design Course Contents Modern Compiler Design – Structure of Compilers for Modern Programming Languages, Cross Compiler, Just -In-Time (JIT) and Adaptive Compilation, Runtime System Architectures. Parser Development - LR Parsers and LR Grammars – Design and Implementation, Parser and Ambiguity, Conflict Resolution, Lex and Yacc Tools. Optimizing Compiler - Control -flow Analysis, Control -flow Graphs, Basic Blocks, Data -flow Analysis Methods, Dependence Analysis, Global Optimizations, Loop Optimizations, Peephole Optimization and Optimal Code Generation, Data Dependence Analysis in Loops, Loop Scheduling. Recommended Readings Text Books: - 1. Aho, Lam, Sethi and Ullman: Compilers – Principles, Techniques and Tools, Pearson Education 2. Steven Muchnick : Advanced Compiler Design &

Implementation, Morgan Kaufmann 3. Holub: Compiler Design in C, Prentice Hall India. 4. Keith Cooper and Linda Torczon : Engineering a Compiler, Morgan Kaufmann.

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR**  
Department/Centre : Department of Computer Science & Engineering Course Code : 21CST804 Course Name : Android Programming Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Basics: Review of Java Programming, Setting up and configuring Android Studio setup, Android Emulator Hello Android example, AndroidManifest.xml, R.java file, Activity, Fragment, Layout Manager - Relative Layout, Linear Layout, Table Layout, Grid Layout. Activity & Fragment: Activity Lifecycle, Activity Example, Intent – implicit and explicit, Intent filters, Fragment Lifecycle, Fragment Example, UI Widgets – buttons (toggle, switch, image), check box; Android Menu: Option Menu, Context Menu, Popup Menu; View. Android Service: lifecycle, example, Data Storage, Shared Preference, SQLite, Content Provider, Android Notification Adding functionality: Multimedia API, Speech API, telephony API, Location API Sensors: Sensor API, Working with WiFi, Working with Camera, Motion Sensor, Position Sensor; Android Graphics App development project. Recommended Readings Text Books: - 1. Official Android Website

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR**  
Department/Centre : Department of Computer Science & Engineering Course Code : 21CST806 Course Name : Computer Vision Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Introduction, Pixels and Filters, Image pyramids and Fourier transform, Hough transform, Edge detection, RANSAC, Feature detectors, Harris, Feature descriptors, Corner detection and matching, 2D transformations, Image homographs, Camera models, camera calibration, radiometry, color, shading, Bag of words, SIFT, SURF, Segmentation, Image indexing and search, Nearest Neighbor Match, Object Recognition, Face recognition, Differential motion: Optical flow, Feature Tracking & Motion Layers, Performance Evaluation Recommended Readings Text Books: - 1. Computer Vision: Algorithms and Applications, by Richard Szeliski 2. Computer Vision: A Modern Approach, by David Forsyth and Jean Ponce. 3. Computer Vision: Models, Learning, and Inference by, Simon J. D. Prince, Cambridge University Press. 4. Concise Computer Vision: An Introduction Into Theory and Algorithms, by Reinhard Klette, Springer

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR**  
Department/Centre : Department of Computer Science & Engineering Course Code : 21CST807 Course Name : Cyber Physical Systems Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Characteristics of Cyber-Physical Systems (CPS) Cyber-Physical Systems (CPS) in the real world, Basic principles of design and validation of CPS, Industry 4.0, AutoSAR, IIOT implications, Building Automation, Medical CPS CPS physical systems modeling and formalisms: CPS - Platform components - CPS HW platforms - Processors, Sensors, Actuators, CPS Network - WirelessHart, CAN, Automotive Ethernet, Scheduling Real Time CPS tasks. Principles of Dynamical Systems - Dynamical Systems and Stability, Controller Design Techniques and Performance under Packet drop and Noise CPS implementation issues - From features to automotive software components, Mapping software components to ECUs, CPS Performance Analysis - effect of scheduling, bus latency, sense and



actuation faults on control performance, network congestion, and building real-time networks for CPS Safe Reinforcement Learning: Robot motion control, Autonomous Vehicle control Gaussian Process Learning, Smart Grid Demand Response, Building Automation Secure Deployment of CPS: Secure Task mapping and Partitioning, State estimation for attack detection, Automotive Case study : Vehicle ABS hacking, Power Distribution Case study : Attacks on SmartGrids Recommended Readings Text Books: - 1. "Introduction to Embedded Systems – A Cyber –Physical Systems Approach" - E. A. Lee, SanjitSeshia 2. "Principles of Cyber -Physical Systems" - Rajeev Alur MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST808 Course Name : Data Analytics Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Fundamentals of Learning, Basic Programming skills, Course Contents Introduction: Data Analytics, Big Data, Current landscape of perspectives - Skill sets needed; Statistical Inference -Populations and samples, Statistical modeling, Probability: Probability theory, conditional probability; probability distributions, fitting a model. Basic Analysis Techniques, Basic analysis techniques, Statistical hypothesis generation and testing, Chi-Square test, t-Test, Analysis of variance, Correlation analysis, Maximum likelihood test Exploratory Data Analysis (EDA) and the Data Science Process: Basic tools (plots, graphs and summary statistics) of EDA - Philosophy of EDA - The Data Science Process, Data Visualization - Basic principles, ideas and tools for data visualization. Python for common data analysis: libraries like NumPy, Pandas matplotlib, and seaborn. Data wrangling and management: Accessing database, CSV, and JSON data, Data cleaning and transformations, APIs and other tools for scraping the Web, Data Management : knowledge of SQL such as MySQL, NoSQL like MongoDB, Cassandra etc. Python for Data cleaning and transformations using Pandas and Sklearn. Mining Social -Network Graphs - Social networks as graphs - Clustering of graphs - Direct discovery of communities in graphs - Partitioning of graphs - Neighborhood properties in graphs. Recommended Readings Text Books: - 1. Trevor Hastie Robert Tibshirani Jerome Friedman, The Elements of Statistical Learning, Data Mining, Inference, and Prediction, 2nd Edn, Springer, 2014 2. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O'Reilly. 2014. 3. Jiawei Han, MichelineKamber and Jian Pei. Data Mining: Concepts and Techniques, Third Edition. ISBN 0123814790. 2011. 4. Mohammed J. Zaki and Wagner Miera Jr. Data Mining and Analysis: Fundamental Concepts and Algorithms. Cambridge University Press. 2014. MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST809 Course Name : Data Compression Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Object Oriented Analysis and Design Course Contents Introduction: Compression techniques, lossless compression, lossy compression, measures of performance, modeling and coding. Mathematical preliminaries - Overview, introduction to information theory, models, physical models, probability models, Markov models. Basic Coding Schemes: Statistical Methods - Shannon -Fano Algorithm, Huffman Algorithm, Adaptive Huffman Coding. Arithmetic Coding (Encoding, Decoding, Adaptive Coding). Dictionary Methods - LZ77, LZ78, LZW Algorithms. Case study of

lossless compression standards. Lossless Compression standards: zip, gzip, bzip, unix compress, GIF, JBIG. Image and Video Compression: Discrete Cosine Transform, JPEG. Wavelet Methods - Discrete Wavelet Transform, JPEG 2000. Motion Compensation, Temporal and Spatial Prediction. MPEG and H.264. Audio Compression: Digital Audio, WAV, FLAC, MPEG -1/2 Audio Layers. Recommended Readings Text Books: - 1. Khalid Sayood. 2012. Introduction to Data Compression (4th ed.). Elsevier 2. David Salomon, Giovanni Motta. 2010. Handbook of Data Compression. Springer, London MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST810 Course Name : Data Mining Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Introduction to data mining: Motivation and significance of data mining, data mining functionalities, interestingness measures, classification of data mining system, major issues in data mining. Data pre-processing: Need, data summarization, data cleaning, data integration and transformation, data reduction techniques – Singular Value Decomposition (SVD), Discrete Fourier Transform (DFT), Discrete Wavelet Transform (DWT), data discretization and concept hierarchy generalization. Mining frequent patterns, associations and correlations: Basic concepts, efficient and scalable frequent itemset mining algorithms, mining various kinds of association rules – multilevel and multidimensional, association rule mining versus correlation analysis, constraint based association mining. Classification and prediction: Definition, decision tree induction, Bayesian classification, rule based classification, classification by backpropagation and support vector machines, associative classification, lazy learners, prediction, accuracy and error measures. Cluster analysis: Definition, clustering algorithms partitioning, hierarchical, density based, grid based and model based; Clustering high dimensional data, constraint based cluster analysis, outlier analysis – density based and distance based. Data mining on complex data and applications: Algorithms for mining of spatial data, multimedia data, text data; Data mining applications, social impacts of data mining, trends in data mining. Recommended Readings Text Books: - 1. Han, J. and Kamber, M., “Data Mining - Concepts and Techniques”, 3rd Ed., Morgan Kaufmann Series. 2. Ali, A. B. M. S. and Wasimi, S. A., “Data Mining - Methods and Techniques”, Cengage Publishers. 3. Tan, P.N., Steinbach, M. and Kumar, V., “Introduction to Data Mining”, Addison Wesley – Pearson 4. Pujari, A. K., “Data Mining Techniques”, 4th Ed., Sangam Books. MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST812 Course Name : Deep Learning Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Course Overview: Introduction to Deep Learning and its Applications. Introduction to Statistical Learning: Multi-Layer Perceptron, Back Propagation, Linear Regression, etc. Convolutional Neural Networks: Convolution, pooling, Activation Functions, Back propagation of CNN, Weights as templates, Translation invariance, Training with shared parameters. CNN Architecture Design and Discussion: AlexNet, VGG, GoogLeNet, ResNet, Capsule Net, etc. Loss Functions and Optimization: Optimization, stochastic gradient descent, dropout, batch normalization, etc. Sequential Modelling: Recurrent and Recursive

Nets, RNN, LSTM, GRU, Image captioning, visual question answering, etc.  
 Visualization and Understanding: Visualizing intermediate features and outputs, Saliency maps, Visualizing neurons, Cam-Grad, etc. Generative Models: Variational Autoencoders, Generative Adversarial Networks like pix2pix, CycleGAN, etc.  
 Deep Reinforcement Learning: Reinforcement Learning (RL) Background, Policy gradients, hard attention Q-Learning  
 Deep Learning Applications: Object Detection: RCNN, Fast RCNN, Faster RCNN, YOLO, Retina Net, SSD, etc. Semantic Segmentation: DeepLabV3, PSP Net, etc. Adversarial Attacks on CNN  
 Recommended Readings Text Books: - 1. Ian Goodfellow and Yoshua Bengio and Aaron Courville, "Deep Learning," MIT Press. 2. Michael A. Nielsen, "Neural Networks and Deep Learning," Determination Press, 2015.

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR**  
 Department/Centre : Department of Computer Science & Engineering  
 Course Code : 21CST815 Course Name : Distributed Systems Credits : 3  
 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None  
 Course Contents  
 Introduction to Distributed Systems, OS and Advanced OS, various distributed systems, Trends in Distributed System and challenges, Networking: network protocols, point-to-point communication. Introduction – Clocks, events and process states – Synchronizing physical clocks - Logical time and logical clocks – Global states, Limitations, Lamport's logical clock, vector clock, causal ordering, global state, Cuts. Distributed Mutual Exclusion: Lamport, Recart-agrawala, and Maekawa's algorithms; Suzuki-kasami broadcast algorithm, and Raymond's tree based algorithm, Elections algorithms, Transactions and Concurrency Control – Transactions -Nested transactions – Locks – Optimistic concurrency control – Timestamp ordering – Atomic Commit Distributed transactions: two phase commit, three-phase commit, ACID/BASE models Techniques of Inter process Communication: the API for internet protocols – External data representation and Multicast communication, Sun RPC: programming and implementation, Network virtualization: Overlay networks. Case study: MPI Remote Method Invocation And Objects: Remote Invocation – Introduction – Request-reply protocols – Remote procedure call – Remote method invocation. Case study: Java RMI – Group communication – Publish-subscribe systems – Message queues – Shared memory approaches – Distributed objects – Case study: Enterprise Java Beans -from objects to components. Distributed Deadlock Detection: Resource Vs. Communication deadlock, Replication, Strategies to handle deadlock, Ho-Ramamoorthy, Path-Pushing, Edge-Chasing, Diffusion Computation-based algorithms. Agreement Protocols: System model, Classification of agreement problems, Solutions to Byzantine Agreement (BA) problems. Distributed Scheduling: Issues in Load Distribution, Components of a load distribution algorithm, Load Distribution Algorithms, V-system, Sprite, and Condor. Network file systems: design, NFS, AFS (scale), DFS & CIFS (cache control), CODA (redundancy) Google File System (GFS), Hadoop Distributed File System (HDFS) Distributed Shared Memory: Algorithms for implementing DSMs, Memory Coherence, and Coherence Protocols, IVY Process Management: Process Migration: Features, Mechanism – Threads: Models, Issues, Implementation. Resource Management: Introduction - Features of Scheduling Algorithms –Task Assignment Approach – Load Balancing Approach – Load Sharing Approach Recovery: Classification of failures, Synchronous and

Asynchronous Check pointing and Recovery. Fault Tolerance: Commit Protocols, Voting Protocols, Failure Resilient Processes. Protection and Security: Access Matrix Model, Implementation of access matrix, Unix, and Amoeba. Case study -Distributed systems Recommended Readings Text Books: - 1. Andrew S. Tanenbaum, Maarten Van Steen, "Distributed Systems Principles and Paradigm," 2nd Edition, Pearson 2. George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair "Distributed Systems - Concepts and Design," 5th Edition, Pearson 3. M. Singhal & N. Shivaratri, "Advanced Concepts in Operating Systems: Distributed, Database and Multiprocessor Operating Systems", Tata McGraw Hill, 2015 4. John Bloomer, "Power Programming with RPC," O'Reilly & Associates, Inc 5. Advanced Programming in the Unix Environment by W. Richard Stevens, Addison -Wesley, 6. Liu M.L., "Distributed Computing, Principles and Applications", Pearson Education, 7. Distributed Systems - An Algorithmic approach by Sukumar Ghosh MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST816 Course Name : E -Commerce Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: knowledge of Digital Market, Basics of Computer Network and security Course Contents Introduction: Definition of Electronic Commerce, technology and prospects, incentives for engaging in electronic commerce, needs of E -Commerce, E -Commerce Infrastructure, advantages and disadvantages, Impact of E -commerce on business, E -Commerce Models. Network Infrastructure for E - Commerce. Internet and Intranet based E -commerce: Issues, problems and prospects, Network Infrastructure, Network Access Equipments, Broadband telecommunication. Mobile Commerce: Introduction, Wireless Application Protocol, WAP technology, Mobile Information device. Web Security: Security Issues on web, Importance of Firewall, components of Firewall, Transaction security, Emerging client server, Security Threats, Network Security, Factors to consider in Firewall design, Limitation of Firewalls. Encryption: Encryption techniques, Symmetric Encryption: Keys and data encryption standard, Triple encryption, Secret key encryption; Asymmetric encryption: public and private pair key encryption, Digital Signatures, Virtual Private Network. Customer Service Expectations of the E -commerce Experience, Electronic Payments: Overview, The SET protocol, Payment: Smart card, credit card, magnetic strip card, E -Checks, Credit/Debit card based EPS, online Banking. EDI Application in business, E- Commerce Law, Forms of Agreement, Govt. policies and Agenda Recommended Readings Text Books: - 1. Turban, "Electronic Commerce 2004: A Managerial Perspective", Pearson Education 2. Pete Lohsin, John Vacca "Electronic Commerce", New Age International 3. Bajaj and Nag, "E -Commerce the cutting edge of Business", TMH 6 4. Laudon, "E -Commerce: Business, Technology, Society", Pearson Education MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST817 Course Name : Hardware Software Codesign Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Logic System Design/ Digital Logic Design Course Contents Codesign overview, device Modeling and methodologies of system design, Hardware software partitioning and scheduling, Co simulation, synthesis and verifications, Architecture, Interface and reconfiguration, System on chip, Application specific processors ( DSP),

Codesign tools and case studies Recommended Readings Text Books: - 1. A Practical Introduction to Hardware/Software Codesign, Patrick Schaumont, Springer, 2009, ISBN 978 -1-4419 -5999 -7 2. Specification and Design of Embedded Systems Daniel D. Gajski , Frank Vahid, S. Narayan, & J. Gong, Prentice Hall, 1994 3. Hardware / Software Co -Design: Principles and Practice, JStaunstrup and Wayne Wolf, Prentice Hall, 1994. MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST818 Course Name : Image Analysis Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Image Preliminaries & Image Processing: Overview, Computer imaging systems, Human visual system, image model, etc. Geometric transformations: Translation, rotation, scaling and shearing. Frequency transformation: Discrete Fourier transform (DFT), fast Fourier transform (FFT), short - time Fourier transform (STFT), Multi -resolution Expansions: Wavelet Transforms in 1 -D and 2 - D. The Fast Wavelet Transform Wavelet Packets Transform. Feature Extraction and Dimension Reduction Color, Texture, Shape and structure Features in spatial and frequency domains, Corner Detection, Hough Transform, Principal Component Analysis, Linear Discriminant Analysis, Feature Reduction in Input and Feature Spaces. Image Segmentation. Gray -level thresholding, Supervised vs. Unsupervised thresholding, Binarization using Otsu's method, Locally adaptive thresholding, Color -based segmentation, Region oriented segmentation, Use of motion in segmentation, Spatial techniques, Frequency domain techniques. Features Based Image Matching: Scale Space Image Processing, Different Feature descriptors: Key Point Detection, SIFT descriptor SURF descriptor Bag of Visual Words approach, Geometric consistency check, Vocabulary tree Panoramic Imaging, Template Matching, Mono Panorama, Stereo Panorama. Recommended Readings Text Books: - 1. J G Proakis and D G Manolakis, "Digital Signal Processing," Pearson, Fourth edition 2. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Prentice Hall, 3rd Edition, 2007. 3. Bishop, Pattern Recognition and Machine Learning 4. Duda, Pattern Classification MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST819 Course Name : Information Retrieval Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Introduction to Information Retrieval: The nature of unstructured and semi -structured text. Inverted index and Boolean queries. Text Indexing, Storage and Compression: Text encoding: tokenization, stemming, stop words, phrases, index optimization. Index compression: lexicon compression and postings, lists compression. Gap encoding, gamma codes, Zipf's Law. Index construction. Postings size estimation, merge sort, dynamic indexing, positional indexes, n -gram indexes, real -world issues. Retrieval Models: Boolean, vector space, TFIDF, Okapi, probabilistic, language modeling, latent semantic indexing. Vector space scoring. The cosine measure. Efficiency considerations. Document length normalization. Relevance feedback and query expansion. Rocchio. Performance Evaluation: Evaluating search engines. User happiness, precision, recall, F -measure. Creating test collections: kappa measure, interjudge agreement. Text Categorization and Filtering: Introduction to text classification. Naive Bayes

models. Spam filtering. Vector space classification using hyperplanes; centroids; k Nearest Neighbors. Support vector machine classifiers. Kernel functions. Boosting. Text Clustering: Clustering versus classification. Partitioning methods. k -means clustering. Mixture of Gaussians model. Hierarchical agglomerative clustering. Clustering terms using documents. Advanced Topics: Summarization, Topic detection and tracking, Personalization, Question answering, Cross language information retrieval. We b Information Retrieval: Hypertext, web crawling, search engines, ranking, link analysis, PageRank, HITS, XML and Semantic web. Recommended Readings Text Books: - 1. Manning, Raghavan and Schutze, Introduction to Information Retrieval, Cambridge University Press. 2. Baeza -Yates and Ribeiro -Neto, Modern Information Retrieval, Addison -Wesley. 3. SoumenChakrabarti, Mining the Web, Morgan -Kaufmann 4. David A. Groosman, Information Retrieval, Algorithm and Heuristics, Springer MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST820 Course Name : Internet of Things Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Networks, Wireless Communication Course Contents Introduction: Internet of Things and Connected Products, IoT paradigm, Smart objects, Goal orientation, Convergence of technologies; Business Aspects of the Internet of Things. Internet and “Things”: Layers, Protocols, Packets, Services, Performance parameters of a packet network and applications: Web, Peer -to-peer, Sensor networks, and Multimedia. Hardware and Software: Hardware components, Microcontrollers and Software; Operating Systems. Protocols and Platforms -IoT Communication Protocols, Transport Protocols, Application Protocols; Cloud computing for IoT. Services and Attributes: Data creation, Data gathering and Data dependency; Robustness, Scaling, Privacy, Security, Trust. Designing & Developing IoT applications: Introduction, IoT Design Methodology , Python Data Types & Data Structures, Control Flow, Functions, Modules, Packages, File Handling, Date/ Time Operations, Classes, Python Packages Application: Implications for the society, IoT case study. Recommended Readings Text Books: - 1. The Internet of Things: Key Applications and Protocols, David Boswarthick, Olivier Hersent, and Omar Elloumi, Wiley 2. Building the Internet of Things with IPv6 and MIPv6, Daniel Minoli, Wiley. 3. Latest research articles MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST822 Course Name : Natural Language Processing Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Data structures and algorithms, and strong programming skills Course Contents Introduction to NLP tasks in syntax, semantics, and pragmatics. Applications such as information extraction, question answering, and machine translation. The problem of ambiguity. The role of machine learning. Brief history of the field. N -gram Language Models. The role of language models. Simple N -gram models. Estimating parameters and smoothing. Evaluating language models. Part Of Speech Tagging and Sequence Labeling Lexical syntax. Hidden Markov Models (Forward and Viterbi algorithms and EM training). Neural Networks and LSTM Introduction to perceptron and backpropagation, LSTM Recurrent Neural Networks Syntactic parsing Grammar formalisms and treebanks. Efficient parsing for context -free grammars (CFGs). Statistical parsing and probabilistic CFGs (PCFGs).

Lexicalized PCFGs. Neural shift-reduce dependency parsing Semantic Analysis Lexical semantics and word-sense disambiguation. Compositional semantics. Semantic Role Labeling and Semantic Parsing. Information Extraction (IE) Named entity recognition and relation extraction. IE using sequence labeling. Machine Translation (MT) Basic issues in MT. Statistical translation, word alignment, phrase-based translation, and synchronous grammars. Advanced Language Processing Advance language modeling (including LDA), other applications like summarization, question answering Recommended Readings Text Books: - 1. Speech and Language Processing: An Introduction to Natural Language MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST823 Course Name : Nature Inspired Algorithms Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Programming languages, Data structures and Algorithms Course Contents Introduction to Algorithms, Optimization, Search for optimality, computational intelligence, Nature Inspired solutions and characteristic, Nature inspired Metaheuristics and its brief history, Analysis of Optimization Algorithms, Nature Inspired Algorithms, parameter Tuning and control Constrained and unconstrained optimizations, Random Walks and Optimizations, evolutionary strategies and Evolutionary Algorithms (EA), Simulated Annealing (SA) Algorithm and its behavior, Genetic Algorithms(GA) - genetic operator, parameters, fitness functions, genetic programming and convergence analysis, GA variants, Differential Evolution (DE), various Applications. Swarm Intelligence optimization, Particle Swarm Optimization(PSO) Algorithm, Ant Colony Optimization (ACO) Algorithms, Artificial Bee Colony (ABC) optimization algorithms, Cuckoo Search (CS) Algorithms, Intelligent Water Drop Algorithm (IWD), Bat Algorithms(BA), Firefly Algorithms(FA) Framework for self-tuning algorithms, Dealing with constraints, constraints handling, fitness functions, multi-objective optimization techniques and its applications, Hybrid algorithms, Ways to Hybridize Recommended Readings Text Books: - 1. Nature-Inspired Optimization Algorithms – by Xin-She Yang (Author), June 30, 2016 2. Mathematical Foundations of Nature-Inspired Algorithms, Xin-She Yang, Xing-Shi He, Springer; 1st ed. 2019 edition 3. Nature-Inspired Metaheuristic Algorithms: Second Edition, Xin-She Yang, Luniver Press 4. Introduction to Evolutionary Computing, A. E. Eiben and J. E. Smith, Second Printing, Springer, 2007 5. Evolutionary Algorithms in Engineering Applications, Editors: Dipankar Dasgupta and Zbigniew Michalewicz, Springer-Verlag, 1997 6. D. E. Goldberg, Genetic Algorithms in search, Optimization and Machine Learning, Pearson India, 7. Optimization Techniques and Applications with Examples By Xin-She Yan, Wiley publisher MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST825 Course Name : Network Performance Modelling Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Introduction to Network Modeling: Network modeling, Computer Network as a discrete event system, Modeling and measurement tools, Network performance metrics – first order and second order metrics, Network capacity, Difference between throughput and capacity Network Calculus: Models for data flows, arrival curves and service curves, Greedy shapers, Basic min-plus and max-plus calculus, min-plus and max-plus systems,

Optimal smoothing, FIFO systems and aggregate scheduling, Time varying shapers, Systems with losses, Case studies – (1) Analyzing spanning tree based data forwarding using network calculus, (2) Bound on loss rate Stochastic Scheduling and Resource Allocation: Stochastic scheduling, dynamic resource allocation, Dynamic programming models for stochastic scheduling, Queuing networks – open loop and closed loop networks, Jackson networks, Network fairness – proportional and max-min fairness, Markov process and its application for analyzing network resource allocation and fairness, available bandwidth estimation, Case studies – (1) TCP/IP flow and congestion control, (2) Modeling dynamic routing and scheduling as a queuing network problem, (3) Analysis of IEEE 802.11 channel access using two dimensional Markov process. Network Games: Introduction to game theory, Zero sum games, Nash equilibrium, Pareto optimality, Cooperative and Non-cooperative games, General network games – resource sharing games, routing games, congestion games, Mechanism design, Case studies – (1) Selfish routing in networks and price of anarchy, (2) Oblivious routing, (3) Network resource allocation games Protocol Analysis: Modeling discrete event system using petri-nets, basics of petri nets, stochastic petri nets, queuing petri nets, properties of petri nets, structural analysis of petri nets, Petri net modeling tools – simQPN, Case studies – (1) Wireless channel model using stochastic petri net, (2) Data center network throughput analysis using queuing Petri Nets Recommended Readings Text Books: - 1. "Routing, Flow, and Capacity Design in Communication and Computer Networks", Michał Pióro, Deepankar Medhi, ISBN: 0125571895, Publisher: Morgan Kaufmann 2. The Network Calculus Book by Jean-Yves Le Boudec and Patrick Thiran is available for free download: [http://ica1www.epfl.ch/PS\\_files/NetCal.htm](http://ica1www.epfl.ch/PS_files/NetCal.htm) 3. Anurag Kumar, D. Manjunath and Joy Kuri, "Communication Networking: An Analytical Approach" Morgan Kaufman Publishers 4. Dimitri P. Bertsekas and Robert G. Gallager, "Data Networks" : Materials are available at <http://web.mit.edu/dimitrib/www/datanets.html> 5. "Network Optimization: Continuous and Discrete Models", D. Bertsekas 6. Research Publications - will be discussed and distributed time to time MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST826 Course Name : Neural Networks Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Basic understanding of probability and statistics, linear algebra and calculus. A basic knowledge of programming (preferably Python) is essential. Course Contents Introduction to Neural Architecture, McCulloch-Pitts networks, Learning Rules, Perceptrons, Regression and least mean square algorithm, Multilayer perceptrons, Back propagation: generalized delta rule, limitations, modifications – momentum, variable learning rate, conjugate gradient. Radial-basis function networks, Support vector Machines, Unsupervised learning and self-organization, Boltzmann machines and deep networks, Convolutional networks, Recurrent networks, Associative Memories, Adaptive Resonance Theory, Applications of Neural Networks. Recommended Readings Text Books: - 1. Simon Haykin : Neural Networks: A Comprehensive Foundation, Pearson MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST827 Course Name : Parallel Processing &



Algorithms Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None

Course Contents Introduction to parallel computing. Parallel processing terminology, Pipelining Vs Data parallelism, Control parallelism, Scalability, Control parallel approach, Data parallel approach, Data parallel approach with I/O. The PRAM Shared-Memory Model, Distributed-Memory or Graph Models, Circuit Model and Physical Realizations PRAM and Basic Algorithms, PRAM Submodels and Assumptions, Data Broadcasting, Semigroup or Fan-In Computation, Parallel reduction, Prefix sums, List ranking, Preorder tree traversal, Merging two sorted lists, Graph coloring, Reducing the number of processors, Problems defying fast solutions on PRAMS. Thread and process level parallel architectures: MIMD, multi-threaded architectures. Distributed and shared memory MIMD architectures. Dynamic interconnection networks. Mapping and scheduling: Mapping data to processors on processor arrays and multicomputers, Dynamic Load Balancing on multicomputers, Static scheduling on UMA multiprocessors, Deadlock. Parallel programming and parallel algorithms: Programming models, parallel programming on multiprocessors and multicomputers. Parallel algorithm structure, analyzing parallel algorithm. Elementary parallel algorithms, Matrix algorithms, sorting, Graph algorithms. Parallel Algorithm Complexity, Asymptotic Complexity, Algorithm Optimality and Efficiency, Complexity Classes, Parallelizable Tasks and the NC Class, Parallel Programming Paradigms, Solving Recurrences Sorting and Selection Network: Design of Sorting Networks, Batcher Sorting Networks, Mesh-Based Architectures: Sorting on a 2D Mesh or Torus, Routing on a 2D Mesh or Torus, Numerical 2D Mesh Algorithms, Low-Diameter Architectures: Hypercubes and Their Algorithms, Sorting and Routing on Hypercubes

Recommended Readings Text Books: - 1. J. Jaja, An Introduction to Parallel Algorithms, Addison Wesley, 1992. 2. F. T. Leighton, Introduction to Parallel Algorithms and Architectures: Arrays, Trees, Hypercubes, Morgan Kaufmann Publishers, San Mateo, California, 1992 3. Behrooz Parhami, Introduction to Parallel Processing, Algorithms and Architecture, Kluwer Academic Publishers, 2002

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST828 Course Name : Parallelizing Compiler Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Basic course in Compiler Design Course Contents Introduction – Compilation for parallel machines and automatic detection of parallelism, structure of a parallelizing compiler. Dependence Theory and Practice - Types of dependences, data and control dependencies, dependence analysis, direction vectors, loop carried and loop independent dependences, tests for data dependence and their applicability, construction of data dependence and control dependence graphs. Parallel Code Generation - Automatic extraction of parallelism, representation of iteration spaces of nested loops, loop based transformations such as loop distribution, loop coalescing, loop interchange and cycle shrinking transformation. Interprocedural Analysis and Optimization - aliasing information, summary data flow analysis, interprocedural constant propagation, interprocedural data dependence analysis and parallelization of call statements. Recommended Readings Text Books: - 1. Randy Allen, Ken Kennedy: Optimizing compilers for modern architectures. Morgan Kaufmann 2. Steven Muchnick : Advanced Compiler Design & Implementation, Morgan Kaufmann.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST830 Course Name : Quantum Computing Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Introduction to quantum computing, Relevant Linear algebra for quantum computing, Postulates of quantum mechanics, Classical computing, Quantum circuits, Quantum Fourier Transform Quantum search algorithms, Physical realization of quantum computers. Quantum noise, Quantum operations, quantum information and quantum channel Recommended Readings Text Books: - 1. Pittenger A. O., An Introduction to Quantum Computing Algorithms 2. Nielsen M. A., Quantum Computation and Quantum Information, Cambridge University Press. 3. Benenti G., Casati G. and Strini G., Principles of Quantum Computation and Information, Vol. I: Basic Concepts, Vol II: Basic Tools and Special Topics, World Scientific .

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST831 Course Name : Real Time Systems Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Introduction : Definition, Typical Real Time Applications; Digital Control, High Level Controls, Signal Processing etc., Release Times, Deadlines, and Timing Constraints, Hard Real Time Systems and Soft Real Time Systems, Reference Models for Real Time Systems: Processors and Resources, Temporal Parameters of Real Time Workload, Periodic Task Model, Precedence Constraints and Data Dependency. (7 hours) Real Time Scheduling: Common Approaches to Real Time Scheduling: Clock Driven Approach, Weighted Round Robin Approach, Priority Driven Approach, Dynamic Versus Static Systems, Optimality of Effective -Deadline -First (EDF) and Least -Slack -Time -First (LST) Algorithms, Offline Versus Online Scheduling, Scheduling Aperiodic and Sporadic jobs in Priority Driven and Clock Driven Systems. (8 hours) Resources Access Control: Effect of Resource Contention and Resource Access Control (RAC), Non - preemptive Critical Sections, Basic Priority -Inheritance and Priority -Ceiling Protocols, Stack Based Priority -Ceiling Protocol, Use of Priority -Ceiling Protocol in Dynamic Priority Systems, Preemption Ceiling Protocol, Access Control in Multiple -Unit Resources, Controlling Concurrent Accesses to Data Objects. (8 hours) Multiprocessor System Environment :Multiprocessor and Distributed System Model, Multiprocessor Priority -Ceiling Protocol, Schedulability of Fixed - Priority End -to-End Periodic Tasks, Scheduling Algorithms for End -to-End Periodic Tasks, End - to-End Tasks in Heterogeneous Systems, Predictability and Validation of Dynamic Multiprocessor Systems, Scheduling of Tasks with Temporal Distance Constraints. (9 hours) Real Time Communication : Model of Real Time Communication, Soft and Hard RTCommunication systems , Priority -Based Service and Weighted Round -Robin Service Disciplines for Switched Networks, Medium Access Control Protocols for Broadcast Networks, Internet and Resource Reservation Protocols, Real Time Protocols, Communication in Multicomputer System. An Overview of Real Time Operating Systems and Databases: Features of RTOS, UNIX as RTOS, POSIX Issues, Temporal Consistency, Concurrency Control. (8 hours) Recommended Readings Text Books: - 1. Real Time Systems: Theory and Practice – Mall Rajib, Pearson Education, 2009 2. Real -Time Systems: Scheduling, Analysis, and

Verification – Albert M. K. Cheng, Wiley, 2002. 3. H. Kopetz, "Real time systems: Design Principles for distributed embedded applications", Springer Publications, 2011. 4. Douglass, Real Time UML: Advances in the UML for Real -Time Systems, 3/ e, Addison - Wesley, 2004. 5. Awad, Kuusela& Ziegler, Object -Oriented Technology for Real Time Systems: A Practical Approach Using OMT and Fusion, I/e, Pearson Education, 1996. 6. Ward & Mellor, Structured Development for Real -Time Systems, Vol. III: Implementation Modeling Techniques, Prentice Hall, 1986. MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST832 Course Name : Robotics and Control Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Introduction to robotics -origin of automation, Classification of robots, Rotations and translation of vectors, Transformations and Euler angle representations, Homogeneous transformations, Problems, Trajectory planning, Actuators, Velocity and position sensors. Range, proximity, touch sensors, Control of Robot Manipulators: PD control, Nonlinear Control, Stability, Lyapunov's Direct Method, Adaptive Control, Robot Vision, Image segmentation, Template matching, Polyhedral objects, Shape analysis, Grasping and industrial automation Recommended Readings Text Books: - 1. M. Spong, S. Hutchinson, and M. Vidyasagar, Robot Modeling and Control Wiley (2006) 2. Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, "Industrial Robotics, Technology programming and Applications", 3. Craig. J. J. "Introduction to Robotics - mechanics and control", Addison - Wesley, 1999 4. Nagrath Gopal "Control Systems Engineering -Principles and Design" New Age Publishers 5. K. Ogata, "Modern control engineering", Pearson 2002. MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST801 Course Name : 5G TECHNOLOGY Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Introduction and Key Specs of 5G Technologies, Opportunities and Challenges in mmWave MIMO Communication, Channel Models for mmWave MIMO Systems, Hybrid Signal Processing for mmWave MIMO, Digital and Analog Beamforming, Hybrid RF/ BB Precoder and Combiner Design for mmWave MIMO, Hybrid Transceiver Architectures for mmWave MIMO, Sparse Signal Processing and Channel Estimation for mmWave MIMO, Optimal Design of Beams and Sensing Matrix for Channel Estimation. Overview of Sub 6GHz Multiple Antenna, MIMO and MU-MIMO Technologies, Signal Processing for MIMO Systems, Optimal Power Allocation and Precoding for MIMO, Introduction to 5G Massive MIMO Systems, Key Features of Massive MIMO and Advantages over Point -to-Point and MU -MIMO, Signal Processing Operations for Massive MIMO in UL and DL, Massive MIMO Channel Model – Large/ Small Scale Fading, Properties of Random Vectors and Massive MIMO Analysis, Analysis of Spectral Efficiency in Massive MIMO Systems and Power Scaling, Pilot Design and Channel Estimation in Massive MIMO Systems Transmitter and Receiver Schemes with Imperfect CSI, Spectral Efficiency Analysis of Massive MIMO with Imperfect CSI, Power Scaling in Massive MIMO with Imperfect CSI and Comparison with Perfect CSI, Multi -Cell Massive MIMO Model, Channel Estimation with Pilot Reuse and Pilot Contamination. New Modulation Schemes for 5G - Spatial Modulation (SM), Space

Shift Keying (SSK) and Optimal Receiver, Generalized Spatial Modulation (GSM), Spectral Efficiency Comparison of GSM with Conventional V-BLAST. Introduction to Non-Orthogonal Multiple Access (NOMA) Technology, Efficiency of NOMA wrto Conventional Orthogonal Multiple Access (OMA), Fixed NOMA Protocol for UL/ DL – Performance Analysis, Ordered NOMA Protocol and Performance Analysis, Comparison with Fixed NOMA, Optimal Power Allocation for NOMA Systems Overview of Multicarrier Modulation , Introduction to OFDM and MIMO OFDM Transceiver Design, Motivation for Filter Band Multi Carrier (FBMC) Technology in 5G, System Model for FBMC and Signal Processing, Offset QAM (OQAM) Modulation and Transceiver Design, MIMO -FBMC System – Transmit/ Receive Signal Processing, Introduction to Full-Duplex Technology, Key Features and Advantages of Full Duplex Systems, Linear/ Non-Linear Self-Interference and Analog, Digital Cancellation Stages Introduction to 5G New Radio (NR) Standard, Introduction to 5G NB-IoT Technology, Overview of LTE-Cat M1 and Cat NB 1 Standards/ Systems 5G advanced concepts : Softwareization, virtualization, NFV, VNFV, 5G Slicing and etc Machine Type Communication(MTC) : Use cases and categorization, MTC Requirements, Fundamental techniques for MTC, Massive MTC, Ultra-reliable low-latency MTC, D2D Communication: from 4G to 5G, Radio resource management for mobile broadband D2D, Multi-hop D2D, communications for proximity and emergency services, Multi-operator D2D communication. 5G Radio Access Technologies: Access design principles for multi-user communications, Multi-carrier with filtering, Non-orthogonal schemes for efficient multiple access, Radio access for dense deployments, Radio access for V2X communication, Radio access for massive machine-type communication. Recommended Readings Text Books: - 1. Asif Osseiran, Jose F.Monserrat and Patrick Marsch, “5G Mobile and Wireless Communications Technology”, Cambridge University Press, 2016. 2. Jonathan Rodriguez, “Fundamentals of 5G Mobile Networks”, Wiley, 2015 3. Patrick Marsch, Omer Bulakci, Olav Queseth and Mauro Boldi, “5G System Design – Architectural and Functional Considerations and Long Term Research”, Wiley, 2018 MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST834 Course Name : Selected Topics in Operating System Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Operating Systems Course Contents Introduction: Introduction and Background, Power of abstractions, Hardware resources, OS Functionalities, Managing the CPU and Memory. OS-Structure: Commercial OS, Monolithic structure, DOS like -structures. SPIN Approach to extensibility, Logical Protection Domains, Customized OS, Mechanism for events. Exokernel and MicroKernel: Approach to extensibility, Default core services in Exokernel, Secure Binding, Memory Management, L3 MicroKernel Approach, Potentials for Performance Loss, Strikes against Microkernel, Address Space Switches, Thread switches and IPC. Virtualization: Introduction, Platform Virtualization, Hypervisors, Full Virtualization, Para Virtualization. Memory Virtualization: Memory Subsystem recall, Shadow page table. VM oblivious page sharing, Memory Allocation Policies. CPU Virtualization and Device Virtualization: Control and Data transfer in Action, Disk IO Virtualization Protection & Security: Potential Security violations, External versus Internal Security,

Policies and Mechanisms, Protection Domain, Design Principles for Secure Systems, Access Matrix Model & its Implementation., Case Studies: Unix Operating system, Hydra Kernel, Amoeba, Andrew.

Recommended Readings Text Books: - 1. Abraham Silberschatz, Peter B. Galvin and Greg Gagne, Operating System Concepts, 9th Edition, Wiley 2. Virtualization Essentials by Matthew Portnoy, Second Edition 3. Advanced Concepts In Operating Systems by Singhal, Tata McGraw -Hill Education 4. Daniel Bovet and Marco Cesati, Understanding the Linux Kernel, 3rd Edition, O' Reilly Media, 2008. 5. <https://in.udacity.com/course/advanced-operating-systems--ud189/>

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR  
Department/Centre : Department of Computer Science & Engineering Course Code : 21CST833 Course Name : Selected Topics in Computing Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Programming in C / Python, Operating Systems, Database Management Systems, Computer Networks, Computer Architecture Course Contents Topics will be announced by the Course Instructor at the beginning of the course depending on the emerging and evolving architectures. However, a sample list of topics are given for 2020 -21 as below: Cluster and Grid Computing, Cloud Computing Big Data Analytics, Data Science, Data Lakes Internet of Things, 5G and beyond Software Defined Networks, Network Function Virtualization Quantum Computing, Block Chain Recommended Readings Text Books: - 1. Request for Comments, Red Books, White Papers 2. Research Papers on various aspects as decided by the Instructor 3. Lecture Notes of the Instructor 4. William Stallings, Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud, Addison -Wesley Professional, 2016 5. Kai Hwang, Min Chen, Big -Data Analytics for Cloud, IoT and Cognitive Computing, Wiley - Blackwell, 2017

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR  
Department/Centre : Department of Computer Science & Engineering Course Code : 21CST835 Course Name : Social Media Mining Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Online Social Networks (OSNs): Introduction - Types of social networks (e.g., Twitter, Facebook), Measurement and Collection of Social Network Data, Social Networks - Basic Structure and Measures, Basics of Text Processing over Social Data, Entity linking and entity resolution for Social data. Characteristics of OSNs: Information Diffusion, Experimental studies over OSNs, Sampling, Fundamentals of Social Data Analytics: Topic Models, Random Walks, Heterogeneous Information Networks Applied Social Data Analytics: Recommendation Systems, Community identification and link prediction. Advanced Topics: Online experiments for Computational Social Science, Big Data Sampling Recommended Readings Text Books: - 1. Matthew A. Russell. Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Google+, Github, and More, 2nd Edition, O'Reilly Media 2. Jennifer Golbeck, Analyzing the social web, Morgan Kaufmann 3. Charu Aggarwal (ed.), Social Network Data Analytics, Springer 4. Reza Zafarani, Mohammad Ali Abbasi, Huan Liu, Social Media Mining An Introduction, Cambridge University Press

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR  
Department/Centre : Department of Computer Science & Engineering Course Code : 21CST836 Course Name : Social Network Analysis Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Network Models:

Properties of Real -World Networks: Degree Distribution, Clustering Coefficient, Average Path Length. Random Graphs , Small -World Model, Preferential Attachment Model, Modeling of Real -World Networks using Random Graphs, Small -World Model and Preferential Attachment Model Network Measures: Centrality: Degree Centrality, Eigenvector Centrality, Katz Centrality, PageRank, Centrality, Closeness Centrality, Group Centrality. Transitivity and Reciprocity, Balance and Status, Similarity: Structural Equivalence, Regular Equivalence. Community Analysis: Community Detection, Community Detection Algorithms: Member -Based Community Detection, Group -Based Community Detection. Community Evolution: How Networks Evolve, Community Detection in Evolving Networks. Community Evaluation: Evaluation with Ground Truth, Evaluation without Ground Truth . Recommendation: Classical Recommendation Algorithms: Content -Based Methods, Collaborative Filtering (CF), Extending Individual Recommendation to Groups of Individuals, Recommendation Using Social Context, Evaluating Recommendations: Evaluating Accuracy of Predictions, Evaluating Relevancy of Recommendations Graph Representation Learning, Knowledge Graphs and Meta Paths, Graph Convolutional Networks, Link Prediction, Influence Maximization & Outbreak Detection. Recommended Readings Text Books: - 1. Networks, Crowds, and Markets: Reasoning About a Highly Connected World by David Easley and Jon Kleinberg. 2. Networks: An introduction by Mark Newman. 3. The Development of Social Network Analysis” by Linton C Freeman 4. Zafarani, Reza, Mohammad Ali Abbasi, and Huan Liu. Social media mining: an introduction. Cambridge University Press

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST837 Course Name : Software Project Management Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Software Engineering, Computer Programming (C/Java/Python/C++), Microsoft Excel Course Contents Software Project Concepts : Software Project Categorization, Stakeholders, Software project Activities, Practices & Standards, Selecting Process Models (Spiral, Incremental, Prototyping, RAD, Agile). Estimation & Evaluation techniques, Cost Benefit Analysis, Risk Analysis for Project Evaluation, Program management, Project effort and cost estimation; Basis of estimation, Estimation method categorization, SLOC, Function Point Analysis, COCOMO, Putnam’s work. Estimation using FP. Project Planning: Stepwise planning, Activity based approach (WBS), Sequencing and Scheduling of Activities, Critical Path Method. Risk Analysis and Management: Risk Identification, Projection, Risk Identification, Projection, Risk Refinement, Risk Monitoring and Management Schedule and Cost Monitoring: Collecting Data & Reporting, Graphical Visualization techniques, Cost Monitoring, Earned Value analysis, Requirements management, Change Control. Contract Management: Types of Contracts, Stages in Contract Placement, Typical Terms of a Contract, Contract Management and Acceptance. Software Configuration Management (SCM), SCM Tools, Project Reviews Testing and Software Reliability, Metrics, ISO and CMMI, Project Scheduling & Tracking, Software Quality Assurance, Software Configuration Management Recommended Readings Text Books: - 1. Bob Hughes, Mike Cotterell, Rajib Mall, “Software Project Management”, 6th Edition, Tata McGraw Hill, 2017. 2. Pankaj Jalote, Software Project Management in Practice. 3. Roger S. Pressman,

Software Engineering 4. Royce, "Software Project Management", Pearson Education, 1999. 5. Robert K. Wysocki, Effective Software Project Management, Wiley, 2009.

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR** Department/Centre : Department of Computer Science & Engineering Course Code : 21CST838 Course Name : Software Testing and Validation Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Software engineering, basic computer programming skills Course Contents Testing Environment and Test Processes: Software Testing Environment, Overview of Software Testing Process, Organizing for Testing, Developing the Test Plan, Verification Testing, Analyzing and Reporting Test Results, Acceptance Testing. Levels of Testing, Unit Testing, Integration Testing, Defect Bash Elimination. System Testing, Usability and Accessibility Testing, Configuration Testing, Compatibility Testing. Functional and Non -functional system testing, Compliance Testing, Load Testing, Performance Testing and Security Testing. Static and dynamic testing, Black -box or functional testing, Equivalence partitioning, BVA, structural, White box or glass box testing, Mutation Testing, Data flow testing. Test Automation: Software Testing Tools, Software Test Automation, Debugging, Case study. Recommended Readings Text Books: - 1. Srinivasan Desikan and Gopalaswamy Ramesh, "Software Testing – Principles and Practices", Pearson Education 2. A.P. Mathur, Foundations of Software Testing, Pearson publications 3. NareshChauhan , "Software Testing Principles and Practices " Oxford University Press , New Delhi . 4. Ilene Burnstein, " Practical Software Testing", Springer International Edition. 5. RenuRajani, Pradeep Oak, "Software Testing – Effective Methods, Tools and Techniques", Tata McGraw Hill. 6. William Perry, "Effective Methods of Software Testing", Third Edition, Wiley Publishing

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR** Department/Centre : Department of Computer Science & Engineering Course Code : 21CST840 Course Name : VLSI Algorithms Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Logic synthesis & verification: Introduction to combinational logic synthesis, Binary Decision Diagram, Hardware models for High -level synthesis. VLSI Algorithms Partitioning: Problem formulation, classification of partitioning algorithms, Group migration algorithms, simulated annealing & evolution, other partitioning algorithms. Placement, floor planning & pin assignment: Problem formulation, simulation base placement algorithms, other placement algorithms, constraint -based floorplanning, floor planning algorithms for mixed block & cell design. General & channel pin assignment. Global Routing: Problem formulation, classification of global routing algorithms, Maze routing algorithm, line probe algorithm, Steiner Tree based algorithms, ILP based approaches. Detailed routing: problem formulation, classification of routing algorithms, single layer routing algorithms, two -layer channel routing algorithms, three -layer channel routing algorithms, and switchbox routing algorithms. Over the cell routing & via minimization: two layers over the cell routers, constrained & unconstrained via minimization Compaction: problem formulation, one -dimensional compaction, two dimension -based compaction, hierarchical compaction. Recommended Readings Text Books: - 1. NaveedSherwani, "Algorithms for VLSI Physical Design Automation", 3rd Edition, 2005, Springer International Edition 2. S.H. Gerez, "Algorithms for VLSI Design Automation", 1999, WILEY Student Edition, John

Wiley & Sons (Asia) Pvt. Ltd. 3. Christoph Meine & Thorsten Theobald, "Algorithms and Data Structures for VLSI Design", KAP, 2002. 4. Rolf Drechsler: "Evolutionary Algorithm for VLSI", Second edition MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST841 Course Name : Wireless Sensor Networks Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Introduction: Introduction to adhoc/sensor networks: Key definitions of adhoc/ sensor networks, unique constraints and challenges, advantages of adhoc/sensor network, driving applications, issues in adhoc wireless networks/sensor network, data dissemination and gathering, Historical Survey of Sensor Networks Basic Architectural Framework: Traditional layered stack, Cross-layer designs, Sensor network architecture, Physical Layer, Basic Components, Hardware Platforms: Motes, Sensor Devices, Types of Sensors, Sensor's Specification MAC Protocols : Fundamentals of MAC protocols - Low duty cycle protocols and wakeup concepts - Contention Based protocols - Schedule-based protocols - SMAC - BMAC - Traffic-adaptive medium access protocol (TRAMA) - The IEEE 802.15.4 MAC protocol. Routing Protocols: Issues in designing a routing protocol, classification of routing protocols, table-driven, on-demand, hybrid, flooding, hierarchical, and power aware routing protocols. Sensor network security: Security Requirements, Issues and Challenges in Security Provisioning, Network Security Attacks, Layer wise attacks in wireless sensor networks, possible solutions for jamming, tampering, black hole attack, flooding attack. Key Distribution and Management, Secure Routing – SPINS, reliability requirements in sensor networks. Programming in WSNs: Challenges and limitations of programming WSNs, Introduction to TinyOS, -Programming in Tiny OS using NesC, Emulator TOSSIM, Open research issues Recommended Readings Text Books: - 1. Feng Zhao, Leonidas Guibas, "Wireless Sensor Network", Elsevier, 1st Ed. 2004 (ISBN: 13 - 978-1-55860 -914-3) 2. Kazem, Sohraby, Daniel Minoli, Taieb Znati, "Wireless Sensor Network: Technology, Protocols and Application", John Wiley and Sons 1st Ed., 2007 (ISBN: 978 -0-471-74300 -2). 3. Raghavendra, Cauligi S, Sivalingam, Krishna M., Zanti Taieb, "Wireless Sensor Network", Springer 1st Ed. 2004 (ISBN: 978 -4020 -7883 -5). 4. E. H. Callaway, Jr. E. H. Callaway, Wireless Sensor Networks Architecture and Protocols, CRC Press, 2009 MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST821 Course Name : Machine Learning Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Basic understanding of probability and statistics, linear algebra and calculus. A basic knowledge of programming (preferably Python) is essential. Course Contents Advanced linear Algebra (e.g., SVD). The learning problem – learning versus design, types of learning - supervised, unsupervised, reinforcement and other views of learning. Linear Modeling: A least squares approach, linear modeling, making predictions, vector/matrix notation, linear regression, nonlinear response from a linear model. Generalization and over-fitting. The Bayesian approach to machine learning: exact posterior, marginal likelihoods Probability based learning: Bayes theorem, Bayesian prediction, conditional independence and factorization, the Naive Bayes model. Error based learning: simple linear regression, multi variable linear regression



with gradient descent Logistic regression – gradient descent, non linear transformations the Z space. Similarity based learning: nearest neighbor, k - nearest neighbors, efficient distance computations: the KD trees Information based learning: learning and trees, Classification and regression trees. Ensemble methods, Boosting, Bagging, Random forests. Neural networks – the perceptron, Multilayer perceptron, activation functions, gradient descent, deriving back propagation. Multi -task and transfer learning, Deep -learning. Linear discriminant analysis (LDA), Principal component analysis (PCA) SVM - optimal separation, the margin and support vectors, a constrained optimization problem, kernels – polynomial, radial basis, sigmoid Performance Measures and Evaluation – for categorical targets, prediction scores, multinomial targets, continuous targets. Clustering – the general problem, hierarchical and partitional clustering, K -means clustering. Recommended Readings Text Books: - 1. Learning from Data, Yaser S Abu -Mostafa, AML books 2. Machine learning, Marsland, CRC press 3. An Introduction to Machine Learning, KubatMiroslav, Springer 4. Fundamentals of Machine Learning for predictive data analytics, John D Kelleher, MIT Press MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST829 Course Name : Pattern Recognition Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: An undergraduate level understanding of probability, statistics and linear algebra is assumed. A basic knowledge of Python is essential. Course Contents The classification process: features, training and learning, approaches to classification Non metric methods: Information, Entropy and Impurity, decision tree classifier - ID3, C4.5. Discriminant functions: linear discriminant functions, piece -wise linear discriminant functions, generalized discriminant functions. Statistical pattern recognition: measured data and measurement errors, probability theory, conditional probability and Bayes rule, Naive Bayes classifier, Continuous random variables, The multivariate Gaussian, Covariance matrix and Mahalanobis distance Parametric learning: Bayesian decision theory, discriminant functions and decision boundaries, MAP (Maximum A Posteriori Estimator) Non Parametric learning: Histogram estimator and Parzen windows, k -NN classification, Artificial Neural Networks, Kernel Machines, SVM. Feature extraction and selection: reducing dimensionality, feature selection - Inter/Intra class distance, Feature extraction: Principal component analysis, Linear discriminant analysis. Un supervised learning: Clustering, K - Means clustering, Fuzzy c -Means clustering, (Agglomerative) Hierarchical clustering Estimating and Comparing Classifiers: No free lunch, Bias and variance trade -off, cross -validation and resampling methods, Measuring classifier performance, Comparing classifiers - ROC curves, McNemar's test, other statistical tests Recommended Readings Text Books: - 1. Pattern Classification, Duda Hart, Wiley 2. Pattern Recognition and Classification, Geoff Dougherty, Springer 3. Statistical Pattern Recognition, Andrew R Webb, Wiley 4. Pattern Recognition and Machine Learning, Christopher Bishop, Springer 5. Pattern Recognition and Image Analysis, Earl Gose, Johnsonbaugh, PHI MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department /Centre : Department of Computer Science & Engineering Course Code : 21CST805 Course Name : Big Data Analytics Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Overview

of Database Management Systems, Introduction to Big Data, Introduction to distributed file system, Big Data and its importance, Four Vs, Drivers for Big data, Big data analytics. Apache Hadoop & Hadoop Eco -System, Moving Data in and out of Hadoop, Understanding inputs and outputs of MapReduce, Data S erialization. Hadoop Architecture, Hadoop Storage: HDFS, Common Hadoop Shell commands, Anatomy of File Write and Read, Name -Node, Secondary Name -Node, and Data -Node, Hadoop MapReduce paradigm, Map and Reduce tasks, Job, Task trackers - Cluster Setup, SSH & Hadoop Configuration – HDFS Administering, Monitoring & Maintenance. Pig, Pig Latin Language, Hive Introduction, Hive queries. Spark Introduction. Cassandra CQL query language and CQL data model: Key space, Table definition, Column, and Data Types. Mongo DB Cluster analysis, K -means algorithm, Naïve Bayes, Parallel k -means using Hadoop, parallel particle swarm algorithm using MapReduce, case studies on big data mining. Parallel swarm Intelligence. Recommended Readings Text Books: - 1. Dan Sulliva ,NoSQL for Mere Mortals 1st Edition., Pearson Publishers, 2014 2. Pramod J. Sadalage, Martin Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence 1st Edition, Pearson Publishers,ISBN -13: 978-0321826626, 2017. 3. John D. Kelleher, Brian Mac Namee, Aoife D'Arcy, Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms, Worked Examples, and Case Studies (The MIT Press) 4. John D. Kelleher, Brendan Tierney, Data Science (MIT Press Essential Knowl edge series).

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST811 Course Name : Data Visualization Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Modern Visualisation tools and techniques, Create multiple versions of digital visualizations using various software packages; Identify appropriate data visualization techniques given particular requirements imposed by the data; App ly appropriate design principles in the creation of presentations and visualizations; Analyse, critique, and revise data visualizations Information overload and issues in decision making Design of visual encoding schemes to improve comprehension of data and their use in decision making Use of Tableau - Data visualization tool for data analysts, scientists, statisticians, etc. to visualize the data and get a clear opinion based on the data analysis, Comparing classifiers - ROC curves, McNemar's test, other statistical tests. Recommended Readings Text Books: - 1. A first course Sosulski, K. (2018). Data Visualization Made Simple: Insights into Becoming Visual. New York: Routledge. 2. The Visual Display of Quantitative Information (2nd Edition). E. Tufte. G raphics Press, 2001. MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST839 Course Name : System on Chip Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Transaction -Level Modeling& Electronic System -Level Languages, Hardware Accelerators, Media Instructions, Co -processors, System -Level Design Methodology ,High -Level Synthesis (C - to-RTL), Hardware Synthesis and Architect ure Techniques Source -Level Optimizations. Scheduling Resource, Binding and Sharing. Recommended Readings Text Books: - 1. De Micheli, editor Special Issue on Hardware/Software Co -design Proceedings of IEEE, Vol 85, No. 3,

March 1997 2. D. D. Gajski, F. Vahid, S. Narayan, J. Gong :Specification and Design of Embedded Systems, Prentice Hall, Englewood Cliffs, NJ, 1994 3. J. Staunstrup and W. Wolf, editors: Hardware/Software Co -Design: Principles and Practice Kluwer Academic Publishers, 1997 4. G. DeMichel i, R. Ernst, and W. Wolf, editors, Readings in Hardware/Software Co -Design, Academic Press, 2002. MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CSL760 Course Name : Pro gram Analysis Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Introduction to analysis tools: debugging, disassembly, emulators, virtualization Introduction: Program Representation, Syntactic Analysis, Program Semantics, Static and dynamic analysis, Syntactic Analysis, Dataflow Analysis and Abstract Interpretation , Interprocedural analysis, Context -sensitive, Pointer analysis, Call Graph Construction, slicing and profiling, Control Flow Analysis, Dynamic Analysis for Data Race Detection Model Checking, Symbolic execution, Program Repair, Hoare Logic, SMT solver s Recommended Readings Text Books: - 1. Pierce, Benjamin C. Types and Programming Languages. MIT Press, 2002. 2. Winskel, Glynn. The Formal Semantics of Programming Languages: An Introduction. MIT Press, 1993. 3. Nielson, Nielson, and Hankin. Principles of Program Analysis. Springer, 2010. 4. Baier, and Katoen. Principles of Model Checking. MIT Press, 2008. 5. Chlipala, Adam. Certified Programming with Dependent Types: A Pragmatic Introduction to the Coq Proof Assistant. MIT Press, 2013. MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR DEPARTMENT of Computer Science and Engineering M.Tech. Computer Science and Information Security Semester. I S.No. Course Code Course Title Course Category Type Credit L T P 1. 21CST523 Cryptography PC Theory 3 3 0 0 2 21CST521 Advanced Data Structures and Algorithms PC Theory 3 3 0 0 3. 21CST522 Computer and Network Security PC Theory 4 3 0 2 4. 21CST854 Department Elective – 1 PE Theory 3 3 0 0 5. 21CST855 Department Elective – 2 PE Theory 3 3 0 0 6. 21CSP524 Programming Lab -1 PC Lab 2 0 1 2 Total 18 Semester. II S.No. Course Code Course Title Course Category Type Credit L T P 1. 21CST526 Research Methodology PC Theory 2 2 0 0 2 21CST872 Department Elective – 3 PE Theory 3 3 0 0 3. 21CST873 Department Elective – 4 PE Theory 3 3 0 0 4. 21CST874 Department Elective – 5 PE Theory 3 3 0 0 5. 21CST875 Department Elective – 6 PE Theory 3 3 0 0 6. 21CSP525 Design Lab PC Lab 2 0 1 2 7. 21CSP527 Security Tools Lab PC Lab 2 0 1 2 Total 18 Semester. III S.No. Course Code Course Title Course Category Type Credit L T P 1. 21CSS623 Technical Documentation and Presentation PC --- 2 0 1 2 2 21CSP622 Literature Review PC --- 2 0 1 2 3. 21CSD621 Dissertation – 1 PC --- 8 0 0 16 Total 12 Semester. IV S.No. Course Code Course Title Course Category Type Credit L T P 1. 21CSD624 Dissertation – 2 PC --- 12 0 0 24 Total 12 Total Credits: 60 MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST523 Course Name : Cryptography Credits : 3 L - 3 T - 0 P - 0 Course Type : Core Prerequisites: None Course Contents Number theory: Prime numbers, GCD, Euclidean Algorithm, Extended Euclidean Algorithm, Fermat's theorem, Euler's theorem, Chinese remainder theorem, Discrete logarithms, Primality testing algorithms, Probability, Bays

Theorem. Introduction to Information security and cryptography, Basic terminology and concepts, Classical Cryptographic techniques and their cryptanalysis, Shannon perfect secrecy, One Time Pad, Pseudo random generators, Semantic security, indistinguishability based Security. Stream ciphers and RC4, Various types of attacks, Chosen-Plaintext Attack. Chosen-Ciphertext Attack etc. Block Ciphers: Data Encryption Standard (DES), Advanced Encryption Standard (AES), DES attacks, Modes of operations One-way function, trapdoor one-way function, Public key cryptography, RSA cryptosystem, Diffie-Hellman key exchange algorithm, ElGamal Cryptosystem Cryptographic hash functions, secure hash algorithm, Message authentication, digital signature, RSA digital signature. Recommended Readings Text Books: - 1. William Stallings, Cryptography and Network Security: Principles and Practice, Prentice Hall 2. Douglas R. Stinson, Cryptography: Theory and Practice, Chapman and Hall 3. J. Katz and Y. Lindell, Introduction to Modern Cryptography, CRC press 4. N. Koblitz, Number Theory and Cryptography, Springer, 2001

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST521 Course Name : Advanced Data Structures and Algorithms Credits : 3 L - 3 T - 0 P - 0 Course Type : Core Prerequisites: None Course Contents RAM model – Notations, Recurrence analysis - Master's theorem and its proof - Amortized analysis, Recurrence equations. Advanced Data Structures: B-Trees, Binomial Heaps, Fibonacci Heaps, AVL trees, Red-black trees, B-trees, Splay trees, Interval trees; Disjoint set – union and path compression, Amortized analysis. Greedy Algorithms: shortest distance, minimum spanning tree, interval scheduling, interval partitioning; Divide and Conquer: sorting, integer and polynomial multiplication; Dynamic programming: Longest common subsequence. Chain of matrix multiplication, sequence alignment, Bellman Ford. Convex hull and Voronoi diagrams, line segments, Optimal polygon triangulation; Primality testing, Integer factorization; Graph algorithms: Matching and Flows; Parallel algorithms: Basic techniques for sorting, searching, merging. Intractability: Independent Set, Vertex Cover Randomized algorithms, Probabilistic algorithms. Approximate Algorithms: Vertex-cover, set-covering problems, Travelling Salesman problem. N Complexity classes - NP-Hard and NP-complete Problems - Cook's theorem NP completeness reductions, undecidability. Recommended Readings Text Books: - 1. Cormen, Leiserson, Rivest: Introduction to Algorithms, Prentice Hall of India. 2. Aho A.V, J.D Ulman: Design and analysis of Algorithms, Addison Wesley 3. Brassard : Fundamental of Algorithmics, PHI 4. Sara Baase: Computer Algorithms: Introduction to Design and Analysis, Pearson Education. 5. Papadimitriou, Steiglitz: Combinatorial Optimization: Algorithms and Complexity, PHI. 6. Motwani and Raghavan: Randomized Algorithms, Cambridge University Press 7. Vazirani: Approximation Algorithms, Springer Verlag 8. Joseph Ja'Ja': Introduction to Parallel Algorithms, Addison-Wesley 9. Kleinberg, Tardos: Algorithm Design, Addison Wesley. 10. Dexter Kozen: The Design and Analysis of Algorithms. Springer, 1992. 11. Sanjoy Dasgupta, Christos Papadimitriou, and Umesh Vazirani: Algorithms, McGraw Hill. 12. Robert Sedgewick and Kevin Wayne. Algorithms 4/e. Addison-Wesley. 13. Robert Tarjan: Data Structures and Network Algorithms, Society for Industrial and Applied Mathematics. MALAVIYA

NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST522 Course Name : Computer and Network Security Credits : 4 L - 3 T - 0 P - 2 Course Type : Core Prerequisites: None Course Contents Introduction (a) Security(b) Malware(c) OWASP top ten and other major security issues in the world(d) CVE and other information(e) Introduce various type of security areas Software and OS Security: Common Bugs, Buffer Overflow, Runtime Defences against memory safety vulnerabilities, program verification and other vulnerabilities, Principles in OS Security; Mechanisms for confining bad code, Mechanisms for confining bad code : isolation, sandboxing, SFI and Virtualization, Trusted Computing Network and Web Security: Secure web site design (SQL injection, XSS, etc.), Browser Security, Security problems in network protocols: TCP/IP, DDoS Attacks, Network worms and bot -nets: attacks and defences, DNS and BGP security, Network defence tools – Firewall and Intrusion Detection. Future Networks Security: Introduction - The Security in Existing wireless Networks, Upcoming wireless networks and challenges, Thwarting and malicious behaviour – Naming and addressing, security association and secure neighbour discovery, secure routing in multichip wireless networks and privacy protection. Mobile OS Security and Privacy: Android, IOS security challenges, processor security, privacy, anonymity and censorship and other security issues according to the current situations and future requirements Recommended Readings Text Books: - 1. Security in Computing (3rd edition) 2. Research publications on security MALAVIYA

NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CSP524 Course Name : Programming Lab 1 Credits : 2 L - 0 T - 1 P - 2 Course Type : Core Prerequisites: Programming skills required Course Contents Programming exercises and experiments in Computer Networks and Security. a. Experiments on LAN Trainer Kit: Performance study of data link layer protocols, implementation and testing Network Layer routing protocols, understanding the steps involved in RC4 algorithm encryption b. Programming exercises using sockets c. Design and implementation of a Data Sniffer Programming exercises and experiments in Advanced Data Structures a. Primality testing b. Recursive algorithms c. Sorting algorithms d. Heaps, priority queues, and binary search trees e. Red-black trees f. Graph based algorithms g. String matching algorithms Programming on advanced data structures by choosing the right data representation formats based on the requirements of the problem and selecting the right algorithmic paradigm (such as greedy, dynamic programming, divide and conquer etc.). Implement the basic cryptographic algorithms: a. Euclidean and Extended Euclidean algorithm for finding the Greatest Common Divisor of two large integers. b. Chinese remainder theorem. c. Modular polynomial arithmetic d. Diffie - Hellman Key exchange protocol Implement the advanced cryptographic algorithms: Congruence of squares. Finding a congruence of squares modulo n to factor n. Construction of Finite Field of characteristic 2. Computations in elliptic curve over a finite field Recommended Readings Text Books: - 1. Menezes, P.C. van Oorschot, S.A. Vanstone: Handbook of Applied Cryptography: CRC Press, 1996. 2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, "Introduction to Algorithms (3rd Edition)", T. Publisher: MIT Press. 3. Peter Brass,

“Advanced Data Structures”, Cambridge University Press, 2008. 4. Abhijit Das and C.E.Venimadhavan, Public-key Cryptography: Theory and Practice, Pearson, 2009. Bottom of Form 5. Introduction to Modern Cryptography, Jonathan Katz and Yehuda Lindell. 6. LAN Trainer user Manual MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST526 Course Name : Research Methodology Credits : 2 L - 2 T - 0 P - 0 Course Type : Core Prerequisites: None Course Contents Unit I: Data Structures and Algorithms: Review of Data Structures , and most commonly used algorithms in Computer Science and Engineering – Sorting, DFS/BFS, and Pattern Searching. Unit II: Linear Algebra: Vectors - linear vector spaces, linear independence, norms and inner products, Basis and dimension, Matrices, Matrix operations, Inverse of a matrix Orthogonalization, Properties of determinants, Eigenvalues and eigenvectors, SVD and pseudo inverse, KL or Hotelling transform. Unit III: Transforms Signals and representation, Convolution, Frequency Transforms, Properties of Fourier Transform, DFT, DCT and FFT, Introduction to wavelets, applications in Computer Science and Engineering Unit III: Probability and Statistics Statistics: Introduction to statistical analysis, hypothesis testing – null and alternate, statistical tests – chi-square, ANOVA, data validation Probability models and axioms, Bayes’ rule, discrete and continuous random variables, Probability distributions: normal distribution and properties, conditional, marginal and joint probability distribution, PRNG (pseudo random number generators) - randomness tests, introduction to information theory and cryptography: an Introduction Unit IV: Machine Learning: Linear and non-linear regression, supervised learning – neural network, binary decision diagram, SVM, k-NN, unsupervised learning – Clustering, Hidden Markov Models, Introduction to deep learning. Unit V: Case Studies in Research Domains of CSE. Recommended Readings Text Books: - 1. Gilbert Strang: Linear Algebra, MIT Cambridge Press. 2. Sheldon Ross: First Course in Probability, Pearson. 3. Mark Girolami, Simon Rogers: First Course In Machine Learning, CRC Press. 4. Anirban Das Gupta: Probability and Statistics for Machine Learning, Springer. 5. The Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani, second ed, Springer 6. Ian Goodfellow: Deep learning, MIT Cambridge Press. MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CSP525 Course Name : Design Lab Credits : 2 L - 0 T - 1 P - 2 Course Type : Core Prerequisites: Students must have prior programming experience in C/C++ or any language; mathematics through differential equations, and numerical analysis Course Contents Operating Systems and Unix Environments: features of UNIX/Linux for scientific and technical computing; languages, compilers, debuggers, performance tools, make files, build systems, shell scripting, file management, source code control. Research Documentation and Simple Data Visualization: tools for generating research and code documentation: LATEX, Doxygen, plotting tools. Software Best Practices: software design cycle, regression testing, defensive programming, verification, code coverage Scientific Libraries: availability of common math libraries and usage for scientific computing. High performance Computing (HPC): Tool and techniques operating Systems and Unix Environments: features of UNIX/Linux for scientific and

technical computing; languages, compilers, debuggers, performance tools, make files, build systems, shell scripting, file management, source code control. Research Documentation and Simple Data Visualization: tools for generating research and code documentation: LATEX, Doxygen, plotting tools. Software Best Practices: software design cycle, regression testing, defensive programming, verification, code coverage. Scientific Libraries: availability of common math libraries and usage for scientific computing. High performance Computing (HPC): Tool and techniques.

**Recommended Readings Text Books:** - 1. Eric S. Raymond, The Art of Unix Programming, Addison-Wesley 2003. 2. Heister, T. and Rebholz, L. G., Introduction to Scientific Computing for Scientists and Engineers. De Gruyter Press, 2015. 3. John Levesque, High Performance Computing: Programming and Applications

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre :** Department of Computer Science & Engineering  
**Course Code :** 21CSP527 **Course Name :** Security Tools Lab  
**Credits :** 2 L - 0 T - 1 P - 2 **Course Type :** Core **Prerequisites:** NIL

**Course Contents** Etherreal/ Wireshark real time network analyzer, packet sniffing techniques ,TCPDump, Safety control using Metasploit , Vulnerability assessment using Nessus tool, Intrusion detection using Snort, Wireless safety tools, Network tracking using Nagios, Kali Linux tools, Hardware and software security tools

**Recommended Readings Text Books:** - 1. On line resources

**Electives Courses for CS -IS**

- 21CST802 Advanced Computer Networks
- 21CST804 Android Programming
- 21CST848 Biometrics
- 21CST850 Cloud Security
- 21CST851 Cyber Security
- 21CST852 Data Compression
- 21CST853 Deep Learning
- 21CST856 Digital Forensics
- 21CST857 Embedded System Security
- 21CST858 Internet of Things
- 21CST871 Wireless Security
- 21CST859 Intrusion Detection
- 21CST861 Nature Inspired Algorithms
- 21CST862 Network Performance Modelling
- 21CST863 Pattern Recognition
- 21CIL736 Program Analysis
- 21CST864 Public Key Infrastructure and Trust Management
- 21CST865 Quantum Cryptography
- 21CST866 Security Analysis of Protocols
- 21CST821 Machine Learning
- 21CST867 Selected Topics in Cryptography
- 21CST868 Social Network Analysis
- 21CST869 Software Testing and Validation
- 21CST870 VLSI Algorithms
- 21CST849 Blockchain Technologies

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre :** Department of Computer Science & Engineering  
**Course Code :** 21CST802 **Course Name :** Advanced Computer Networks  
**Credits :** 3 L - 3 T - 0 P - 0 **Course Type :** Elective **Prerequisites:** None

**Course Contents** Wireless networking: a. Bluetooth, 802.11 standards b. Information theory, bandwidth, multiple access c. Wireless Terahertz Networks d. 5G and 6G communication e. Intelligent Transportation Systems

**Emerging networking technologies:** a. Host configuration and service discovery principles b. Future routing architectures c. IPv6 deployment scenarios and challenges, IPv6 transition/integration d. Advanced IP multicast, including IPv6 multicast and SSM e. Software -defined networki ng f. Delay -tolerant networking g. Future home network architectures h. IP network management and monitoring i. Social Networks

**Recommended Readings Text Books:** - 1. Tanenbaum A S and Wetherall D J (2010). Computer Networks. 2. Hagen S, (2006). IPv6 Essentials. 3. Recent publications on the relevant fields

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre :**

Department of Computer Science & Engineering Course Code : 21CST804 Course Name : Android Programming Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Basics: Review of Java Programming, Setting up and configuring Android Studio setup, Android EmulatorHello Android example, Android Manifest.xml, R.java file, Activity, Fragment, Layout Manager - Relative Layout, Linear Layout, Table Layout, Grid Layout A ctivity, Intent & Fragment: Activity Lifecycle, Activity Example, Intent – implicit and explicit, Intent filters, Fragment Lifecycle, Fragment Example, UI Widgets – buttons (toggle, switch, image), check box; Android Menu: Option Menu, Context Menu, Popup Menu; View Android Service: lifecycle, example, Data Storage, Shared Preference, SQLite, Content Provider, Android Notification Adding functionality: Multimedia API, Speech API, telephony API, Location API Sensors: Sensor API, Working with WiFi, Working with Camera, Motion Sensor, Position Sensor; Android Graphics App development project Recommended Readings Text Books: - 1. Official Android Website MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST848 Course Name : Biometrics Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: A basic knowledge of statistics, linear algebra, and programming is expected. Course Contents Introduction: Person recognition, Biometric systems, Biometric functionalities, biometrics system errors, the design cycle of biometric systems. Fingerprint recognition: friction ridge patterns, fingerprint acquisition, feature extraction and matching, palm prints. Face recognition: image acquisitions, face detection, feature extraction and matching, handling pose, illumination and expression variations Iris recognition: image acquisition, Iris segmentation, Iris normalization, Iris encoding and matching, Iris quality assessment tec hniques Additional Biometric Traits: Ear, Gait, Hand geometry, Soft biometrics Multibiometrics: sources of multiple evidence, fusion levels: sensor, feature, score, rank and decision level fusion. Security of biometric systems: adversary attacks, attack s at user interface, attacks on biometric processing, attacks on template database. Recommended Readings Text Books: - 1. Introduction to Biometrics, Anil K Jain Arun Ross, Springer 2. The Science of Biometrics, Ravindra Das, Springer 3. Practical Biometrics, Julian Ashbourn, Springer MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST850 Course Name : Cloud Security Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Computer Networks, Operating System Course Contents Introduction of Cloud Computing: Taxonomy and related technologies, Essential Characteristics, Service and Deployment Models. Virtualization: Types of Virtualizati on and Hypervisors, Virtualization at Storage, Compute and Network, Hypervisors (Types and Case studies), Virtual Machine Provisioning, Virtual Machine Migration. Architectures:Standards, Orchestration, Provisioning, Portability, Interoperability, Federate d Cloud, Security: CIA Triad, Vulnerabilities in Cloud, Threats to Infrastructure, Data and Access Control;Identity Management; Multi Tenancy Issues; Attack taxonomy; Intrusion Detection, VM Specific attacks, VM Introspection, Management; Trusted Cloud I nitiative of Cloud Security Alliance (CSA). Forensics: NIST Forensics Reference Architecture, Forensic Science Challenges, Architectural



Issues, Evidence Collection and Analysis, Anti -Forensics, Incident Response, Standards and Framework Recommended Readings Text Books: - 1. K. Hwang, G. C. Fox, and J. Dongarra, Distributed and Cloud Computing, 1st ed.: Morgan Kaufmann, 2011 2. R. Buyya, J. Broberg, and A. M. Goscinski, Cloud Computing: Principles and Paradigms: Wiley -Blackwell, 2011 3. S. Dinkar and G. Manjunath, Moving to the Cloud: Developing Apps in the New World of Cloud Computing Syngress Media, U.S., 2012. 4. W. Stallings, Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud, 1st ed.: Addison -Wesley Professional, 2015. 5. T. Erl, Z. Mahmood, and R. Puttini, Cloud Computing: Concepts, Technology & Architecture: Prentice Hall/PearsonPTR, 2014. 6. R. L. Krutz and R. D. Vines, Cloud Security - A Comprehensive Guide to Secure Cloud Computing, Wiley Publishing, 2010 7. T. Mather, S. Kumaraswamy, and S. Latif, Cloud Security and Privacy - An Enterprise Perspective on Risks and Compliance, O Reilly Publishers, 2009. 8. V. (J. R.) Winkler, G. Speake, P. Foxhoven, Securing the Cloud: Cloud Computer Security Techniques and Tactics, Syngress, 2011.

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR** Department/Centre : Department of Computer Science & Engineering Course Code : 21CST851 Course Name : Cyber Security Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: NIL Course Contents Overview of Cyber Security, Internet Governance – Challenges and Constraints, Cyber Threats, Need for a Comprehensive Cyber Security Policy. Cyber Security Safeguards (Overview): Access control, Audit, Authentication, Biometrics, Cryptography, Deception, Denial of Service Filters, Ethical Hacking, Firewalls, Intrusion Detection Systems, Response, Scanning, Security policy, Threat Management. Network Security & Web Security: Security Issues in TCP/IP, which includes TCP, DNS, Routing (basic problems of security in TCP/IP, IPsec, BGP Security, DNS Cache poisoning, etc), Network Defense tools such as Firewalls, Filtering, DNSSec, NSec3, Distributed Firewalls, Web Application Security: Cross -Site Scripting Attacks, Cross -Site Request Forgery, SQL Injection Attacks Intrusion, Physical Theft, Abuse of Privileges, Unauthorized Access by Outsider, Malware infection, Intrusion detection and Prevention Techniques, Anti - Malware software, Network based Intrusion detection Systems, Network based Intrusion Prevention Systems, Host based Intrusion prevention Systems, Security Information Management, Network Session Analysis, System Integrity Validation. Cyber Forensics: Introduction to Cyber Forensics, Handling Preliminary Investigations, Controlling an Investigation, Conducting disk - based analysis, Investigating Information -hiding, Scrutinizing E -mail, Validating Email header information, Tracing Internet access, Tracing memory in real -time. Security in Mobile Platforms: Android vs. iOS security model, threat models, information tracking, rootkits, Threats in mobile applications, analyzer for mobile apps to discover security vulnerabilities, Viruses, Spywares, and keyloggers and malware detection. Cyberspace and the Law Recommended Readings Text Books: - 1. Latest research papers, journals and articles 2. Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Nina Godbole and SunitBelapure. 3. Cybersecurity Essentials By Charles J. Brooks, Christopher Grow, Philip Craig, Donald Short - 2018 4. Cybersecurity: Attack and Defense Strategies: Infrastructure Security with Red Team and Blue Team

TacticsBook by ErdalOzkaya and Yuri Diogenes MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST852 Course Name : Data Compression Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Object Oriented Analysis and Design Course Contents Introduction: Compression techniques, lossless compression, lossy compression, measures of performance, modeling and coding. Mathematical preliminaries - Overview, introduction to information theory, models, physical models, probability models, Markov models. Basic Coding Schemes: Statistical Methods - Shannon -Fano Algorithm, Huffman Algorithm, Adaptive Huffman Coding. Arithmetic Coding (Encoding, Decoding, Adaptive Coding). Dictionary Methods - LZ77, LZ78, LZW Algorithms. Case study of lossless compression standards. Lossless Compression standards: zip, gzip, bzip, unix compress, GIF, JBIG. Image and Video Compression: Discrete Cosine Transform, JPEG. Wavelet Methods - Discrete Wavelet Transform, JPEG 2000. Motion Compensation, Temporal and Spatial Prediction. MPEG and H.264. Audio Compression: Digital Audio, WAVE, FLAC, MPEG -1/2 Audio Layers. Recommended Readings Text Books: - 1. Khalid Sayood. 2012. Introduction to Data Compression (4th ed.). Elsevier. 2. David Salomon, Giovanni Motta. 2010. Handbook of Data Compression. Springer, London.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST853 Course Name : Deep Learning Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Course Overview: Introduction to Deep Learning and its Applications. Introduction to Statistical Learning: Multi -Layer Perceptron, Back Propagation, Linear Regression, etc.Convolutional Neural Networks: Convolution, pooling, Activation Functions, Back propagation of CNN, Weights as templates, Translation invariance, Training with shared parameters.CNN Architecture Design and Discussion: AlexNet, VGG, GoogLeNet, Res Net, Capsule Net, etc. Loss Functions and Optimization: Optimization, stochastic gradient descent, dropout, batch normalization, etc.Sequential Modelling: Recurrent and Recursive Nets, RNN, LSTM, GRU, Image captioning, visual question answering, etc. Visualization and Understanding: Visualizing intermediate features and outputs, Saliency maps, Visualizing neurons, Cam -Grad, etc. Generative Models: VariationalAutoencoders, Generative Adversarial Networks like pix2pix, CycleGAN, etc. Deep Reinforcement Learning: Reinforcement Learning (RL) Background, Policy gradients, hard attention Q -Learning Deep Learning Applications: Object Detection: RCNN, Fast RCNN, Faster RCNN, YOLO, Retina Net, SSD, etc., Semantic Segmentation: DeepLabV3, PSP Net, etc. Adversarial Attacks on CNN. Recommended Readings Text Books: - 1. Ian Goodfellow and YoshuaBengio and Aaron Courville, "Deep Learning," MIT Press. 2. Michael A. Nielsen, "Neural Networks and Deep Learning," Determination Press, 2015.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST856 Course Name : Digital Forensics Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Operating Systems, Computer Networks & Security Course Contents File System Forensics: Duplicating hard disks for "dead analysis", reading hidden data on a disk's Host Protected Area (HPA), Direct

versus BIOS access, dead versus live acquisition, Disk partitions - DOS, Apple, and GPT partitions, BSD disk labels, Sun Volume; multiple disk volumes - RAID and disk spanning; Analyzing FAT, NTFS, Ext2, Ext3, UFS1, and UFS2 file systems, Finding evidence: File metadata, recovery of deleted files, Using The Sleuth Kit (TSK), Autopsy Forensic Browser, and related open source tools Web Forensics: network-based evidence in Windows and Unix environments, Reconstructing Web browsing, email activity, Tracing domain name ownership and the source of e-mails System Forensics: Windows Registry changes, Duplicating and analyzing the contents of PDAs and flash memory devices Electronic document, computer image verification and authentication. Recommended Readings Text Books: - 1. Brian Carrier. File System Forensic Analysis, Addison Wesley. 2. Chris Prosise, Kevin Mandia. Incident Response and Computer Forensics, McGraw Hill. Course Technology. 3. Linda Volonino, Reynaldo Anzaldúa, and Jana Godwin. Computer Forensics: Principles and Practices, Prentice Hall. 4. Keith J. Jones, Richard Bejtlich, and Curtis W. Rose. Real Digital Forensics: Computer Security and Incident Response, Addison Wesley. 5. Vacca, John R., Computer Forensics Computer Crime Scene Investigation, Charles River Media. 6. Nelson, Phillips, Enfinger, Stuart. Guide to computer Forensics and Investigation

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR**  
Department/Centre : Department of Computer Science & Engineering Course Code : 21CST857 Course Name : Embedded System Security Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Security Flaws and Attacks in Embedded systems: Code injection, Invasive and Non invasive physical and logical attacks Defenses Against Code Injection Attacks: Methods using Address Obfuscation and Software Encryption, Anomaly Detection. Safe Languages, Code Analyzers Compiler, Library, and Operating System Support for embedded systems. security, Control Flow Checking, IP Protection: Encryption of IP Cores, additive and Constraint -Based watermarking. Implementation of DES 3DES, AES, RC4, MD5, RSA algorithms Recommended Readings Text Books: - 1. Security in Embedded Hardware

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR**  
Department/Centre : Department of Computer Science & Engineering Course Code : 21CST858 Course Name : Internet of Things Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Computer Networks, Wireless Communication Course Contents Introduction: Internet of Things and Connected Products, IoT paradigm, Smart objects, Goal orientation, Convergence of technologies; Business Aspects of the Internet of Things. Internet and "Things": Layers, Protocols, Packets, Services, Performance parameters of a packet network and applications: Web, Peer-to-peer, Sensor networks, and Multimedia. Hardware and Software: Hardware components, Microcontrollers and Software; Operating Systems. Protocols and Platforms -IoT Communication Protocols, Transport Protocols, Application Protocols; Cloud computing for IoT. Services and Attributes: Data creation, Data gathering and Data dependency; Robustness, Scaling, Privacy, Security, Trust. Designing & Developing IoT applications: Introduction, IoT Design Methodology, Python Data Types & Data Structures, Control Flow, Functions, Modules, Packages, File Handling, Date/ Time Operations, Classes, Python Packages Application: Implications for the society, IoT case study. Recommended Readings Text Books: - 1. The Internet of Things: Key

Applications and Protocols, David Boswarthick, Olivier Hersent, and Omar Elloumi, Wiley 2. Building the Internet of Things with IPv6 and MIPv6, Daniel Minoli, Wiley. 3. Latest research articles MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST871 Course Name : Wireless Security Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Computer Networks Course Contents Foundations of Wireless Security: Wireless as a necessity, advantages and disadvantages, information security and wireless LANs, wireless LAN standards and types, Wireless LAN vulnerabilities. Risks and Threats of Wireless: Social Engineering, phishing, search engine scanning, Denial-of-service, malicious code, War driving, rogue access points, RFID. Wireless Security Models: Wireless Security Basics, Equivalent Privacy Standard (WEP), Extensible Authentication Protocol (EAP), Wi-Fi Protected Access (WPA), WPA2, 802.11i, attacks on WEP, EAP, WPA, 802.11i. Designing a secure wireless network: Basic principles of security design - layering, limiting, diversity, obscurity, simplicity; network segmentation, hardware placement, wireless device security. Wireless security Policy: policy overview, risk assessment, designing security policy, impact analysis, wireless security policy areas, types of wireless security policies. Recommended Readings Text Books: - 1. Wireless Security Handbook, by Aaron E. Earle, Auerbach Publications 2. CWSP Guide to Wireless Security, by Mark Ciampa, 1st Edition. MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST859 Course Name : Intrusion Detection Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Introduction - Intrusion Detection System (IDS), Intrusion Prevention System (IPS), Unauthorized access – buffer overflow, packet fragmentation, out-of-spec packets Review of Network protocol – TCP/IP, Intrusion detection through tcpdump. IDS and IPS – Architecture and internals. Malicious and non-malicious traffic, IP headers, TCP, UDP and ICMP protocols and header formats, Header information to detect intrusion, logs and their analysis, IDS through reaction and response Intrusion analysis – data correlation, tools, SNORT - A case study. Recommended Readings Text Books: - 1. Matt Fearnow, Stephen Northcutt, Karen Frederick, and Mark Cooper. Intrusion Signatures and Analysis, SAMS. 2. Carl Endorf, Gene Schultz, Jim Mellander, Intrusion Detection and Prevention, McGraw Hill. 3. Paul E. Proctor. The Practical Intrusion Detection Handbook, Prentice Hall. 4. Stephen Northcutt and Judy Novak. Network Intrusion Detection, SAMS. MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST861 Course Name : Nature Inspired Algorithms Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Data structures Course Contents Introduction to Algorithms, Optimization, Search for optimality, computational intelligence, Nature Inspired solutions and characteristic, Nature inspired Metaheuristics and its brief history, Analysis of Optimization Algorithms, Nature Inspired Algorithms, parameter Tuning and control Constrained and unconstrained optimizations, Random Walks and Optimizations, evolutionary strategies and Evolutionary Algorithms (EA), Simulated Annealing (SA) Algorithm and its behavior, Genetic Algorithms(GA) - genetic operator, parameters, fitness

functions, genetic programming and convergence analysis, GA variants, Differential Evolution (DE), various Applications. Swarm Intelligence optimization, Particle Swarm Optimization (PSO) Algorithm, Ant Colony Optimization (ACO) Algorithms, Artificial Bee Colony (ABC) optimization algorithms, Cuckoo Search (CS) Algorithms, Intelligent Water Drop Algorithm (IWD), Bat Algorithms (BA), Firefly Algorithms (FA) Framework for self-tuning algorithms, Dealing with constraints, constraints handling, fitness functions, multi-objective optimization techniques and its applications, Hybrid algorithms, Ways to Hybridize. Recommended Readings Text Books: - 1. Nature-Inspired Optimization Algorithms – by Xin-She Yang (Author), June 30, 2016 2. Mathematical Foundations of Nature-Inspired Algorithms, Xin-She Yang, Xing-Shi He, Springer; 1st ed. 2019 edition 3. Nature-Inspired Metaheuristic Algorithms: Second Edition, Xin-She Yang, Luniver Press 4. Introduction to Evolutionary Computing, A. E. Eiben and J. E. Smith, Second Printing, Springer, 2007 5. Evolutionary Algorithms in Engineering Applications, Editors: Dipankar Dasgupta and Zbigniew Michalewicz, Springer-Verlag, 1997 6. D. E. Goldberg, Genetic Algorithms in search, Optimization and Machine Learning, Pearson India 7. Optimization Techniques and Applications with Examples By Xin-She Yan, Wiley publisher

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR** Department/Centre : Department of Computer Science & Engineering Course Code : 21CST862 Course Name : Network Performance Modelling Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents

Introduction to Network Modeling: Network modeling, Computer Network as a discrete event system, Modeling and measurement tools, Network performance metrics – first order and second order metrics, Network capacity, Difference between throughput and capacity Network Calculus: Models for data flows, arrival curves and service curves, Greedy shapers, Basic min-plus and max-plus calculus, min-plus and max-plus systems, Optimal smoothing, FIFO systems and aggregate scheduling, Time varying shapers, Systems with losses, Case studies – (1) Analyzing spanning tree based data forwarding using network calculus, (2) Bound on loss rate Stochastic Scheduling and Resource Allocation: Stochastic scheduling, dynamic resource allocation, Dynamic programming models for stochastic scheduling, Queuing networks – open loop and closed loop networks, Jackson networks, Network fairness – proportional and max-min fairness, Markov process and its application for analyzing network resource allocation and fairness, available bandwidth estimation, Case studies – (1) TCP/IP flow and congestion control, (2) Modeling dynamic routing and scheduling as a queuing network problem, (3) Analysis of IEEE 802.11 channel access using two dimensional Markov process. Network Games: Introduction to game theory, Zero sum games, Nash equilibrium, Pareto optimality, Cooperative and Non-cooperative games, General network games – resource sharing games, routing games, congestion games, Mechanism design, Case studies – (1) Selfish routing in networks and price of anarchy, (2) Oblivious routing, (3) Network resource allocation games Protocol Analysis: Modeling discrete event system using petri-nets, basics of petri nets, stochastic petri nets, queuing petri nets, properties of petri nets, structural analysis of petri nets, Petri net modeling tools – simQPN, Case studies – (1) Wireless channel model using stochastic petri net, (2) Data center network throughput analysis

using queuing Petri Nets Recommended Readings Text Books: - 1. "Routing, Flow, and Capacity Design in Communication and Computer Networks", Michael Pióro, Deepankar Medhi, ISBN: 0125571895, Publisher: Morgan Kaufmann 2. The Network Calculus Book by Jean -Yves Le Boudec and Patrick Thiran is available for free download: [http://ica1www.epfl.ch/PS\\_files/NetCal.htm](http://ica1www.epfl.ch/PS_files/NetCal.htm) 3. Anurag Kumar, D. Manjunath and Joy Kuri, "Communication Networking: An Analytical Approach" Morgan Kaufman Publishers 4. Dimitri P. Bertsekas and Robert G. Gallager, "Data Networks": Materials are available at <http://web.mit.edu/dimitrib/www/datanets.html> 5. "Network Optimization: Continuous and Discrete Models", D. Bertsekas 6. Research Publications - will be discussed and distributed time to time

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR** Department/Centre : Department of Computer Science & Engineering Course Code : 21CST863 Course Name : Pattern Recognition Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: An undergraduate level understanding of probability, statistics and linear algebra is assumed. A basic knowledge of Python is essential. Course Contents The classification process: features, training and learning, approaches to classification Non metric methods: Information, Entropy and Impurity, decision tree classifier- ID3, C4.5. Discriminant functions: linear discriminant functions, piece -wise linear discriminant functions, generalized discriminant functions. Statistical pattern recognition: measured data and measurement errors, probability theory, conditional probability and Bayes rule, Naive Bayes classifier, Continuous random variables, The multivariate Gaussian, Covariance matrix and Mahalanobis distance Parametric learning: Bayesian decision theory, discriminant functions and decision boundaries, MAP (Maximum A Posteriori Estimator) Non Parametric learning: Histogram estimator and Parzen windows, k -NN classification, Artificial Neural Networks, Kernel Machines, SVM. Feature extraction and selection: reducing dimensionality, feature selection - Inter/Intra class distance, Feature extraction: Principal component analysis, Linear discriminant analysis. Unsupervised learning: Clustering, K - Means clustering, Fuzzy c -Means clustering, (Agglomerative) Hierarchical clustering. Estimating and Comparing Classifiers: No free lunch, Bias and variance trade -off, cross -validation and resampling methods, Measuring classifier performance, Comparing classifiers - ROC curves, McNemar's test, other statistical tests.

Recommended Readings Text Books: - 1. Pattern Classification, Duda Hart, Wiley 2. Pattern Recognition and Classification, Geoff Dougherty, Springer 3. Statistical Pattern Recognition, Andrew R Webb, Wiley 4. Pattern Recognition and Machine Learning, Christopher Bishop, Springer 5. Pattern Recognition and Image Analysis, Earl Gose, Johnsonbaugh, PHI

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR** Department/Centre : Department of Computer Science & Engineering Course Code : 21CIL736 Course Name : Program Analysis Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Introduction to analysis tools: debugging, disassembly, emulators, virtualization Introduction: Program Representation, Syntactic Analysis, Program Semantics, Static and dynamic analysis, Syntactic Analysis, Dataflow Analysis and Abstract Interpretation, Interprocedural analysis, Context -sensitive, Pointer analysis, Call Graph Construction, slicing and profiling, Control Flow Analysis, Dynamic Analysis for Data

Race Detection Model Checking, Symbolic execution, Program Repair, Hoare Logic, SMT solvers

**Recommended Readings Text Books:** - 1. Pierce, Benjamin C. Types and Programming Languages. MIT Press, 2002. 2. Winskel, Glynn. The Formal Semantics of Programming Languages: An Introduction. MIT Press, 1993. 3. Nielson, Nielson, and Hankin. Principles of Program Analysis. Springer, 2010. 4. Baier, and Katoen. Principles of Model Checking. MIT Press, 2008. 5. Chlipala, Adam. Certified Programming with Dependent Types: A Pragmatic Introduction to the Coq Proof Assistant. MIT Press, 2013.

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR**  
 Department/Centre : Department of Computer Science & Engineering  
 Course Code : 21CST864  
 Course Name : Public Key Infrastructure and Trust Management  
 Credits : 3 L - 3 T - 0 P - 0  
 Course Type : Elective  
 Prerequisites: None  
 Course Contents Public key infrastructure - components and architecture. PKI interoperability, deployment and assessment PKI data structures – certificates, validation, revocation, authentication, cross - certification. Repository, Certification Authority (CA) and Registration Authority (RA), trusted third party, digital certificates PKI services – authentication, non -repudiation, privilege management, privacy, secure communication. Key management – certificate revocation list, root CA, attacks on CA, key backup. PKI standards – SSL, LDAP, IPsec, X.500, X.509, S/MIME Trust models – strict v/s loose hierarchy, four corners distribution. Certificate path processing – path construction and path validation.

**Recommended Readings Text Books:** - 1. Ashutosh Saxena, Public Key Infrastructure, Tata McGraw Hill 2. Carlisle Adams, Steve Lloyd. Understanding PKI: Concepts, Standards, and Deployment Considerations, Addison Wesley. 3. John R. Vacca. Public Key Infrastructure: Building Trusted Applications and Web Services, Auerbach. 4. Messaoud Benantar, Introduction to the Public Key Infrastructure for the Internet, Pearson Education.

**MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR**  
 Department/Centre : Department of Computer Science & Engineering  
 Course Code : 21CST865  
 Course Name : Quantum Cryptography  
 Credits : 3 L - 3 T - 0 P - 0  
 Course Type : Elective  
 Prerequisites: None  
 Course Contents Preliminaries: Quantum Information Theory, Quantum Information Theory, Unconditional Secure Authentication and Entropy. Quantum Key Distribution: Quantum Channel, Public Channel, QKD Gain, Finite Resources, Adaptive Cascade: Introduction, Error Correction and the Cascade Protocol, Adaptive Initial Block -Size Selection, Fixed Initial Block -Size, Dynamic Initial Block - Size. Attack Strategies on QKD Protocols: Attack Strategies in an Ideal Environment, Individual Attacks in an Realistic Environment. QKD Systems, Statistical Analysis of QKD Networks in Real-Life Environment: Statistical Methods, Results of the Experiments, Statistical Analysis. QKD Networks Based on Q3P : QKD Networks, PPP, Q3P, Routing and Transport. Quantum - Cryptographic Networks from a Prototype to the Citizen. The Ring of Trust Model, Model of the Point of Trust Architecture, Communication in the Point of Trust Model, Exemplified Communications, A Medical Information System Based on the Ring of Trust.

**Recommended Readings Text Books:** - 1. Quantum Cryptography and Secret -Key Distillation, Gilles van Assche, Cambridge University Press, 2006. 2. Paul Kaye, Raymond Laflamme, and Michele Mosca, An Introduction to Quantum Computing, Oxford University Press (2007). 3. Michael A. Nielsen and Isaac L. Chuang, Quantum

Computation and Quantum Information, Cambridge University Press (2000).

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre :  
Department of Computer Science & Engineering Course Code : 21CST866 Course  
Name : Security Analysis of Protocols Credits : 3 L - 3 T - 0 P - 0 Course Type :  
Elective Prerequisites: None Course Contents Cryptographic background;  
Authentication, Key establishment and IP security; Denial of service; Anonymity and  
MIX networks; Fairness and contract signing, Privacy and protection of individual  
information; Wireless security (mobile phones, WiFi); Protocol analysis tools: Finite  
-state checking; Infinite -state symbolic analysis; Probabilistic model checking; Game  
-based verification; Process algebras (spi -calculus and applied pi calculus); Protocol  
logics (BAN, DDMP, Isabelle); Introduction to Probabilistic polynomial time calculus;  
Relating cryptographic and formal models. Recommended Readings Text Books: - 1.  
Latest reputed conference and journal articles as chosen by the instructor. 2.  
Maximum Security, 2nd Edition, SAMS Books by Anonymous, 1998, 3. Maximum  
Linux Security, SAMS Books by Anonymous, 2000, ISBN: 0 -672- 31670 -6. 4. 10  
Risks of PKI: What You're not Being Told about Public Key Infrastructure, by Ellison  
and Schneier MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR  
Department/Centre : Department of Computer Science & Engineering Course Code :  
21CST860 Course Name : Machine Learning Credits : 3 L - 3 T - 0 P - 0 Course Type  
: Elective Prerequisites: Basic understanding of probability and statistics, linear  
algebra and calculus. A basic knowledge of programming (preferably Python) is  
essential. Course Contents Advanced linear Algebra (e.g., SVD). The learning  
problem – learning versus design, types of learning - supervised, unsupervised,  
reinforcement and other views of learning. Linear Modelling: A least squares  
approach, linear modeling, making predictions, vector/matrix notation, linear  
regression, nonlinear response from a linear model. Generalization and over -fitting.  
The Bayesian approach to machine learning: exact posterior, marginal likelihoods  
Probability based learning: Bayes theorem, Bayesian prediction, conditional  
independence and factorization, the Naive Bayes model. Error based learning: simple  
linear regression, multi variable linear regression with gradient descent Logistic  
regression – gradient descent, nonlinear transformations the Z space. Similarity  
based learning: nearest neighbor, k - nearest neighbors, efficient distance  
computations: the KD trees Information based learning: learning and trees,  
Classification and regression trees. Ensemble methods, Boosting, Bagging, Random  
forests. Neural networks – the perceptron, Multilayer perceptron, activation functions,  
gradient descent, deriving back propagation. Multi - task and transfer learning, Deep  
learning. Linear discriminant analysis (LDA), Principal component analysis (PCA) SVM  
- optimal separation, the margin and support vectors, a constrained optimization  
problem, kernels – polynomial, radial basis, sigmoid Performance Measures and  
Evaluation – for categorical targets, prediction scores, multinomial targets, continuous  
targets. Clustering – the general problem, hierarchical and partitional clustering, K  
-means clustering. Recommended Readings Text Books: - 1. Learning from Data,  
Yaser S Abu -Mostafa, AML books 2. Machine learning, Marsland, CRC press 3. An  
Introduction to Machine Learning, Kubat Miroslav, Springer 4. Fundamentals of  
Machine Learning for predictive data analytics, John D Kelleher, MIT Press 5.



Learning from Data, Yaser S Abu -Mostafa, AML books MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST867 Course Name : Selected Topics in Cryptography Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Maths Course Contents Basic Concepts: Information theoretic vs. computational security. One way functions, Pseudo randomness generators and functions, Permutations, hash functions. Private -key encryption using pseudo randomness. Private -key authentication. – Public key encryption (and number theory). Public key authentication. Interactive protocols: Touch of complexity theory, Interactive proof systems; 0 -knowledge proof systems, 0 -knowledge authentication, Electronic cash; non -interactive zero-knowledge. Oblivious transfer: Definitions, constructions, and applications, Secure Multiparty computations, Database (differential) privacy. – Proofs of work – Block -chain consensus protocols. Recommended Readings Text Books: - 1. Introduction to Modern Cryptography: Principles and Protocols, by Jonathan Katz and Yehuda Lindell 2. A Graduate Course in Applied Cryptography by Dan Boneh and Victor Shoup 3. The Joy of Cryptography by Mike Rosulek. 4. Oded Goldreich: Foundations of Cryptography Vol 1 and Vol 2 MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST868 Course Name : Social Network Analysis Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Data Structures and Algorithms Course Contents Network Models: Properties of Real -World Networks: Degree Distribution, Clustering Coefficient, Average Path Length. Random Graphs , Small -World Model, Preferential Attachment Model, Modeling of Real -World Networks using Random Graphs, Small -World Model and Preferential Attachment Model Network Measures: Centrality: Degree Centrality, Eigenvector Centrality, Katz Centrality, PageRank, Centrality, Closeness Centrality, Group Centrality. Transitivity and Reciprocity, Balance and Status, Similarity: Structural Equivalence, Regular Equivalence. Community Analysis: Community Detection, Community Detection Algorithms: Member -Based Community Detection, Group -Based Community Detection. Community Evolution: How Networks Evolve, Community Detection in Evolving Networks. Community Evaluation: Evaluation with Ground Truth, Evaluation without Ground Truth Recommendation: Classical Recommendation Algorithms: Content -Based Methods, Collaborative Filtering (CF), Extending Individual Recommendation to Groups of Individuals, Recommendation Using Social Context, Evaluating Recommendations: Evaluating Accuracy of Predictions, Evaluating Relevancy of Recommendations Graph Representation Learning, Knowledge Graphs and Meta Paths, Graph Convolutional Networks, Link Prediction, Influence Maximization & Outbreak Detection. Recommended Readings Text Books: - 1. Networks, Crowds, and Markets: Reasoning About a Highly Connected World by David Easley and Jon Kleinberg. 2. Networks: An introduction by Mark Newman. 3. The Development of Social Network Analysis” by Linton C Freeman 4. Zafarani, Reza, Mohammad Ali Abbasi, and Huan Liu. Social media mining: an introduction. Cambridge University Press MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR Department/Centre : Department of Computer Science & Engineering Course Code : 21CST869 Course Name : SOFTWARE TESTING &

**VALIDATION Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites:** Software engineering, basic computer programming skills **Course Contents** Testing Environment and Test Processes: Software Testing Environment, Overview of Software Testing Process, Organizing for Testing, Developing the Test Plan, Verification Testing, Analyzing and Reporting Test Results, Acceptance Testing. Levels of Testing, Unit Testing, Integration Testing, Defect Bash Elimination. System Testing, Usability and Accessibility Testing, Configuration Testing, Compatibility Testing. Functional and Non-functional system testing, Compliance Testing, Load Testing, Performance Testing and Security Testing. Static and dynamic testing, Black-box or functional testing, Equivalence partitioning, BVA, structural, White box or glass box testing, Mutation Testing, Data flow testing. Test Automation: Software Testing Tools, Software Test Automation, Debugging, Case study. Recommended Readings Text Books: - 1. Srinivasan Desikan and Gopalaswamy Ramesh, "Software Testing – Principles and Practices", Pearson Education,. 2. A.P. Mathur, Foundations of Software Testing, Pearson publications 3. Naresh Chauhan , "Software Testing Principles and Practices " Oxford University Press , New Delhi . 4. Elene Burnstein, " Practical Software Testing", Springer International Edition. 5. Renu Rajani, Pradeep Oak, "Software Testing – Effective Methods, Tools and Techniques", Tata McGraw Hill. 6. William Perry, "Effective Methods of Software Testing", Third Edition, Wiley Publishing. **MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR** Department/Centre : Department of Computer Science & Engineering Course Code : 21CST870 Course Name : VLSI Algorithms Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: None Course Contents Logic synthesis & verification: Introduction to combinational logic synthesis, Binary Decision Diagram, Hardware models for High-level synthesis. VLSI Algorithms Partitioning: Problem formulation, classification of partitioning algorithms, Group migration algorithms, simulated annealing & evolution, other partitioning algorithms. Placement, floor planning & pin assignment: Problem formulation, simulation base placement algorithms, other placement algorithms, constraint-based floorplanning, floor planning algorithms for mixed block & cell design. General & channel pin assignment. Global Routing: Problem formulation, classification of global routing algorithms, Maze routing algorithm, line probe algorithm, Steiner Tree based algorithms, ILP based approaches. Detailed routing : problem formulation, classification of routing algorithms, single layer routing algorithms, two-layer channel routing algorithms, three-layer channel routing algorithms, and switchbox routing algorithms. Over the cell routing & via minimization: two layers over the cell routers, constrained & unconstrained via minimization. Compaction: problem formulation, one-dimensional compaction, two dimension-based compaction, hierarchical compaction. Recommended Readings Text Books: - 1. Naveed Sherwani, "Algorithms for VLSI Physical Design Automation", 3rd **MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR** Department/Centre : Department of Computer Science & Engineering Course Code : 21CST849 Course Name : Blockchain Technologies Credits : 3 L - 3 T - 0 P - 0 Course Type : Elective Prerequisites: Network Security, Cryptography, Course Contents **INTRODUCTION TO BLOCKCHAIN** Distributed Ledger Technology, Decentralization, Bitcoin Network and Architecture, Block in a Blockchain, Advantages over Traditional Databases,

Mining Mechanism, Types of Blockchain: Public, Private, Consortium, Cryptography: Elliptic Curve Cryptography, Hash Functions, Merkle Tree, Merkle Patricia Trie, Digital Signature, Wallets and Keys, User Addresses and Privacy CRYPTO CURRENCY History, Distributed ledger, Creation of Coins, Double spending, Bitcoin protocols, Transaction in Bitcoin Network, AltCoins, Ethereum, EVM, Accounts, Transactions, Gas, Fees, Smart Contracts, Eth 2.0 MINING AND CONSENSUS Definitions, Types of Mining Algorithms, Proof of Work, Proof of Stake, Proof of Burn. Sharding Chains SMART CONTRACTS ON ETHEREUM Setting up Ethereum Node using Geth Client, Smart Contracts and DApps, Truffle, Ganache CLI, Metamask, Remix, Solidity, Writing and Deploying Smart Contracts in Sol idity, Connection to Web3.js Library, Vulnerabilities in Smart Contracts, Attacks, Prevention of Attacks, Decentralized Autonomous Organization (DAO), Building an Initial Coin Offering (ICO). BLOCKCHAIN USE CASES AND APPLICATIONS Use -Cases in Cryptocurre ncy and Other Sectors like Finance, Voting System, and Healthcare, etc. Future of Blockchain. Recommended Readings Text Books: - 1. Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction