

| B.TECH. | L | T | P | C |
|---|----------|----------|----------|----------|
| CS : Introduction to Game Design (IGD) | 3 | 0 | 0 | 3 |

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| Unit – 1 Introduction | 10 Hours |
| History of Video Games, Impact of Games on Society, Introduction to the Class, Role of the Game Designer, Game Design, Game types, Game genres, Game Writing, UI Layout, Asset Management, game state, gamer services, and Interactive Storytelling Understanding Hardware, Input Devices, Output Devices, Network Requirements, Managing Game Performance, CPU vs GPU, and Graphics Networking Performance, Dramatic elements of games and Narrative Design, Narrative Game. | |
| Unit – 2 Game Design and Development | 10 Hours |
| Concepts: Mathematical concepts, Collision Detection and resolution, Real-time game Physics, Graphics, System dynamics, Challenge, Skill and Chance, Character Animation, Animate basic characters, Transform objects, Artificial Intelligence Agents, Architecture, and Techniques, Overview of Pathfinding, Audio Programming, Conceptualization, Communication, Networking, and Multiplayer | |
| Unit – 3 Audio-Visual Design and Production | 10 Hours |
| Visual Design, 3D Modelling using 3D Studio Max, 3D Environments, 2D Textures and Texture mapping, Special Effects, Lighting, Animation, Cinematography, Audio design and production, Social play Games as culture, Introduction to Unity and 3D games. | |
| Unit – 4 Scripting and Development | 12 Hours |
| Level design and properties of living things, Functionality, Completeness, and Balance, Simple Playtesting and Quality Assurance, Design a board game, Game economies, Black Friday, the board game, Unity Demos, Courses Wiki, Lesson Files, Managing Projects, Interface and Assets, Unity Interfaces, Prototyping and Scripting Basics, Collection, Inventory and HUD, Building Unity Game, Terrain, Unity Terrain Assets, Camera, Layer, GUI, Curves, Surfaces, Visible Surface. | |
| Total Contact Time: 42 Hours | |

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| Recommended Books |
| 1. Steve Rabin, Introduction to Game Development, Cengage Technology (2010). |
| 2. Michael Dawson, Beginning C++ Through Game Programming, Cengage Learning (2010). |
| 3. Kelly C., Programming 2D Games, A K Peters/CRC Press(2012). |
| 4. A. Thorn, Learn Unity for 2D Game Development, Apress, (2013). |

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| B.TECH. | L | T | P | C |
| CS : Human Computer Interface (HCI) | 3 | 0 | 0 | 3 |

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| Unit – 1 Introduction | 10 Hours |
| Human perception, human vision, Gestalt principles describing human visual perception, visual structure, color vision, peripheral vision, attention, and memory, attention shapes thought and action, recognition, and recall, learning from experience, performing learned actions, problem solving and calculation, factors affecting learning, time requirements. | |
| Unit – 2 System Design | 12 Hours |
| Usability of interactive systems: guidelines, principles, and theories; development processes, managing design processes, evaluating interface designs, software tools; interaction styles, direct manipulation, and virtual environments, menu selection, form filling and dialog boxes, command and natural languages, interaction devices, collaboration; design issues: Quality of Service, balancing function and fashion, user manuals, online help, and tutorials, information search and visualization; societal and individual impact of user interfaces | |
| Unit – 3 Interaction Design | 10 Hours |
| Introduction, the process, the user experience; understanding and conceptualizing interaction, conceptual models, interface metaphors, interaction types; cognitive aspects: cognition frameworks; social interaction; emotional interaction; interfaces: interface types, natural user interfaces, choosing interface. | |
| Unit – 4 System Analysis and Evaluation | 10 Hours |
| Data gathering; data analysis, interpretation, and presentation; practical issues in the process of interaction design; establishing requirements: data gathering and processing, task description, task analysis; design, prototyping, and construction: conceptual design, physical design, scenarios, prototypes; evaluation: types of evaluation, evaluation case studies, inspections: heuristic evaluation and walkthroughs, analytics, predictive models; evaluation framework: DECIDE – a framework to guide evaluation. | |
| Total Contact Time: 42 Hours | |

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| Recommended Books |
| 1. B. Schneiderman, C. Plaisant, M. Cohen and S. Jacobs, <i>Designing the User Interface: Strategies for Effective Human-Computer Interaction</i> , 5th Edition, Person Education, 2009. |
| 2. J. Johnson, <i>Designing with the Mind in Mind: Simple Guide to Understanding User Interface Design Rules</i> , Elsevier/Morgan-Kaufmann, 2010. |
| 3. H. Sharp, Y. Rogers, J. Preece, <i>Interaction Design: Beyond Human - Computer Interaction</i> , 3rd edition, Wiley, 2011. |
| 4. D. Norman, <i>The Design of Everyday Things</i> , Currency/ Doubleday, 1990. |

| B.TECH. | L | T | P | C |
|---|----------|----------|----------|----------|
| CS : Augmented and Virtual Reality (AVR) | 2 | 0 | 2 | 3 |

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| Unit – 1 Introduction | 05 Hours |
| Fundamental Concept and Components of Augmented, Virtual, Mixed, and Extended Reality. Primary Features and Present Development on Different Realities. Augmented and Mixed Reality, Taxonomy, technology and features of augmented reality, the difference between AR and VR, Challenges with AR | |
| Unit – 2 Concepts of Augmented Reality | 06 Hours |
| Major entities of Augmented Reality: Sensors, Processors, and Displays. Types of Input --Tracker, Sensor, Digital Glove, Movement Capture, Video-based Input, 3D Menus & 3DScanner, etc. Output -- Visual /Auditory / Haptic Devices and Displays. Different types of Sensor Tracking, Different types of Processors, Different Types of Displays. Concepts Related to AR: Dimensionality, Computer Graphics, Depth Cues, Registration and Latency, Content Management: Types of Content, Content Creation, Content Visualization. | |
| Unit – 3 Concepts of Virtual Reality | 06 Hours |
| Virtual reality tools, introduction to scientific visualization and virtual reality, hardware requirements, sound, animation techniques, VR on flight simulation. Advanced Techniques in CG: Management of Large Scale Environments & Real-Time Rendering. | |
| Unit – 4 Interfaces, Interaction, and Prototyping | 05 Hours |
| Browsing Interface, 3D AR Interfaces, Tangible Interfaces, Tangible AR Interfaces, Augmented and Tangible Interface, Natural AR Interfaces, AR Interaction Cycle, Prototyping Cycle, Different methods to make prototypes, Prototyping techniques, Prototyping tools, Advantages and Disadvantages of Prototyping. Mobile AR: Advantages, Disadvantages, and Architectures. | |
| Unit – 5 Software, Tools, and Applications | 06 Hours |
| AR Software Production: Sensor, Application Engine, Rendering Engines. Integration of existing tools into AR software, Virtual Reality Modelling Language (VRML), Tools: AR Toolkit, OpenGL, Unity. Applications: Different Domains, Real-time applications. Future trends in Augmented and Virtual Reality. | |
| Total Contact Time: 28 Hours | |

| Recommended Books |
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| 1. Burdea, G. C. & P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEE Press, 2003/2006. |
| 2. Alan B. Craig, Understanding Augmented Reality, Concepts & Applications, Morgan Kaufmann, 2013. |
| 3. Alan Craig, William Sherman, and Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009. |
| 4. LaValle "Virtual Reality", Cambridge University Press, 2016. |
| 5. John Vince, "Virtual Reality Systems ", Pearson Education Asia, 2007. |
| 6. Anand R., "Augmented and Virtual Reality", Khanna Publishing House, Delhi. |

Indian Institute of Information Technology (IIIT), Surat
B.Tech - Computer Science and Engineering
List of Experiments

| Subject Code CS | Augmented and Virtual Reality (AVR) | Credits: 1 (0-0-2) Total hours: 28 Weeks: 14 |
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| Course Objectives | To have a hands-on session with the Augmented and Virtual Reality Tools. | |
| Sr. No. | Experiment | Hours |
| 1 | Introduction to Virtual Reality Modeling Language (VRML) | 02 Hours |
| 2 | To design 2D and 3D objects using VRML | 02 Hours |
| 3 | Installation of OpenGL/Unity Tool | 02 Hours |
| 4 | Hands-on available functionalities in OpenGL/Unity. | 02 Hours |
| 5 | Multiplayer 2D Ping-Pong Game Development in OpenGL/Unity. | 04 Hours |
| 6 | To Develop a 3D Game in OpenGL/Unity | 04 Hours |
| 7 | To Develop AR applications using VRML, OpenGL, and Unity Tools (Mini Project) | 10 Hours |

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| B.TECH. IV Semester-7 | L | T | P | C |
| CS 751: Block-chain Technology | 3 | 0 | 0 | 3 |

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| Unit - 1 | 8 Hours |
| <i>Introduction:</i> Introduction, Background and History, Purpose and Scope, Money, Currency, Ledgers, Bitcoin Core, Distributed Database, Two General Problem, Byzantine General problem and Fault Tolerance, Hadoop Distributed File System, Distributed Hash Table, ASIC resistance, Turing Complete. <i>Cryptography:</i> Hash function, Digital Signature - ECDSA, Memory Hard Algorithm, Zero Knowledge Proof | |
| Unit - 2 | 12 Hours |
| <i>Block Chain:</i> Introduction, Advantage over conventional distributed database, Block chain Network, Mining Mechanism, Distributed Consensus, Merkle Patricia Tree, Gas Limit, Transactions and Fee, Anonymity, Reward, Chain Policy, Life of Block chain application, Soft & Hard Fork, Private and Public block chain. | |
| Unit - 3 | 14 Hours |
| <i>Distributed Consensus:</i> Nakamoto consensus, Proof of Work, Proof of Stake, Proof of Burn, Difficulty Level, Sybil Attack, Energy utilization and alternate. | |
| <i>Crypto Currency:</i> History, Distributed Ledger, Bitcoin protocols - Mining strategy and rewards, Ethereum -Construction, DAO, Smart Contract, GHOST, Vulnerability, Attacks, Side chain, Name coin | |
| Unit - 4 | 8 Hours |
| <i>Crypto Currency Regulation:</i> Stakeholders, Roots of Bit coin, Legal Aspects-Crypto currency Exchange, Black Market and Global Economy. Applications: Internet of Things, Medical Record Management System, Domain Name Service and future of Block chain, Block chain Use Cases – Finance, Industry, Blockchain in Government and Blockchain Security | |
| Total Contact Time: 42 Hours | |

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| Recommended Books |
| 1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press |
| 2. Antonopoulos, Mastering Bitcoin: Unlocking Digital Cryptocurrencies |
| 3. Satoshi Nakamoto, Bitcoin: A Peer-to-Peer Electronic Cash System |
| 4. DR. Gavin Wood, "ETHEREUM: A Secure Decentralized Transaction Ledger,"Yellow paper.2014 |
| 5. Nicola Atzei, Massimo Bartoletti, and Tiziana Cimoli, A survey of attacks on Ethereum smart contracts |

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| B.TECH. Semester - | L | T | P | C |
| CS : Computer Ethics and Public Policy | 3 | 0 | 0 | 3 |

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| Unit – 1 Introduction: Why Computer Ethics? | 04 Hours |
| A Brief History of Computers and the Internet, Meaning of Ethics, Distinction between Law and Ethics, Computer Ethics as a Unique Kind of Ethics | |
| Unit – 2 Philosophical & Professional Ethics | 12 Hours |
| Introduction of Dimensions of Ethics, Descriptive and Normative claims, Meta Ethics, Ethical Theory: Ethical Relativism, Utilitarianism, Deontological Theories, Virtue Ethics; Individual and Social Policy Ethics, Characteristics of Profession, Codes of Ethics and Professional Conduct, The Ethical Decision-Making Process, Steps in the Ethical Decision-Making Process, Culture Clash on the Net case and its solution, Wired Ethics for IT workers and IT users, Ethics after Information Retrieval | |
| Unit – 3 Privacy Concerns and Case Studies | 14 Hours |
| Understanding computer privacy issues, Reframing the issues, Legislative background, Global Perspective, Proposal for better privacy protection, cybersquatting, Fake IDs, Identity Theft, Intellectual property, Open-Source Software, Phishing, Pharming, Software Bombs, Sale of Term Papers Online, Sale of Academic Degrees Online, Web Spoofing, Internet Fraud Case, Free Software Case, Finals Week Case, Software Licensing: Stuck in the Middle Case, Borrowed Hardware Case, Risks of academic Cheating by Computer Case, Cookies, Employee Monitoring, Government Surveillance, Hackers, Fingering Case, E-mail Addresses Case, Deceased Student Case, Chain Letter Case, Accountability of Bloggers, Online Voting, Google and Chinese Censorship Case, File Transfer Case, Ethical Issues in Parasitic Computing | |
| Unit – 4 Ethics and the Internet; Social Implications and Social Values | 12 Hours |
| Significant characteristics, Hacking and Hackers ethics, New spice of old crime, Netiquette, Policy approaches, ACM Code of Ethics and Professional Conduct, Software Engineering Code of Ethics and Professional Practice, The Ten Commandments of Computer Ethics, The World Summit on the Information Society, Geneva Plan of Action, Tunis Commitment, Technology and Social Change, Embedded values and Impeded values, Democratic values in Internet, Digital Bridge or Digital divide and access of information, Overarching and Future Issues | |
| Total Contact Time: 42 Hours | |

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| Recommended Books |
| 1. Johnson, Deborah G. (2001). Computer ethics, 3rd edition. Upper Saddle River, NJ: Prentice Hall. A philosophical survey of the ethical issues arising around computer technology. |
| 2. Moor, James H. (1985). "What Is Computer Ethics?" Metaphilosophy 16(4): 266–275. Classic piece on why the study of computer ethics is needed. |
| 3. Advisory Committee on Automated Personal Data Systems. Records, Computers, and the Rights of Citizens. U. S. Department of Health, Education, and Welfare Publication No. (OS) 73–94, July 1973. |

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| B.TECH. | L | T | P | C |
| CS : Cyber Security | 3 | 0 | 0 | 3 |

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| Unit – 1 Introduction | 08 Hours |
| Defining Cyberspace and Overview of Computer and Web-technology, Architecture of cyberspace, Communication, and web technology, Internet, World wide web, Advent of Internet, Internet infrastructure for data transfer and governance, Internet Society, Regulation of cyberspace, Concept of cyber security, Issues and challenges of cyber security | |
| Unit – 2 Cybercrime and Cyberlaw | 08 Hours |
| Classification of cyber crimes, Common cyber crimes- cyber crime targeting computers and mobiles, cyber crime against women and children, financial frauds, social engineering attacks, malware and ransomware attacks, zero-day and zero click attacks, Cybercriminals modus-operandi, Reporting of cyber crimes, Remedial and mitigation measures, Legal perspective of cybercrime, IT Act 2000 and its amendments, Cybercrime and offenses, Organisations dealing with Cybercrime and Cyber security in India, Case studies. | |
| Unit – 3 Social Media Overview and Security | 09 Hours |
| Introduction to Social Networks. Types of Social media, Social media platforms, Social media monitoring, Hashtag, Viral content, Social media marketing, Social media privacy, Challenges, opportunities and pitfalls in online social networks, Security issues related to social media, Flagging and reporting of inappropriate content, Laws regarding the posting of inappropriate content, Best practices for the use of Social media, Case studies. | |
| Unit – 4 E-Commerce and Digital Payments | 09 Hours |
| Definition of E-Commerce, Main components of E-Commerce, Elements of E-Commerce security, E-Commerce threats, E-Commerce security best practices, Introduction to digital payments, Components of digital payment and stakeholders, Modes of digital payments- Banking Cards, Unified Payment Interface (UPI), e-Wallets, Unstructured Supplementary Service Data (USSD), Aadhar enabled payments, Digital payments related common frauds and preventive measures. RBI guidelines on digital payments and customer protection in unauthorized banking transactions. Relevant provisions of the Payment Settlement Act,2007. | |
| Unit – 5 Digital Devices Security Tools and Technologies for Cyber Security | 08 Hours |
| End Point device and Mobile phone security, Password policy, Security patch management, Data backup, Downloading and management of third party software, Device security policy, Cyber Security best practices, Significance of host firewall and Ant-virus, Management of host firewall and Anti-virus, Wi-Fi security, Configuration of basic security policy and permissions. | |
| Total Contact Time: 42 Hours | |

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| Recommended Books |
| 1. Cyber Crime Impact in the New Millennium, by R. C Mishra, Author Press. Edition 2010. |
| 2. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, Wiley India Pvt. Ltd. (First Edition, 2011) |
| 3. Security in the Digital Age: Social Media Security Threats and Vulnerabilities by Henry A. Oliver, Create Space Independent Publishing Platform. (Pearson, 13th November 2001) |
| 4. Electronic Commerce by Elias M. Awad, Prentice Hall of India Pvt Ltd. |
| 5. Cyber Laws: Intellectual Property & E-Commerce Security by Kumar K, Dominant Publishers. |
| 6. Network Security Bible, Eric Cole, Ronald Krutz, James W. Conley, 2nd Edition, Wiley India Pvt. Ltd. |

7. Fundamentals of Network Security by E. Maiwald, McGraw Hill.

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| B.TECH. IV Semester-7 | L | T | P | C |
| CS : Advanced Internet Technologies | 3 | 0 | 0 | 3 |

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| Unit - 1 | 10 Hours |
| Internetworking: Advanced Routing Algorithms, Congestion Control and avoidance, Quality of Service, Active Queue Management and Bufferbloat, Data Center Networks | |
| Unit - 2 | 10 Hours |
| High-Speed Browser Networking: Primer on Latency and Bandwidth, Building Blocks of TCP, Building Blocks of UDP, Wifi, Mobile Networks IPv6: IPv4 deficiencies, Patching Work done with IPv4, IPv6 addressing, Multicast, Anycast, ICMPv6, Neighbour discovery, Routing | |
| Unit - 3 | 10 Hours |
| Software Defined Networking and OpenFlow: Centralized and Distributed Control and Data Planes, SDN Controllers, Data Center Concepts, Network Function Virtualization, Mininet, Programming SDNs, OpenFlow Switch, Wire Protocol, OpenStack Neutron plug-in | |
| Unit - 4 | 12 Hours |
| Network management Protocols: SNMP, RMON, NETCONF, Network Management Tools and Applications, Systems and Engineering Storage and Networking: Storage and Networking Concepts, Fiber Channel Internals, Fiber Channel SAN Topologies, Fiber Channel Products, IP SAN Technology, IP SAN Products, Management of SANs, SAN Issues | |
| Total Contact Time: 42 Hours | |

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| Recommended Books and URL/s |
| <ol style="list-style-type: none"> 1. Paul Göransson Chuck Black Timothy Culver. Software Defined Networks A Comprehensive Approach, Elsevier 2017 2. James Kurose, Keith Ross. Computer Networking: A Top-Down Approach, Global 8th Edition 3. ILYA GRIGORIK. High-Performance Browser Networking, https://hpbn.co/ 4. Mahbub Hassan, Raj Jain. High Performance TCP/IP Networking Concepts, Issues, and Solutions 5. Mani Subramanian, Timothy A. Gonsalves, N. Usha Rani; Network Management: Principles and Practice; Pearson Education India 6. William Stallings, High-Speed Networks and Internets, Pearson Education, 7. Muthukumaran B, Introduction to High Performance Networks, Tata Mc Graw Hill |

| B.TECH. | L | T | P | C |
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| CS : Data Mining and Data Warehousing | 3 | 0 | 0 | 3 |

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| Prerequisite |
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| Unit – 1 Introduction | 10 Hours |
| Introduction to Data mining: Motivation for Data Mining, its importance, Role Data in Data Mining, Data Mining functionalities, patterns in data mining, Type of patterns, Classification of Data Mining Systems, Major issues in Data Mining | |
| Unit – 2 | 10 Hours |
| Data Warehousing and OLTP technology for Data Mining, Data Mining Languages, and System Architectures, Concept Description: Characterization and Comparison, Mining Association Rules in Large Databases | |
| Unit – 3 | 12 Hours |
| Classification and Prediction, Cluster Analysis, Mining Complex Data, Applications and Trends in Data Mining Characteristics of data warehouse, Data Mart, Online Analytical Processing, OLAP tools, | |
| Unit-4 | 10 Hours |
| Data warehouse Architecture, Organizational Issuer, Tools for Data warehousing, Performance consideration, case studies. | |
| Total Contact Time: 42 Hours | |

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| Recommended Books |
| 1. J. Han & M. Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann, 2nd Ed, 2006. 2. M. J. A. Berry and G. Linoff, Mastering Data Mining: The Art and Science of Customer Relationship Management, Wiley Computer Publishing, 2000. 3. P. Adriaans & D. Zantinge, Data Mining, Addison Wesley, 1996. 4. R. Mattison, Data Warehousing: Strategies, Tools and Techniques, McGraw Hill, 1996. 5. P. Ponniah, Data Warehousing Fundamentals: A Comprehensive Guide for IT Professionals, Wiley, 2001. |

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| B.TECH. | L | T | P | C |
| CS : Wireless Sensor Networks | 3 | 0 | 0 | 3 |

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| Prerequisite |
| Computer Networks |

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| Unit – 1 Introduction | 06 Hours |
| Introduction to mobile ad hoc networks and wireless sensor networks concepts and architectures. Wireless LAN and PAN, IEEE 802.11 Standard, HIPERLAN, Bluetooth, Home-RF. | |
| Unit – 2 Routing Protocols in Adhoc Network | 09 Hours |
| Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks. Classifications of Routing Protocols. Table-Driven Routing Protocols. On-Demand Routing Protocols. Hybrid Routing Protocols. Routing Protocols with Efficient Flooding Mechanisms. Hierarchical Routing Protocols. Power-Aware Routing Protocols. | |
| Unit – 3 MAC Protocols in Adhoc Network | 09 Hours |
| Issues in Designing a MAC Protocol for Ad Hoc Wireless Networks. Design Goals of a MAC Protocol for Ad Hoc Wireless Networks. Classifications of MAC Protocols. Contention-Based Protocols. Contention-Based Protocols with Reservation Mechanisms. Contention-Based MAC Protocols with Scheduling Mechanisms. MAC Protocols That Use Directional Antennas. Other MAC Protocols. | |
| Unit – 4 Transport and Security Protocols in Adhoc Network | 09 Hours |
| 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. TCP Over Ad Hoc Wireless Networks. Other Transport Layer Protocols for Ad Hoc Wireless Networks. Security in Ad Hoc Wireless Networks. Network Security Requirements. Issues and Challenges in Security Provisioning. Network Security Attacks. Key Management. Secure Routing in Ad Hoc Wireless Networks. | |
| Unit – 5 Wireless Sensor Networks | 09 Hours |
| Wireless sensor networks architecture: hardware and software components of a sensor node, OS for WSN, WSN MAC layer strategies; naming and addressing; Clock Synchronization; Node Localization; WSN Routing. | |
| Total Contact Time: 42 Hours | |

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| Recommended Books |
| 1. C Sivarama Murthy and B S Manoj, "Ad-Hoc Wireless Networks, Architectures and Protocols", PH, 2004. |
| 2. Labiod. H, "Wireless Adhoc and Sensor Networks", Wiley, 2008. |
| 3. Li, X, "Wireless ad -hoc and sensor Networks: theory and applications", Cambridge University Press, 2008. |

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| B.TECH. Semester- CS : Fuzzy Logic and Neural Networks | L | T | P | C |
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| Unit - 1 | 12 Hours |
| <i>Fuzzy Sets and Fuzzy Relations</i> : Introduction, Classic sets, fuzzy sets, crisp relations, fuzzy relations, tolerance and equivalence relations | |
| <i>Fuzzy Inference Systems and Fuzzy Clustering</i> : membership function, fuzzification, fuzzy inference, defuzzification methods, fuzzy logic controller, fuzzy c-means clustering, applications of fuzzy logic, fuzzy tolerance and equivalence relations, value assignments. | |
| Unit - 2 | 10 Hours |
| <i>Properties of Membership Functions, Fuzzification, and Defuzzification</i> : Features of the Membership Function, Various Forms, Fuzzification, Defuzzification to Crisp Sets, λ -cuts for Fuzzy Relations, Defuzzification to Scalars. | |
| <i>Logic and Fuzzy Systems</i> : Classical logic, Fuzzy logic, Fuzzy systems, Natural Language, Linguistic Hedges, Fuzzy (Rule-Based) Systems, Graphical Techniques of Inference. | |
| Unit - 3 | 10 Hours |
| <i>Automated Methods for Fuzzy Systems</i> : Definitions, batch least squares algorithm, recursive least squares algorithm, gradient method, clustering method, learning from example, modified learning from example. | |
| <i>Development of Membership Functions</i> : Membership value assignments, intuition, inference, rank ordering, neural networks, genetic algorithms, inductive reasoning. | |
| Unit - 4 | 10 Hours |
| <i>Introduction</i> : What is neural network?, human brain and biological neuron, model of an artificial neuron, activation functions, neural network architectures, artificial intelligence and neural networks. | |
| <i>Learning Processes</i> : What is learning?, types of learning: supervised, unsupervised and reinforcement learning, basic learning rules: error correction learning, memory-based learning, habbian learning, competitive learning, boltzmann learning, learning tasks. | |
| Total Contact Time: 42 Hours | |

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| Recommended Books |
| 1. Simon Haykin, "Neural Networks – A comprehensive Foundation", Pearson Education, 1999. |
| 2. T. J. Ross, "Fuzzy Logic with Engineering Applications", Wiley, 2005. |
| 3. S. Rajasekaran, and G. A. Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Applications", PHI, New Delhi, 2004. |
| 4. D. K. Pratihar, "Soft Computing", Narosa Publication House, 2008. |
| 5. J. R. Jang, C. Sun, and E. Mizutani, "Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence", PHI, New Delhi, 2012. |
| 6. J. M. Zurada, "Introduction to Artificial Neural Systems", West Publishing Company, 1992. |
| 7. Bart Kosko, "Neural Networks and Fuzzy Systems: A dynamical systems approach to machine intelligence", PHI, 1997. |
| 8. H. J. Zimmermann, "Fuzzy Set Theory & its Applications", 2nd Ed., Kluwer Academic, 1991. |

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| B.TECH. Semester- CS : Probabilistic Graphical Model | L | T | P | C |
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Prerequisite

Probability Theory, Statistics, Basic Programming, Algorithm Design and Analysis

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| Unit – 1: Introduction | 8 Hours |
| Introduction: Motivation, Structured Probabilistic Models, Overview and Roadmap Probability Theory, Graphs, Bayesian Networks: Exploiting Independence Properties, Bayesian Networks, Independencies in Graphs, From Distributions to Graphs Undirected Graphical Models: The Misconception Example, Parameterization, Markov Network Independencies, Parameterization Revisited, Bayesian Networks and Markov Networks, Partially Directed Models. | |
| Unit – 2: Learning Graphical Models and Complexity analysis | |
| Learning Graphical Models: Motivation, Goals of Learning, Learning as Optimization, Learning Tasks Parameter Estimation: Maximum Likelihood Estimation, MLE for Bayesian Networks, Bayesian Parameter Estimation, Bayesian Parameter Estimation in Bayesian Networks, Learning Models with Shared Parameters, Generalization Analysis. Exact Inference (Variable Elimination): Analysis of Complexity, Variable Elimination, complexity and Graph Structure; Exact Inference (Clique Trees): Variable Elimination and Clique Trees, Message Passing (Sum Product), Message Passing (Belief Update), Constructing a Clique Tree. | |
| Unit – 3: Inference | |
| Particle-Based Approximate Inference: Forward Sampling, Likelihood Weighting and Importance Sampling, Markov Chain Monte Carlo Methods, Collapsed Particles, Deterministic Search Methods MAP Inference: Overview, Variable Elimination for (Marginal) MAP, Max-Product in Clique Trees, Max Product Belief Propagation in Loopy Cluster Graphs, MAP as a Linear Optimization Problem, Using Graph Cuts for MAP. | |
| Unit – 4: Data, Models | |
| Partially Observed Data: Foundations, Parameter Estimation, Bayesian Learning with Incomplete Data, Structure Learning, Learning Models with Hidden Variables Learning Undirected Models: Overview, The Likelihood Function, Maximum (Conditional) Likelihood Parameter Estimation, Parameter Priors and Regularization, Learning with Approximate Inference, Structure Learning. | |
| Unit - 5 : Optimization | |
| The Exponential Family: Introduction, Exponential Families, Factored Exponential Families, Entropy and Relative Entropy, Projections Inference as Optimization: Introduction, Exact Inference as Optimization, Propagation Based Approximation, Propagation with Approximate Messages, Structured Variational Approximation. | |
| Total Contact Time: 42 Hours | |

Recommended Books

1. Probabilistic Graphical Models: Principles and Techniques by Daphne Koller and Nir Friedman. MIT Press
2. Modeling and Reasoning with Bayesian networks by Adnan Darwiche.
3. Pattern Recognition and Machine Learning by Chris Bishop.
4. Machine Learning: a Probabilistic Perspective by Kevin P. Murphy.
5. Information Theory, Inference, and Learning Algorithms by David J. C. Mackay.
6. Bayesian Reasoning and Machine Learning by David Barber.

- 7. Graphical models, exponential families, and variational inference by Martin J. Wainwright and Michael I. Jordan.
- 8. <http://www.cs.cmu.edu/~epxing/Class/10708-14/lecture.html>
- 9. <https://cs.stanford.edu/~ermon/cs228/index.html>
- 10. <https://ermongroup.github.io/cs228-notes/>
- 11. <http://people.csail.mit.edu/dsontag/courses/pgm13/>

| B.TECH. | L | T | P | C |
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| CS : Deep Learning (DL) | 2 | 0 | 2 | 3 |

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| Prerequisite |
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| Unit – 1 Introduction | 06 Hours |
| Brief introduction to neural networks. Error Cost Function, Mean-Square Error, Cross-Entropy. Linear vs Non-linear functions: Activation Function – Linear, Sigmoid, Softmax, Relu. Optimization: Gradient Descent Algorithm, Momentum Based Gradient Descent Algorithm | |
| Unit – 2 Feedback Networks | 06 Hours |
| Algorithm for Pattern Association/Reconstruction: Associative memory networks, Hetero Associative Memory neural networks, Auto Associative Memory Networks, Bi-directional Associative memory networks. Feedback Networks: Discrete Hopfield Net, Continuous Hopfield Network | |
| Unit – 3 Convolutional Neural Networks | 8 Hours |
| Convolutional Neural Network: Architecture, Convolution Operation, Filters, Pooling Operation – Max pooling, Average pooling, Global pooling. Dilated CNN. Evaluation metrics. Dense Embeddings: word2vec – Skip-gram model, Continuous Bag Of Words (CBOW) Model. | |
| Unit – 4 Recurrent Neural Network | 8 Hours |
| Deep Recurrent Neural Network: Long Short Term Memory (LSTM) – Architecture. Gated Recurrent Unit (GRU). Attention Mechanism. Recursive Neural Network. Models (CNN, RNN and LSTM network) for real-time applications. | |
| Total Contact Time: 28 Hours | |

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| Recommended Books |
| 1. <i>Neural Network</i> by Simon Haykin, Pearson Education/PHI |
| 2. <i>Deep Learning, Part II</i> . Goodfellow, I., Bengio, Y., Courville, A., MIT Press, 2016. |
| 3. <i>Learning deep architectures for AI</i> . Bengio, Yoshua. Foundations and trends in Machine Learning 2.1 (2009): 1127. |

Indian Institute of Information Technology (IIIT), Surat
B.Tech - Computer Science and Engineering
List of Experiments

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|--------------------------|---|---|
| Subject Code CS | Deep Learning (DL) | Credits: 1 (0-0-2) Total hours: 28 Weeks: 14 |
| Course Objectives | Student will be able to know working of deep architectures like convolutional neural network and variants of recurrent neural network | |
| Sr. No. | Experiment | Hours |
| 1 | Installation and working on various tools viz. Python, ANACONDA, Tensorflow, Keras, Google Colab, etc. | 2 hours |
| 2 | Understanding key technology foundations required application setup for different domain with Deep Learning. Developing Neural Networks for Regression analysis | 2 hours |
| 3 | Developing data crawling system for implementing real-time problems with deep learning. Implementation of associative memory network. | 4 hours |
| 4 | Development of real-time data based application using deep learning algorithms. Use of Word Embedding. Implementations of Self Organizing map. | 4 hours |
| 5 | Image pre-processing techniques, their advantages and implementations. | 2 hours |
| 6 | Development of auto labelling data (text, images, audio, video) algorithms using Python | 2 hours |
| 7 | Use of machine learning and deep learning techniques for solving image related problems. | 6 hours |
| 8 | Comparative evaluation of deep learning models. | 6 hours |

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| B.TECH. | L | T | P | C |
| CS : Bioinformatics | 3 | 0 | 0 | 3 |

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| Unit – 1 Introduction | 08 Hours |
| Concepts of Cell, tissue, types of cell, components of cell, organelle. Functions of different organelles. Concepts of DNA: Basic Structure of DNA; Double Helix structure; Watson and Crick model. Exons and Introns and Gene Concept. Concepts of RNA: Basic structure, Difference between RNA and DNA. Types of RNA. Concept of Protein: Basic components and structure. Introduction to Central Dogma: Transcription and Translation, Introduction to Metabolic Pathways. | |
| Unit – 2 | 08 Hours |
| Introduction to Bioinformatics. Recent challenges in Bioinformatics. Protein Sequence Databases, DNA sequence databases. Sequence database search programs like BLAST and FASTA. NCBI different modules: GenBank; OMIM, Taxonomy browser, PubMed. | |
| Unit – 3 | 10 Hours |
| DNA Mapping and Assembly: Size of Human DNA, Copying DNA: Polymerase Chain Reaction (PCR), Hybridization and Microarrays, Cutting DNA into Fragments, Sequencing Short DNA Molecules, Mapping Long DNA Molecules. De-Brujin Graph. Sequence Alignment: Introduction, local and global alignment, pairwise and multiple alignment, Dynamic Programming Concept. Alignment algorithms: Needleman and Wunsch algorithm, Smith-Waterman. | |
| Unit-4 | 10 Hours |
| Probabilistic Models; Hidden Markov Model: Concepts, Architecture, Transition matrix, estimation matrix. Application of HMM in Bioinformatics: Gene-finding, profile searches, multiple sequence alignment and regulatory site identification. Bayesian networks Model: Architecture, Principle, Application in Bioinformatics. | |
| Unit 5 | 06 Hours |
| Assigning protein function and predicting splice sites: Decision Tree Gene Expression Clustering. K Means Algorithm | |
| Total Contact Time: 42 Hours | |

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| Recommended Books |
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1. Vavid W. Mount: Bioinformatics: Sequence and Genome analysis
2. Arthur M. Leok: Introduction to Bioinformatics, Oxford
3. Rastogi et.al: Bioinformatics-Methods and applications genomics, Proteomics and Drug Discovery, Prentice Hall.
4. Dan Gasfield: Algorithms on Strings, Trees and Sequences, Computer Science and Computational Biology, Cambridge University Press
5. M.S. Waterman: Introduction to Computational Biology: Maps, Sequences and Genomes, 1995.
6. Gibes, Jam beck: Developing Bio-informatics Computer Skills, SPD.

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| B.TECH. | L | T | P | C |
| CS : Distributed Computing Systems(DCS) | 3 | 0 | 0 | 3 |

Prerequisite

Operating Systems, Computer Architecture & Organisation, Database Management System, Data Structures

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| Unit – 1 Introduction | 08 Hours |
| Introduction Distributed Systems and Applications, Distributed vs parallel systems, models of distributed systems, Message Passing mechanisms IPC and RPC. | |
| Unit – 2 Concepts of DCS | 12 Hours |
| Clock synchronization, physical & logical clocks, vector clocks, verifying clock algorithms, mutual exclusion using time stamps, election algorithms, Distributed mutual exclusion using time stamps, tokens & quorums, centralized & distributed algorithms, proof of correctness & complexity, drinking philosophers problem, Implementation & performance evaluation of DME Algorithms. | |
| Unit – 3 System Design | 12 Hours |
| Leader election algorithms, global states, global predicates, termination detection, Control of distributed computation, disjunctive predicates, and performance evaluation of leader election algorithms on simulated environments. | |
| Unit – 4 Application and Security | 10 Hours |
| Distributed File Systems and Services, Shared data, Synchronization Transactions, and Concurrency Control. Distributed databases, Name service, Timing & Coordination, Replication, Security, and Fault Tolerance. | |
| Total Contact Time: 42 Hours | |

Recommended Books

1. Vijay K Garg "Elements of Distributed Computing", Wiley & Sons, 2002.
2. Pradeep Sinha, "Distributed Operating Systems- Concepts and Design", PHI, 2000.
3. A.S. Tanenbaum and M.V. Steen, "Distributed Systems – Principles and Paradigms", PHI.2003.
4. George Coulouris, Jean Dollimore & Timo Kindberg, "Distributed Systems: Concepts & Design", 2nd Edition, Addison Wesley 2003.
5. V. Rajaraman, C. Siva Ram Murthy, "Parallel, Computers Architecture & Programming", PHI.
6. Khemkalyani and Singal, "Distributed Computing".
7. Nancy Lynch, "Distributed Algorithm" (8) Singal and Shivaratri, "Distributed OS".

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| B.Tech. - Semester - | L | T | P | C |
| CS : MOBILE COMPUTING | 3 | 0 | 0 | 3 |

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| UNIT 1 | 06 Hrs |
| Introduction: Introduction to Mobile Computing ,Applications of Mobile Computing, Challenges in mobile computing, Generations of Mobile Communication Technologies - [2G,3G,4G,5G],Multiplexing, Spread spectrum, MAC Protocols: TDMA, FDMA, CDMA. | |
| UNIT 2 | 14 Hrs |
| Mobile Communication System: Cellular Network, GSM Network, GSM Architecture, GPRS Network : Architecture, Comparison between GSM and GPRS | |
| Mobility Management: Mobility, Handoff, Types of handoffs, Location management, HLR-VLR scheme, Hierarchical scheme, Predictive location management schemes, Mobile IP, cellular IP. | |
| UNIT 3 | 12 Hrs |
| Ad hoc Network Routing Protocols: Ad hoc network routing protocols, Destination sequenced distance vector algorithm, Cluster-based gateway switch routing, Global state routing, Dynamic source routing, Ad hoc on-demand routing, Location aided routing, Zonal routing algorithm, Multicast Routing- ODMRP | |
| UNIT 4 | 10 Hrs |
| Mobile Transport and Application Layer : Mobile TCP, WAP, Architecture, WDP, WTLS ,WTP, WSP ,WAE ,WTA Architecture ,WML | |
| Data Dissemination and Management: Challenges, Data dissemination, Mobile data replication, Mobile data caching, Mobile cache maintenance, mobile web caching, caching in ad hoc networks | |
| Total: 42 Hours | |

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| B.TECH. | L | T | P | C |
| CS : Social Network Analysis | 3 | 0 | 0 | 3 |

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| Unit – 1 Introduction | 8 Hours |
| Introduction of Social media data, Semantic web, Limitation of Semantic Web | |
| Emergence of the Social Web: Difficulty to describe Social Web, Social Network Analysis- Key Concepts and measures in network analysis, Web based networks, Application of Social Network Analysis | |
| Unit – 2 Modeling, Aggregating, Knowledge Representation | |
| 14 Hours Introduction of Ontology, Role in Semantic Web, Ontology based Knowledge Representation, Ontology language for the Semantic Web | |
| Modeling and Aggregating Social Network data: Network Data Representation, Ontology representation of social individuals- social relationships, Aggregating and Reasoning with Social Network Data, Advanced Representation | |
| Unit – 3 Extraction and Mining Communities in Social Networks | 10 Hours |
| Association Rule Mining, Supervised Learning, Unsupervised Learning, Semi-supervised Learning, Markov models, K-Nearest Neighbouring, Detecting Community Structure in Networks, the Evolution of Social Networks, Extracting Evolution of Web Community from a Series of Web Archive, Temporal Analysis on Semantic Graph using Three-Way Tensor, Decomposition, Analysis of Communities and Their Evolutions in Dynamic Networks | |
| Unit – 4 Predicting Human Behaviour and Privacy Issues, Visualization and Application of Social Networks | 10 Hours |
| User Data Management, Inference and Distribution, Enabling new human experiences, Reality Mining, Privacy in Online Social Networks: Trust model based on Subjective Logic, Network analysis, Transitivity analysis | |
| Visualization and Application of Social Networks: Graph Theory- Centrality, Clustering, Matrix representation, Visualizing online social networks with matrix-based representation, Node-Link Diagram, Hybrid Diagram, Applications of Social Networks | |
| Total Contact Time: 42 Hours | |

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| Recommended Books |
| 1. Peter Mika, "Social Networks and the Semantic Web", First Edition, Springer(2007). |
| 2. John P. Scott, "Social Network Analysis", (1991). |
| 3. Song Yang, Franziska B. Keller, Lu Zheng, "Social Network Analysis: Methods and Examples", SAGE Publications(2016). |
| 4. Borko Furht, "Handbook of Social Network Technologies and Applications", 1st Edition, Springer, (2010). |

| B.TECH. | L | T | P | C |
|-----------------------------------|----------|----------|----------|----------|
| CS : Information Retrieval | 3 | 0 | 0 | 3 |

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| Prerequisite |
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| Unit – 1 Introduction | 10 Hours |
| Introduction: Basic IR system structure, Retrieval techniques: Boolean retrieval, term-vocabulary, postings-lists, Dictionaries and tolerant retrieval: Wildcard queries, Spelling correction, Phonetic correction; Inverted indices: Preprocessing steps, tokenization, stemming, stopword removal, term weighting; | |
| Unit – 2 Models | 10 Hours |
| vector space model, probabilistic model, language models; Evaluation: standard test collection, concept of relevance, precision, recall based metrics, reciprocal rank | |
| Unit – 3 Relevance Feedback and Classifications | 12 Hours |
| Relevance feedback and query expansion: Rocchio algorithm; Text classification: Naïve Bayes; Text clustering: Flat Clustering, Hierarchical Clustering. | |
| Unit-4 Web Search and link Analysis | 10 hours |
| Web search: Structure of Web, web graph, Hidden Web, User intent, Web crawl. Link Analysis: Web as a graph, PageRank, Hubs and Authorities; : Social search: Community-based search activities, Question Answering, Collaborative Searching | |
| Total Contact Time: 42 Hours | |

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| Recommended Books |
| 1. An Introduction to Information Retrieval, By Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, Cambridge University Press. |
| 2. Information Retrieval: Algorithms and Heuristics, By David A. Grossman, Ophir Frieder |

| B.TECH. | L | T | P | C |
|-----------------------------|----------|----------|----------|----------|
| CS : Ethical Hacking | 2 | 0 | 2 | 3 |

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| Prerequisite |
| Computer Networks, Network Security |

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| Unit – 1 Introduction | 06 Hours |
| Introduction and Information Security Overview, Hacking and Ethical hacking concepts, Hacker behaviour & mindset, Hacking Methodology. | |
| Unit – 2 | 07 Hours |
| Footprinting Concepts and Methodology, Footprinting Tools and Countermeasures, Active and Passive Sniffing, Network Scanning Concepts and Tools, Preparation of Ethical Hacking and Penetration Test Reports and Documents. | |
| Unit – 3 | 08 Hours |
| Social Engineering attacks and countermeasures, Password attacks, Privilege Escalation and Executing Applications, Network Infrastructure Vulnerabilities, IP spoofing, DNS spoofing, DoS attacks. Web server and application vulnerabilities, SQL injection attacks, Vulnerability Analysis and Reverse Engineering, Buffer overflow attacks. Client-side browser exploits, privilege escalation | |
| Unit – 4 | 07 Hours |
| Malware Threats: Malware Concepts, Trojan Concepts, Virus and Worm Concepts, Malware Analysis, Countermeasures, Anti-Malware Software, Malware Penetration Testing Metasploit framework, Penetration testing tools in Kali Linux. | |
| Total Contact Time: 28 Hours | |

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| Recommended Books |
| <ol style="list-style-type: none"> 1. Baloch, R., Ethical Hacking and Penetration Testing Guide, Auerbach Publications, CRC Press, 2015. 2. Sagar Rahalkar, Quick Start Guide to Penetration Testing: With NMAP, OpenVAS and Metasploit, 1st Edition, Apress publications, 2019, Softcover ISBN: 978-1-4842-4269-8. 3. David Kennedy, Jim O'Gorman, Devon Kearns, Mati Aharoni, Metasploit: The Penetration Tester's Guide, No Starch Press, 2011, ISBN: 159327288X,9781593272883 4. Michael Hixon, Justin Hutchens, Kali Linux. Network Scanning Cookbook, Packt Publishing, 2017, ISBN: 139781787287907 5. Glen D. Singh, Learn Kali Linux 2019: Perform Powerful Penetration Testing Using Kali Linux, Metasploit, Nessus, Nmap, And Wireshark, Packt Publishing, 2019, ISBN: 1789611806. 6. Christopher Hadnagy, Social Engineering: The Science of Human Hacking, 2 nd Edition, Wiley Publisher, 2018, ISBN-13: 978- 1119433385. |

Indian Institute of Information Technology (IIIT), Surat
B.Tech - Computer Science and Engineering
List of Experiments

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| Name of Subject: Ethical Hacking |
| Subject Code: |

| Lab No. | Name of Experiment |
|----------------|--|
| 1 | Performing footprinting using Google Hacking, website information, information about an archived website, to extract contents of a website. |
| 2 | To trace any received email, to fetch DNS information. |
| 3 | Scanning networks, Enumeration and sniffing: Use port scanning, network scanning tools, IDS tool, sniffing tool and generate reports. |
| 4 | Malware Threats: Worms, viruses, Trojans: Use Password cracking, Dictionary attack. |
| 5 | Use DoS attack. |
| 6 | ARP poisoning in windows, Ifconfig, ping, netstat, traceroute, Steganography tools |
| 7 | Developing and implementing malwares : Creating a simple keylogger in python, creating a virus, creating a trojan. |
| 8 | Hacking web servers, web applications: Hacking a website by Remote File Inclusion, Disguise as Google Bot to view hidden content of a website, to use Kaspersky for Lifetime without Patch |
| 9 | Sql injection and : SQL injection for website hacking |
| 10 | Implement Session hijacking |
| 11 | Wireless network hacking, cloud computing security, cryptography : Using Cryptool to encrypt and decrypt password, implement encryption and decryption using Ceaser Cipher. |
| 12 | Pen testing : Penetration Testing using Metasploit |
| 13 | Pen testing : Penetration Testing using metasploitable |

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| B.TECH. III Semester-5 | L | T | P | C |
| CS 524: Object Oriented Programming | 3 | 0 | 0 | 3 |

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| Prerequisite |
| Fundamentals of Computer Programming |

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| Introduction to JAVA | 8 Hours |
| Basics of Java programming, Data types, Variables, Operators, Control structures including selection, Looping, Java methods, Overloading, Math class, Arrays in java | |
| Objects and Classes | 8 Hours |
| Basics of objects and classes in java, Constructors, Finalizer, Visibility modifiers, Methods and objects, Inbuilt classes like String, Character, String Buffer, File, this reference. | |
| Inheritance and Polymorphism | 8 Hours |
| Inheritance in java, Super and sub class, Overriding, Object class, Polymorphism, Dynamic binding, Generic programming, Casting objects, Instance of operator, Abstract class, Interface in java, Package in java, UTIL package | |
| Event and GUI programming | 10 Hours |
| Event handling in java, Event types, Mouse and key events, GUI Basics, Panels, Frames, Layout Managers: Flow Layout, Border Layout, Grid Layout, GUI components like Buttons, Check Boxes, Radio Buttons, Labels, Text Fields, Text Areas, Combo Boxes, Lists, Scroll Bars, Sliders, Windows, Menus, Dialog Box, Applet and its life cycle, Introduction to swing | |
| I/O Programming, Multithreading in JAVA | 8 Hours |
| Text and Binary I/O, Binary I/O classes, Object I/O, Random Access Files | |
| Thread life cycle and methods, Runnable interface, Thread synchronization, Exception handling with try-catch-finally, Collections in java, Introduction to JavaBeans and Network Programming | |
| Total Contact Time: 42 Hours | |

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| Recommended Books |
| 1. Introduction to Java Programming (Comprehensive Version), Daniel Liang, Seventh Edition, Pearson. |
| 2. Programming in Java, Sachin Malhotra & Saurabh Chaudhary, Oxford University Press. |
| 3. Murach's Beginning Java 2, Doug Lowe, Joel Murach and Andrea Steelman, SPD. |
| 4. Core Java Volume-I Fundamentals, Eighth Edition, Horstmann & Cornell, Pearson Education. |
| 5. The Complete Reference, Java 2 (Fourth Edition), Herbert Schild, TMH. |