CENTRE FOR ADVANCED STUDIES
Dr. APJ Abdul Kalam Technical University, Lucknow

M.TECH - COMPUTER SCIENCE AND ENGINEERING (CSE)
with choice based specialization in

Cyber Security (CyS)
&
Information and Communication Technologies (ICT)
&
Machine Learning (ML)

Program Structure
Effective from academic session 2021-22

Centre for Advanced Studies (Dr. A.P.J. Abdul Kalam Technical University, Lucknow, U.P.) is starting with Master of Technology in Computer Science & Engineering with choice based specialization in Cyber Security, ICT and Machine Learning from the academic session 2021-22. The curriculum has been developed considering the present and future needs of industry and higher education. The Centre will facilitate both industry ready and research based ambience to students with world class e-library, renowned faculty members to achieve academic excellence and other services.

This is a specialized program aimed to provide the student with in-depth knowledge of domains not only in the field of Computer Science and Engineering but also in the specialized area of their choice. The course structure will help students to develop knowledge and skill in the following proportionate:

90% Technical /Research	○ Information Processing Platform, OS Security, Networking in a global Distributed Environment, Security Techniques, technical experience in industrial design, risk analysis, physical and data security and auditing techniques, VLSI design and communication , Pattern Recognition and Machine Learning , IoT and data science. ○ Excellent Visionary Skill that focus on scalability, cost effectiveness and implementation ease.
10% Business Process & Managerial Practices	○ Know the Business Dynamics, Business Processes and good planning , ability to work with all management level and resolve issues, Business Need with Security Requirement. ○ Consulting Skill, Communication Skill, Legal Understanding.

M.Tech in Computer Science & Engineering with Specialization in Cyber Security aims at providing a strong background for students to get specialized knowledge to design solutions and management policy to build up secure and reliable systems in the modern era of distributed computing. The course covers a Common Body of Knowledge (CBK) about the major 10 security domains for information security professionals :

- Cryptography
- Security Architecture and Design
- Operations Security
- Access Control
- Telecommunications and Network Security
- Information Security Governance and Risk Management
- Software Development Security
- Business Continuity and Disaster Recovery Planning
- Legal, Regulations, Investigations and Compliance

M.Tech in Computer Science & Engineering with Specialization in ICT program aims to provide exposure to students to learn the cutting edge of technology, research and development for solving real-world problems in bridging gap in urban and rural developments. The course enable students in broadening their knowledge of ICT disciplines, major area include:

- Machine Intelligence and Analytics
- Parallel & Distributed Computing

- Signal and Image Processing
- Communication Systems
- VLSI and embedded system
- Intelligent Systems and Security

M.Tech in Computer Science & Engineering with Specialization in ML program, One of the popular applications of AI is Machine Learning (ML), in which computers, software, and devices perform via cognition (very similar to human brain). Machine learning applications are used everywhere everyday. In this specialisation, the students will learn about the cutting edge technology and apply the taught concepts to create machine learning applications. The courses taught in this specialisation include:

- Foundation of Machine Learning
- Neural Networks and Evolutionary Algorithms
- Reinforcement Learning
- Deep Learning
- Machine Learning Applications
- Topological Data Analysis

Program Structure : M.Tech course is a full time two year program and classes will be held on all working days. The Program Structure has been designed such that the students shall study core subjects of Computer Science and Engineering as well as the courses for specialization.

In Semester 1, students shall study Advanced Core courses of Computer Science & Engineering while in the next two semesters students shall study in depth subject of Specialization with its core and elective subjects. Semester IV is Thesis/ Dissertation.

Every core course consists of lecture (L) hours, tutorial (T) hours and practical (P) hours. Elective courses consist of Lecture (L) hours only. The credit (C) for a course is dependent on the number of hours of instruction per week in that course, as given below:

(1) 1h/week of Lecture (L) = 1 credit
(2) 2h/week of Practical (P) = 1 credit
(3) 1h/week of Tutorial(T) = no credit
(4) Credit (C) for a Theory course = No. of hours of lectures per week + No. of hours of tutorials per week = L + T
(5) Credit (C) for a Lab course = ½* No. of hours of lab per week = P

Course Code Abbreviation :

MCSC – Core Course Common to CyS , ICT and ML
MCSE – Elective Course Common to CyS / ICT / ML
MCySC- Core Course for Cyber Security
MICTC- Core Course for ICT
MMLC- Core Course for ML
MMLE- Elective Course for ML
MCySE- Elective Course for Cyber Security
MICTE- Elective Course for ICT

Course Credit Distribution

CATEGORY	PROGRAM CORE FOR CSE	SPECIALIZATION CORE COURSE	SPECIALIZATION ELECTIVES COURSE	PROJECT	NON TEACHING COURSE	TOTAL CREDIT
CREDITS	25	10	9	18	2	64

SEMESTER	COURSE TYPES	CREDITS	
Semester 1			
1	Core Course	(4 credit * 3 course) + (3 credit * 2 course) + (1 credit * 1 course) = 19	TOTAL COURSE = 6 TOTAL SEM CREDIT = 19
Semester 2			
2	Core Courses	(4 credit * 1 course) + (1 credit * 1 course) = 5	
2	Core Course (specialization)	3 credit *1 course=3 4 credit *1 course = 4	3+4=7 TOTAL COURSE =

2	Elective Course (specialization)	3 credit * 2 course = 6	6 TOTAL SEM CREDIT = 18
Semester 3			
3	Core Courses	3 credit * 1 course = 3	TOTAL COURSE = 3 + 1 Thesis TOTAL SEM CREDIT = 13
3	Core Course (specialization)	3 credit * 1 course = 3	
3	Elective course (specialization)	3 credit * 1 course = 3	
3	Thesis/Dissertation- I	4 credit	
Semester 4			
4	Thesis / Dissertation-II	14 credit	TOTAL COURSE = 1 MAJOR PROJECT TOTAL SEM CREDIT = 14
TOTAL PROGRAM CREDIT			64

Semester I

Core Subject common to all branches:

S. No.	Course Co de	Subject	Credit			
			L	T	P	Total
1.	MCSC-105	Discrete Mathematics and Graph Theory	3	0	0	3
2.	**MCSC-103**	Advanced Computer Networks and Communication	3	0	2	4
3.	**MCSC-104**	Foundation of Machine Learning	3	0	2	4
4.	**MCSC-102**	Probability & Statistics	3	0	0	3
5.	MCSC-101	Analysis and Design of Algorithms.	3	0	2	4
6.	MCSC-106	Independent Study and Research - I	0	0	2	1

Total Semester credit: 19

Semester II

S. No.	Course Code	Subject	Credit			
			L	T	P	Total
CORE COURSES - COMPULSARY (Common for All Branches)						
1.	MCSC-201	The Internet of things	3	0	2	4
2.	MCSC-202	Independent Study and Research - II	0	0	2	1
CYBER SECURITY CORE COURSES - COMPULSARY						
3.	MCySC-202	Fundamentals of information Security & Practices	3	0	0	3
4.	MCySC-201	Cryptography	3	0	2	4
ICT CORE COURSES - COMPULSARY						
5.	MICTC-201	Mathematical Foundations for Computing in ICT	3	0	0	3
6.	**MICTC-202**	Embedded System	3	0	2	4

ML CORE COURSES - COMPULSARY						
7.	**MMLC-201**	Neural Networks and Evolutionary Algorithms	3	0	0	3
8.	MMLC-202	Pattern Recognition	3	0	2	4
CYBER SECURITY ELECTIVE COURSES - ANY TWO						
9.	MCSE-201	Introduction to Formal Methods and Verification of Large Systems	3	0	0	3
10.	**MCySE-204**	Ethical Hacking	3	0	0	3
11.	**MCySE-201**	Security Standards & Project Management	3	0	0	3
12.	**MCySE-202**	System Security	3	0	0	3
13.	**MCySE-203**	Identity and Access Management & Trusted Computing	3	0	0	3
ICT ELECTIVE COURSES - ANY TWO						
14.	**MCSE-201**	Introduction to Formal Methods and Verification of Large Systems	3	0	0	3
15.	**MICTE-202**	Speech Communication and Biomedical Signal Processing	3	0	0	3
16.	**MCSE-202**	Data Science	3	0	0	3
17.	**MICTE-201**	Information theory and coding	3	0	0	3
18.	**MCSE-203**	Computer Vision	3	0	0	3
ML ELECTIVE COURSES - ANY TWO						
19.	**MMLE-201**	Big Data Analytics	3	0	0	3
20.	**MMLE-202**	Optimization Techniques	3	0	0	3
21.	**MCSE-202**	Data Science	3	0	0	3
22.	MMLE-203	Probabilistic Graphical Model	3	0	0	3
23.	**MCSE-203**	Computer Vision	3	0	0	3

Total credits: 18

Semester III

S. No.	Course Code	Subject	Credit			
			L	T	P	Total
CORE COURSES - COMPULSARY (Common for All Branches)						
1.	**MCSC -301**	Research Methodology	3	0	0	3
2.	MCSC-302	**Thesis / Dissertation –I**	0	0	8	4
CYBER SECURITY CORE COURSES - COMPULSARY						
3.	**MCySC-301**	Digital and Cyber Forensics	3	0	0	3
ICT CORE COURSES - COMPULSARY						
4.	**MICTC-301**	Multimedia Signal Processing	3	0	0	3
ML CORE COURSES - COMPULSARY						
5.	**MMLC-301**	Deep Learning *(Pre Req:Neural Networks and Evolutionary Algorithms*)	3	0	0	3
CYBER SECURITY ELECTIVE COURSES - ANY ONE						
6.	MCSE-301	Cloud Computing	3	0	0	3
7.	**MCySE-301**	Network Protocol Security	3	0	0	3
		(Pre Req: System Security)				
8.	**MCSE-302**	Wireless Sensor Network	3	0	0	3
9.	**MCSE 304**	Media Security	3	0	0	3
10.	MCSE-303	Intelligent System and Green Computing	3	0	0	3
ICT ELECTIVE COURSES - ANY ONE						
11.	**MCSE-302**	Wireless Sensor Network	3	0	0	3
12.	**MICTE301**	Secure Coding *(Pre Req: Information theory and coding)*	3	0	0	3
13.	MCSE-301	Cloud Computing	3	0	0	3

14.	**MCSE 304**	Media Security	3	0	0	3
15.	**MCSE-303**	Intelligent System and Green Computing	3	0	0	3
ML ELECTIVE COURSES - ANY ONE						
16.	**MMLE-301**	Advanced Kernel Methods	3	0	0	3
17.	**MMLE-302**	Reinforcement Learning	3	0	0	3
18.	MCSE-301	Cloud Computing	3	0	0	3
19.	**MMLE-303**	Machine Learning Applications	3	0	0	3
20.	**MMLE-304**	Topological Data Analysis	3	0	0	3

Total credits: 13

Semester IV

S. No.	Course Code	Subject	Credits			
			L	**T**	**P**	Total
CORE COURSE – COMPULSORY						
1.	**MCSC-401**	**Thesis / Dissertation-II**	**-**	**-**	**28**	**14**
Total credits: 14						

VISION

To recognize itself into a world class centre of excellence in the field of Computer Science and Engineering for Postgraduate Degree as well as cutting edge Research and Development for the global good.

MISSION

M1. To impart quality education for Postgraduate Studies meeting the needs of industry and society, and achieve excellence through research and development.

M2. To provide a stimulating platform for creating and disseminating research based knowledge/technologies through innovation and entrepreneurship for the development of State/Country.

M3. To facilitate quality research work in the field of Computer Science and Engineering by practising professional ethics and team-spirit.

M4. To promote interactions of the department with alumni, institutions, industries and other stake-holders through networking and collaboration.

PEOs

PEO1. Graduates will possess theoretical knowledge as well as professional skills in the areas of Machine Learning, Cyber Security, and Information and Communication Technologies, to pursue a career in leading organizations.

PEO2. Graduates will demonstrate active involvement and participation in Research and Development leading to innovative contributions at both national and international levels.

PEO3. Graduates will engage in lifelong learning with a strong inclination towards research and development by pursuing higher studies as a competent professional.

PEO4. Graduates will work with values and professional ethics to create and disseminate optimized solutions for addressing the challenges faced by industry/society.

PROGRAM OUTCOMES

1. **PO1:** An ability to independently carry out research /investigation and development work to solve practical problems
2. **PO2:** An ability to write and present a substantial technical report/document.
3. **PO3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
4. **PSO 1:** An ability to apply advanced knowledge of Computer Science & Engineering, in the areas of Machine Learning, Cyber Security, and Information and Communication Technologies, to design and implement efficient, effective and optimized solutions targeting the real problems of the industry through research and development.
5. **PSO 2:** An ability to develop innovative, sustainable and adaptive solutions for catering the needs of the society by applying standard principles in computing and professional ethics.

SEMESTER-I

MCSC-101	Analysis and Design of Algorithms	L 3	T 0	P 2	C 4
Prerequisite	None				

Course Content

Network flows (max flow and min-cost flow/circulation) , Data structures (Fibonacci heaps, splay trees, dynamic trees) , Linear programming (structural results, algorithms) and SDP based , Dealing with intractability: approximation algorithms (techniques for design and analysis), Dealing with large data sets (compression, streaming algorithms, compressed sensing), Computational geometry, Hardness of approximation - Approximation Algorithms based on Algorithmic Game Theory, Randomized Algorithms, complexity theory, Parallel Algorithms.

Lab : Programming on searching , sorting and linked list , Binary Tree, Binary Search Tree, Traversal: BFS, DFS; Minimum Spanning Tree, Implementing String Matching Algo's, Greedy & Dynamic Approach, Backtrack/ Branch & Bound, Approximation Algorithms.

Text Books: -

1. Introduction to Algorithms, by Cormen, Leiserson, Rivest, and Stein, MIT Press, Third Edition, 2009.

Reference Books: -

1. Algorithms, by Dasgupta, Papadimitrou and Vazirani, McGraw-Hill Education, 2006.
2. Computer Algorithms, by Horowitz, Sahni, and Rajasekaran, Silicon Press, 2007.
3. Algorithm Design, by Kleinberg and Tardos, Pearson, 2005 .
4. Algorithm Design, by Goodrich and Tamassia, Wiley, 2001.

MCSC-102	Probability and Statistics	L 3	T 0	P 0	C 3
Prerequisite	**None**				

Course Content

Introduction. Events and outcomes. Probability rules. Conditional probability. Independence. Bayes' Rule. Combinatorics. Random variables and their distributions. Discrete random variables. Discrete distributions: Bernoulli, Binomial, Geometric, Negative Binomial, Poisson. Continuous distributions and probability densities. Continuous distributions: Exponential, Gamma, Weibull, Hyperexponential, Normal Expectation and moments. Central Limit Theorem. Simulation of discrete and continuous random variables. Monte Carlo methods. Stochastic processes. Main concepts and classification. Bernoulli process. Poisson process. Markov chains and simple queuing systems. Simulation, performance evaluation, bootstrapping. Statistics and sampling distribution of the sample mean; Statistics and sampling distribution of the sample proportion .Statistical inference; Parameter Estimation (Method of Moments, Maximum Likelihood Method); Confidence Intervals (Pivotal Quantity Method). Hypothesis Testing; type I and type II errors; anomalous events and how to identify them. Parameters and statistics. Parameter estimation and hypothesis testing. Graphics and exploratory data analysis, Simple/multiple regression and least squares, Logistic regression, Analysis of variance, Robust and nonparametric statistics.

Text Books: -

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9thEdition, John Wiley & Sons, 2006.
2. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2003(Reprint).
3. S. Ross: A First Course in Probability, 6th Ed., Pearson Education India, 2002.
4. W. Feller, An Introduction to Probability Theory and its Applications, Vol. 1, 3rd Ed., Wiley, 1968.

Reference Books: -

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.
2. T.Veerarajan : Engineering Mathematics (for semester III), Tata McGraw-Hill, New Delhi.
3. R.K. Jain and S.R.K. Iyenger: Advance Engineering Mathematics; Narosa Publishing House, New Delhi.
4. J.N. Kapur: Mathematical Statistics; S. Chand & Sons Company Limited, New Delhi.
5. D.N.Elhance,V. Elhance & B.M. Aggarwal: Fundamentals of Statistics; Kitab Mahal Distributers, New Delhi.

MCSC -103	ADVANCED COMPUTER NETWORKS AND COMMUNICATION,	L 3	T 0	P 2	C 4
Prerequisite	None				

Course Content

1) telecommunications history; 2) telecommunications media (conducted and radiated); 3) transmission characteristics (including an introduction to coding and modulation techniques); 4) error characteristics, detection, and correction; 5) local and wide area networking applications, hardware, and software; 6) the OSI model; 7) industry standards; 8) topologies; 9) protocols; 10) internetworking devices; 11) communications management; 12) security and recovery; 13) information system applications; and 14) the selection of telecommunications and networking systems communication security, Digital signatures, authentication protocols. WLAN, Mobile IP. SNMP (V1 and V2)-Organizational model-System Overview, The information model, communication model-Functional model, SNMP proxy server. Broadband networks and services, ATM Technology, Configuration management, Fault management, performance management. Network Management Tools, Network Statistics Measurement Systems Web Based Management, XML Based Network Management

Lab: Programming protocol USING C/C++ and MATLAB and practicing theory.

Text Books:

1. Computer Networking: A Top-Down Approach, James F. Kuros and Keith W. Ross, Pearson, 6th Edition,2012
2. A Practical Guide to Advanced Networking , Jeffrey S. Beasley and Piyasat Nilkaew, Pearson, 3rd Edition,2012
3. Computer Networks , Andrew S. Tanenbaum, David J. Wetherall, Prentice, 5th Edition,2010

Reference Book:

1. Data Communication and Computer Networks, by Prakash C.Gupta, PHI.
2. Networking Ali-in-one Desk Reference by Doug Lowe, Wiley Dreamtech
3. Computer Network by Godbole, Tata McGraw Hill.
4. Computer Networking, by Stanford H. Rowe, Marsha L. Schuh

MCSC-104	Foundation of Machine Learning	L 3	T 0	P 2	C 4
Prerequisite	None				

Course Content

Foundations for ML: ML Techniques overview, Validation Techniques (Cross Validations), Feature Reduction/Dimensionality reduction, Principal components analysis (Eigen values, Eigen vectors, Orthogonality).

Regression: Regression basics: Relationship between attributes using Covariance and Correlation,

Relationship between multiple variables: Regression (Linear, Multivariate) in prediction. Multiple Linear Regression.

Clustering: Distance measures, Different clustering methods (Distance, Density, Hierarchical), Iterative distance-based clustering;

Classification: Naïve Bayes Classifier, Feature selection, K-Nearest Neighbours classifier, Support Vector Machines, Decision Trees, Ensembles methods : boosting and its impact on bias and variance

Text Books:-

1. Tom Mitchell, "Machine Learning", McGraw Hill, 1997
2. Ryszard S. Michalski, Jaime G. Carbonell, and Tom M. Mitchell, "Machine Learning: An Artificial Intelligence Approach", Tioga Publishing Company.

Reference Books:-

3. Trevor Hastie, Robert Tibshirani & Jerome Friedman, "The Elements of Statically Learning", Springer Verlag, 2001
4. William W Hsieh, "Machine Learning Methods in the Environmental Sciences, Neural Networks", Cambridge Univ Press.
5. Richard o. Duda, Peter E. Hart and David G. Stork, "Pattern classification", John Wiley & Sons Inc., 2001.
6. Chris Bishop, "Neural Networks for Pattern Recognition", Oxford University Press, 1995

MCSC-105	Discrete Mathematics and Graph Theory	L 3	T 0	P 0	C 3
Prerequisite	None				

Course Content

Basic counting principle: Pigeonhole principle, inclusion - exclusion principle, recurrence relations, generating functions. Fundamentals of logic, set theory, language, and finite state machines.

Undirected and direct graphs, modelling with graphs, trial and cycle- Eulerian trial and Hamilton cycle, connectivity and trees. Graph algorithms: BFS, DFS, shortest path, optimal spanning trees, matching, job assignment problem, optimal transportation through flows in networks.

Text Books

1. Discrete Mathematics and its Applications - Kenneth H. Rosen 7th Edition -Tata McGraw Hill Publishers - 2007 **(T1)**
2. Narsingh Deo: Graph Theory with Applications to Engineering and Computer Science, PHI, 1974 **(T2)**

Reference Books

3. Elements of Discrete Mathematics, C. L Liu, McGraw-Hill Inc, 1985. **(R1)**
4. Tremblay, J.P. and Manohar.R, " Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw Hill Pub. Co. Ltd, New Delhi, **(R2)**
5. B. Kolman and R.C. Busby: Discrete mathematical structures for computer science Prantice Hall, New-Delhi. **(R3)**
6. S. Malik and M. K. Sen: Discrete Mathematics, Cengage Learning India Pvt. Ltd. **(R4)**

MCSC-106	INDEPENDENT STUDY AND RESEARCH-1	L -	T -	P 1	C 1
Prerequisite	None				

SEMESTER-II

MCSC-201	The Internet Of Things	L 3	T 0	P 2	C 4
Prerequisite	None				

Course Content:

The IoT Networking: Technologies involved in IoT Development: Internet/Web and Networking, Sub-netting, Communication protocol, Network Topologies referred with Web, Introduction to Web Servers, Introduction to Cloud Computing IoT Platform overview of IoT supported Hardware platforms such as: Raspberry pi, ARM Cortex Processors, Arduino and Intel Galileo boards. Network Fundamentals: Overview and working principle of Wired Networking equipment's – Router, Switches, Overview and working principle of Wireless Networking equipment's – Access Points, Hubs etc. Linux Network configuration Concepts: Networking configurations in Linux Accessing Hardware & Device Files interactions. **IoT Architecture:** History of IoT, M2M – Machine to Machine, Web of Things, IoT protocols **Applications:** Remote Monitoring & Sensing, Remote Controlling, Performance Analysis, the Architecture, The Layering concepts, IoT Communication Pattern, IoT protocol Architecture, The 6LoWPAN Security aspects in IoT, IoT Application Development: Application Protocols MQTT, REST/HTTP, CoAP, MySQL Back-end Application Designing Apache for handling HTTP Requests, PHP & MySQL for data processing, MongoDB Object type Database, HTML, CSS & jQuery for UI Designing, JSON lib for data processing, Security & Privacy during development, Application Development for mobile Platforms: Overview of Android / IOS App Development tools, Case Study & advanced IoT Applications: IoT applications in home, infrastructures, buildings, security, Industries, Home appliances, other IoT electronic equipment's. Use of Big ata and Visualization in IoT, Industry 4.0 concepts. Agriculture, Healthcare, Activity Monitoring.

Lab: Programming and implementation on different sensor devices, gateways, radio, Arduino etc in C/Python practicing theory.

Text Books:-

1. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press, 2012.
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet ofThings", Springer, 2011.
3. David Easley and Jon Kleinberg, "Networks, Crowds, and Markets: Reasoning About a HighlyConnected World", Cambridge University Press, 2010.
4. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applicationsand Protocols", Wiley, 2012.

Reference Books:-

1. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)",1st Edition, VPT, 2014.
2. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to ConnectingEverything", 1st Edition, Apress Publications, 2013.
3. CunoPfister, Getting Started with the Internet of Things, O"Reilly Media, 2011, ISBN: 978-1-4493-9357-1

MCySC201	CRYPTOGRAPHY	L 3	T 0	P 1	C 4
Prerequisite	None				

Course Content:

History and overview of cryptography, identification protocols. Password protocols, salts, PBKDF2; one time passwords (S/Key and SecurID); challenge response authentication, One time pad and stream ciphers perfect secrecy and the one time pad, semantic security and stream ciphers, Block ciphers. Case studies: Feistel networks, DES, 3DES, and DES basic modes of operation: CBC and counter mode. Block cipher abstractions: PRPs and PRFs. Pseudo Random Permutations (PRP); Pseudo Random Functions (PRF); security against chosen plaintext attacks (CPA); nonce-based CBC encryption and nonce-based counter mode. Attacks on block ciphers exhaustive search, time-space trade-offs, differential & linear cryptanalysis, meet in the middle, side channels. Message integrity: definition and applications CBC-MAC and PMAC. Collision resistant hashing, Merkle-Damgard and Davies-Meyer. MACs from collision resistance. Elliptic key cryptography. Case studies: SHA and HMAC. Authenticated encryption: security against active attacks, intro to session setup using a key distribution canter (KDC). Cryptography using arithmetic modulo primes, vanilla key exchange (DiffieHellman); the CDH and discrete-log assumptions. Public key encryption semantically secure El Gamal encryption; CCA security. Arithmetic modulo composites. RSA and Rabin functions, how to encrypt with trapdoor permutations. Digital signatures: definitions and applications. How to sign using RSA. More signature schemes Lamport and Merkle schemes. Overview of signatures based on discrete-log certificates and trust management. Authenticated key exchange and SSL/TLS session setup, Zero knowledge protocols.

Lab: Programming and implementation of cipher, cryptographic algorithms and digital signatures in C/java and practicing theory.

Text Books:-

1. William Stallings, Cryptography and network security, Pearson Education.
2. Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone , Handbook of Applied Cryptography, CRC Press.
3. **Reference Books:-**
4. Margaret Cozzens, Steven J Miller, The mathematics of encryption, American Mathematical Society
5. Bruce Schneier Applied Cryptography, John Wiley and Sons 5. Mark Stamp, Information Security: Principles and Practice, John Wiley and Sons 6. Matt Bishop, Computer Security, Art and Science, Pearson Education
6. Oded Goldreich: Foundations of Cryptography Vol 1
7. Oded Goldreich: Foundations of Cryptography Vol 2
8. Cryptography: Theory and Practice by Douglas R. Stinson, CRC press.

MCySC-202	Fundamentals of Information Security & Practices	L 3	T 0	P 0	C 3
Prerequisite					

Course Content

Introduction to information security, need, scope, basic principles- CIAA , policies, procedures, Guidelines, Standards Administrative Measures and Technical Measures info sec culture, interpretation of info sec culture, dynamic organizational model, modeling the information sharing of organization. Standards available for infosec: Cobit, ISO 27001 Overview, Vulnerability, Threat and Risk, Risk Assessment and Mitigation + Quick fixes,

Introduction to HIPPA/PCI DSS/ BCP / DRP / ITIL. Segregation and Separation of Duties & Roles and responsibilities. Introduction to IT ACT 2000. Current trends in security, OWASP, OSSTMM SANS 2014 Trends That Will Reshape Organizational Security , issues of info security in Choose your own IT (CYOIT) , Increased virtualization and use of cloud and software-as a-service (SaaS) , Supply chain integrity worries ,The Internet of Things/Everything , Bitcoin currencies, Security Services, Security Mechanism , Security Attacks and explanation. Use of different information security models in emerging IT Technologies. Types of assessments for Information Security - VAPT of Networks; Assessment of Security Devices (Web Filtering, Firewalls, IDS / IPS, Routers; Data Center Assessment; Security of Application Software; SAP Security; Desktop Security; RDBMS Security. Use of information security for Nations defence. Computer Software and Intellectual Property-Objective, Copyright Protection, Reproducing, Defences, Patent Protection, Database and Data Protection-Objective, domain name and Intellectual Property, disputes under Intellectual Property Rights, Jurisdictional Issues, International Perspective.

Text Books: -

1. Malcolm Harkins, Managing Risk and Information Security, Apress, 2012.
2. Daniel Minoli, Information Technology Risk Management in Enterprise Environments, Wiley, 2009

Reference Books: -

1. Andy Jones, Debi Ashenden, Risk Management for Computer Security: Protecting Your Network & Information Assets, 1st Edition, Butterworth-heinemann, Elsevier, 2005.
2. Andreas Von Grebmer, Information and IT Risk Management in a Nutshell: A pragmatic approach to Information Security, 2008, Books On Demand Gmbh

MICTC-201	Mathematical Foundations for Computing in ICT	L 3	T 0	P 0	C 3
Prerequisite	None				

Course Content

Fundamental Concepts of Mathematics: Statements Connectives Truth Tables Normal forms Predicate calculus Inference Theory for Statement Calculus and Predicate Calculus automata theorem proving. Review of Permutation and Combination Proofs - Mathematical Induction - Pigeon hole principle - Principle of Inclusion and Exclusion - generating function - Recurrence relations. Semi goup - Monoid Groups- Cyclic group - Permutation group - Substructures - Homomorphism of semi group, monoid and groups - Cosets and Lagrange Theorem Normal Subgroups - Rings and Fields. Recursive functions - Primitive recursive functions - computable and non - computable functions. Partial order relation, posset Lattices. Discrete Structures: Modular Arithmetic, Graphs, Trees, State machines, Counting Analysis techniques based on counting methods and recurrence equations; Discrete Probability Theory; Application of these in Computer Science and algorithms.

Text Books:-

1. Trembly and Manohar, "Discrete mathematical structures with applications to Computer Science", Tata McGrawHill, 2002.
2. Kenneth H. Rosen, "Discrete mathematics and its applications", McGrawHill International Editions 1999.

Reference Books:-

1. Dr. M.K.Venkataraman.,Dr.N.Sridharan and N.Chandrasekaran, Discrete Mathematics,National Publishing Company,Chennai.of India(2004)
2. John E.Hopcroft,Rajeev Motwani,Jeffery D.Ullman, `` Introduction to Automata Theory, Languages and Computation ", Pearson Education, Asia, 2001.
3. John C.Martin, `` Introduction to Languages and the theory of Computation", Tata McGraw-Hill Publishing Company Limited,New Delhi.
4. http://www.research.ibm.com/haifa/dept/svt/papers/Mathematical_Logic.pdf
5. Mathematical Logic and its Application to Computer Science - Lecture Notes EitanFarchi, Ben-Chaim, March 3, 2010

MICTC-202	EMBEDDED SYSTEM	L 3	T 0	P 0	C 3
Prerequisite	None				

Course Content

Overview of Embedded System- Categories, Requirements , Challenges and Issues in Embedded Software Development, Applications. Hardware Architecture, Micro- Controller Architecture, Communication Interface Standards, Embedded System Development Process, Embedded Operating systems, Types of Embedded Operating systems. 8Bit microcontrollers Architecture on chip peripherals instruction set/ programming of Intel M CS51 family (8 bit) microcontroller, Inter facing of 8051 with LCD, ADC, sensors, stepper motor, key board, DAC, memory. Real Time & Database Applications: Real-Time Embedded Software Development, Sending a Message over a Serial Link, Simulation of a Process Control System, Controlling an Appliance from the RT Linux System, Embedded Database Applications using examples like Salary Survey, Energy Meter Readings. Microchip PIC16 family PIC16F873 processor features architecture memory organization register file map I/ O ports. Implementing Embedded Systems. Impact of VLSI technology on digital systems and architectures. A variety of applications of these architectures explored with emphasis on digital signal processing and other arithmetic intensive computations. Introduction to hierarchical structural design: IC design for parallel architecture: Use of pipelining and parallelism, self-synchronized designs, VLSI computing structures. Introduction to systolic arrays, mapping algorithms on systolic arrays, design of systolic arrays, system examples and design exercises. Circuits and DSP. architecture design: Fast filtering algorithms, retiming and pipelining, block processing, folding, distributed arithmetic architectures, VLSI performance measures (area, power, and speed), structural modelling in VHDL. DSP module synthesis: Arithmetic unit architectures (adders, multipliers, dividers), bit-parallel, bit-serial, digit-serial, carry-save architectures, redundant number system, modelling for synthesis in VHDL, synthesis via SYNOPSYS, place and route via CADENCE.

Text Books:-

1. Andrew N Sloss, Dominic Symes and Chris Wright, ARM system developers guide, Elsevier, Morgan Kaufman publishers, 2008.
2. Shibu K V, Introduction to Embedded Systems, Tata McGraw Hill Education, Private Limited, 2nd Edition.

Reference Books:-

1. Shibu K.V, Introduction to Embedded Systems, McGraw Hill.2014.
2. Jonathan W.Valvano, Embedded Microcomputer Systems Real Time Interfacing, Third Edition Cengage Learning, 2012.
3. Raj Kamal, Embedded Systems-Architecture,programming and design, 3 edition,TMH.2015.
4. Lyla, Embedded Systems, Pearson , 2013.
5. David E. Simon, An Embedded Software Primer, Pearson Education,2000.

MMLC-201	NEURAL NETWORKS AND EVOLUTIONARY ALGORITHMS	L 3	T 0	P 0	C 3
Prerequisite	None				

Course Content

Artificial Neural Networks: Biological neurons and its working. Simulation of biological neurons to problem solving. Different ANNs architectures. Training techniques for ANNs. Applications of ANNs to solve some real life problems. Fuzzy logic: Introduction to Fuzzy logic. Fuzzy sets and membership functions. Operations on Fuzzy sets. Fuzzy relations, rules, propositions, implications and inferences. Defuzzification techniques. Fuzzy logic controller design. Some applications of Fuzzy logic. Genetic Algorithms: Concept of Genetics and Evolution; and its application to probabilistic search techniques, Basic GA framework and different GA architectures. GA operators: Encoding, Crossover, Selection, Mutation. Solving single-objective optimization problems using GAs. Deep Learning: Deep Feed Forward network, Regularizations, Training deep models, dropouts, Convolutional Neural Network, Recurrent Neural Network, Deep Belief Network.

Text Books:-

1. S. Rajsekaran & G.A. Vijayalakshmi Pai, “Neural Networks,Fuzzy Logic and Genetic Algorithm:Synthesis and Applications” Prentice Hall of India.
2. Timothy J. Ross, “Fuzzy Logic with Engineering Applications” Wiley India.

Reference Books:-

3. N.P.Padhy,”Artificial Intelligence and Intelligent Systems” Oxford University Press. Reference Books.
4. S.Haykin, Neural Networks – A Comprehensive Foundation, Prentice Hall.
5. Neural Networks and Fuzzy Logic System by Bart Kosko, PHI Publications.
6. Fuzzy Sets, Fuzzy Logic, and Fuzzy Systems by Lotfi A. Zadeh.
7. Bose, Neural Network fundamental with Graph , Algo.&Appl, TMH.

MMLC-202	Pattern Recognition	L 3	T 0	P 2	C 4
Prerequisite					

Course Content

Introduction, Algorithmic models of learning, Learning classifiers, functions, relations, grammars, probabilistic models, value functions, behaviors and programs from experience. Bayesian, maximum a posteriori, and minimum description length frameworks. Parameter estimation, sufficient statistics, decision trees, neural networks, support vector machines, Bayesian networks, bag of words classifiers, N-gram models; Markov and Hidden Markov models, probabilistic relational models, association rules, nearest neighbor classifiers, locally weighted regression, ensemble classifiers. Computational learning theory, mistake bound analysis, sample complexity analysis, VC dimension, Occam learning, accuracy and confidence boosting. Dimensionality reduction, feature selection and visualization. Clustering, mixture models, k-means clustering, hierarchical clustering, distributional clustering. Reinforcement learning; Learning from heterogeneous, distributed, data and knowledge. Selected applications in data mining, automated knowledge acquisition, pattern recognition, program synthesis, text and language processing, internet-based information systems, human-computer interaction, semantic web, and bioinformatics and computational biology.

Text Books: -

1. Richard O. Duda, Peter E. Hart, David G. Stork, “Pattern Classification”, John Wiley publication, 2nd edition, 2001.
2. Tou. Rafael. Gonzalez. “Pattern Recognition Principle”, Pearson Education.

Reference Books: -

6. Robert Schalkoff, “Pattern Recognition: Statistical, Structural and Neural Approaches”, John Wiley & Sons, Inc.1992.

7. Digital Image Processing, M. Anji Reddy, Y. Hari Shankar, BS Publications.

MCSE-201	Introduction to Formal Methods and Verification of Large Systems	L	T	P	C
		3	0	0	3
Prerequisite	None				

Course Content:-

Process algebras and concurrent systems: Reactive systems, Formal methods for reactive systems, Labelled transition systems, Operational semantics for concurrent processes, Operators for process modelling, Pi-calculus. Behavioural equivalences and proof techniques: Bisimulation, Induction and co-induction proofs, Induction as a fixed point technique, Weak bisimulation, Weak bisimulations "upto", Bisimulation in concurrency, Other equivalences such as failure equivalence, testing, testing equivalence. Type systems: Revisit to Pi-calculus, Simply typed Pi-calculus, Input output types, Linear types, Session types. Model checking: Finite state model checking, Symbolic model checking, Probabilistic model checking, Real time model checking, Optimal scheduling using model checking. Stochastic modelling: Foundation, Quantitative modelling, Markovian methods, PEPA as case study. Experimental practice on mobility workbench (MBW), concurrency workbench (CWB-NC), CTMC.

Text Books:-

1. Robin Milner: Communicating and mobile systems: The π-Calculus,Cambridge University Press, 1999
2. Matthew Hennessy: A distributed Pi-Calculus, Cambridge University Press, 2007

Reference Books:-

1. Davide Sangiorgi and David Walker: The π -Calculus: A theory of Mobile Processes, Cambridge University Press, 2001
2. Ed Clarke, Orna Grumberg, Doron Peled : Model Checking, MIT Press, 1999
3. B. Berard, M Bidoit, A. Finkel, F. Laroussinie, A. Petit, L. Petrucci, P. Schnobelen : Systems and software verification, Springer, 2001
4. L. Aceto, A. Ingolfsdottir, K. G. Larsen, J. Srba : Reactive systems: Modelling,specification and verification, Cambridge University Press, 2007
5. Manuals of MBW, CWB-NC,CTMC.

MCySE-201	Security Standards & Project Management	L 3	T 0	P 0	C 3
Prerequisite	None				

Course Content

Introduction, design goals, role and security architecture relationship to information security, incident management and IT auditing processes; security risk management; legal and ethical issues of security and privacy .Trusted computing base, protection measures of trusted computing base, system security assurance concepts, confidentiality and integrity models, security risk management process, data classification, regulatory requirements, web services. What is information security management (ISM) , Why ISM is important to an organization , What are the benefits of ISM, What is the background of ISM ,What are the key concepts and principles in ISO/IEC 27001:2013 , The terms and definitions used, The main requirements of ISO/IEC 27001:2013, COBIT , ITIL, PCI DSS,HIPPA.

Text Books:-

1. Bob Hughes and Mike Cotterell, Software Project Management, Tata McGraw Hill (2009)
2. Roger Pressman, A practitioner's Guide to Software Engineering, Tata McGraw Hill (2014)

Reference Books:-

1. Head First PMP: A Brain Friendly Guide To Passing The Project Management Professional Exam (2013)
2. Royce, "Software Project Management", Pearson Education, 1999.
3. Robert K. Wysocki, Effective Software Project Management, Wiley, 2009.

MCySE-202	System Security	L	T	P	C
		3	0	0	3
Prerequisite	None				

Course Content

Introduction to Database Security Issues, Types of Security, Database Security and DBA, Access Protection, User Accounts, and Database Audits. Introduction to Access Control, Purpose and fundamentals of access control, brief history, Policies of Access Control, Models of Access Control, and Mechanisms, Discretionary Access Control(DAC), NonDiscretionary Access Control , Mandatory Access Control (MAC). Capabilities and Limitations of Access Control Mechanisms: Access Control List (ACL) and Limitations, Capability List and Limitations, Role-Based Access Control (RBAC) and Limitations, Core RBAC, Hierarchical RBAC, Statically Constrained RBAC, Dynamically Constrained RBAC, Limitations of RBAC. Comparing Discretionary Access Control and Mandatory Access Control, Role-Based Access Control , Access Control Policies for E-Commerce and the Web, Introduction to Statistical Database Security, Introduction to Flow Control, Covert Channels. Concept of Trusted system and multilevel security model as : Bell lapadula model ,Biba‟s intrigity model, Clark-Wilson model, Domain type enforcement model, , mapping the enterprise view to the system view, RBAC for UNIX and JAVA environments Case study: Multiline Insurance Company. Database vulnerability and attack: SQL Injection, and security mechanisms : Advanced Encryption Standards, Public Key Encryption , Digital Signatures , Dabase auditing : Data Control Language (DCL) activities, Data Definition Language (DDL) activities, and Data Manipulation Language (DML). Smart card operating system-fundamentals, design and implantation principles, memory organization, smart card files, file management, atomic operation, smart card data transmission ATR,PPS Security techniques-user identification , smart card security, quality assurance and testing, smart card life cycle-5 phases, smart card terminals.

Text Books:-

1. William Stallings, Network Security Essentials: Applications and Standards, Prentice Hall, 4th edition, 2010.
2. Michael T. Goodrich and Roberto Tamassia, Introduction to Computer Security, Addison Wesley, 2011.

Reference Books:-

1. William Stallings, Network Security Essentials: Applications and Standards, Prentice Hall, 4th edition, 2010.
2. Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone, Handbook of Applied Cryptography, CRC Press, 2001.

MCySE-204	Ethical Hacking	L 3	T 0	P 0	C 3
Prerequisite	None				

Course Content

Computer network and defense fundamentals, Network security threats, vulnerabilities, and attacks. Overview of the Top 20 OWASP Security vulnerabilities. CVSS
Scoring system including VAPT techniques, Network security controls, protocols, and devices, Network security policy design and implementation, Physical security, Host security, Secure firewall configuration and management, Secure IDS configuration and
management, Secure VPN configuration and management, Wireless network defense, Network traffic monitoring and analysis, Network risk and vulnerability management, Data
backup and recovery, Network incident response and management , ethical hacking, Foot
printing and reconnaissance, Scanning networks, Enumeration, Sniffing, System hacking, Malware threats, Social engineering, Denial of service, Session hijacking, Hacking web
applications, SQL injection, Hacking wireless networks, Hacking web servers, Hacking
mobile platforms, Evading IDS, Firewalls, and Honeypot.

Text Books:-

James S. Tiller, "The Ethical Hack: A Framework for Business Value Penetration Testing", Auerbach Publications, CRC Press

Reference Books:-

- EC-Council, "Ethical Hacking and Countermeasures Attack Phases", Cengage Learning
- Michael Simpson, Kent Backman, James Corley, "Hands-On Ethical Hacking and Network Defense", Cengage Learnin

MCySE-203	IDENTITY AND ACCESS MANAGEMENT & TRUSTED COMPUTING	L	T	P	C
		3	0	0	3
Prerequisite	None				

Course Content

Identity and access management (IAM) overview , Attributes of information security, Symmetric and asymmetric cryptography ,Hashing and digital signature,Key management, Public Key Infrastructure (PKI) Architecture: certification and registration authority, Life cycle management, Types of certificates and usage patterns Encryption, Digital signature, Client certificate,SSL server certificate, Attribute based certificate, Case studies (e.g. email protection, mobile banking, and document signing), Identification verification and authentication overview, Mechanisms of identification and authentication -One time password, Biometric, Digital signature, Smartcard, Soft/hard tokens, Mobile device, Risk based authentication, Step-up authentication, Single-sign on and federated single-sign-on,OATH, OpenID, BorwserID, and SAML, Architecture framework and industrial tools, Trusted computing role in identity assurance, Security risks associated with the discussed mechanisms Access control , Principles of authorization , Access control schemes , OAuth protocol, Enterprise rights management and digital rights management, Privileged account management , Governance and compliance . IAM framework and use cases, IAM architecture framework, IAM echo system, IAM and cloud computing, Illustrative use cases - Border control, E-passport, National ID, E-banking, E-health system and EMV scheme

	INFORMATION THEORY AND CODING	L	T	P	C
		3	0	0	3
Prerequisite	None				

Course Content

Entropy, mutual information, channel capacity, information rate, Shannon's noiseless coding theorem and Shannon's fundamental coding theorem; modelling of information sources zero memory and Markov models; modelling of information channels--BSC and BEC channels, additivity of information and cascaded channels; construction of compact source codes--Kraft inequality, compact codes, Huffman and Shannon Fano compression codes; and analysis and design of error control channel codes--Hamming distance, binary linear codes and the parity-check matrix, Hamming codes, checksum codes, cyclic codes and the generator polynomial and CRC codes, convolutional codes, Viterbi and other decoding algorithms.

Text Books:-

1. T. M. Cover, J. A. Thomas, Elements of Information Theory, Wiley.
2. R. Togneri, C.J.S deSilva, Fundamentals of Information Theory and Coding Design, Taylor and Francis.

Reference Books:-

3. R. J. McEliece, The Theory of Information and Coding, Cambridge Uinversity Press.
4. R. Bose, Information Theory Coding and Cryptography, Tata McGraw Hill.
5. J. A. Thomas and T. M. Cover: Elements of information theory, Wiley, 2006.
6. J. H. van Lint: Introduction to Coding Theory, Third Edition, Springer, 1998.
7. F. J. MacWilliams and N.J. Sloane: Theory of Error Correcting Codes, Parts I and II, North-Holland, Amsterdam, 1977.
8. D. Stinson: Combinatorial Designs: Constructions and Analysis, Springer, 2003.

MICTE-202	SPEECH COMMUNICATION AND BIOMEDICAL SIGNAL PROCESSING	L	T	P	C
		3	0	0	3
Prerequisite	None				

Course Content

The Speech Production mechanism. Physiological and Mathematical Model. Relating the physiological and mathematical model. Categorization of Speech Sounds based on the source-system and the articulatory model. Basic Speech Signal Processing Concepts. Discrete time speech signals, relevant properties of the fast Fourier transform and Z-transform for speech recognition, convolution, linear and non linear filter banks. Spectral estimation of speech using the Discrete Fourier transform. Pole-zero modelling of speech and linear prediction (LP) analysis of speech. Homomorphic speech signal de convolution, real and complex cepstrum. The Speech Recognition Front End. Feature extraction for speech recognition, Static and dynamic features for speech recognition, robustness issues, discrimination in the feature space, feature selection. Mel frequency cepstral co-efficients (MFCC), Linear prediction cepstral coefficients (LPCC), Perceptual LPCC. Distance measures for comparing speech patterns. Log spectral distance, cepstral distances, weighted cepstral distances, distances for linear and warped scales Vector quantization 12 models and applications in speaker recognition. Gaussian mixture modelling for speaker and speech recognition. Discrete and Continuous Hidden Markov modelling for isolated word and continuous speech recognition. Using the HTK toolkit for building a simple speech recognition system. Biomedical Signals and Images ECG: Cardiac electrophysiology, relation of electrocardiogram (ECG) components to cardiac events, clinical applications. Guest lecture. Speech Signals: The source-filter model of speech production, spectrographic analysis of speech. Speech Coding: Analysis-synthesis systems, channel vocoders, linear prediction of speech, linear prediction vocoders. Imaging Modalities: Survey of major modalities for medical imaging: ultrasound, X-ray, CT, MRI, PET, and SPECT.MRI: Physics and signal processing for magnetic resonance imaging. Fundamentals of Deterministic Signal and Image Processing. Data Acquisition: Sampling in time, aliasing, interpolation, and quantization. Digital Filtering: Difference equations, FIR and IIR filters, basic properties of discrete-time systems, convolution. DTFT: The discrete-time Fourier transform and its properties. FIR filter design using windows. DFT: The discrete Fourier transform and its properties, the fast Fourier transform (FFT), the overlap-save algorithm, digital filtering of continuous-time signals. Sampling Revisited: Sampling and aliasing in time and frequency, spectral analysis. Image processing, I: Extension of filtering and Fourier methods to 2-D signals and systems. Image processing II: Interpolation, noise reduction methods, edge detection, homomorphic filtering. Probability and Random Signals PDFs: Introduction to random variables and probability density functions (PDFs). Classification: Bayes' rule, detection, statistical classification. Random signals I: Time averages, ensemble averages, auto-correlation functions, cross correlation functions. Random signals II: Random signals and linear systems, power spectra, cross spectra, Wiener filters. Blind

source separation: Use of principal component analysis (PCA) and independent component analysis (ICA) for filtering.

MCSE-202	DATA SCIENCE	L 3	T 0	P 0	C 3
Prerequisite	None				

Course Content

Data Science: Statistical Thinking, Examples, Numerical Data, Summary Statistics, From Population to Sampled Data, Different Types of Biases, Probability, Statistical Inference. Association and Dependence , Association and Causation ,Conditional Probability and Bayes Rule, Simpsons Paradox, Confounding ,Introduction to Linear Regression, Special Regression Models ,Exploratory Data Analysis and Visualization-Goals ,Graphs of Data, Graphs of Fitted Models, Graphs to Check Fitted Models, Principles of graphics. Apply basic machine learning algorithms (Linear Regression, k-Nearest Neighbors (k-NN), k-means, Naive Bayes) for predictive modeling. Bayesian Modeling-Bayesian inference: combining models and data in a forecasting problem, Bayesian hierarchical modeling for studying public opinion, Bayesian modeling for Big Data.

Text Books:-

1. Introducing Data Science, Davy Cielen, Arno D. B. Meysman, Mohamed Ali, Manning Publications Co., 1st edition, 2016.
2. Ethics and Data Science, D J Patil, Hilary Mason, Mike Loukides, O' Reilly, 1st edition, 2018.

Reference Books:-

3. Data Science from Scratch: First Principles with Python, Joel Grus, O'Reilly, 1st edition, 2015.
4. Doing Data Science, Straight Talk from the Frontline, Cathy O'Neil, Rachel Schutt, O' Reilly, 1st edition, 2013.
5. Mining of Massive Datasets, Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, Cambridge University Press, 2nd edition, 2014.

MCSE-203	COMPUTER VISION	L 2	T 0	P 1	C 3
Prerequisite	None				

Course Content

Digital Image Formation and low-level processing: Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing. Feature Extraction: Edges -Canny, LOG, DOG; Line detectors (Hough Transform), Corners-Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space. Analysis-Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT. Image Segmentation: Region Growing, Edge Based approaches to segmentation, Mean- Shift, Texture Segmentation; Object detection. Pattern Analysis: Clustering: K-Means, K-Medoids, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA. Motion Analysis: Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation.

Lab: Tools for Image Processing and Computer Vision, OpenCV, Histograms, gray level slicing, bit plane slicing, morphological operations, machine learning algorithms, image segmentation, object detection

Text Books:-

1. Rafael C. Gonzalez and Richard E. Woods, “Digital Image Processing”, Pearson Education, Third edition, 2009.
2. Milan Sonka, Vaclav Hlavac and Roger Boyle, “Image Processing, Analysis and MachineVision”, Third Edition, CL Engineering, 2013.

Reference Books:-

3. Justin Solomon, “Mathematical Methods for Computer Vision, Robotics, and Graphics”, Stanford University, 2013.
4. Christopher M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006.
5. Anil K. Jain, “Fundamentals of Digital Image Processing”, Pearson Edition, 2001.
6. S. Jayaraman and others, “Digital Image Processing”.

MMLE-201	BIG DATA ANALYTICS	L 3	T 0	P 0	C 3
Prerequisite	None				

Course Content

Big Data introduction - Big data: definition and taxonomy - Big data value for the enterprise - Setting up the demo environment - First steps with the Hadoop "ecosystem" The Hadoop ecosystem - Introduction to Hadoop - Hadoop components: MapReduce/Pig/Hive/HBase - Loading data into Hadoop - Handling files in Hadoop - Getting data from Hadoop Querying big data with Hive - Introduction to the SQL Language - From SQL to HiveQL, Querying big data with Hive - Introduction to HIVE e HIVEQL - Using Hive to query Hadoop files Big data & Machine learning - Quick into to Machine learning - Big Data & Machine Learning - Machine learning tools - Spark & SparkML , H2O , Azure ML.

Text Books:-

1. Tom White "Hadoop: The Definitive Guide" Third Edition, O'reilly Media, 2012.
2. Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, Paul Zikopoulos,"Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data", McGrawHill Publishing, 2012.

Reference Books:-

3. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
4. Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", CUP, 2012.
5. Da Ruan, Guoquing Chen, Etienne E.Kerre, Geert Wets, "Intelligent Data Mining", Springer, 2007.
6. Jiawei Han, Micheline Kamber "Data Mining Concepts and Techniques", 2nd Edition, Elsevier, Reprinted 2008.
7. Pete Warden, "Big Data Glossary", O'Reilly, 2011.

MMLE-202	OPTIMIZATION TECHNIQUES	L 3	T 0	P 0	C 3
Prerequisite	None				

Course Content

Mathematical preliminaries, Linear algebra and matrices, Vector space, eigen analysis, Elements of probability theory, Elementary multivariable calculus, Linear Programming, Introduction to linear programming model, Simplex method, Duality, Karmarkar's method, Unconstrained optimization, One-dimensional search methods, Gradient-based methods, Conjugate direction and quasi-Newton methods, Constrained Optimization, Lagrange theorem, FONC, SONC, and SOSC 14 conditions, Non-linear problems, Non-linear constrained optimization models, KKT conditions, Projection methods

Text Books:-

1. Rao S. S. - 'Engineering Optimization, Theory and Practice' - New Age International Publishers - 2012 - 4th Edition
2. G. Hadley, "Linear programming", Narosa Publishing House, New Delhi, 1990.

Reference Books:-

3. Deb K. - 'Optimization for Engineering Design Algorithms and Examples' – PHI – 2000.
4. Arora J. - 'Introduction to Optimization Design' - Elsevier Academic Press, New Delhi – 2004.
5. Saravanan R. - 'Manufacturing Optimization through Intelligent Techniques' - Taylor & Francis (CRC Press) – 2006.
6. Hardley G. -'Linear Programming' - Narosa Book Distributors Private Ltd. - 2002

MMLE- 203	PROBABILISTIC GRAPHICAL MODEL	L 3	T 0	P 0	C 3
Prerequisite	None				

Course Content

Fundamentals: Fundamentals of Probability Theory - Views of Probability, Random Variables and Joint Distributions, Conditional Probability, Conditional Independence, Expectation and Variance, Probability Distributions - Conjugate Priors, Introduction to Exponential Family; Fundamentals of Graph Theory - Paths, Cliques, Subgraphs, Cycles and Loops.

Graphical Models: Introduction - Directed Models (Bayesian Network), Undirected Models (Markov Random Fields), Dynamic Models (Hidden Markov Model & Kalman Filters) and Factor Graph; Conditional Independence (Bayes Ball Theorem and D-separation), Markov Blanket, Factorization (Hammersley-Clifford Theorem),

Equivalence (I-Maps & Perfect Maps); Factor Graphs - Representation, Relation to Bayesian Network and Markov Random Field.

Inference in graphical models: Exact Inference - Variable Elimination, Elimination Orderings, Relation to Dynamic Programming, Dealing with Evidence, Forward-Backward Algorithm, Viterbi Algorithm; Junction Tree Algorithm; Belief Propagation (Sum Product); Approximate Inference - Variational Methods (Mean Field, Kikuchi & 13 Bethe Approximation), Expectation Propagation, Gaussian Belief Propagation; MAP Inference - Max-Product, Graph Cuts, Linear Programming Relaxations to MAP (Tree-Reweighted Belief Propagation, MPLP); Sampling - Markov Chain Monte Carlo, Metropolis Hastings, Gibbs (Collapsing & Blocking), Particle filtering.

Learning in Graphical Models: Parameter Estimation - Expectation Maximization, Maximum Likelihood Estimation, Maximum Entropy, Pseudolikelihood, Bayesian Estimation, Conditional Likelihood, Structured Prediction; Learning with Approximate Inference; Learning with Latent Variables; Structure Learning, Structure Search, L1 priors.

Text Books:-

1. Probabilistic Graphical Models: Principles and Techniques, Daphne Koller and Nir Friedman, MIT Press, 2009.

Reference Books:-

2. Kevin Murphy, Machine Learning - A Probabilistic Perspective (Adaptive Computation and Machine Learning Series) MIT Press
3. Kiran Karkal, Building Probabilistic Graphical Models with Python - Packt Publishing
4. Peter Flach, “Machine Learning: The Art and Science of Algorithms that Make Sense of Data”, First Edition, Cambridge University Press, 2012.
5. Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series,2014.

MCSC-202	INDEPENDENT STUDY AND RESEARCH-2	L -	T -	P 1	C 1
Prerequisite	None				

SEMESTER-III

MCSC-301	Research Methodology	L 3	T 0	P 0	C 3
Prerequisite	None				

Course Content

1. Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method - Understanding the language of research - Concept, Construct, Definition, Variable. Research Process 2. Problem Identification & Formulation -Research Question - Investigation Question- Measurement Issues - Hypothesis - Qualities of a good Hypothesis -Null Hypothesis & Alternative Hypothesis. Hypothesis Testing - Logic & Importance 3. Research Design: Concept and Importance in Research - Features of a good research design - Exploratory Research Design - concept, types and uses, Descriptive Research Designs - concept, types and uses. Experimental Design: Concept of Independent & Dependent variables. 4. Qualitative and Quantitative Research: Qualitative research - Quantitative research - Concept of measurement, causality, generalization, replication. Merging the two approaches. 5. Measurement: Concept of measurement- what is measured? Problems in measurement in research - Validity and Reliability. Levels of measurement - Nominal, Ordinal, Interval, Ratio. 6. Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample - Practical considerations in sampling and sample size. 7. Data Analysis: Data Preparation -Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis - Cross tabulations and Chi-square test including testing hypothesis of association. 8. Interpretation of Data and Paper Writing - Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism. 9. Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline. 10. Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism.

Text Books: -

1. C. R. Kothari, Gaurav Garg, Research Methodology Methods and Techniques , New Age International publishers, Third Edition.
2. Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, 2nd Edition, SAGE, 2005).

Reference Books: -

3. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
4. Creswell, John W. Research design: Qualitative, quantitative, and mixed methods approaches. Sage publications, 2013.

MCySC301	DIGITAL AND CYBER FORENSICS	L 3	T 0	P 0	C 3
Prerequisite	None				

Course Content

Computer forensics in today's world • Computer forensics investigation process, Data Acquisition and Duplication • Understanding hard disks and file systems • Defeating anti-forensics techniques • Operating system forensics • Network forensics • Investigating web attacks • Database forensics • Cloud forensics • Malware forensics • Investigating email crimes • Mobile forensics process , Mobile OS architecture, boot process, and file systems , Mobile threats and security • Forensics report writing and presentation , encryption and stenography analysis. **Investigation process:** legal process of investigation, jurisdiction and agencies, internet investigation, IP address and domain names, investigation method, evidence collection. **Legal Issues:** Constitutional law, search and seizure guidelines, ECPA, challenges in process, international computer crime law.

Text Books:-

1. Nina Godbole and SunitBelapore; "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley Publications, 2011.
2. Shon Harris, "All in One CISSP, Exam Guide Sixth Edition", McGraw Hill, 2013.
3. Jon Erickson , "Hacking: The Art of Exploitation", 2nd Edition, No Starch Press, 2008.
4. Mike Shema, "Hacking Web Apps: Detecting and Preventing Web Application SecurityProblems", First edition, Syngress Publishing, 2012
5. Bill Nelson, Amelia Phillips and Christopher Steuart; "Guide to Computer Forensics and Investigations" – 3rd Edition, Cengage, 2010 BBS
6. Pavan Duggal; "Cyber Law – The Indian Perspective", Saakshar LawPublications.

Reference Books:-

1. Digital Forensics and Cyber Crime: 7th International Conference, ICDF2C 2015, Seoul, South Korea, October 6-8, 2015
2. William Stallings, Cryptography and network security, Pearson Education.
3. National Security and Counterintelligence in the Era of Cyber Espionage (Advances in Digital Crime, Forensics, and Cyber Terrorism) by Eugenie de Silva
4. Alfred J. Menezes, Paul. C. Van Oorschot, and Scott A. Vanstone "Handbook of Applied Cryptography", CRC press, Lib of Congress -2006

MICTC-301	MULTIMEDIA SIGNAL PROCESSING	L 3	T 0	P 0	C 3
Prerequisite	None				

Course Content

Discrete-time signals and systems, Constant coefficient difference equation. Review of Z Transform: properties, R.O.C, stability and Causality criterion. Structures for digital filters. DTFT and DFT: properties, linear and circular convolution. FFT: Decimation in time & Decimation in frequency. Design of IIR Filters: Bilinear transformation, Impulse invariant transformation. Butterworth, Chebychev, Inverse Chebychev and Elliptical filters etc. Design of F.I.R filters by windowing: rectangular, Bartlett, Hann, Hamming, Kaiser Window filters, Design method, Relationship of Kaiser to other windows. Application of MATLAB for design of digital filters. Advanced signal processing techniques: Multi-rate Signal processing down sampling/up sampling. 19 Representation of deterministic signals: Orthogonal representation of signals. Dimensionality of signal spaces. Construction of orthogonal basis functions. Time-bandwidth relationship: RMS duration and bandwidth, uncertainty relations. Random variables: Distribution and density functions, some special random variables, Conditional distributions and total probability. Functions of one random variable: Mean, variance, Moments, Characteristic functions. Functions of two random variables: Moments and joint distributions, Conditional distributions, Conditional expected values, Mean square estimation. Random Processes: Definition and classification, stochastic integrals, Fourier transforms of random processes, stationary and nonstationary processes, correlation functions. Ergodicity, power spectral density, transformations of random processes by linear systems. Representation of random processes (via sampling, K-L expansion and narrow band representations).

Text Books:-

1. Introduction to Multimedia and its applications, V. K. Jain, 1st edition, 2012, Khanna Book Publishing.
2. Multimedia Signal Processing: Theory and Applications in Speech, Music and Communications, Saeed V. Vaseghi, 2007, Wiley.

Reference Books:-

4. Introduction to Data Compression, Khalid Sayood, 3rd edition, 2005, Morgan Kauffman Harcourt India.
5. Multimedia Communications: Applications, Networks, Protocols and Standards, Fred Halsall, 2 nd edition, 2002, Pearson.
6. Multimedia Image and Video Processing, Ling Guan, Yifeng He, Sun-Yuan Kung, 2nd edition, 2017, Kindle.
7. Multimedia Information Networking, Nalin K. Sharda, 2003, PHI.
8. Multimedia Fundamentals: Vol 1 - Media Coding and Content Processing, Ralf Steinmetz, Klara Narstedt, 2004, Pearson Education.

MMLC-301	Deep Learning	L 3	T 0	P 0	C 3
Prerequisite	Neural Networks and Evolutionary Algorithms				

Course Content

Course overview: What is deep learning? DL successes; Gradient descent, logistic regression, Probability, continuous and discrete distributions; maximum-likelihood;

Intro to neural networks: cost functions, hypotheses and tasks; training data; maximum-likelihood based cost, cross entropy, MSE cost; feed-forward networks; MLP, sigmoid units; neuroscience inspiration; Learning in neural networks: output vs hidden layers; linear vs nonlinear networks;

Back propagation: learning via gradient descent; recursive chain rule (back propagation), bias-variance trade-off, regularization; output units: linear, Softmax; hidden units: tanh, RELU;

Deep learning strategies (GPU training, regularization, RLUs, dropout, etc.); Transfer Learning; Deep Learning Models: Convolutional neural networks, Deep Belief Nets and its variants, recurrent neural networks, unsupervised deep learning: auto encoders, deep generative models.

Text Books:-

1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016..
2. Bishop, C. ,M., Pattern Recognition and Machine Learning, Springer, 2006.

Reference Books:-

3. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
4. Golub, G.,H., and Van Loan,C.,F., Matrix Computations, JHU Press,2013.
5. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.

MCSE -301	CLOUD COMPUTING	L 3	T 0	P 0	C 3
Prerequisite	None				

Course Content

Introduction , Cloud Computing Architecture - Cloud Reference Model, Types of Clouds, Cloud Interoperability & Standards, Scalability and Fault Tolerance, **Cloud Solutions:** Cloud Ecosystem, Cloud Business Process Management, Cloud Service Management. **Cloud Offerings**: Cloud Analytics, Testing Under Control, Virtual Desktop Infrastructure. **Cloud Management & Virtualization Technology:** Resiliency, Provisioning, Asset management, Concepts of Map reduce, Cloud Governance, High Availability and Disaster Recovery. **Virtualization**: Fundamental concepts of compute, storage, networking, desktop and application virtualization. Virtualization benefits, server virtualization, Block and file level. Storage virtualization Hypervisor management software, Infrastructure Requirements, Virtual LAN (VLAN) and Virtual SAN (VSAN) and their benefits. **Cloud Security**: Cloud Information security fundamentals, Cloud security services, Design principles, Secure Cloud Software Requirements, Policy Implementation, Cloud Computing Security Challenges, Virtualization security Management, Cloud Computing Security Architecture. Market Based Management of Clouds, Federated Clouds/Inter Cloud: Characterization & Definition, Cloud Federation Stack, Third Party Cloud Services. Case study: Google App Engine, Microsoft Azure, Hadoop, Amazon, Aneka. Performance, scalability and consistency on Clouds.

Text Books:-

1. Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010.
2. Mastering Cloud Computing - Raj Kumar Buyya, Christian Vecchiola and S. Tanurai Selvi (TMH), 2012.
3. Cloud Computing for Dummies - Judith Hurwitz, R. Bloor, M. Kanfman, F. Halper (Wiley India Edition).
4. Distributed and Cloud Computing - Kaittwang Geoffrey C. Fox and Jack J Dongrra (Elsevier India) 2012

Reference Books:-

5. Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate - Michael Miller (Que Publishing), Online, August 2008
6. Cloud Computing – Insights into New Era Infrastructure - Kumar Saurabh (Wiley Indian Edition), 2011
7. Cloud Computing Best Practices for Managing and Measuring Processes for On-demand Computing, Applications and Data Centers in the Cloud with SLAs-Haley Beard (Emereo Pvt. Limited), July 2008.

MCySE -304	MEDIA SECURITY	L 3	T 0	P 0	C 3
Prerequisite	None				

Course Content

Mathematical Preliminaries: Discrete Fourier Transform (DFT), Discrete Cosine Transform, Random Sequence Generation, The Chaotic Map, Error Correction Code, Set Partitioning in Hierarchical Tree. Introduction to Multimedia Security, Brief history and applications of Information Security, Fundamentals of Information Security, Basics of Digital Imaging and Digital Audio, Introduction to Cryptography, Introduction to Digital Watermarking; Multimedia Security, Introduction to Digital Rights Management (DRM)Multimedia Encryption, Classical Cryptography, Symmetric Encryption, Hash Functions, Message Authentication Codes, Asymmetric Encryption, Digital Signatures, Overview of Advanced Encryption Standard (AES); Block and stream ciphers; Information theoretic secrecy. Principles for selective encryption; Image and Video encryption schemes: Chaotic maps, Transform domain encryption, Huffman tree mutation, Steganography; Steganalysis, Introduction to Steganography, Steganalysis Schemes, JPEG Steganography: LSB Embedding in DCT Coefficients (JSteg), Detecting JSteg with Histograms, patching up the histograms with Outguess, Hamming Codes and Syndrome Coding, Matrix Embedding and Wet Paper Codes, chi square test, Steganalysis: Sample Pair Analysis, Digital Watermarking, Introduction to digital watermarking, Models of Watermarking, Basic Message Coding, Error Correction, Coding, Mutual Information and Channel Capacity, How to Design a Good Digital Watermark, Digital, Watermarking Schemes, Digital Watermarking: Protocol, Video Watermarking, Audio Watermarking, Binary Image Watermarking, Introduction to Digital Right Management Product & Laws, Introduction to DRM Products, Introduction to DRM Laws, Fingerprinting; Digital Forensics, Data Sanitization; Privacy Preserving Surveillance.

Text Books: -

1. William Stallings, Cryptography and network security, Pearson Education.
2. Fundamentals of Media Security by WeiQi Yan, Jonathan Weir
3. Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone, Handbook of Applied Cryptography, CRC Press.

Reference Books:

4. Michael Cross, "Social Media Security" eBook ISBN: 9781597499873, Paperback ISBN: 9781597499866, 2013.
5. Margaret Cozzens, Steven J Miller, The mathematics of encryption, American Mathematical Society.
6. Bruce Schneier Applied Cryptography, John Wiley and Sons 5. Mark Stamp, Information Security: Principles and Practice, John Wiley and Sons 6. Matt Bishop, Computer Security, Art and Science, Pearson Education.
7. Oded Goldreich: Foundations of Cryptography Vol 1 6.
8. Oded Goldreich: Foundations of Cryptography Vol 2 7.
9. Cryptography: Theory and Practice by Douglas R. Stinson, CRC press.

MCySE-301	NETWORK PROTOCOL SECURITY	L 3	T 0	P 0	C 3
Prerequisite	System Security				

Course Content

Understand Security Issues Related to Networks- OSI and TCP/IP Models, Internet Protocol (IP) Networking, Network Topographies and Relationship, Commonly Used Ports and Protocols, and HTTP Proxying, Network Access Control: Network Access Control, Extensible Authentication Protocol, IEEE 802.1X Port-Based Network Access Control, IP Security: IP Security Overview, IP Security Policy, Encapsulating Security Payload, Combining Security Associations, Internet Key Exchange (IKE). IPv6 Security, Transport-Level Security: Web Security Considerations, Secure Sockets Layer, Transport Layer Security, HTTPS standard, Secure Shell (SSH) application., Simple Network Management Protocol (SNMP), Electronic Mail Security: Pretty Good Privacy, S/MIME, 17 Domain Keys Identified Mail, Wireless Network Security: Mobile Device Security, IEEE 802.11i, Wireless LAN Security.

Text Books:-

1. John Stuppi, Omar Santos, "CCNA Security 210-260 Official Cert Guide", Publisher: Cisco Press, ISBN: 9780134077857, Release Date: September 2015.
2. Mark Rhodes-Ousley, Roberta Bragg, Keith Strassberg, "Network Security: The Complete Reference", Publisher: McGraw-Hill Osborne Media, Edition: First, Released: October, 2013.

Reference Books:-

9. Joseph Migga Kizza, “Computer Network Security”, Springer, 2005.
10. Douglas R. Stinson, “Cryptography Theory and Practice”, Third Edition, Chapman & Hall/CRC, 2006.
11. William Stallings, “Network Security Essentials Applications and Standards”, Pearson Education, Fourth Edition, 2011.
12. William Stallings, Lawrie Brown, “Computer Security: Principles and Practice”, First Edition, 2008

MCSE -302	Wireless Sensor Networks	L 3	T 0	P 0	C 3
Prerequisite	None				

Course Content

Syllabus: Introduction to Wireless Sensor Networks and applications Tracking chemical plumes- Smart transportation, Network Architecture - Energy Consumption of Sensor Nodes ,Operating Systems and Execution Environments, Network Architecture -Sensor Network Scenarios, Hardware Platforms, ns-3 core , Medium Access Control Protocol design, Introduction to Markov Chain, MAC Protocol Analysis, Routing protocols-Resource-aware routing, Data-centric, Geographic Routing, Broadcast, Multicast, MANETS, Routing protocols for WSN, Opportunistic Routing Analysis, Clustering, QoS management ,Sensor mode selection, localization, Time Synchronization, Security-SPINS, Static and dynamic key distribution, Energy Harvesting WSNs, Programming in WSNs, Sensor Node Hardware Berkeley Motes, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming, Open Research Issues.

Lab: Programming routing protocol a sensor network using ns-3, practicing theories in simulator.

Text Books:-

1. Protocols and Architectures for Wireless Sensor Networks. by Holger Karl and Andreas Willig
2. Wireless Sensor Networks: Technology, Protocols, and Applications by Kazem Sohraby , Daniel Minoli and Taieb Znati.

Reference Books:-

3. Waltenegus Dargie,Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice", Wiley Publishers, 2010, ISBN: 978-0-470-99765-9
4. Carlos De Morais Cordeiro, Dharma Prakash Agrawal, “Ad Hoc and Sensor Networks: Theory and Applications”, World Scientific Publishers, 2011, ISBN: 981-256-681-3
5. Dorothea Wagner and Roger Wattenhofer, “Algorithms for Sensor and Ad Hoc Networks”, Advanced Lectures, Springer, Lecture Notes in Computer Science 4621, 2007, ISBN-13 978-3-540-74990-5.

MCSE-303	INTELLIGENT SYSTEM AND GREEN COMPUTING	L	T	P	C
		3	0	0	3
Prerequisite	None				

Course Content

Artificial Intelligence and expert systems. Advanced Intelligent Systems- Neural Computing and Machine Learning, Neural Network Fundamentals, Neural Network Application Development, Data Collection and Preparation, Neural Network Architecture Neural Network Preparation, Learning Algorithms, back propagation, Testing, Implementation. Application of Advanced Intelligent Systems: Credit Approval with Neural Networks, Stock Market Prediction System with Modular Neural Networks, Integrated ANNs and Expert Systems, Optimization Algorithms. Intelligent Agents: An Overview, Characteristics of Agents, Single Task, Why Intelligent Agents? Classification and Types of Agents, Internet-Based Software Agents, Electronic Commerce Agents. Understand the overall need for an organisation to adopt a Green IT strategy, Provide an understanding of the historic development and context of the Kyoto Protocol. The key elements of Green IT, commonly accepted definitions, IT as an energy consumer, IT as a green 'enabler', The concept and dangers of 'Green Wash', Identify and understand an organisation's external drivers and opportunities for greening its IT, identify and understand the internal drivers, opportunities and benefits of adopting a Green IT strategy for both an organisation and its IT service provider(s) -Cost, Operations, Marketing/PR, Culture. The role of a Green IT policy, the importance of a Green IT policy, Definition of carbon footprints: direct and indirect emissions - Examples of an organisation's footprints: direct and indirect emissions, an understanding of carbon emissions across a product/service lifecycle including: 1. Concept & design 2. Material extraction 3. Transport 4. Manufacture 5. Usage 6. Disposal, Carbon Footprint Calculators, Carbon Offsetting and Carbon Neutrality, Carbon trading. Establishing a continuous improvement framework for Green ICT including use of the ITIL Continual Service Improvement Model. Understand the importance and risks, issues and opportunities around improving efficiency. Understand how best to re-use, recycle and dispose of IT assets.

Text Books: -

1. Artificial Intelligence Engines: A Tutorial Introduction to the Mathematics of Deep Learning, By – James V Stone.
2. Artificial Intelligence and Machine Learning By – Chandra S.S.V.
3. Basics of Artificial Intelligence & Machine Learning By – Dr. Dheeraj Mehrotra
4. Design Technologies for Green and Sustainable Computing Systems" by Partha Pratim Pande and Amlan Ganguly.
5. Green Computing for DIPLOMA KARNATAKA" by I A Dhotre
6. Green IT Strategies and Applications-Using Environmental Intelligence by Bhuvan Unhelkar

Reference Books:

7. Michael Negnevitsky , "Artificial intelligence – a guide to intelligent systems (3rd edition)", Publisher: Addison Wesley, ISBN-13: 978-1408225745,2011.
8. Alin Gales, Michael Schaefer, Mike Ebbers, ―Green Data Center: steps for the Journey, Shroff/IBM rebook, 2011.
9. John Lamb, ―The Greening of IT, Pearson Education, 2009.
10. Jason Harris, ―Green Computing and Green IT- Best Practices on regulations & industry, Lulu.com, 2008

11. Carl speshocky, ―Empowering Green Initiatives with IT, John Wiley & Sons, 2010.

MICTE-301	SECURE CODING (Pre Req: Information theory and coding)	L 3	T 0	P 0	C 3
Prerequisite	None				

Course Content

Introduction: Security, CIA Triad, Viruses, Trojans, and Worms in a Nutshell, Security Concepts exploit, threat, vulnerability, risk, attack. Malware Terminology: Rootkits, Trapdoors, Botnets, Key loggers, Honeypots. Active and Passive Security Attacks. IP Spoofing, Tear drop, DoS, DDoS, XSS, SQL injection, Smurf, Man in middle, Format String attack. Types of Security Vulnerabilities- buffer overflows, Invalidated input, race conditions, access-control problems, weaknesses in authentication, authorization, or cryptographic practices. Access Control Problems. Need for secure systems: Proactive Security development process, Secure Software Development Cycle (S-SDLC), Security issues while writing SRS, Design phase security, Development Phase, Test Phase,
Maintenance Phase, Writing Secure Code – Best Practices SD3 (Secure by design, default and deployment), Security principles and Secure Product Development Timeline. Threat modelling process and its benefits: Identifying the Threats by Using Attack Trees and rating threats using DREAD, Risk Mitigation Techniques and Security Best Practices. Security techniques, authentication, authorization. Defence in Depth and 20 Principle of Least Privilege. Secure Coding Techniques: Protection against DoS attacks, Application Failure Attacks, CPU Starvation Attacks, Insecure Coding Practices In Java Technology. ARP Spoofing and its countermeasures. Buffer Overrun- Stack overrun, Heap Overrun, Array Indexing Errors, Format String Bugs. Security Issues in C Language: String Handling, Avoiding Integer Overflows and Underflows and Type Conversion Issues- Memory Management Issues, Code Injection Attacks, Canary based countermeasures using Stack Guard and Propolice. Socket Security, Avoiding Server Hijacking, Securing RPC, ActiveX and DCOM Database and Web-specific issues: SQL Injection Techniques and Remedies, Race conditions, Time of Check Versus Time of Use and its protection mechanisms. Validating Input and Inter process Communication, Securing Signal Handlers and File Operations. XSS scripting attack and its types – Persistent and Non persistent attack XSS Countermeasures and Bypassing the XSS Filters. Testing Secure Applications: Security code overview, secure software installation. The Role of the Security Tester, Building the Security Test Plan. Testing HTTP-Based Applications, Testing File-Based Applications, Testing Clients with Rogue Servers

Text Books: -

1. Secure Programming HOWTO by David A. Wheeler
2. Secure Coding: Principles & Practices by Mark G. Graff, Kenneth R. van Wyk

Reference Books:

1. Writing Secure Code, Michael Howard and David LeBlanc, Microsoft Press, 2nd Edition, 2004.
2. Buffer Overflow Attacks: Detect, Exploit, Prevent by Jason Deckar, Syngress,1st Edition, 2005

3. Threat Modeling, Frank Swiderski and Window Snyder, Microsoft Professional, 1st Edition, 2004.

MMLE-301	ADVANCED KERNEL METHODS	L 3	T 0	P 0	C 3
Prerequisite	None				

Course Content

Kernel Vector Spaces: Fundamentals of kernel-based machine learning- The learning subspace property (LSP) and "kernelization" of learning models, Unsupervised learning for cluster discovery, Supervised learning for linear classifiers, Generalized inner products and kernel functions

Kernel-induced vector spaces- Mercer kernels and kernel-induced similarity metrics, Training-data-independent and dependent intrinsic feature vectors, The kernel-trick for non-vectorial data analysis. Feature selection,

PCA/KPCA and Cluster Discovery PCA and kernel PCA- Subspace projection and PCA, Kernel principal component analysis (KPCA), Unsupervised learning for cluster discovery

Kernel methods for cluster analysis-Kernel-based K-means learning models, Kernel K-means for non-vectorial data analysis, K-means learning models in kernel induced spectral space, Kernelized K-means learning models. Kernel ridge regressors, Support Vector Machines and variants, Kernel-based regression and regularization analysis-Linear least squares-error analysis, Kernel-based regression analysis, Multi-kernel regression analysis,

Linear regression and discriminant analysis for supervised classification-Kernelized learning models in empirical space: linear kernels Linear support vector machines, SVM with fuzzy separation: roles of slack variables, Kernel-based support vector machines, Kernel methods for green Machine learning technologies Efficient kernel methods for learning and classification-System design consideration, Selection of cost-effective kernel functions,

Classification of complexities: empirical and intrinsic degrees, Learning complexities: empirical and intrinsic degrees. Kernel methods and Statistical estimation theory-Kernel methods for estimation, prediction, and system identification.

Text Books:-

1. Soman, K. P., Loganathan, R., & Ajay, V. (2009). Machine learning with SVM and other kernel methods. PHI Learning Pvt. Ltd.
2. Kernel methods for pattern analysis - Shawe-Taylor, J.; Cristianini, N, Cambridge University Press, 2004. ISBN: 0521813972
3. Scholkopf, B. and Smola, A. J., Learning with Kernels: Support Vector Machines, Regularization, Optimization, and Beyond, The MIT Press (2001).

Reference Books:-

4. Pattern Recognition and Machine Learning. Bishop, C. M. Springer (2010).
5. Introduction to Machine Learning with Python. Mueller, A. C. & Guido, S. O'REILLY' Publishers (2016).

MMLE-302	REINFORCEMENT LEARNING	L 3	T 0	P 0	C 3
Prerequisite	None				

6. Cristianini, N. and Shawe-Taylor, J., An Introduction to Support Vector Machines and other kernel-based methods, Cambridge Univ. Press (2000).

Course Content

Introduction to Reinforcement Learning, How to act given know how the world works: Tabular setting, Markov processes, Policy search, Policy iteration, Value iteration, Learning to evaluate a policy when don't know how the world works, Model-free learning to make good decisions: Q-learning, SARSA, Scaling up: RL with function approximation, RL with function approximation, Imitation learning in large spaces, Policy search, Exploration/Exploitation, Meta-Learning, Batch Reinforcement Learning, Monte Carlo Tree Search

Text Books:-

1. "Reinforcement Learning: An Introduction", Richard S. Sutton and Andrew G. Barto, 2nd Edition.
2. "An Introduction to Deep Reinforcement Learning", Vincent François-Lavet, Peter Henderson, Riashat Islam, Marc G. Bellemare and Joelle Pineau.
3. "Algorithms for Reinforcement Learning", Csaba Szepesvari.
4. "Probability, Statistics, and Random Processes for Electrical Engineering", 3rd Edition, Alberto Leon-Garcia.
5. Lecture Notes on Introduction to Probability, Dimitri P. Bertsekas and John N. Tsitsiklis.

Reference Books:-

1. R.S. SUTTON, A.G. BARTO (2015), Reinforcement Learning: An Introduction, The MIT Press, 2nd Edition.
2. Belousov B., Abdulsamad H., Klink P., Parisi S., Peters J. (2021), Reinforcement Learning Algorithms: Analysis and Applications, Studies in Computational Intelligence : Book 883, Springer International Publishing.

MMLE-303	MACHINE LEARNING APPLICATIONS	L 3	T 0	P 0	C 3
Prerequisite	None				

Course Content

Image pre-processing: Read image, resize image, Remove noise (Denoise), Segmentation, and Morphology (smoothing edges). Feature extraction Techniques: Gray Level Co-occurrence Matric (GLCM), Local Binary Pattern (LBP), Canny Edge Operator and Bag of Words (BoW). Dimensionality Reduction Techniques: Principal Component Analysis (PCA), Independent Component Analysis (ICA), Linear Discriminant Analysis (LDA) and Autoencoders (AE). Classification methods: Logistic Regression, Naive Bayes Classifier, Nearest Neighbor, Support Vector Machines, Decision Trees, Random Forest, Neural Networks. Applications of Machine learning in Medicine and biology: Machine Learning to Detect and Diagnose Breast Cancer: Dividing the Data Set, Defining the Metrics, Evaluating the Models, creating a machine learning/deep learning Model, Evaluating Output Quality Through Receiver Operating Curves, Segmentation of Nuclei in microscopic Images using U-Net and similar problems, Machine learning applications in One dimensional signals like biomedical signals, speech signals.

Text Books:-

1. Rafael C. Gonzalez and Richard E. Woods, “Digital Image Processing”, Pearson Education, Third edition, 2009.
2. Milan Sonka, Vaclav Hlavac and Roger Boyle, “Image Processing, Analysis and MachineVision”, Third Edition, CL Engineering, 2013.
3. Tom M. Mitchell, ―Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.
4. Ethem Alpaydin, ―Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press 2004.

Reference Books:-

5. Justin Solomon, “Mathematical Methods for Computer Vision, Robotics, and Graphics”, Stanford University, 2013.
6. Christopher M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006.
7. Anil K. Jain, “Fundamentals of Digital Image Processing”, Pearson Edition, 2001.
8. S. Jayaraman and others, “Digital Image Processing”.
9. Stephen Marsland, ―Machine Learning: An Algorithmic Perspective, CRC Press, 2009

MMLE-304	TOPOLOGICAL DATA ANALYSIS	L 3	T 0	P 0	C 3
Prerequisite	None				

Course Content

Basic concepts (graphs, connected components, topological space, manifold, point clouds)

Combinatorial structures on point cloud data (simplicial complexes), New techniques in dimension reduction (circular coordinates, etc.)

Clustering (topology-based data partition, classification), Homology and persistent homology, Topological signatures for classification

Structural inference and reconstruction from data, Topological algorithms for massive data Multivariate and high-dimensional data analysis, Topological data analysis for visualization (vector fields, topological structures), Practical applications of TDA

Reference Books

Text Books:-

1. Computational topology, Herbert Edelsbrunner and John L. Harer, AMS
2. Algebraic Topology, Allen Hatcher, Cambridge U. Press.

Reference Books:-

3. Curve and surface reconstruction: Algorithms with mathematical analysis, Tamal K. Dey, Cambridge U. Press
4. Topology and Data by Gunnar Carlson, Bull. Amer. Math. Soc. 46 (2009).

MCSC-302	THESIS / DISSERTATION - I	L 0	T 0	P 8	C 4
Prerequisite	None				

SEMESTER-IV

MCSC -401	THESIS /DISSERTATION - II	L 0	T 0	P 28	C 14
Prerequisite	None				

Content

The students will continue to work on the problem identified in Minor Project (in Semester III) as per the work plan. The work is continued until all stated objectives and deliverables are met. Student will prepare a comprehensive report containing introduction to the problem, literature review, methodology, results and discussion and conclusion. Research Progress Seminar will be held twice a month for continuous evaluation. The thesis grading shall be done on the basis of research outcomes in the form of a working prototype or a patent or a publication in peer reviewed Journal, International Conference or National Conference.