A

Syllabus Booklet

of

Department of Computer Science and Information Technology

(AICTE Approved)

Central University of Jammu, Bagla
(Rahya-Suchani) Distt. Samba, J&K-181143

About the Department

The Department of Computer Science & Information Technology under the aegis of the School of Basic & Applied Sciences was established in the year 2012. The Department is well equipped with state-of-the-art laboratories of all major domains of Computer Science and Information Technology with excellent internet, servers, hardware and software support like Video-conferencing etc. Amenities like gymnasium, TT, Bus etc. are also available.

Our Alumni are pursuing higher studies in most reputed Universities and Institutes. The Department is equally active in research with many quality publications each year in IEEE, Science direct, ACM, Springer, Wiley etc. Different scholarships/fellowships are also available for the deserving students of the Central University of Jammu.

Vision of the Department

To become a leader in providing quality education in computer science by inculcating international standard technical skills along with core ethical values among students and prepare them to be outstanding computer technocrats and nation builders.

Mission of the Department

M1. To impart education to students through quality teaching, hands-on training, and application-oriented projects.
M2. To develop analytical and problem-solving skills using the latest technologies and techniques to help them to compete in the IT industry
M3. To encourage innovation and research to bridge the digital divide and contribute to the growth and development of the society and country at large.

Programmes of the Department

1. **M.Tech. (CST)** 2. **Ph.D. (CSIT)**

M. Tech. (Computer Science & Technology)

Programme Educational Objectives (PEOs)

We focus on the following objectives to realize our vision.
PEO-1: To gain in-depth knowledge of Computer Science and Technology and acquire capabilities to compete at the global level with an ability to discriminate, evaluate, analyze and synthesize existing
and new knowledge to conduct research in theoretical, practical, and policy contexts.
PEO-2: Have in-depth knowledge and research skills to professionally practice in a variety of fields including Security, Machine Learning, Internet of Things (IoT), Natural Language Processing, and Ubiquitous Computing.
PEO-3: Acquire professional and intellectual integrity and ethics, learn independently and continuously to upgrade the knowledge and competence with enthusiasm.

Programme Outcomes (POs)

A postgraduate of the Computer Science and Technology Program will demonstrate
PO-1: An ability to independently carry out research and development work to solve practical problems.
PO-2: An ability to write and present a substantial technical report/document.
PO-3: 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.

PO-4: An ability to use modern computational tools in modeling, simulation, and analysis with effective participation in multi-disciplinary teams and contribute towards achieving the common goals of the team.
PO-5: An ability to work with integrity and ethics in their professional practice having an understanding of responsibility towards society with sustainable development for a lifetime.

Faculty Members of CSIT

SN	Faculty Name	Designation	Research Area
1	Prof. Devanand	Professor	Simulation Modelling
2	Dr. Yashwant Singh	Associate Professor and HoD	IoT, Cyber Security of CPS
3	Dr. Bhavna Arora	Assistant Professor	NLP, Cyber Security
4	Dr. Arvind Selwal	Assistant Professor	Pattern Recognition
5	Dr. Neerendra Kumar	Assistant Professor	Robotics, AI
6	Dr. Deepti Malhotra	Assistant Professor	AI and NLP

Research Thrust Areas of the Department

- **Cyber-Physical System (Internet of Things)**
  Vulnerability analysis of IoT and embedded devices, Functional programming applications, Reconfigurable computing, Embedded control units, Design and development of robots and sensor platforms, WSN, and IoT routing.
- **Security and Cryptography**
  Information and network security, Theoretical and applied cryptography, Side-channel attacks and cryptanalysis, Privacy.
- **AI and Machine Learning**
  Data-Mining, Information Retrieval, Machine Translation, Natural Language Processing, Neural networks and Deep Learning, Pattern Recognition, Reinforcement Learning, Sentiment Analysis, Speech Recognition.

Course Scheme of M.Tech. (Computer Science and Technology)

Semester – I

Course Code	Course Title	Credit	CIA	MSE	ESE	Max. Marks
Core courses						
PGMTH1C016T	Advanced Data Structures & Algorithms	4	25	25	50	100
PGMTH1C017T	Data Communication and Computer Networks	4	25	25	50	100
PGMTH1C014L	Advanced Data Structures & Algorithms Lab.	2	12.5	12.5	25	50
Elective – I Course (Any One)						
PGMTH1E029T	Cloud Computing and Architectures	4	25	25	50	100
PGMTH1E026T	Information Security					
PGMTH1E028T	Secure Industrial Control Systems					
PGMTH1E027T	Modelling Simulation & Optimization					
Elective – II Course (Any One)						
PGMTH1E030T	Soft Computing	4	25	25	50	100
PGMTH1E031T	Mobile Applications Development					
PGMTH1E032T	Digital Image Processing					
PGMTH1E033T	Scientific Computing					
PGMTH1E002L	Lab based on Elective – II	2	12.5	12.5	25	50
Interdisciplinary Course						
*MOOC course available on SWAYAM/NPTEL/IDC offered by other Departments		4	-	-	-	100
Total		**24**	-	-	-	**600**

Semester – II

Course Code	Course Title	Credit	CIA	MSE	ESE	Max. Marks
Core courses						
PGMTH2C011T	Advanced Database Management Systems	4	25	25	50	100
PGMTH2C012T	Advanced Software Design, Development and Testing	4	25	25	50	100
PGMTH2C007L	Advanced Database Management Systems Lab.	2	-	-	-	50
Elective – III Course (Any One)						
PGMTH2E031T	Network & Cyber Security	4	25	25	50	100
PGMTH2E032T	Big Data Analytics					
PGMTH2E033T	Computing Systems for Robotics					
PGMTH2E034T	Agile Software Development					

Elective – IV (Any One)						
PGMTH2E035T	Wireless Sensor Networks	4	25	25	50	100
PGMTH2E036T	Data Warehousing and Mining					
PGMTH2E037T	Computer Vision					
PGMTH2E038T	Advanced Object Oriented Programming					
PGMTH2E002L	Lab based on Elective – IV	2	12.5	12.5	25	50
Interdisciplinary Course						
*MOOC course available on SWAYAM/NPTEL/IDC offered by other Departments		4	-	-	-	100
Total		**24**	-	-	-	**600**

Semester – III

Course Code	Course Title	Credit	CIA	MSE	ESE	Max. Marks
Core courses						
PGMTH3C010T	Artificial Intelligence and Machine Learning	4	25	25	50	100
PGMTH3C008D	Dissertation – Part I	8	50	50	100	200
PGMTH3C002P	Research Seminar	2	12.5	12.5	25	50
Elective – V Course (Any One)						
PGMTH3E019T	Pattern Recognition	4	25	25	50	100
PGMTH3E020T	Internet of Things					
PGMTH3E021T	Cryptography					
PGMTH3E022T	Digital Forensics					
PGMTH3E023T	Cyber Physical Systems					
Total		**18**	-	-	-	**450**

Semester – IV

Course Code	Course Title	Credit	CIA	MSE	ESE	Max. Marks
Core courses						
PGMTH4C004D	Dissertation – Part II	18	112.5	112.5	225	450
Total		**18**	-	-	-	**450**

*****Department will prepare and notify a list of courses available through MOOC platforms at least 15 days advance before commencement of the semester.

Sequence of Pre-requisite

Information Security (1st Sem.)→Network and Cyber Security (2nd Sem.)→Cryptography (3rd Sem.)
Digital Image Processing (1st Sem.)→Computer Vision (2nd Sem.)→Pattern Recognition (3rd Sem.)
Cloud Computing and Architecture (1st Sem.)→Big Data Analytics (2nd Sem.)
Secure Industrial Control Systems (1st Sem.)→Cyber Physical Systems (3rd Sem.)

SEMESTER-I

Advanced Data Structures and Algorithms

Course Code: PGMTH1C016T

Course Title: Advanced Data Structures and Algorithms

Semester: I

Credits: 04

Rationale

Data Structures are widely used in Computer Science and Engineering for designing simple to complex algorithms. Organizing or structuring data is important for the implementation of efficient algorithms and program development. Efficient problem solving needs the application of appropriate data structure during program development.

Course Outlines

Contents	**No. of Lectures**
Unit - I Algorithm Analysis: Analyzing Algorithms, Time Complexity Analysis of Iterative and Recursive Program, Introduction to Asymptotic Notations, Big (Oh), Big Omega , Big theta. Basic Data Structures: Stacks, Queues, Linked List.	**10**
Unit - II Hashing: Review of Hashing, Hash Function, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Linear Probing, Quadratic Probing, Double Hashing, Rehashing, Extendible Hashing.	**10**
Unit -III Trees: Binary Search Trees, AVL Trees, Red Black Trees, 2-3 Trees, B/B+-Trees, Splay Tree.	**10**
Unit - IV Text Processing: String Operations, Brute-Force Pattern Matching, The Boyer Moore Algorithm, The Knuth-Morris-Pratt Algorithm, Standard Tries,	**10**

Compressed Tries, Suffix Tries, The Huffman Coding Algorithm, The Longest Common Subsequence Problem (LCS), Applying Dynamic Programming to the LCS Problem.	
Unit - V Computational Geometry: One Dimensional Range Searching, Two Dimensional Range Searching, Constructing a Priority Search Tree, Searching a Priority Search Tree, Priority Range Trees, Quadtrees, k-D Trees. Recent Trends in Hashing, Trees and various computational geometry methods for efficiently solving the new evolving problem. .	**10**

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Analyze algorithms in terms of time and space complexity by using the concept of Asymptotic Notations.
- Understand the implementation of symbol tables using hashing techniques.
- Develop and analyze algorithms for red-black trees, B-trees and Splay trees.
- Develop algorithms for text processing and other similar applications.
- Identify suitable data structures and develop algorithms for computational geometry problems.

Text Books

1. R. S Salaria, “Data Structures & Algorithms using C”, Fifth Edition 2018.
2. S. Sridhar,” Design and Analysis of Algorithms”, Oxford Publication 2015.

Reference Books

1. Aaron M. Tenenbaum, ”Data Structures Using C and C++”, Fourth Edition, Pearson Education Asia Fourth Edition 2015.
2. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C++”, 2nd Edition, Pearson, 2004.
3. Seymour Lipschutz, “Theory and problems of Data Structures”, Tata McGraw- Hill Third Edition 2007.
4. Sartaj Sahni, “Handbook of DATA STRUCTURES and APPLICATIONS”, Chapman & Hall/CRC,2005.
5. Thomas H. Cormen, “Introduction to Algorithms”, PHI, Third Edition 2012.

Data Communication and Computer Networks

Course Code: PGMTH1C017T

Course Title: Data Communication and Computer Networks

Semester: I

Credits: 04

Rationale

Data communication and computer networks have been growing with rapid technological progress. Computer communication through networking becomes an essential part of our life. By considering the importance of networking in day-to-day life, it is essential for students to know the concept of networks, the internet, layered structure, and switching. This course deals with the important concepts and techniques related to data communications and enables the student to have an insight into the technology involved to make network communication possible.

Course Outlines

Contents	**No of Lectures**
Unit-I Computer Networks and Internet: Internet, Protocol, The Network Edge, The Network Core, Interactive Programs for Tracing Routes in the Internet, Java Applet: Message Switching and Packet Switching, Access Networks and Physical Media, Delay and Loss in Packet-Switched Networks, Protocol Layers and Their Service Models, Internet Backbones, NAPs and ISPs, A Brief History of Computer Networking.	**10**
Unit-II Application Layer: Principles of Application-Layer Protocols, The World Wide Web: HTTP, File Transfer: FTP, Electronic Mail in the Internet, The Internet's Directory Service: DNS, Interactive Programs for Exploring DNS, Socket Programming with TCP, Socket Programming with UDP, Building a Simple Web Server.	**10**
Unit-III Transport Layer: Transport-Layer Services and Principles, Multiplexing and Demultiplexing Applications, Connectionless Transport: UDP, Principles of	**10**

Reliable of Data Transfer, Java Applet: Flow Control in Action, Connection-Oriented Transport: TCP, Principles of Congestion Control, TCP Congestion Control.	
Unit-IV Network Layer and Routing: Introduction and Network Service Model, Routing Principles, Hierarchical Routing, Internet Protocol, Java Applet: IP, Fragmentation, Routing in the Internet, What is Inside a Router?, IPv6, Multicast Routing. Link Layer and Local Area Network: The Data Link Layer: Introduction, Services, Error Detection and Correction, Multiple Access Protocols and LANs, LAN Addresses and ARP, Ethernet, CSMA/CD Applet, Hubs, Bridges and Switches, Wireless LANs: IEEE 802.11, The Point-to-Point Protocol, ATM, X.25 and Frame Relay.	**10**
Unit-V Multimedia Networking : Multimedia Networking Applications, Streaming Stored Audio and Video, Making the Best of the Best-Effort Service: An Internet Phone Example, RTP, Beyond Best Effort, Scheduling and Policing Mechanisms for Providing QoS Guarantees, Integrated Services, RSVP, Differentiated Services. Security in Computer Networks: Network Security, Principles of Cryptography, Authentication, Integrity, Key Distribution and Certification, Secure E-Mail, Internet Commerce, Network-Layer Security: IPsec. Network Management: Network Management, The Infrastructure for Network Management, The Internet Network Management Framework, ASN.1, Firewalls.	**10**

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Analyze the functioning of data communication and computer networks.
- Select relevant transmission media and switching techniques as per need.
- Analyze transmission errors with respect to IEEE standards.
- Configure various networking devices and different TCP/IP services.
- Work with datagram and internet socket programming.

Text Books

1. Forouzan, Behrouz A., “Data Communications and Networking”, Tata McGraw Hill New Delhi, 4/e 2006.
2. James F. Kurose, Keith W. Ross, “Computer Networking”, Pearson, 2012.

Reference Books

1. Behrouz A. Forouzan , “TCP/IP Protocol Suite”, McGraw- Hill, 4/e, 2009.
2. Larry L. Peterson & Bruce S. Davie, “Computer Network: A System Approach”, Morgan Kaufmann, 5/e, 2012.
3. Charles M. Kozierok, “The TCP/IP Guide”, No Starch Press, 2005.
4. Behrouz A. Forouzan , “Introduction to Computer Networks McGraw- Hill, 4/e, 2009
5. Andrew s. Tanenbaum j. Wetherall, “Computer Networks”, 5/e, Pearson, 2011.

Cloud Computing and Architectures

Course Code: PGMTH1E029T

Course Title: Cloud Computing and Architectures

Semester: I

Credits: 04

Rationale

Cloud Computing is a large-scale distributed computing paradigm that has become a driving force for information technology over the past several years. The exponential growth of data size in scientific instrumentation/simulation and social media has triggered the wider use of cloud computing services. This course covers topics and technologies related to Cloud Computing, different architectural models of cloud computing, the concepts of virtualization and cloud orchestration. Advanced cloud programming paradigms such as Hadoop's Map Reduce are also included in the course.

Course Outlines

Contents	**No of Lectures**
Unit-I Cloud Computing: Introduction, Vision of Cloud Computing, Desired Features and Benefits, Issues and Challenges of Cloud Computing, Building Cloud Computing Environments, Distributed Computing and Enabling Technologies, Parallel Versus Distributed Computing.	**10**
Unit-II Introduction, Characteristics of Virtualized Environments, Taxonomy of Virtualization Techniques, Need for Virtualization, Pros and Cons of Virtualization Types of Virtualization, Hardware, Storage and Network virtualization, Concept of Hypervisors, Virtual machines provisioning and manageability, VM provisioning process.	**10**
Unit-III Cloud Computing Architecture: Introduction, Cloud Reference Model, Architecture, Infrastructure as a Service, Platform as a Service, Software as a Service, Types of Clouds, Public, Private, Hybrid and Community, Cloud Storage definition, Provisioning cloud storage, Unmanaged Cloud Storage,	**10**

Managed Cloud Storage.	
Unit-IV Understanding Cloud Security: Confidentiality, Integrity, Authenticity, Availability, Threat, Vulnerability, Risk, Security Controls, Security mechanisms, Security Policies. Threat Agents, Anonymous Attacker, Aalicious Service Agent, Trusted Attacker, Malicious Insider, Cloud Security Threats, Traffic Eavesdropping, Malicious Intermediary, Denial of Service, Insufficient Authorisation, Virtualization Attack. Encryption, Symmetric and Asymmetric.	**10**
Unit-V Apache Hadoop. Introduction, Framework to Process Big Data, Master/ Slave Architecture, Core components, Map-Reduce Programming Model, Map Reduce Working, Working of Mapper, Working of Reducer, Running Hadoop on Cloud, Design of data applications based on Map Reduce in Apache Hadoop. Cloud Platform in Industry: Amazon web services, Google APP Engine, Microsoft Azure.	**10**

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Understand cloud computing models, namely, infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS).
- Understand security implications in cloud computing.
- Analyse the operation, implementation and performance of cloud computing systems, and the relative merits and suitability of each for complex data-intensive applications.
- Understand the underlying principle of cloud virtualization and cloud storage.

Text Books

1. Rajkumar Buyya, Christian Vacchiola, S Thamarai Selvi, "Mastering Cloud computing" McGraw Hill 2013.
2. Barrie Sosinsky, "Cloud Computing Bible", Wiley Publishers 2010.

Reference Books

1. Rajkumar Buyya, James Broberg, Andrzej Goscinski, "Cloud Computing Principles and Paradigms", Wiley Publishers 2011.

2. Tim Mather, Subra Kumaraswamy, Shahed Latif, "Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance"", O'Reilly 2010.

3. Toby Velte, Antohy T Velte, Robert Elsenpete, "Cloud Computing: A Practical Approach", McGraw Hill 2009.

4. Kai Hwang, Geoffrey C. Fox, Jack.J.Dongarra, "Distributed and Cloud Computing", Elsevier, 2014.

5. Zaigham Mahmood and Ricardo Puttini, "Cloud Computing- Concepts, Technology & Architecture", Pearson,2017.

Information Security

Course Code: PGMTH1E026T

Course Title: Information Security

Semester: I

Credits: 04

Rationale

Information security is a set of strategies for managing the processes, tools and policies necessary to prevent, detect, document and counter threats to digital and non-digital information. Information security solutions provide digital protection to confidential information that will ensure protection from potential threats such as Adware and Ransomware. The course aims to make the students acquire knowledge on standard algorithms used to provide confidentiality, integrity and authenticity.

Course Outlines

Contents	**No of Lectures**
Unit-I Information Security Overview: Services, Mechanisms, Attacks and its types, counter-measures, OSI Security Architecture, Model for Network Security, Trade-offs related to Information Security. Cryptography: Introduction to Cryptography, Symmetric key Cryptography, Asymmetric key Cryptography.	**10**
Unit-II Data Encryption Standard: DES cipher, Block Cipher Principles, The Strength of DES, Differential and Linear Cryptanalysis, Block Cipher Design Principles, Block Cipher Modes of Operation. Advanced Encryption Standard: Evaluation Criteria for AES, The AES Cipher, Triple DES, RC5	**10**
Unit-III Key Management: Key Management, Diffie-Hellman Key Exchange Message Authentication and Hash Functions: Authentication Requirements, Authentication Functions, Message Authentication Codes, Hash Functions, Security of Hash Functions and MACs. Hash Algorithms: MD5 Message Digest Algorithm, Secure Hash Algorithm and HMAC, Digital Signatures	**10**

Unit-IV Network Security Practice: Authentication Applications: Kerberos, X.509 Authentication Service, Electronic Mail Security: Pretty Good Privacy, S/MIME. IP Security: IP Security Overview, IP Security Architecture, Authentication Header, Encapsulating Security Payload, Combining Security Associations, Key Management, Web Security: Web Security Considerations, Secure Sockets Layer and Transport Layer Security, Secure Electronic Transaction.	**10**
Unit-V System Security: Intruders, Intrusion Detection and Prevention System, Password Management, Malicious Software: Viruses and Related Threats, Virus Countermeasures, Firewalls: Firewall Design Principles, Trusted Systems.	**10**

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Aquent with basic concepts of information Security and Privacy.
- Define the concepts of Information security and their use.
- Describe the principles of symmetric and asymmetric cryptography.
- Understand and apply the various symmetric key algorithms.
- Understand and use the various key management and remote authentication mechanisms.

Text Books

1. William Stallings, "Network Security Essentials", Pearson, 4th Edition, 2011
2. Forouzan, Behrouz A., "Data Communications and Networking", Tata McGraw Hill New Delhi, 4/e 2006

Reference Books

1. Kaufman, Perlman, and Speciner, "Network Security", Prentice-Hall, 2nd Edition 2001
2. Michael E. Whitman, "Principles of information Security", Cengage Learning, 4th Edition, 2011
3. Chwan-Hwa (John) Wu, J. David Irwin, "Introduction to Computer Networks and Cyber Security", CRC Press, 1st Edition, 2014
4. William Stallings, "Cryptography and Network Security: Principles and Practice", Pearson Education, 6th Edition, 2017

Secure Industrial Control Systems

Course Code: PGMTH1E028T

Course Title: Secure Industrial Control Systems

Semester: I

Credits: 04

Rationale

Our world is growing more and more dependent upon technology and systems that monitor and control industrial processes. The electric power grid, water and sewage systems, oil and natural gas pipelines, and many more critical infrastructures utilize Industrial Control Systems/Supervisory Control and Data Acquisition (ICS/SCADA) systems. ICS/SCADA is used to monitor and control these infrastructure processes. This course will provide a strong foundation in the field of ICS/SCADA Cyber Security.

Course Outlines

Contents	**No. of Lectures**
Unit - I Introduction: Definition of SCADA, Features of SCADA, Fundamental Principles of Modern SCADA Systems, Applications of SCADA, Advantages and Disadvantages of SCADA, Future of SCADA and Control Systems Security. Related Fields**:** Industrial Control System (ICS), Distributed Control System (DCS), Programmable Logic Controller (PLC) and Smart Instrumentation, SCADA vs DCS, SCADA vs IoT.	**10**
Unit - II SCADA System Components: Programmable Logic Controller (PLC), Remote Terminal Unit (RTU), Intelligent Electronic Device (IED), Communication Network and Communication Protocols(MODBUS, DNP3,and IEC 60870-5-101) , Master Terminal Unit (MTU) or Master Station Unit (MSU), and SCADA/HMI Systems. SCADA Architectures: Hardware Architecture (Client Layer, Data Server Layer), Software Architecture, First Generation-Monolithic, Second	**10**

Generation-Distributed, Third Generation-Networked, and Fourth Generation-Web Based Architecture.	
Unit -III Security in SCADA: SCADA Security breach in terms of Confidentiality, Integrity, and Availability, and Non-Repudiation, Comparing ICS and IT Systems security, Firewall and its impact on SCADA performance. Attacks on SCADA Networks: Attack on Hardware, Attack on Software, Attack on Network Connection, Vulnerabilities and its types in SCADA, SCADA Attack Detection methods, SCADA Attacks Prevention methods.	**10**
Unit - IV Vulnerability Assessment: Network Reconnaissance (NMap/ZenMap), Packet Analysis (WireShark and TCP Dump), Penetration Testing tools (Kali Linux and Metasploit), and Reverse Engineering and its tools (Binwalk/Gidra). Basics of Cryptographic Algorithms: DES, AES, RSA, Deffie-Hellman, and Elliptic Curve Cryptography (ECC).	**10**
Unit - V SCADA Security Prevention: Centralized Key Distribution, Decentralized Key Distribution, Public Key Cryptography, Private Key Cryptography. Key based Prevention methods: SCADA Key Establishment (SKE), SCADA Key Management Architecture (SKMA), Logical Key Hierarchy (LKH), Advanced SCADA Key Management Architecture (ASKMA), ASKMA+, Hybrid Key Management Architecture (HKMA), Advanced Hybrid SCADA Key Management Architecture (AHSKMA), Limited Self Healing Key Distribution (LiSH+), ID Based Key Management Architecture (ID-KMA), and NTRU Cryptographic Algorithm for SCADA Networks.	**10**

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Understand fundamentals of ICS protocols.
- Know the basic working knowledge of SCADA & DCS.
- Analyze SCADA & DCS Security Management Implementation and Guidelines.
- Access the risk and cybersecurity concerns of ICS/SCADA.
- Understand the SCADA networks and their role in Automation.

Text Books

1. T. Macaulay and B. L. Singer, “Cyber security for Industrial Control Systems: SCADA, DCS, PLC, HMI, and SIS”, Auerbach Publications, 2011.

2. J. Lopez, R. Setola, and S. Wolthusen, “Critical Infrastructure Protection Information Infrastructure Models, Analysis, and Defense”, Springer-Verlag Berlin Heidelberg, 2012.

References Books

1. Stuart A. Boyer: “SCADA-Supervisory Control and Data Acquisition”, Instrument Society of America Publications, USA, 2004.
2. Gordon Clarke, Deon Reynders: “Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems”, Newness Publications, Oxford, UK,2004.
3. William T. Shaw, “Cyber Security for SCADA Systems”, Penn Well Books, 2006.
4. David Bailey, Edwin Wright, “Practical SCADA for industry”, Newness, 2003.
5. Wiebe, “A guide to utility automation: AMR, SCADA, and IT systems for electric power”, PennWell Books, 1999.

Modeling Simulation and Optimization

Course Code: PGMTH1E027T

Course Title: Modeling Simulation and Optimization

Semester: I

Credits: 04

Rationale

Simulation modeling and optimization solve real-world problems safely and efficiently. It provides an important method of analysis that is easily verified, communicated, and understood. Across industries and disciplines, simulation modeling provides valuable solutions by giving clear insights into complex systems.

Course Outlines

Contents	**No of Lectures**
Unit-I Introduction: Systems, models, deterministic and stochastic systems, static and dynamic systems, discrete event simulation, continuous simulation, Monte Carlo simulation. Discrete Event Simulation: Time-advance mechanisms, event modeling of discrete dynamic systems, event graphs, process oriented and event oriented approaches, single-server single queue model.	**10**
Unit-II GPSS: Program model, entities and transactions, blocks in GPSS, user defined functions, SNA, logic switches, save locations, user chains, tabulation of result, programming examples. Random Number Generation: Congruence generators, long period generators, statistical quality measures of generators, uniformity and independence testing, chi-square and other hypotheses testing, runs testing.	**10**
Unit-III Random Variable Generation: random variable, probability density and distribution functions, Location, scale and shape parameters, discrete and continuous probability distributions; Inverse transform method, composition	**10**

and acceptance-rejection methods, efficiency and quality measures of generators; Input Modelling, selection of distribution for a random source, fitting distributions to data, constructing empirical distributions from data.	
Unit-IV Random Processes and Queuing Models: random process, discrete/continuous time processes, Markovian property, Markov chain, state transition diagrams, birth-death process, Little's theorem, steady state analysis of M/M/1 model; multi-server models, M/G/1 and other queuing models, Burke's theorem, network of queues, Jackson theorem.	**10**
Unit-V Network Simulation: SimEvent tool box in R/Python/Octave, general features of network simulation packages, case study of OMNET++/ns2/ns3/NetSim.	**10**

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Understand the basic concepts of modeling and simulation.
- Know GPSS model and understand different statistical tests for measuring quality of generators.
- Understand the concept of random numbers and the method to generate random numbers.
- Understand random processes and different queuing models.

Text Books

1. Network Simulation: SimEvent tool box in R/Python/Octave, general features of network simulation packages, case study of OMNET++/ns2/ns3/NetSim.
2. Banks, J., Carson, L.S., Nelson, B.L. and Nicol, D.M., "Discrete Event System Simulation", 4th Ed., Pearson Education

Reference Books

1. Law, A.M. and Kelton, W.D., "Simulation, Modeling and Analysis", 3rd Ed., Tata McGraw-Hill.
2. Alberto Leon-Garcia, "Probability and Random Processes for Electrical Engineers", 2nd Ed., Pearson Education
3. Jerry Banks, John S Carson, II, Berry L Nelson, David M Nicol -Discrete Event system Simulation, III Edition, Pearson Education, Asia, ISBN – 81- 7808 – 505
4. Narsingh Deo -Systems Simulation with Digital Computer; PHI Publication (EEE), ISBN 87692-028-8

Soft Computing

Course Code: PGMTH1E030T

Course Title: Soft Computing

Semester: I

Credits: 04

Rationale

Soft computing provides an approach to problem-solving using means other than computers. With the human mind as a role model, soft computing is tolerant of partial truths, uncertainty, imprecision and approximation, unlike traditional computing models. The tolerance of soft computing allows researchers to approach some problems that traditional computing can't process.

Course Outlines

Contents	**No of Lectures**
Unit-I Soft Computing: Introduction, soft computing vs. hard computing, various types of soft computing techniques, Applications of soft computing techniques, Introduction, Structure and function of a neuron, Biological neuron, artificial neuron, definition of ANN, Taxonomy of neural networks, Difference between ANN and human brain, Characteristics and applications of ANN.	**10**
Unit-II Learning rules, Thresholds and activation functions, Single layer network, Perceptron and its training algorithm, Linear Separability, XOR problem, ADALINE, MADALINE, Introduction to multilayer layer Perceptron, Back propagation neural(BPN) networks.	**10**
Unit-III Counter propagation network, Hopfield/Recurrent network, Associative memory, Hopfield v/s Boltzman machine, competitive learning, Kohonen's self	**10**

organizing networks, Adaptive Resonance Theory(ART).	
Unit-IV Introduction to Fuzzy Logic: Classical and Fuzzy Sets: Overview of Classical Sets, Membership Function, Fuzzy rule generation. Operations on Fuzzy Sets, Compliment, Intersections, Unions, Combinations of Operations, Aggregation Operations. Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals & Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations. Fuzzy Logic: FIS, Fuzzification and de-Fuzzification.	**10**
Unit-V Genetic algorithms(GA): Basic concepts, Conventional Vs. GA, Simple, GA working, encoding, fitness function, reproduction, Selection, crossover, mutation, schema analysis, analysis of selection algorithms, convergence, Reproduction, Crossover, and mutation, Mapping objective functions to fitness form, Fitness scaling. Meta-heuristic search: Overview of ACO, PCO.	**10**

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Identify and describe soft computing techniques and their roles in building intelligent machines.
- Apply genetic algorithms to combinatorial optimization problems.
- Evaluate and compare solutions by various soft computing approaches for a given problem.
- Apply fuzzy logic and reasoning to handle uncertainty and solve various engineering problems.

Text Books

1. S, Rajasekaran & G.A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic & Genetic Algorithms, Synthesis & applications, PHI Publication.
2. S.N. Sivanandam & S.N. Deepa, Principles of Soft Computing, Wiley Publications.

Reference Books

1. Rich E and Knight K, Artificial Intelligence, TMH, New Delhi.

2. Bose, Neural Network fundamental with Graph, Algo.& Appl, TMH.
3. Kosko: Neural Network & Fuzzy System, PHI Publication.
4. Klir & Yuan, Fuzzy sets & Fuzzy Logic: Theory & Appli., PHI Pub.
5. Davis E.Goldberg, “Genetic Algorithms: Search, Optimization and Machine Learning”, Addison Wesley, N.Y 2010.

Mobile Applications Development

Course Code: PGMTH1E031T

Course Title: Mobile Applications Development

Semester: I

Credits: 04

Rationale

Mobile application development is one of the rising and growing trends in the industry of mobile. One of the key advantages of Android app development is the easy availability of the Android SDK. Students will learn emerging technologies and tools used to design and implement feature-rich mobile applications for smartphones and tablets.

Course Outlines

Contents	**No of Lectures**
Unit-I Introduction to Mobile Computing, Introduction to Android Development Environment, Factors in Developing Mobile Applications, Mobile Software Engineering, Frameworks and Tools, Generic UI Development Android User.	**10**
Unit-II More on Uis: VUIs and Mobile Apps, Text-to-Speech Techniques, Designing the Right UI, Multichannel and Multi-modal Uis, Storing and Retrieving Data, Synchronization and Replication of Mobile Data, Getting the Model Right, Android Storing and Retrieving Data, Working with a Content Provider.	**10**
Unit-III Communications via Network and the Web: State Machine, Correct Communications Model, Android Networking and Web, Telephony Deciding Scope of an App, Wireless Connectivity and Mobile Apps, Android Telephony Notifications and Alarms: Performance, Performance and Memory management, Android Notifications and Alarms, Graphics, Performance and Multi-threading, Graphics and UI Performance, Android Graphics.	**10**
Unit-IV	**10**

Putting It All Together: Packaging and Deploying, Performance Best Practices, Android Field Service App, Location Mobility and Location Based Services Android Multimedia: Mobile Agents and Peer-to-Peer Architecture, Android Multimedia.	
Unit-V Platforms and Additional Issues: Development Process, Architecture, Design, Technology Selection, Mobile App Development Hurdles, Testing, Security and Hacking, Active Transactions, More on Security, Hacking Android.	**10**

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Identify, define and sketch a mobile application.
- Understand the fundamentals, frameworks, and development life-cycle of mobile application platforms including iOS, Android.
- Design and develop a mobile application prototype in one of the platform.
- Understand the steps to upload mobile apps on Android Play Store.

Text Books

1. Wei-Meng Lee, Beginning Android™ 4 Application Development, by John Wiley & Sons, 2012.
2. The iOS 5 Developer's Cookbook, Erica Sadun, Addison-Wesley, 2012.

Reference Books

1. Android in Practice - Charlie Collins, Michale Galpin, Matthias Kaeppler – Manning Publications 2012.
2. Mobile Computing – 2nd edition – Devi Kamal – Oxford University Press 2012.
3. iOS 9 Application Development in 24 Hours, Sams Teach Yourself, 7th Edition by John Ray.
4. Android Application Development Cookbook- Second Edition by Rick Boyer and Kyle Mew.

Digital Image Processing

Course Code: PGMTH1E032T

Course Title: Digital Image Processing

Semester: I

Credits: 04

Rationale

The significance of digital image processing is threefold; to enhance the appearance of a digital image to a human observer by applying specific operations, to extract from image quantitative and summarized information that is not readily apparent to the human eyes, and to standardize an image in photometric or geometric terms.

Contents	**No. of Lectures**
Unit - I Overview of Digital Image Processing, Origin, usage and applications of Image processing, Fundamental steps and component of image processing system, Introduction to Human Visual System, Sampling, quantisation and convolution, interpolation, Digital representation of images (monochrome & Color), Elements of matrix theory, Digital Imaging Hardware & Software. Simple image operations: Arithmetic, logical and geometrical operations.	**10**
Unit - II Image quality factors, Basic image pre-processing (contrast enhancement, simple noise reduction, colour balancing), spatial transformation Gray Level linear and non-linear transformation, Histogram Processing, Fourier transform, Hadamard and Walsh transformation. Image enhancement in spatial and frequency domain: Basics, smoothing and sharpening domain filters.	**10**
Unit -III Image Restoration & Reconstruction: Introduction, Model of Image degradation, Noise Models, Classification of image restoration techniques, Blind-deconvolution techniques, Lucy Richardson Filtering, Wiener Filtering.	**10**
Unit - IV Image Segmentation & Analysis, Implementation Feature extraction: Edges, Lines & corners detection, Texture & shape measures. Segmentation & thresholding, region extraction, edge (Canny) & region based approach, use of motion in segmentation. overview of various features extraction.	**10**

Unit - V	10
Image Compression & Object Recognition: Introduction to Image Compression and its need, Coding Redundancy, Classification of Compression techniques (Lossy and Lossless - JPEG, RLE, Huffman, Shannon fano), Scalar & Vector Quantization, Introduction to Object Recognition, Object Representation (Signatures, Boundary Skeleton), Overview of Multi-spectral image processing. Introduction to video image processing.	

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Analyze general terminology of digital image processing.
- Examine various types of images, intensity transformations and spatial filtering.
- Develop Fourier transform for image processing in frequency domain.
- Evaluate the methodologies for image segmentation, restoration etc.
- Implement image process and analysis algorithms.

Text books

1. Digital Image Processing using MATLAB, R.C. Gonzalez, R.R. Woods (Person), 2nd Edition.
2. S. Sridhar: Digital Image Processing, Oxford University Press publication, 7th impression 2016.

Reference books

1. Anil Jain, "Fundamentals of Digital Image Processing", Anil Jain PHI, ISBN-81-203- 0929-4.
2. W.K.Pratt.-Digital Image Processing ,3/e Edn., John Wiley & sons, Inc. 2006.
3. M. Sonka et.al Image Processing, Analysis and Machine Vision, 2/e, Thomson, Learning, India Edition, 2007.
4. Digital Image Processing using MATLAB, R.C. Gonzalez, R.R. Woods(Person), 2nd Edition
5. Introduction to Digital Image Processing with MATLAB, Alasdair McAndrew, Cenage Learning.

Scientific Computing

Course Code: PGMTH1E033T

Course Title: Scientific Computing

Semester: I

Credits: 04

Rationale

Computation becomes crucially important in situations like the problem at hand cannot be solved by customary experimental or theoretical means e.g. attempt to predict climate change. The traditional programming languages are not able to deal with complex problems that involve specialised computations on specific formats of data. The modern programming languages such as Python or matrix laboratory are significant to code a complicated algorithm in an efficient manner.

Contents	**No. of Lecture**
Unit-I Introduction to Python: Basic Characteristics of Python, Data Types, Variables, Operators and Branching, Writing Python Code using Jupyter notebook or spider, Core elements of programs: Bindings, Strings, Input/Output, IDEs, Control Flow, Iteration, Guess and Check, Simple Programs Functions: Decomposition and Abstraction, Functions and Scope, Keyword Arguments, Specifications, Iteration vs Recursion, Inductive Reasoning, Files.	**10**
Unit-II Tuples and Lists in Python: Tuples, Lists, List Operations, Mutation, Aliasing, Cloning, Dictionaries, Functions as Objects, Dictionaries, Example with a Dictionary, Global Variables, Debugging, Programming Challenges, Regular expressions, Debugging Examples, Assertions and Exceptions, Assertions, Exceptions, Exception Examples.	**10**
Unit-III Data Handling using Python: Overview of Numpy and Pandas libraries, Numeric and Date Functions, Misusing Statistics, Garbage in Garbage Out, Pyplot library, Data Enhancement, Visualization of Data, Visualizing Results, Overview of OpenCv library, Working with image and video data.	**10**
Unit-IV Overview of MATLAB: Basics, Variables, Matrix operations, Built-in functions,	**10**

Controlling work flow, Basic input/output, Scripts and functions, Reading and writing data, Fitting a model to data, Recursive functions, random numbers and simulations, Solving differential equations, Plotting in 2D and 3D, Creating simple GUI in MATLAB.	
Unit-V Scientific Tools: Scientific paper writing with Latex tool, Graph plotting tools using Origin, Smart Draw, Overview of Simulation tools, Network Simulator NS2, Fuzzy tool, NN tool, GA tool, Cloud-Sim. Robotics Systems tool, TensorFlow.	**10**

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Write scientific programs to implement advanced algorithms.
- Build the GUI applications using MATLAB.
- write a scientific paper in well-structured formats of standard Journals.
- Students will be able to use scientific tools to simulate their algorithms/ techniques.
- Plot scientific graphs and draw effective diagrams using typical tools.

Text books

1. Kenneth A Lambert, "Fundamentals of Python first Programmes", Copyrighted material Course Technology Inc. 1 st edition, 2009.
2. William J. Palm III, "Introduction to MATLAB® for Engineers", 3rd Edition, McGraw-Hill: New York, NY, 2010.

References books

1. Python Programming using problem solving Approach by Reema Thareja, Oxford University, Higher Education Oxford University Press; First edition (10 June 2017), ISBN-10: 0199480173.
2. Holly Moore, MATLAB® for Engineers, 3rd Edition, 2012, Pearson, New York.
3. Data Structures and Algorithms in Python by Michael T Goodrich and Robertto Thamassia, Micheal S Goldwasser, Wiley Publisher (2016).
4. Amos Gilet, MATLAB An Introduction with Applications, Wiley India Pvt. Ltd, 2016
5. Musto Joseph, Engineering Computation: an Introduction Using Matlab and Excel - An Introduction Using MATLAB and Excel, 2017.

SEMESTER-II

Advanced Database Management Systems

Course Code: PGMTH2C011T

Course Title: Advanced Database Management Systems

Semester: II

Credits: 04

Rationale

Advanced database management systems (DBMS) has always been at the core of efficient database and information systems. It treats a wealth of different data models and surveys the foundations of structuring, processing, storing and querying data according to these models. The database management system is the basic software that interacts with a database and the user. DBMS helps to create, update, and eliminate DB objects. This course provides a detailed insight into implementation, efficient retrieval, and modification aspects of relational database systems.

Course Outlines

Contents	**No of Lectures**
Unit-I RDBMS: An overview of the database management system, database system Vs file system, Database system concepts and architecture, data models schema and instances, ER Model, Database models, Representation and Evaluation of Relationship Review of Relational Database Design, Storage, Access Structures.	**10**
Unit-II RDBMS Design: Functional Dependency, Anomalies in a Database, The normalization process, Conversion to first normal form, Conversion to second normal form, Conversion to third normal form, The boyce-code normal form(BCNF), Fourth Normal form and fifth normal form, normalization and database design, De-normalization, Review of SQL99, Basics of query processing, external sorting, file scans.	**10**

Unit-III Query Optimization: Algorithm for Executing Query Operations, External sorting, Select operation, Join operation, PROJECT and set operation, Aggregate operations, Outer join, Heuristics in Query Optimization, Semantic Query Optimization, Converting Query Tree to Query Evaluation Plan, multiquery optimization and application, Efficient and extensible algorithms for multi-query optimization, execution strategies for SQL sub queries, Query Processing for SQL Updates.	**10**
Unit-IV Transaction Processing: Introduction of transaction processing, advantages and disadvantages of transaction processing system, online transaction processing system, serializability and recoverability, view serializability, resolving deadlock, distributed locking. Transaction management in multi-database system, long duration transaction, high-performance transaction system. Concurrency: Enforcing, Serializability by Locks, Locking Systems With Several, Lock Modes, Architecture for a Locking Scheduler Managing Hierarchies of Database Elements, Concurrency Control by Timestamps, Concurrency Control by Validation, Database recovery management.	**10**
Unit-V Advanced Topics in Database: Object Relational and Extended Relational Databases, Active database: starburst, oracle, DB2, chimera, Applications of active database, design principles for active rules, Temporal database, special, text and multimedia database. Video database management, storage management for video, video preprocessing for content representation and indexing, image and semantic-based query processing, real time buffer management.	**10**

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Execute various advance SQL queries related to Transaction Processing & Locking using concept of Concurrency control.
- Demonstrate use of Database Object.
- Understand Functional Dependency and Functional Decomposition.
- Apply various Normalization techniques for database design.

Text Books

1. Korth, Silbertz, Sudarshan, “Database Concepts”, McGraw Hill, 7/e, 2020.
2. Elmasri, Navathe, “Fundamentals of Database Systems”, Addision Wesley, 7/e, 2015

Reference Books

1. Date C J, “An Introduction To Database System”, Addision Wesley, 2010
2. Bipin C. Desai, “An introduction to Database Systems”, Galgotia Publication, 2010
3. Rob and Coronel, “Database Systems 5th Edition”, Cengage Learning, New Delhi, 2018
4. Jiawei Han and Micheline Kamber, “Data Mining Concepts and Techniques”, Morgan Kauffmann Publishers, 3/e, 2011.
5. R. Ramakrishnan, J. Gehrke, Database Management Systems, McGraw Hill, 2004

Advanced Software Design, Development & Testing

Course Code: PGMTH2C012T

Course Title: Advanced Software Design, Development and Testing

Semester: II

Credits: 04

Rationale

This will acquaint students with a systematic and organized approach for developing the software. Also, it provides a scope to students where they can solve small, real-life problems. The student will learn an individual as well as teamwork approach for project development and understand various software quality assurance as well as testing approaches

Course Outlines

Contents	**No of Lectures**
Unit-I Process and product quality, Process classification, Process measurement, Process analysis and modelling and Process change. The CMMI process improvement framework, Configuration management planning, Change management, Version and release management, System building and CASE tools for configuration management.	**10**
Unit-II Metrics in the Process and Project Domains, Software Measurement, Metrics for software quality, Integrating metrics within the software process, Metrics for small organizations and Establishing a software metrics program.	**10**
Unit-III The reuse landscape, Design patterns, Generator-based reuse, Application frameworks and Application system reuse. Components and component models, Component Based Software Engineering (CBSE) process and Component composition.	**10**

User interface design issues, The UI design process, User analysis, User interface prototyping and Interface evaluation. Software maintenance, Business process reengineering, Software reengineering, Reverse engineering, Restructuring, Forward engineering and The economics of reengineering.	
Unit-IV Services as reusable components, Service engineering, Software development with services, Aspect-Oriented Software Development. The separation of concerns, Aspects, join points and point-cuts and Software engineering with aspects.	**10**
Unit-V The Cleanroom Strategy, Functional specification, Cleanroom design, Cleanroom testing; Formal methods and concepts, Applying mathematical notation for formal specification, Formal specification languages and Various types of advanced testing strategies: Regression Testing Random testing, Web Based Testing etc.	**10**

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Design, analyze, implement, test and deliver real-world software systems.
- Design software engineering processes appropriate to a specific problem or set of non-functional requirements.
- Understand and apply cutting edge computing technology to the solution of complex problems in software engineering.
- Work with external stakeholders to develop quality requirements specifications.
- Effectively manage large teams utilizing a variety of software engineering processes.

Text Books

1. Roger S.Pressman, "Software engineering- A practitioner's Approach", McGraw-Hill International, 2011.
2. Ian Sommerville, "Software engineering", Pearson education Asia, 2010.

Reference Books

1. Pankaj Jalote, "Software Engineering", A Precise Approach Wiley, 2011.
2. Ali Behhforoz & Frederick Hudson, "Software Engineering Fundamentals", Oxford Press, 2011.

3. Robert Martin, “Agile Software Development, Principles, Patterns, and Practices”, Pearson; 1/e, 2002.
4. Martin Fowler, “Patterns of Enterprise Application Architecture by, Addison-Wesley; 1/e, 2002.

Network and Cyber Security

Course Code: PGMTH2E031T

Course Title: Network and Cyber Security

Semester: II

Credits: 04

Rationale

Cyber security is the practice of defending an organization's networks, computers and data from unauthorized digital access, attack or damage by implementing various processes, technologies and practices. A good network security system helps to reduce the risk of falling victim of data theft and sabotage. Network security is significant in protecting your workstations from harmful spyware. Huge traffic can cause stability problems and may lead to vulnerabilities in the system.

Course Outlines

Contents	**No of Lectures**
Unit-I Introduction: Information Security, Threats, Vulnerabilities, Cryptographic and non-cryptographic attacks. Types of Malware: Virus, Worms, Trojans, Rootkits, Robots, Adware's, Spywares, Ransom wares, Zombies etc., Malware analysis, Malware obfuscation and mutations, zero day vulnerabilities.	**10**
Unit-II Cybercrimes: Introduction, classification of cybercrimes, types of cybercriminals,3P's in cybercrime-phishing, pharming and phoraging, cyberstalking; internet bots, botnet attacks and defence, network reconnaissance, attack vectors ,advanced persistent threat(APT).	**10**

Unit-III Tools and Techniques: Introduction, Proxy servers, Anonymizers, Keyloggers, Steganography, DOS/DDOS attacks, SQL Injections, Buffer overflow, Web based attacks-Web service protection, Website Hardening, Website exploitation, HTTP response splitting attacks.	**10**
Unit-IV Cyber Threats and defense: Firewalls and its types, Intrusion Detection System (IDS), Intrusion Prevention System (IPS), Virtual Private Networks (VPN) and Access Control, Domain Name system protection-Cache poisoning attack, Honeypots and its working, analysing honeypot data.	**10**
Unit-V Ethical Hacking: Hacking and its types, ethical hacking process, Doxing, Website/ IP information Gathering, Network Mapping, Google Hacking, Discovering IP Range and Open Port, Identifying Target Operating System and Services, Introduction to open source tools e.g. nmap/zenmap/Wireshark etc.	**10**

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Understand the various cyber threats and vulnerabilities.
- Classify the different cyber crimes and preventive measures.
- Analyse tools for cybersecurity.
- Work on various tools for cyber-attacks and defense.
- Develop skills as an ethical hacker.

Text Books

1. Nina Godbole, Sunit Belapure, "Cyber Security", Wiley India, 1st Edition, 2015.
2. Chwan-Hwa (John) Wu, J. David Irwin, "Introduction to Computer Networks and Cyber Security", CRC Press, 1/e, 2014.

Reference Books

1. Behrouz A. Forouzan, "Cryptography and Network Security", McGrawHill, 3/e, 2017.

2. William Stallings, “Network Security Essentials”, Pearson, 4th Edition, 2011.
3. Yuri Diogenes, Erdal Ozkaya, “Cyber Security-Attack and Defense Strategies”, 1/e, Packt Publishing, 2018.

Big Data Analytics

Course Code: PGMTH2E032T

Course Title: Big Data Analytics

Semester: II

Credits: 04

Rationale

The rapid rise of the internet and digital transactions led to an exponential growth in demand for data storage and analytics. Big Data analytics is a data analysis methodology enabled by recent advances in technologies supports high-velocity data capture, storage and analysis. Besides many benefits, the Big Data also has raised few security and privacy concerns. This course introduces the students to the basic concepts of Big Data concerning their storage and analysis.

Course Outlines

Contents	**No of Lectures**
Unit-I Big Data: Introduction, Need of Big Data, Classification of Data, Characteristic Features, Big Data Types, Big Data Handling Techniques, Classification Methods for data and Big Data, Designing Data Architecture Design, Managing Data for Analysis, Data Sources, Data Quality, Data Preprocessing, Big Data vs Traditional Data, Big Data Applications, Different Big Data platforms, Phases in Big Data Analytics.	**10**
Unit-II Introduction to NoSQL, NoSQL Data Store, Big Data NoSQL, Features in No-SQL Transactions, Big Data No SQL Solutions, Significance of NoSQL, CAP theorem, NoSQL Data Architecture Patterns, Graph Databases, Variations of NOSQL Architectural Patterns, Using NoSQL to mange Big Data, Types of Big Data Problems, Comparison of NoSQL with other Databases, Shared Nothing Architecture for Big Data Tasks, Mongo DB Database, Features of Mongo DB, CASSANDRA Databases.	**10**

Unit-III Introduction to Hadoop, Hadoop Core Components, Features of Hadoop, Hadoop Ecosystem Components, Hadoop Streaming, Hadoop Pipes, Design of Hadoop Distributed File System, HDFS Concepts, HDFS Commands, Hadoop Yarn, Hadoop 2 Execution Model, Map reduce Framework, Mapreduce Programming Model, Hadoop Ecosystem, Ambari, HBase, Hive, Pig, Mahout.	**10**
Unit-IV Statistical Methods: Regression Analysis, Simple Linear Regression, Multiple Regressions, Regression Modelling, K-Nearest Neighbour Regression Analysis, Frequent Item sets and Association Rule Mining, Apriori Algorithm, Classification Concepts, Supervised Learning, Unsupervised Learning, K-Nearest Neighbour Classifier, Decision Tree Algorithm, Naive Bayes Classifier, Support Vector Machine Classifier, Adaboost and other Ensemble Classifiers. Clustering: Types of Data in Cluster Analysis, K- means clustering, k-medoids, Hierarchical Clustering, Recommendation System, Models for Recommendation Systems.	**10**
Unit-V Introduction to R language, Advantages of R over other programming languages, Basic R programming commands, Data type in R, Loading and Handling Data in R, Expressions, Variables, Functions, Logical Values, Manipulating Text in Data using R, Different R functions for Understanding Data in Data Frames, Simple Analysis using R, Different Methods for Reading Data, Exploring Dataset in R, Missing Value Treatment in R. Predictive Analytics using R: Linear Regression, Logistic Regression analysis using case studies.	**10**

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Identify Big Data and its Business Implications.
- Understand the benefits that Big Data can offer to organizations.

- Handle the large datasets using Big Data Storage platforms like Hadoop and NoSQL.
- Analyze the different types of datasets using R programming language.
- Apply Machine Learning Techniques using R.

Text Books

1. Raj Kamal and Preeti Saxena, "Big Data Analytics: Introduction to Hadoop, Spark and Machine Learning", Mc Graw Hill Education (India) Private Limited 2019.
2. Seema Acharya,“ Data Analytics Using R”, Mc Graw Hill Education (India) Private Limited 2018.

Reference Books

1. Michael Minelli, Michelle Chambers, and AmbigaDhiraj, "Big Data, Big Analytics: Emerging Business 2013.
2. P. J. Sadalage and M. Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, 2012.
3. Tom White, "Hadoop: The Definitive Guide", Third Edition, O'Reilley, 2012.
4. Eric Sammer, "Hadoop Operations", O'Reilley, 2012.
5. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilley, 2012.

Computing Systems for Robotics

Course Code: PGMTH2E033T

Course Title: Computing Systems for Robotics

Semester: II

Credits: 04

Rationale

Robotics as an application draws from many different fields and allows automation of products as diverse as cars, vacuum cleaners, and factories. The mathematical basis of each area is emphasized, and concepts are motivated using common robotics operating systems and programming exercises. The main objective of this course is to understand ROS publisher-subscriber strategy, working of Simulated Robots, and to implement Robot navigation algorithms.

Course Outlines

Contents	**No of Lectures**
Unit-I Introduction to ROS, publisher-subscribers in ROS, creating user node in ROS. Communication between on ROS nodes through messages. Select and implement the appropriate ROS components for a robotics problem.	**10**
Unit-II Working with turtlesim and turtlebot-gazebo simulators. Building a user defined world in Gazebo. Translation, rotation, scaling of models. Saving and loading of a world. Communicating with the simulators.	**10**
Unit-III Visualize the simulated robot in rviz. Visualizing Sensor Data with rviz. Creating map of the environment in Gazebo. Saving and Loading of the map.	**10**
Unit-IV Apply algorithms for robotic perception, planning, navigation, localization, and manipulation. Implement and use algorithms for controlling mobile robots.	**10**
Unit-V Program and navigate mobile robots: robot and map representations, motion planning.	**10**

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Create their publisher and subscriber in ROS.
- Communicate messages among the ROS nodes.
- Send and receive messages to the simulated robots.
- Navigate Robot using ROS.

Text Books

1. Jason M. O'Kane, "A Gentle Introduction to ROS, independently published", Updated on 2016.
2. Programming Robots with ROS: A Practical Introduction to the Robot Operating System.

Reference Books

1. Carol Fairchild, Dr. Thomas L. Harman, ROS Robotics By Example, Second Edition: Learning to control wheeled, limbed, and flying robots using ROS Kinetic Kame Paperback November 30, 2017.
2. **Introduction to AI Robotics, by Robin R. Murphy,** MIT Press.
3. **Robot Modeling and Control by Mark W. Spong, Seth Hutchinson, M. Vidyasagar, John Wiley & Sons, Inc.**
4. **Robotics: Discover The Science and Technology of the Future with 20 Projects (Build It Yourself) by Kathy Ceceri, Nomad Press (1 August 2012).**

Agile Software Development

Course Code: PGMTH2E034T

Course Title: Agile Software Development

Semester: II

Credits: 04

Rationale

Over last fifteen years, the software industry has explored a number of lightweight development methodologies as alternative approaches for building software. These software development methodologies namely *agile* methodologies emphasize the value of people, programmers, and clients over rigid processes. In this course, students will study the key ideas underlying agile methodologies. We will also explore the practices of a specific agile approach, extreme programming.

Course Outlines

Contents	**No of Lectures**
Unit-I Agile Software Development: Basics and Fundamentals of Agile Process Methods, Values of Agile, Principles of Agile, stakeholders, Challenges, Understanding how traditional software development works and it's problems; Role of Agile practices in the world of software development & Tools used.	**10**
Unit-II Lean Approach: Waste Management, Kaizen and Kanban, add process and products add value. Roles related to the lifecycle, differences between Agile and traditional plans, differences between Agile plans at different lifecycle phases. Testing plan links between testing, roles and key techniques, principles, understand as a means of assessing the initial status of a project/ How Agile helps to build quality	**10**
Unit-III Agile and Scrum Principles: Agile Manifesto, Twelve Practices of XP, Scrum Practices, Applying Scrum. Need of scrum, working of scrum, advanced Scrum	**10**

Applications, Scrum and the Organization, scrum values. Agile Product Management: Communication, Planning, Estimation Managing the Agile approach Monitoring progress, Targeting and motivating the team, Managing business involvement, Escalating issue. Quality, Risk, Metrics and Measurements, Managing the Agile approach Monitoring progress, Targeting and motivating the team, Managing business involvement and Escalating issue.	
Unit-IV Agile Requirements: User Stories, Backlog Management. Agile Architecture: Feature Driven Development. Agile Risk Management: Risk and Quality Assurance, Agile Tools Agile Testing: Agile Testing Techniques, Test-Driven Development, User Acceptance Test.	**10**
Unit-V Agile Review: Agile Metrics and Measurements, The Agile approach to estimating and project variables, Agile Measurement, Agile Control: the 7 control parameters. Agile approach to Risk, The Agile approach to Configuration Management, The Atern Principles, Atern Philosophy, The rationale for using Atern, Refactoring, Continuous integration, Automated Build Tools Scaling Agile for large projects: Scrum of Scrums, Team collaborations, Scrum, Estimate a Scrum Project, Track Scrum Projects, Communication in Scrum Projects, Best Practices to Manage Scrum.	**10**

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Demonstrate the ability to participate effectively in agile practices/process for software development.
- Explain the purpose behind common agile practices.
- Apply agile principles and values to a given situation.
- Identify and address most common problems encountered in adopting Agile methods.

Text Books

1. Robert C. Martin, "Agile Software Development, Principles, Patterns and Practices", Prentice Hall, 2011.
2. Addison Wesley, "Succeeding with Agile : Software Development Using Scrum", Pearson, 2010.

Reference Books

1. Ken Schwaber, Mike Beedle, "Agile Software Development with Scrum", Pearson. 2008.
2. Roger S. Pressman, "Software Engineering, A practitioner's Approach", McGraw Hill 7/e 2015.
3. Sommerville, "Software Engineering", Pearson education 7/e, 2012.
4. Rajib Mall, Fundamentals of software Engineering, Prentice Hall of India.

5. Engineering Software as a Service An Agile Software Approach, Armando Fox and David Patterson

Wireless Sensor Networks

Course Code: PGMTH2E035T

Course Title: Wireless Sensor Networks

Semester: II

Credits: 04

Rationale

Wireless Sensor Networks are pervasive computing systems that consist of sensors embedded in the physical world. These systems have many applications including long-term monitoring of habitats, finding parking spaces in crowded cities, or monitoring the physiology, activity patterns of patients, etc. Wireless sensor networks provide the basis for new computing paradigms that challenge many of the classical approaches to developing distributed and networking systems. This course considers the challenges of developing operating systems, wireless networking protocols, power-management, and middle-ware to support this new type of system.

Course Outlines

Contents	**No of Lectures**
Unit 1 Introduction: Fundamentals of wireless communication technology, electromagnetic spectrum radio propagation, characteristics of wireless channels, modulation techniques, multiple access techniques, wireless LANs, PANs, WANs, and MANs, Wireless Internet.	**10**
Unit-II Introduction to adhoc/sensor networks: Key definitions of adhoc/ sensor networks, unique constraints and challenges, advantages of ad-hoc/sensor network, driving applications, issues in adhoc wireless networks, issues in design of sensor network, sensor network architecture, data dissemination and gathering.	**10**
Unit III MAC Protocols: Issues in designing MAC protocols for adhoc wireless networks, design goals, classification of MAC protocols, MAC protocols for	**10**

sensor network, location discovery, quality, other issues, S-MAC, IEEE 802.15.4.	
Unit IV Routing Protocols: Issues in designing a routing protocol, classification of routing protocols, table-driven, on-demand, hybrid, flooding, hierarchical, and power aware routing protocols.	**10**
Unit-V QoS and Energy Management: Issues and Challenges in providing QoS, classifications, MAC, network layer solutions, QoS frameworks, need for energy management, classification, battery, transmission power, and system power management schemes. Security: Possible attacks, countermeasures, SPINS, Static and dynamic key Distribution.	**10**

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Understand the basis of Sensors with their applications.
- Learn the architecture and placement strategies of Sensors.
- Analyze routing and congestion algorithms.
- Design, develop, and carry out performance analysis of sensors on specific applications.

Text/Reference Books

1. C. Siva Ram Murthy, and B. S. Manoj, "AdHoc Wireless networks ", Pearson Education, 2008
2. Holger Karl and Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks”, John Wiley & Sons, Ltd, 2005.

Reference Books

1. W. Dargie and C. Poellabauer, “Fundamentals of Wireless Sensor Networks –Theory andPractice”, Wiley 2010.
2. Kazem Sohraby, Daniel Minoli and TaiebZnati, “Wireless Sensor Networks, Technology, Protocols, and Applications”, Wiley Inderscience, 2007.
3. Takahiro Hara,Vladimir I. Zadorozhny, and Erik Buchmann, “Wireless Sensor Network Technologies for the Information Explosion Era”, Springer, 2010.
4. Feng Zhao and Leonides Guibas, "Wireless Sensor Networks ", Elsevier publication, 2004.
5. Jochen Schiller, "Mobile Communications", Pearson Education, 2/e, 2003.

Data Warehousing and Mining

Course Code: PGMTH2E036T

Course Title: Data Warehousing and Mining

Semester: II

Credits: 04

Rationale

Due to the importance of extracting knowledge/information from large data repositories, Data mining has become a popular tool. This course deals with the important algorithms and computational paradigms that allow computers to find patterns and regularities in databases and perform predictions. In this course, special emphasis will be given to the algorithms as they provide real knowledge discovery tools. Important related technologies, as data warehousing and on-line analytical processing (OLAP) will be also discussed.

Course Outlines

Contents	**No of Lectures**
Unit-I Introduction to Data Warehousing: Features, Architecture of Data warehouse, Data warehouse schema, OLAP in data warehouse, trends in data warehousing. Data mining, data mining versus knowledge discovery in databases, basic data mining tasks, process of data mining (CRISP-DM), data mining issues, data mining techniques for analysis.	**10**
Unit-II Statistical based: Logistic Regression, Bayes classification, Distance-based, Simple approach, K Nearest Neighbour, Decision tree Induction, Rule-based Classification, Support Vector Machine. Case Study: Prediction of Diabetes using Classification Algorithm.	**10**
Unit-III Clustering: K means Clustering, Agglomerative Hierarchial Clustering, Partitional Algorithms, Squared- Error Clustering, K means Clustering, Anomaly or Outlier Detection, Association Rules, Apriori Algorithm	**10**
Unit-IV Introduction, Working of Predictive analytics, Models: Predictive and Descriptive, Stages of Predictive Analysis, Data Collection, Data Analysis, Statistics, Modelling, Deployment and Monitoring, Graph Mining.	**10**
Unit-V Recent trends in Data Mining: Web Mining, Temporal Mining/Spatial	**10**

Mining, Distributed Data mining, Oracle Data mining, Data mining in Bio Informatics, Data mining as a service (DMaaS).	

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Identify the difference between operational and information systems**.**
- Compare and contrast the pros and cons of various machine learning techniques and to get an insight into when to apply a particular machine learning approach.
- Mathematically analyze various machine learning approaches and paradigms.
- Work with web mining, temporal mining and spatial mining.
- Design intelligent systems that learn automatically.

Text Books

1. Margaret H. Dunham, "Data Mining- Introductory and advanced concepts", Perason, tenth Edition, 2012.
2. Parteek Bhatia, "Data Mining and Data Warehousing: Principles and Practical Techniques", Cambridge, 2019.

Reference Books

1. Vipin Kumar, Pang-Ning Tan, Michael Steinbach, "Introduction to Data Mining",Wesley, 2006.
2. M. Gopal, "Applied Machine Learning", McGrawHill Education, 2019.
3. Reema Thareja , "Data Warehousing",Oxford University Press, Ninth Edition, 2019.
4. Ethem Alpaydin, "Introduction to Machine Learning", Third Edition,PHI Learning Private Limited,2018.
5. Tom M. Mitchel, "Machine Learning", McGrawHill Education,2013.

Computer Vision

Course Code: PGMTH2E037T

Course Title: Computer Vision

Semester: II

Credits: 04

Rationale

Computer vision is a field of artificial intelligence that trains computers to interpret and understand the visual world. Using digital images from cameras and videos and deep learning models, machines can accurately identify and classify objects and then react to what they "see." The focus of the course is to develop the intuitions and mathematics of the lecture methods, and then to learn about the difference between theory and practice in the problem sets.

Course Outlines

Contents	**No of Lectures**
Unit-I Overview, computer imaging systems, lenses, Image formation and sensing, Image analysis, pre-processing and Binary image analysis.	**10**
Unit-II Edge detection, Edge detection performance, Hough transform, corner detection.	**10**
Unit-III Segmentation, Morphological filtering, Fourier transform Recent trends in Activity Recognition, computational photography, Biometrics.	**10**
Unit-IV Feature extraction, shape, histogram, colour, spectral, texture, using CVIPtools, Feature analysis, feature vectors, distance /similarity measures, data pre-processing.	**10**
Unit-V Pattern Analysis: Clustering: K-Means, K-Medoids, Mixture of Gaussians. Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised. Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA,	**10**

ICA, and Non-parametric methods.	

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Develop the practical skills necessary to build computer vision applications using image sensing and analysis.
- Have gained exposure to object and scene recognition and categorization from images.
- Analyse the patterns by applying intelligent techniques.
- Apply computer vision methods to develop real-life intelligent systems.

Text books

1. Richard Szeliski, Computer Vision: Algorithms and Applications 3rd Edion , 2015.
2. E. R. Davies; Computer Vision: Principles, Algorithms, Applications, Learning Kindle Edition.

Reference books

1. Jan Erik Solem, Programming Computer Vision with Python: Techniques and Libraries for Imaging and Retrieving Information, OReilly.
2. Forsyth / Ponce ,Computer Vision: A Modern Approach Paperback – 1 January 2015.
3. Good fellow, Bengio, and Courville :Deep Learning, 1st edion 2016.
4. Fisher et al: Dictionary of Computer Vision and Image Processing, 1st Edion 2014.

Advanced Object Oriented Programming

Course Code: PGMTH2E038T

Course Title: Advanced Object Oriented Programming

Semester: II

Credits: 04

Rationale

In the object-oriented approach, the focus is on capturing the structure and behavior of information systems into small modules that combine both data and process. The main aim of Object-Oriented Design (OOD) is to improve the quality and productivity of system analysis and design by making it more usable.

Course Outlines

Contents	**No of Lectures**
Unit-I The structure of a Java class, Working With Java Data Types, Using Operators and Decision, operators Creating and Using Arrays, Using Loop, Working with Methods and, Encapsulation Working with Inheritance. Class designing, Encapsulation and Visibility Modifiers, Formal and Actual Parameters, Scope of a Parameter, Call by Value, & Primitive Parameters Object Parameters, Overload methods, Use the instance of operator and casting.	**10**
Unit-II I/O Basics Streams, Byte Streams and Character Streams, Read and write data from the console, Use streams to read and write files, Use the Path class to operate on file, and directory paths Process, Thread, Defining a Thread, Instantiate a Thread, Starting Threads, Thread Life-cycle, Thread Priorities, Methods for Threads Implementation, Multithreading.	**10**
Unit-III Basic socket overview, client/server, reserved sockets, proxy servers, internet addressing, networking classes and interfaces, Internet address, TCP/IP Client	**10**

Sockets, URL connection, TCP/IP server sockets. Java as a Database frontend, Database client/server methodology, Two-Tier Database Design, Three-Tier Database Design. The API Components, Limitations Using JDBC(Applications vs. Applets), Security Considerations, JDBC Drivers, JDBC-ODBC Bridge, Current JDBC Drivers.	
Unit-IV Background, The Life Cycle Of a Servlet, The Java Servlet Development Kit, The Simple Servlet, The Servlet API, The Javax Servlet Package, Reading Servlet, Parameters Reading Initialization Parameters, The Javax. Servlet. http package, Handling HTTP Requests and responses, Using Cookies, Session Tracking, Security Issues, Exploring Servlet.	**10**
Unit-V Applets: Applet basics, Including an Applet on a Web Page, Graphics, animation, painting in applet. Java server pages : JSP Development Model, Components of JSP page, Request Dispatching, Session and Thread Management.	**10**

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Evaluate user requirements for software functionality required to decide whether the Java programming language can meet user requirements.
- Develop software in the Java programming language.
- Use the Java programming language for various programming technologies.
- Use certain technologies by implementing them in the Java programming language to solve the given problem.

Text/Reference Books

1. Herbert Schildt, Java - The Complete Reference, Tata McGraw- Hill, Seventh Edition, 2008.
2. Jim Keogh, J2EE- The Complete Reference; Tata Mcgraw-Hill, Edition, 2002.

Reference Books

1. Alur Deepak, Malks Dan and Crupi John, Core J2EE Patterns: Best Practices and Design Strategies, Prentice Hall India (2001).
2. Austin and Pawlan, Advanced Programming for JAVA 2 Platform, Pearson Education (2004).
3. Geary M. David , Core JSTL Mastering the JSP standard Tag Library, Pearson Education(2007).

SEMESTER-III

Artificial Intelligence and Machine Learning

Course Code: PGMTH3C010T

Course Title: Artificial Intelligence and Machine Learning

Semester: III

Credits: 04

Rationale

Artificial intelligence (AI) is playing a very prominent role, and of late, this term has been gaining popularity due to the recent advances in the field of intelligent computing. Machine learning (ML) is that sphere of artificial intelligence where the machines are responsible for ending daily chores and are believed to be smarter than humans. These machines tend to speed up your tasks and processes along with a guaranteed level of precision and accuracy, and therefore these are what make them a useful and important tool.

Contents	**No. of Lectures**
Unit-I Data Science, AI & ML: Application areas, Introduction to AI-Problem formulation, Problem Definition, Production systems, Control strategies, Search strategies. Problem characteristics, Production system characteristics, Heuristic functions Hill Climbing, Depth first and Breath first, Constraints satisfaction, Related algorithms, Measure of performance and analysis of search algorithms. Introduction to Knowledge representation. Machine learning techniques and applications.	**10**
Unit - II Data pre-processing: Data reading and handling with different formats, treating missing values, data visualization(Numpy, pandas and Matplotlib libraries). Supervised Learning (Regression/Classification): Basic methods: Distance-based methods, Nearest-Neighbours, Decision Trees, Naive Baye's. Linear models: Linear Regression, Logistic Regression, Generalized Linear Models, Support Vector Machines, Nonlinearity and Kernel Methods, Beyond. Binary Classification: Multi-class/Structured Outputs, Ranking**.**	**10**
Unit -III Unsupervised Learning: Clustering: K-means/Kernel K-means, Dealing with continuous, categorical values in K-Means. Dimensionality Reduction: PCA and kernel PCA Matrix Factorization and Matrix	**10**

Completion, Generative Models (mixture models and latent factor models).	
Unit - IV Model evaluation and validation: Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests). Limitations and solution of handcrafted machine learning.	**10**
Unit - V Deep Learning: Deep Learning and Feature Representation Learning, Convolutional Neural Networks(CNN), Image classification, Image classification and hyper-parameter tuning, Text classification, Recurrent Neural Networks(RNN), Auto-encoders, Generative Adversarial Networks(GANs), Long Short-Term Memory (LSTM). Counter measuring over fitting and under fitting: Regularization, Dropout and Batch normalization, Overview of attacks on Deep Neural Networks.	**10**

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Analyse various AI problem-solving approaches and knowledge representations.
- Compare and contrast the pros and cons of various machine learning techniques and get an insight into when to apply a particular machine learning approach.
- Apply machine learning for image and text classification.
- Design intelligent systems that learn automatically.
- Design deep learning-based models for automatic classification.

Text books

1. Peter Jackson, "Introduction to Expert Systems", 3rd Edition, Pearson Education, 2007.
2. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012

Reference books

1. Deepak Khemani "Artificial Intelligence", Tata Mc Graw Hill Education 2013.
2. Kevin Night and Elaine Rich, Nair B., "Artificial Intelligence (SIE)", Mc Graw Hill-2008.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning,Springer 2009
4. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007.

Pattern Recognition

Course Code: PGMTH3E019T

Course Title: Pattern Recognition

Semester: III

Credits: 04

Rationale

Pattern recognition aims to classify objects of interest into one of many categories or classes. The objects of interest are referred to as patterns and may range from printed characters and shapes in images to electronic waveforms and digital signals, following the data under consideration. Pattern recognition is fundamental to our understanding of the world; it is an important element in every mathematics curriculum. The importance of patterns usually gets lost in a repeating pattern of two-dimensional shapes.

Contents	**No of Lectures**
Unit-I Introduction to pattern recognition: Learning paradigms, pattern recognition application area, Supervised and unsupervised learning. Probability: independence of events, conditional and joint probability. Processes: Stationary and non-stationary processes, Expectation, Autocorrelation, Cross-Correlation, spectra. Introduction to Statistical, Structural and Neural Approaches.	**10**
Unit-II Statistical Pattern Recognition: Patterns and classification, discriminant functions, Bayes Decision Theory, Minimum-error-rate classification. Classifiers, Discriminant functions, Decision surfaces. Normal density and discriminant functions. Discrete features. Parameter Estimation Methods: Maximum-Likelihood Estimation: Gaussian case. Maximum a Posteriori estimation. Bayesian estimation, Gaussian case. Unsupervised learning and clustering: Criterion functions for clustering, Algorithms for clustering, K-Means, Hierarchical and other methods.	**10**
Unit-III Biometrics as a Pattern Recognition tool: Evolution, Biometric traits, Biometrics Vs. traditional recognition techniques, Characteristics of a good biometrics, Benefits of biometrics, Key biometric processes: verification, identification and biometric matching, Performance measures in biometric systems, FAR, FRR,	**10**

FTE, FTA rate, EER, ROC, DTE etc., Biometrics applications, Challenges to biometrics systems.	
Unit-IV Overview of uni-biometric systems: Fingerprint, Fingerprint Classification, Overview and working of Iris, Hand geometry, Face recognition biometrics systems, sensing devices, comparison of various biometrics, Limitations of Uni-biometrics, Taxonomy of multi-biometrics, Issues in Designing a Multibiometric System, Normalization strategy, Fusion techniques	**10**
Unit-V Multi-biometrics: Taxonomy of multi-biometrics, issues in designing a Multibiometric system, Normalization strategy, Fusion techniques, Attacks and threats vectors in biometrics, Template security schemes, Anti-spoofing techniques, Presentation attacks detection metrics, Biometrics databases. Deep learning in biometrics.	**10**

Course Outcomes
At the end of this course, students will be able to:

- Identify and describe existing pattern recognition approaches for different human interaction modalities (voice, gesture, etc.)
- Evaluate and select the best approach for the recognition and identification of various patterns.
- Compare and identify the best technological solution for designing and implementing a complete recognition system based on pattern matching approach
- Identify a set of business use--cases using pattern based technology and discuss related advantage and drawbacks

Text books

1. C. M. Bishop, Neural Networks for Pattern Recognition, Oxford University Press, 2015.
2. Anil K Jain, Patrick Flynn, Arun A Ross, “Handbook of Biometrics”, Springer, 2008.

Reference books

1. V. N. Vapnik, The Nature of Statistical Learning Theory, Springer, 2000.
2. N. Cristianini and J. Shawe-Taylor, An Introduction to Support Vector Machines, Cambridge University Press, 2000.

3. R. J. Schalkoff, Pattern Recognition: Statistical, Structural and Neural Approaches, Wiley, 1992.
4. Classification and Scene Analysis, Wiley, New York, 1973. L. Miclet, Structural Methods in Pattern Recognition North Oxford 3. Academic, London, 1986.
5. Arun A. Ross , Karthik Nandakumar, A.K.Jain, “Handbook of Multibiometrics”, Springer, New Delhi, 2006.

Internet of Things (IoT)

Course Code: PGMTH3E020T

Course Title: Internet of things (IoT)

Semester: III

Credits: 04

Rationale

Smart devices are everywhere, yet the Internet of Things revolution is still in its infancy. In the Internet of Things (IoT) everyday objects share data over networks, with or without human intervention. Teaching IoT entails selecting among many technical and social topics, such as hardware, networking, data storage, data analysis, data presentation, human-computer interaction, platforms, embedded systems programming, web technologies, ethics, privacy, and security.

Course Outlines

Contents	**No of Lectures**
Unit-I IoT Fundamentals: Genesis of IoT, IoT and Digitization, IoT Impact, Connected Roadways, Connected Factory, Smart Connected Buildings, Smart Creatures, Convergence of IT and OT, IoT Challenges. IoT Network Architecture and Design: Drivers Behind New Network Architectures, Scale, Security, Constrained Devices and Networks, Data, Legacy Device Support, Comparing IoT Architectures, IoT Data Management and Compute Stack, Fog Computing. Edge Computing, The Hierarchy of Edge, Fog, and Cloud.	10
Unit-II Smart Objects: The "Things" in IoT, Sensors, Actuators, and Smart Objects, Sensors, Actuators, Micro-Electro-Mechanical Systems (MEMS), Smart Objects, Smart Objects: A Definition, Trends in Smart Objects, Sensor Networks, Wireless Sensor Networks (WSNs), Communication Protocols for Wireless Sensor Networks	10

Unit-III Connecting Smart Objects: Communications Criteria, Range, Frequency Bands, Power Consumption, Topology, Constrained Devices, Constrained-Node Networks, IoT Fundamentals, Data Rate and Throughput, Latency and Determinism, Overhead and Payload. IoT Access Technologies: IEEE 802.15.4, IEEE 802.15.4g and 802.15.4e, IEEE 1901.2a, IEEE 802.11ah, LoRaWAN, LTE Cat 0, LTE-M, NB-IoT Standardization and Alliances, Physical Layer, MAC Layer, Topology, Security, Competitive Technologies.	10
Unit-IV IP as the IoT Network Layer: The Business Case for IP, The Key Advantages of Internet Protocol, Adoption or Adaptation of the Internet Protocol, The Need for Optimization, Constrained Nodes, Constrained Networks, IP Versions, Optimizing IP for IoT, From 6LoWPAN to 6Lo, Header Compression, Fragmentation, Mesh Addressing, Mesh-Under Versus Mesh-Over Routing, 6Lo Working Group, 6TiSCH, RPL. Application Protocols for IoT: The Transport Layer, IoT Application Transport Methods, Application Layer Protocol, Generic Web-Based Protocols, IoT Application Layer Protocols, CoAP, Message Queuing Telemetry Transport (MQTT).	10
Unit-V Data and Analytics for IoT: An Introduction to Data Analytics for IoT, Structured Versus Unstructured Data, Data in Motion Versus Data at Rest, IoT Data Analytics Overview, IoT Data Analytics Challenges, Machine Learning, Machine Learning Overview, Supervised Learning, Unsupervised Learning, Neural Networks, Machine Learning and Getting Intelligence from Big Data, Predictive Analytics. Securing IoT: A Brief History of OT Security, Common Challenges in OT Security, Erosion of Network Architecture, Pervasive Legacy Systems, Insecure Operational Protocols, Modbus, DNP3 (Distributed Network Protocol), ICCP (Inter-Control Center Communications Protocol), OPC (OLE	10

for Process Control).	

Course Outcomes:

Upon successful completion of this course, candidates will be able to:

- Understand the vision of IoT from a global context.
- Analyze various protocols of IoT.
- Determine the Market perspective of IoT
- Use of Devices, Gateways and Data Management in IoT.
- Apply IoT in various applications like Industrial, Commercial Building Automation, Manufacturing, etc.

Text Books

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things" , Cisco Press, 2017.
2. Raj Kamal, "Internet of Things – Architecture and Design", McGraw Hill, 1/e, 2017.

Reference Books

1. Vijay Madisetti, Arshdeep Bahga, "Internet of Things: A Hands-On Approach". 2016.
2. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applications and Protocols" , Wiley, 2012.
3. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things" , Springer, 2011.
4. Michael Margolis, Arduino Cookbook, "Recipes to Begin, Expand, and Enhance Your Projects" , O'Reilly Media, 2/e, 2011.

Cryptography

Course Code: PGMTH3E021T

Course Title: Cryptography

Semester: III

Credits: 04

Rationale

Cryptography is an indispensable tool used to protect the information in computing systems. It is used to protect data at rest and data in motion. Cryptographic systems are an integral part of standard protocols. Even though the cryptosystem is secure, it relies on mathematical modeling and proofs to show that a particular system satisfies the security properties attributed to it. This course will introduce the students to cryptography and to secure data and provide confidentiality.

Course Outlines

Contents	**No of Lectures**
Unit-I Introduction: Introduction to Cryptography, Need and history, classic and modern cryptography, Classical cryptography, Cryptanalysis of substitution, Vigenere and Hill Ciphers. Principles of Modern Cryptography: Formulation of Exact Definitions, Reliance on Precise Assumptions, Rigorous Proofs of Security, Substitution ciphers, Transposition ciphers: Keyed and Keyless, one-time pads.	**10**
Unit-II Number Theory and Finite Fields: Divisibility and The Division Algorithm, Modular Arithmetic, Euclidean and Extended Euclidean algorithm, groups, rings and fields, Finite Fields of the form GF(p).	**10**
Unit-III Pseudo-Random Number generation: Principles of Pseudo-Random Number	**10**

generation and its use, Stream Ciphers, Pseudo Random Number generators(PRNG) and its requirements, PRNG using block ciphers, True Random number generator (TRNG) , Pseudo random functions (PRF).	
Unit-IV Digital signature standards and algorithms: Concept of Digital Signature, Attacks on Digital Signature, Elliptic Curve Digital Signature, Digital Signature Algorithm, Digital Signature Standards (DSS), Variations and applications of Digital Signatures.	**10**
Unit-V Pseudorandom Objects: Substitution-Permutation Networks, confusion-diffusion paradigm, pseudo randomness of substitution-permutation networks, Attacks on reduced-round substitution-permutation networks, Feistel networks, Differential and Linear cryptanalysis Public-Key Infrastructure: Digital Certificates, Trust Models-Strict Hierarchy Model, Web Browser Model	**10**

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Understand concept of classic and modern cryptography.
- Understand underlying number systems for cryptography.
- Apply cryptography and security principles to system design.
- Analyze and design network security protocols.

Text Books

1. Jonathan Katz and Yehuda Lindell, **"**Introduction to Modern Cryptography", CRC Press,1st Edition, 2007
2. William Stallings, "Cryptography and Network Security: Principles and Practice", Pearson Education, 6th Edition, 2017

Reference Books

1. Douglas R. Stinson, "Cryptography: Theory and Practice", CRC Press, 3rd Edition, 2015
2. Atul Kahate, "Cryptography and Network Security", McGraw Hill, 4th Edition, 2019
3. Trappe & Washington, "Introduction to Cryptography with Coding Theory", Pearson, 2nd Edition, 2006
4. Behrouz A. Forouzan, "Cryptography and Network Security", McGrawHill, 3rd Edition,2017

Digital Forensics

Course Code: PGMTH3E022T

Course Title: Digital Forensics

Semester: III

Credits:04

Rationale

With digital devices becoming ubiquitous, digital evidence is increasingly important to the investigation and prosecution of many types of crimes. These devices often contain information about crimes committed, movement of suspects, and criminal associates. The course provides knowledge on digital forensics legislations, digital crime, forensics processes and procedures, data acquisition and validation, e-discovery tools.

Course Outlines

Contents	**No of Lectures**
Unit-I Introduction to Digital Forensics, Digital Evidence, Digital Forensic Process- Acquisition, Preservation, Analysis and Presentation. Principals of Digital Forensics, Chain of Custody, Challenging Aspects of Digital Evidence, Cybertrail, Digital Foot printing.	**10**
Unit-II Incident response Process: Handling incident, Methodology, process, activities in initial response, post incident activity. Digital Investigations, Conducting Digital Investigations, Digital Investigation Process Models, Scaffolding for Digital Investigations, Applying the Scientific Method in Digital Investigations.	**10**
Unit-III Investigation Tools, eDiscovery, Digital Evidence Collection, Evidence Preservation, E-Mail Investigation, E-Mail Tracking, IP Tracking, E-Mail	**10**

Recovery. Search and Seizure of Computers, Recovering Deleted Evidences, Password Cracking, Forensic Software and Hardware, Analysis and Advanced Tools, Audio Video Analysis	
Unit-IV Computer Intrusions: How Computer Intruders Operate, Investigating Computer Intrusions, Forensic Preservation of Volatile Data, Investigation of Malicious Computer Programs, Discovery of audio, video and social media evidences.	**10**
Unit-V Forensics analysis: validating forensics data, data hiding techniques. Forensics auditing, step-by-step, how-to process for securing, investigating, and auditing or assessing various IT environments. Applying Forensic Science to Computers: Preparation, Survey, Documentation, Preservation, Examination and Analysis, reconstruction, reporting, summary	**10**

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Plan a systematic approach to computer investigations.
- Use forensic tools to collect digital evidence.
- Understand the core concepts related to malware, hardware and software vulnerabilities.
- Perform digital forensics analysis using different tools.

Text Books

1. Larry E.Daniel, Lars E.Daniel, "Digital Forensics for legal Professionals", Syngress (Elsevier), 1st Edition,2012
2. Eoghan Casey, "Digital Evidence and Computer Crime", Academic Press (Elsevier), 3rd Edition, 2011

Reference Books

1. Yuri Diogenes, Erdal Ozkaya, "Cyber Security-Attack and Defense Strategies", Packt Publishing, 1st Edition, 2018
2. Nina Godbole, Sunit Belapure, "Cyber Security", Wiley India, 1st Edition, 2015

3. Bill Nelson, Phillips, Steuart, “Computer Forensics and Investigations”, Cengage Learning, 4th Edition, 2010.
4. John Sammons “The Basics of Digital Forensics: The Primer for Getting Started in Digital Forensics”, Syngress (Elsevier), 1st Edition, 2012

Cyber Physical Systems

Course Code: PGMTH3E023T

Course Title: Cyber Physical Systems

Semester: III

Credits: 04

Rationale

Cyber-physical systems combine digital and analog devices, interfaces, networks, computer systems, and the like, with the natural and man-made physical world. The inherent interconnected and heterogeneous combination of behaviors in these systems makes their analysis and design a challenging task. This course includes design for Cyber Physical Systems Security (CPSS), breaches and enforcement, standardization, best practices, policies, security threat and protection-in-depth modeling, vulnerability and risk assessment for CPSS.

Course Outlines

Contents	**No of Lectures**
Unit-I Introduction to Cyber-Physical Systems: Cyber-Physical Systems (CPS) in the real world, Basic principles of design and validation of CPS, Industry 4.0, AutoSAR, IIOT implications, Building Automation, Medical CPS, CPS. Platform components: CPS Hardware (HW) platforms, Processors, Sensors, Actuators, CPS Network, WirelessHart, CAN, Automotive Ethernet, CPS Software (SW) stack, RTOS.	**10**
Unit-II Scheduling Real Time control tasks, Principles of Automated Control Design: Dynamical Systems and Stability Controller Design Techniques, Stability. Analysis: CLFs, MLFs, stability under slow switching, Performance under Packet drop and Noise.	**10**

Unit-III Matlab toolboxes: Simulink, Stateflow CPS implementation: From features to software components, Mapping software components to ECUs, CPS Performance Analysis, effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion.	**10**
Unit-IV Formal Methods for Safety Assurance of Cyber-Physical Systems: Advanced Automata based modeling and analysis, Basic introduction and examples, Timed and Hybrid Automata, Definition of trajectories, Formal Analysis, Flow pipe construction, reachability analysis Analysis of CPS Software, Weakest Pre-conditions, Bounded Model checking.	**10**
Unit-V CPS SW Verification: Frama-C, CBMC Secure Deployment of CPS, Attack models, Secure Task mapping and Partitioning, State estimation for attack detection Automotive Case study: Vehicle ABS hacking Power Distribution Case study, Attacks on SmartGrids.	**10**

Course Outcomes
Upon successful completion of this course, candidates will be able to:

- Understand the core principles behind the development of CPS.
- Identify safety specifications and critical infrastructures to secure CPS.
- Understand abstraction in CPS designs.
- Express pre-and post-conditions and invariants for CPS models.

Text Books

1. Raj Rajkumar, Dionisio De Niz , and Mark Klein, “Cyber-Physical Systems”, addison-Wesley Professional, 2015.
2. Rajeev Alur, “Principles of Cyber-Physical Systems”, MIT Press, 2015.

Reference Books

1. André Platzer, “Logical Analysis of Hybrid Systems: Proving Theorems for Complex Dynamics”, Springer, 2010.
2. Jean J. Labrosse, “Embedded Systems Building Blocks: Complete and Ready-To-Use Modules in C”, Paul Temme, 2011.

3. E. A. Lee and S. A. Seshia, “Introduction to Embedded Systems: A Cyber-Physical Systems Approach”, 2011.
4. T. D. Lewis “Network Science: Theory and Applications”, Wiley, 2009.
5. P. Tabuada, “Verification and control of hybrid systems: a symbolic approach”, Springer-Verlag 2009.
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Research Seminar

Course Code: PGMTH3C002P
Course Title: Research Seminar
Semester: III
Credits: 02

Responsibilities of the Supervisor:

1. Students will be introduced to reviewing related literature as per the topic allocated by their respective supervisors.
2. Students will be taught the basics of research methodology by their respective supervisors.
3. Students will be acquainted with the skills of writing research articles with publication ethics.

Guidelines for Students:

1. Each student shall be required to make a seminar presentation on any chosen topic connected with the field of specialization twice in a semester.
2. Preparation and presentation of a seminar are intended to investigate an in-depth review of literature, prepare a critical review and develop the confidence to present the material by the student.
3. The seminar shall be evaluated by faculty members assigned to this course, based on the two presentations a report submitted by the candidate, and a viva-voce conducted. The marks of both the presentation will be recorded in Seminar Evaluation Performa.

Seminar Evaluation Performa

Name of Student:_____Roll No:_____
Name of Evaluater:_____
Topic of Seminar:_____
Date(s) of Seminar_____

SN	Evaluation Criteria	Explanation	Max. Marks	1st Presen.	2nd Presen.
1	**Knowledge and Content Organization of presentation**	Information presented as interesting story in logical, easy to follow sequence	**5 (2.5+2.5)**		
2	**Background content**	Material sufficient for clear understanding **AND** exceptionally presented	**5 (2.5+2.5)**		
3	**Methods**	Sufficient for understanding **AND** exceptionally presented	**5 (2.5+2.5)**		
4	**Results (figures, graphs, tables, etc.)**	All figures clear, All appropriately formatted, Exceptionally explained	**5 (2.5+2.5)**		
5	**Contribution of work**	Significance exceptionally well explained	**5 (2.5+2.5)**		
6	**Knowledge of subject**	Demonstrated full knowledge; answered all questions with elaboration	**5 (2.5+2.5)**		
7	**Presentation Skills Graphics (use of Power-point)**	Uses graphics that explain and reinforce text and presentation	**4 (2+2)**		
8	**Mechanics**	Presentation has no misspellings or grammatical errors	**4 (2+2)**		
9	**Eye Contact**	Refers to slides to make points; engaged with audience	**4 (2+2)**		
10	**Elocution** -not ability to speak English language	Correct, precise pronunciation of all terms, Voice is clear and steady; audience can hear well at all times	**4 (2+2)**		
11	**Length and Pace**	Appropriate (30-35 min) Well-paced throughout	**4 (2+2)**		
Total			**50**		
Grand Total (1st Presentation +2nd Presentation) (Out of 50)					

Signature of Evaluator with Date

Dissertation Part-I

Course Code: PGMTH3C008D

Course Title: Dissertation Part-I

Semester: III

Credits: 08

Supervisor Evaluation Performa

Confidential (to be used by Supervisors & not to be shared with others)

M.Tech CST Dissertation Evaluation Sheet to be filled in by all Supervisors and communicated to M.Tech. Coordinator/HoD *before semester evaluation*:

Name of the Student:_____ Roll Number:_____

Title of the Dissertation:_____

Research Area & subarea to which the topic belongs:_____

Name of the Supervisor:_____

Supervisor's evaluation:

Day-to-Day work assessment in III semester: (marks to be awarded out of 100)

Problem Formulation and Identification of Objectives (out of 40)	Literature Surveyed and Schedule of work followed as suggested (out of 40)	Meetings with the supervisor & continuous reporting on progress (out of 20)	Final marks on day-to-day work evaluation out of 100 (sum of marks awarded col:1-3))

Signature of the supervisor with date:

Notes:
i. All students are required to maintain a diary where meeting dates (at least twice a week) with the supervisor and weekly progress work done are to be recorded in brief and endorsed by the supervisor's signature. This diary is required to be submitted at the time of evaluation.
ii. The supervisor will communicate to the student any suggestions made by the external expert and get them implemented

Dissertation Part-I

Course Code: PGMTH3C008D

Course Title: Dissertation Part-I

Semester: III

Credits: 08

External Expert Evaluation Performa

1. Name of External Expert (*Block Letters*): .....
2. Dissertation Title: .....

   .....
3. Research Area & subarea: _____
4. Dissertation Supervisor(s): .....
5. Thesis Viva Date and Time: .....

Roll No. of Student (s)	Name of Student(s)	Literature Review (15)	Identificatio -n of Objectives (15)	Dissertation Design/Plan (20)	Presentation (25)	Viva (25)	Total out of 100 (Sum of cols. 3 to 7)

Comments required for justification if work is **Exceptionally Bad (≤50%)/ Outstanding (≥80%):**

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Suggestions to be communicated to the students & supervisor(s)

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Signature of External Expert with date

SEMESTER-IV

Dissertation Part-II

Course Code: PGMTH4C004D

Course Title: Dissertation Part-II

Semester: IV

Credits: 18

Supervisor Evaluation Performa

Confidential (to be used by Supervisors & not to be shared with others)

M.Tech IV Semester CST Dissertation

Evaluation Sheet to be filled in by all Supervisors and communicated to M.Tech Program Coordinator/HoD *before final evaluation (end-semester):*

Name of the Student:_____ Enrollment No:_____

Title of the Dissertation:_____

_____

Research Area & subarea to which the topic belongs:_____

Name of the Supervisor:_____

Supervisor's evaluation:

Day-to-Day work assessment during iV semester evaluation: (marks to be awarded out of 225)

Meetings with the supervisor & continuous reporting on progress (out of 75)	External expert suggestions implemented and quality of work done (out of 150)	Final marks on day-to-day work evaluation out of 225

Would you like further work on this Dissertation Topic to be offered to the next batch of the students? YES/NO

Do you plan to communicate a paper and/or file an IPR on the work done? YES /NO

Did you publish a paper in peer reviewed Journal? YES NO (UGC Approved/Scopus/SCI, Communicated/Under Review)

Signature of the supervisor with date:

Notes: i. All students are required to maintain a diary where meeting dates (at least twice a week) with the supervisor and weekly progress work done are to be recorded in brief and endorsed by the supervisor's signature. This diary is required to be submitted at the time of evaluation.
ii. Students be advised to prepare a paper (in IEEE format) based on the work for communication.

Dissertation Part-II

Course Code: PGMTH4C004D

Course Title: Dissertation Part-II

Semester: IV

Credits: 18

External Expert Evaluation Performa

1. Name of External Expert (*Block Letters*): .....

2. Dissertation Title: .....

.....

3. Research Area & subarea: _____

4. Dissertation Supervisor(s): .....

5. Viva Date and Time: .....

Roll No of Student	Name of the Student	Quality Literature Reviewed (20)	Thesis Plan/Design/Algorithm (30)	Experimental results & its analysis (50)	Presentation (50)	Viva (50)	Report (25)	Total (225)

Comments required for justification if work is **Exceptionally Bad (≤50%)/ Outstanding (≥80%):**

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Suggestions to be communicated to the students & supervisor(s)

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Signature of External Expert with date

Ph.D. Course-work

Computer Science and Information Technology

Proposed scheme w.e.f. July 2020

Course Code	Subject	Credits	CIA	MSE	ESE	Marks
PGMTH1C001T	Research Methodology	4	25	25	50	100
PHMTH1C002T	Scientific Computing and Tools	4	25	25	50	100
PHUNI1C001T	Research and Publication Ethics (RPE)	2	12.5	12.5	25	50
Elective-I						
PHMTH1E001T	Simulation and Modelling	4	25	25	50	100
PHMTH1E002T	Internet of Things (IoT)					
PHMTH1E003T	Machine Learning					
PHMTH1E004T	Information Security					
PHMTH1E005T	Data Analytics and Data Science					
PHMH1E006T	Computing Systems for Robotics					
Elective-II						
PHMTH1E007T	Wireless Sensor Networks	4	25	25	50	100
PHMTH1E00ET	Natural Language Processing					
PHMTH1E009T	Data Mining Techniques					
PHMTH1E010T	Pattern Recognition					
PHMTH1E011T	Digital Image Processing					
PHMTH1E012T	Optimisation Techniques					
PHMTH1E013T	SCADA system and Applications					
Total		16				400

Research and Publication Ethics

Course Code: PHUNI1C001T

Course Title: RESEARCH AND PUBLICATION ETHICS

Semester: PhD Coursework

Credits: 02

COURSE OBJECTIVES

- Students should be able to understand the scientific computing programming language with Python language.
- To familiarize students with advanced paradigms of scientific computing languages like python and MATLAB
- To make students aware about various scientific simulation tools like NS2, CloudSim, Robotics Tools etc.
- Students should be able write scientific papers using LATEX tool.

Contents
Unit - I
Introduction to Python: Basic Characteristics of Python, Data Types, Variables, Operators and Branching, Core elements of programs: Bindings, Strings, Input/Output, IDEs, Control Flow, Iteration, Guess and Check ; Simple Programs Functions: Decomposition and Abstraction, Functions and Scope, Keyword Arguments, Specifications, Iteration vs Recursion, Inductive Reasoning, Files.
Unit - II
Tuples and Lists in Python: Tuples, Lists, List Operations, Mutation, Aliasing, Cloning ; Dictionaries: Functions as Objects, Dictionaries, Example with a Dictionary, Fibonacci and Dictionaries, Global Variables; Debugging: Programming Challenges, Classes of Tests, Bugs, Debugging, Debugging Examples; Assertions and Exceptions, Assertions, Exceptions, Exception Examples.
Unit - III
Overview of MATLAB: Basics, Variables, Matrix operations, Built-in functions, Controlling work flow, Basic input/output, Scripts and functions, Reading and writing data, Fitting a model to data, Recursive functions, random numbers and simulations, Solving differential equations, Plotting in 2D and 3D. Creating simple GUI in MATLAB.

COURSE OUTCOMES

After completion of course, students would be able to:

- Students will be able writing scientific programs to implement advance algorithms.

- The students will be able to build GUI applications using MATLAB.
- Students will be able write scientific paper in well structured formats of standard Journals.
- Students will be able to use scientific tools to simulate their algorithms/ techniques.
- Students will be able to write Python code to build machine learning models.
- The students will be to plot scientific graphs and draw effective diagrams using typical tools.

TEXT/REFERENCES BOOKS

3. Fundamentals of Python first Programmes by Kenneth A Lambert, Copyrighted material Course Technology Inc. 1 st edition (6th February 2009).
4. Data Structures and Algorithms in Python by Michael T Goodrich and Robertto Thamassia, Micheal S Goldwasser, Wiley Publisher (2016).
5. Python Programming using problem solving Approach by Reema Thareja, Oxford University, Higher Education Oxford University Press; First edition (10 June 2017), ISBN-10: 0199480173.
6. Holly Moore, MATLAB® for Engineers, 3rd Edition, 2012, Pearson, New York.
7. William J. Palm III. 2010. Introduction to MATLAB® for Engineers. 3rd Edition. McGraw-Hill: New York, NY.
8. Amos Gilet, MATLAB An Introduction with Applications, Wiley india Pvt. Ltd, 2016
9. Musto Joseph, Engineering Computation: an Introduction Using Matlab and Excel - An Introduction Using MATLAB and Excel, 2017
10. Kottwitz Stefan ,LaTeX Beginner's Guide, Packt Publishing Limited, 2015.
11. Gratzer George A , Practical LaTeX, Springer International Publishing AG.

Scientific Computing and Tools

Course Code: PHMTH1C002T

Course Title: SCIENTIFIC COMPUTING AND TOOLS

Semester: PhD Coursework

Credits: 02

COURSE OBJECTIVES

- Students should be able to understand the scientific computing programming language with Python language.
- To familiarize students with advanced paradigms of scientific computing languages like python and MATLAB
- To make students aware about various scientific simulation tools like NS2, CloudSim, Robotics Tools etc.
- Students should be able write scientific papers using LATEX tool.

Contents
Unit - I
Introduction to Python: Basic Characteristics of Python, Data Types, Variables, Operators and Branching, Core elements of programs: Bindings, Strings, Input/Output, IDEs, Control Flow, Iteration, Guess and Check ; Simple Programs Functions: Decomposition and Abstraction, Functions and Scope, Keyword Arguments, Specifications, Iteration vs Recursion, Inductive Reasoning, Files.
Unit - II
Tuples and Lists in Python: Tuples, Lists, List Operations, Mutation, Aliasing, Cloning ; Dictionaries: Functions as Objects, Dictionaries, Example with a Dictionary, Fibonacci and Dictionaries, Global Variables; Debugging: Programming Challenges, Classes of Tests, Bugs, Debugging, Debugging Examples; Assertions and Exceptions, Assertions, Exceptions, Exception Examples.
Unit - III
Overview of MATLAB: Basics, Variables, Matrix operations, Built-in functions, Controlling work flow, Basic input/output, Scripts and functions, Reading and writing data, Fitting a model to data, Recursive functions, random numbers and simulations, Solving differential equations, Plotting in 2D and 3D. Creating simple GUI in MATLAB.

COURSE OUTCOMES

After completion of course, students would be able to:

- Students will be able writing scientific programs to implement advance algorithms.

- The students will be able to build GUI applications using MATLAB.
- Students will be able write scientific paper in well structured formats of standard Journals.
- Students will be able to use scientific tools to simulate their algorithms/ techniques.
- Students will be able to write Python code to build machine learning models.
- The students will be to plot scientific graphs and draw effective diagrams using typical tools.

TEXT/REFERENCES BOOKS

12. Fundamentals of Python first Programmes by Kenneth A Lambert, Copyrighted material Course Technology Inc. 1 st edition (6th February 2009).
13. Data Structures and Algorithms in Python by Michael T Goodrich and Robertto Thamassia, Micheal S Goldwasser, Wiley Publisher (2016).
14. Python Programming using problem solving Approach by Reema Thareja, Oxford University, Higher Education Oxford University Press; First edition (10 June 2017), ISBN-10: 0199480173.
15. Holly Moore, MATLAB® for Engineers, 3rd Edition, 2012, Pearson, New York.
16. William J. Palm III. 2010. Introduction to MATLAB® for Engineers. 3rd Edition. McGraw-Hill: New York, NY.
17. Amos Gilet, MATLAB An Introduction with Applications, Wiley india Pvt. Ltd, 2016
18. Musto Joseph, Engineering Computation: an Introduction Using Matlab and Excel - An Introduction Using MATLAB and Excel, 2017
19. Kottwitz Stefan ,LaTeX Beginner's Guide, Packt Publishing Limited, 2015.
20. Gratzer George A , Practical LaTeX, Springer International Publishing AG.

Research Methodology

Course Code: PHMTH1C001T

Course Title: Research Methodology

Semester: PhD Coursework

Credits: 04

COURSE OBJECTIVES

- Students should understand a general definition of research design.
- Students should know why educational research is undertaken, and the audiences that profit from research studies.
- Students should be able to identify the overall process of designing a research study from its inception to its report.
- Students should be familiar with ethical issues in educational research, including those issues that arise in using quantitative and qualitative research.

Contents
Unit - I
Research Methodology: Objectives and Motivation of Research, Types of Research, Research Approaches, Significance of Research, Research Methods verses Methodology, Research and Scientific Method, Important of Research Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the society in general. Defining the Research Problem: Definition of Research Problem, Problem Formulation, Necessity of Defining the Problem, Technique involved in Defining a Problem.
Unit - II
Literature Survey: Importance of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Information through Internet. Literature Review: Need of Review, Guidelines for Review, Record of Research Review.
Unit -III
Research Design: Meaning of Research Design, Need of Research Design, Feature of a Good Design Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research Plan, Design of Experimental Set-up, Use of Standards and Codes.
Unit - IV
Data Collection: Collection of primary data, Secondary data, Data organization, Methods of

data grouping, Diagrammatic representation of data, Graphic representation of data. Sample Design, Need for sampling, some important sampling definitions, Estimation of population, Role of Statistics for Data Analysis, Parametric V/s Non Parametric methods, Descriptive Statistics, Measures of central tendency and Dispersion, Hypothesis testing, Use of Statistical software. Data Analysis: Deterministic and random data, Uncertainty analysis, Tests for significance: Chisquare, student's t-test, Regression modeling, Direct and Interaction effects, ANOVA, F-test, Time Series analysis, Autocorrelation and Autoregressive modeling.

Unit - V

Research Report Writing: Format of the Research report, Synopsis, Dissertation, Thesis its Differentiation, References/Bibliography/Webliography, Technical paper writing/Journal report writing, making presentation, Plagiarism, Research ethics, Use of visual aids. Research Proposal Preparation: Writing a Research Proposal and Research Report, Writing Research Grant Proposal

COURSE OUTCOMES

After completion of course, students would be able to:

- understand some basic concepts of research and its methodologies
- identify appropriate research topics
- select and define appropriate research problem and parameters
- prepare a project proposal (to undertake a project)
- organize and conduct research (advanced project) in a more appropriate manner
- write a research report and thesis
- write a research proposal (grants)

TEXT/REFERENCES BOOKS

1. C.R Kothari, Research Methodology, Methods & Technique; New Age International Publishers, 2004
2. R. Ganesan, Research Methodology for Engineers, MJP Publishers, 2011
3. Ratan Khananabis and Suvasis Saha, Research Methodology, Universities Press, Hyderabad, 2015.
4. Y. P. Agarwal, Statistical Methods: Concepts, Application and Computation, Sterling Publs., Pvt., Ltd., New Delhi, 2004
5. Vijay Upagade and Aravind Shende, Research Methodology, S. Chand & Company Ltd., New Delhi, 2009
6. G. Nageswara Rao, Research Methodology and Quantitative methods, BS Publications, Hyderabad, 2012.
7. Naval Bajjai "Business Research Methods" Pearson 2011.
8. Prahalad Mishra " Business Research Methods " Oxford 2016

Internet of Things (IoT)

Course Code: PHMTH1E002T

Course Title: Internet of Things (IoT)

Semester: PhD Coursework

Credits: 04

Course Overview

Internet of Things (IoT) actually refers to uniquely identifiable objects or things and their virtual representations in an internet-like infrastructure. The IoT allows objects to be sensed and/or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit.

Course Objectives

- Able to understand the application areas of IOT.
- Able to realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks.
- Able to understand building blocks of Internet of Things and characteristics.

Course Outlines

Contents	No of Lectures
Unit-I Evolution of Internet of Things ,Enabling Technologies ,IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models ,Simplified IoT Architecture and Core IoT Functional Stack – Fog, Edge and Cloud in IoT ,Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects	10
Unit-II	10

IOT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN ,Network Layer: IP versions, Constrained Nodes and Constrained Networks , Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks ,Application Transport Methods: Supervisory Control and Data Acquisition ,Application Layer Protocols: CoAP and MQTT.	
Unit-III **Data analytics and supporting services** Structured Vs Unstructured Data and Data in Motion Vs Data in Rest , Role of Machine Learning , No SQL Databases ,Hadoop Ecosystem – Apache Kafka, Apache Spark , Edge Streaming Analytics and Network Analytics ,Xively Cloud for IoT, Python Web Application Framework ,Django AWS for IoT , System Management with NETCONF-YANG	10
Unit-IV **Case studies/industrial applications** Cisco IoT system ,IBM Watson IoT platform, Manufacturing ,Converged Plantwide Ethernet Model (CPwE) , Power Utility Industry ,Grid Blocks Reference Model ,Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control	10
Unit-V **Design and development:** Design Methodology ,Embedded computing logic, Microcontroller, System on Chips , IoT system building blocks ,Arduino ,Board details, IDE programming ,Raspberry Pi . **IoT Security**: IoT Vulnerabilities, Threats and Attacks, Case study of IoT breaches(Mirai, Stuxnet)	10

Course Outcomes:

On completion of the course the student should be able to

- Understand the vision of IoT from a global context.
- Analyze various protocols for IoT.

- Determine the Market perspective of IoT
- Use of Devices, Gateways and Data Management in IoT.
- Application of IoT in Industrial and Commercial Building Automation and Real World Design Constraints.

Text/Reference Books

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017
2. Vijay Madisetti, Arshdeep Bahga, "Internet of Things: A Hands-On Approach"
3. Olivier Hersent, David Boswarthick, Omar Elloumi , The Internet of Things – Key applications and Protocols, Wiley, 2012
4. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), Architecting the Internet of Things, Springer, 2011.
5. Michael Margolis, Arduino Cookbook, Recipes to Begin, Expand, and Enhance Your Projects, 2nd Edition, O'Reilly Media, 2011.

Wireless Sensor Networks

Course Code: PHMTH1E007T

Course Title: Wireless Sensor Networks

Semester: PhD Coursework

Credits: 04

Course Overview

This course provides a basic understanding of wireless sensor networks by the study of Architect sensor networks for various application setups. Students will learn the fundamental concepts of wireless sensor networks and have a basic knowledge of the various protocols at various layers. Further students will be exposed to the techniques for performance evaluation of sensor networks and identify bottlenecks. The students will acquaint themselves with the Understanding of the fundamental concepts of wireless sensor networks and have a basic knowledge of the various protocols at various layers

Course Objectives

- Architect sensor networks for various application setups.
- Devise appropriate data dissemination protocols and model links cost.
- Evaluate the performance of sensor networks and identify bottlenecks.
- Understanding of the fundamental concepts of wireless sensor networks and have a basic knowledge of the various protocols at various layers

Course Outlines

Contents	**No of Lectures**
Unit-I **Introduction to Wireless Sensor Networks:** Wireless Sensor Networks and Wireless Adhoc Networks, Motivations , Applications, Performance metrics, History and Design factors of WSNs **Network Architecture:** Traditional layered stack, Cross-layer designs, Sensor	**10**

Network Architecture **Hardware Platforms:** Motes, Hardware parameters	
Unit-II **Introduction to ns-3: I**ntroduction to Network Simulator 3 (ns-3), Description of the ns-3 core module and simulation example. Topology Management in Wireless Sensor Network, Mobile WSNs, Opportunistic Mobile Networks.	**10**
Unit-III **Medium Access Control Protocol design:** Fixed Access, Random Access, WSN protocols: synchronized, duty-cycled **Introduction to Markov Chain:** Discrete time Markov Chain definition, properties, classification and analysis **MAC Protocol Analysis:** Asynchronous duty-cycled. X-MAC Analysis (Markov Chain).	**10**
Unit-IV **Routing protocols:** Introduction, MANET protocols **Routing protocols for WSN**: Resource-aware routing, Data-centric, Geographic Routing, Broadcast, Multicast **Opportunistic Routing Analysis**: Analysis of opportunistic routing (Markov Chain) Advanced topics in wireless sensor network	**10**
Unit-V **Security**: Possible attacks, countermeasures, SPINS, Static and dynamic key Distribution. **Deployment:** Real Life Deployment of WSNs, Underwater Sensor Networks(USN)	**10**

Course Outcomes

After completion of course, students would be able to:

- Describe and explain radio standards and communication protocols for wireless sensor networks.

- Explain the function of the node architecture and use of sensors for various applications.
- Be familiar with architectures, functions and performance of wireless sensor networks systems and platforms.

Text/Reference Books

1. W. Dargie and C. Poellabauer, “Fundamentals of Wireless Sensor Networks –Theory and Practice”, Wiley 2010
2. KazemSohraby, Daniel Minoli and TaiebZnati, “wireless sensor networks - Technology, Protocols, and Applications”, Wiley Interscience 2007

Takahiro Hara,Vladimir I. Zadorozhny, and Erik Buchmann, “Wireless Sensor Network Technologies for the Information Explosion Era”, springer 20

SCADA System and Applications

Course Code: PHMTH1E013T

Course Title: SCADA System and Applications

Semester: PhD Coursework

Credits: 04

Course Overview

Supervisory control and data acquisition (SCADA) is a system of software and hardware elements that allows industrial organizations to: control industrial processes locally or at remote locations; monitor, gather, and process real-time data. It directly interact with devices such as sensors, valves, pumps, motors, and more through human-machine interface (HMI) software and record events into a log file

SCADA systems are crucial for industrial organizations since they help to maintain efficiency, process data for smarter decision and communicate system issues to help mitigate downtime.

Course Objectives

- To understand what is meant by SCADA and its functions.
- To know SCADA communication.
- To get an insight into its application.

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Course Outlines

Contents	No of Lectures
Unit-I **Introduction to SCADA**: Data acquisition systems, Evolution of SCADA, Communication technologies, Monitoring and supervisory functions, SCADA applications in Utility Automation.	10
Unit-II **Industries SCADA:** Industries SCADA System Components: Schemes-Remote Terminal Unit (RTU), Intelligent Electronic Devices (IED), Programmable Logic Controller (PLC), Communication Network, SCADA Server, SCADA/HMI Systems.	10

Unit-III **SCADA Architecture**: Various SCADA architectures, advantages and disadvantages of each system - single unified standard architecture -IEC 61850.	10
Unit-IV **SCADA Communication**: various industrial communication technologies -wired and wireless methods and fiber optics. open standard Communication protocols.	10
Unit-V **SCADA Applications**: Utility applications- Transmission and Distribution sector- operations, monitoring, analysis and improvement. Industries - oil, gas and water.Case studies, Implementation, Simulation Exercises	10

Course Outcomes:

On completion of the course the student should be able to

- Describe the basic tasks of Supervisory Control Systems (SCADA) as well as their typical applications**.**
- Acquire knowledge about SCADA architecture, various advantages and disadvantages of each system.
- Knowledge about single unified standard architecture IEC 61850.
- To learn about SCADA system components: remote terminal units, PLCs, intelligent electronic devices, HMI systems, SCADA server.
- Learn and understand about SCADA applications in transmission and distribution sector, industries etc.

Text/Reference Books

1. Stuart A. Boyer: "SCADA-Supervisory Control and Data Acquisition", Instrument Society of AmericaPublications, USA,2004.
2. Gordon Clarke, Deon Reynders: "Practical Modern SCADA Protocols: DNP3, 60870.5 and RelatedSystems", Newnes Publications, Oxford, UK,2004.
3. William T. Shaw, "Cybersecurity for SCADA systems", PennWell Books, 2006.
4. David Bailey, Edwin Wright, "Practical SCADA for industry", Newnes, 2003.
5. Wiebe, "A guide to utility automation: AMR, SCADA, and IT systems for electric power",PennWell 1999.

Computing Systems for Robotics

Course Code: PHMTH1E006T

Course Title: Computing Systems for Robotics

Semester: PhD Coursework

Credits: 04

Course Overview: This course provides a detailed insight into implementation of the user commands on the robot.

Course Objectives:

- To understand the working of Robot Operating System (ROS).
- To understand message passing through ROS using publisher-subscriber strategy.
- To understand basic operations on robot.
- To understand classical navigation algorithms.

Course Outlines

Contents	No. of Lectures
Unit-I Introduction to ROS, publisher-subscribers in ROS, creating user node in ROS. Communication between on ROS nodes through messages. Select and implement the appropriate ROS components for a robotics problem.	**8**
Unit-II Working with turtlesim and turtlebot-gazebo simulators. Building a user defined world in Gazebo. Translation, rotation, scaling of models. Saving and loading of a world. Communicating with the simulators.	**10**
Unit-III Visualize the simulated robot in rviz. Visualizing Sensor Data with rviz. Creating map of the environment in Gazebo. Saving and Loading of the map.	**12**
Unit-IV Apply algorithms for robotic perception, planning, navigation, localization, and manipulation. Implement and use algorithms for controlling mobile robots.	**12**
Unit-V Program and navigate mobile robots: robot and map representations, motion planning.	**8**

Course Outcomes

After completion of course, students would be able to:

- Send commands to the robot with the help of ROS.
- Implement classical navigation algorithms to the robot.

Text/Reference Books

1. Jason M. O'Kane, A Gentle Introduction to ROS, independently published, Updated on 2016-09-06 to version 2.1.3. (Electronic copies freely available from: https://www.cse.sc.edu/~jokane/agitr/).

2. Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy by Lentin Joseph.
3. Programming Robots with ROS: A Practical Introduction to the Robot Operating System by Morgan Quigley, Brian Gerkey, William D. Smart .
4. ROS Robotics By Example -Second Edition: Learning to control wheeled, limbed, and flying robots using ROS Kinetic Kame Paperback –November 30, 2017 by Carol Fairchild, Dr. Thomas L. Harman.

Natural Language Processing

Course Code: PHMTH1E008T

Course Title: Natural Language Processing

Semester: Ph.D Course Work

Credits: 04

Course Overview

This course presents an introduction to the computational modelling of natural language. Topics covered include: computational morphology, language modelling, syntactic parsing, lexical and compositional semantics, and discourse analysis. The student will also learn selected applications such as automatic summarization, machine translation, and speech processing. Student will also study machine learning algorithms that are used in natural language processing.

Course Objectives

- Understanding of the field of natural language processing.
- Understand the theoretical underpinnings of natural language processing in linguistics and formal language theory.
- Analyse linguistic structure in text, including parsing and semantic analysis.
- Integrate techniques drawn from fields as diverse as linguistics and artificial intelligence.

Course Outlines

Contents	**No of Lectures**
Unit-I **Introduction**- Human languages, models, ambiguity, processing paradigms; Phases in natural language processing, applications. Text representation in computers, encoding schemes. **Linguistics resources**- Introduction to corpus, elements in balanced corpus, TreeBank, PropBank, WordNet, VerbNet etc. Resource management with XML, Management of linguistic data with the help of GATE, NLTK.	**10**
Unit-II Regular expressions, Finite State Automata, word recognition, lexicon.	**10**

Morphology, acquisition models, Finite State Transducer. N-grams, smoothing, entropy, HMM, ME, SVM, CRF. **Part of Speech tagging**- Stochastic POS tagging, HMM, Transformation based tagging (TBL), Handling of unknown words, named entities, multi word expressions.	
Unit-III A survey on natural language grammars, lexeme, phonemes, phrases and idioms, word order, agreement, tense, aspect and mood and agreement, Context Free Grammar, spoken language syntax. **Parsing**- Unification, probabilistic parsing, TreeBank	**10**
Unit-IV **Semantics**- Meaning representation, semantic analysis, lexical semantics, WordNet **Word Sense Disambiguation**- Selectional restriction, machine learning approaches, and dictionary based approaches. **Discourse**- Reference resolution, constraints on co-reference, algorithm for pronoun resolution, text coherence, discourse structure.	**10**
Unit-V **Applications of NLP**- Spell-checking, Summarization **Information Retrieval**- Vector space model, term weighting, homonymy, polysemy, synonymy, improving user queries. Overview of Machine Translation	**10**

Course Outcomes

After completion of course, students would be able to:

- Be familiar with the concept of language, grammar, semantics and ambiguity
- Explore the research challenges in NLP

Text/Reference Books

1. Allen, James, "Natural Language Understanding", Second Edition, Benjamin/Cumming, *2012.*
2. Jurafsky, Dan and Martin, James, "Speech and Language Processing", Seventh Edition, Prentice Hall, 2017.
3. Bhargav Srinivasa-Desikan, "Natural Language Processing and Computational Linguistics: A practical guide to text analysis with Python, Gensim, spacy, and Keras, Packt", 2018.
4. Radford, Andrew et. al., "Linguistics, An Introduction", Second Edition, Cambridge University Press, 2018.

Data Analytics and Data Science

Course Code: PHMTH1E005T

Course Title: Data Analytics and Data Science

Semester: PhD Coursework

Credits:

Course Overview

The main goal of this course is to help students learn, understand, and practice big data analytics and machine learning approaches, which include the study of modern computing big data technologies and scaling up machine learning techniques.

Course Objectives

- Conceptualization and summarization of big data.
- Trivial data versus Big data
- Big data computing environment
- Machine learning techniques

Course Outlines

Contents	**No of Lectures**
Unit-I **Introduction to big data and data science** Need of big data; Classification of data; Big data: Classification, definition, types, handling techniques; Scalability and parallel processing; designing data architecture; data sources, quality, pre-processing and storing; Data storage and analysis Data science process – roles, stages in data science project – working with data from files – working with relational databases – exploring data – managing data – cleaning and sampling for modelling and validation	**10**
Unit-II **Introduction to Hadoop** Hadoop and its ecosystem: Components, features, streaming, pipes; Hadoop	**10**

distributed file system: HDFS data storage, HDFS commands; MapReduce framework and programming model; Hadoop yarn: execution model, Hadoop Ecosystem tools	
Unit-III **NOSQL Big data management and MapReduce** NOSQL: Introduction; NOSQL data store; NOSQL data architecture patterns; NOSQL to manage data MapReduce: Introduction; MapReduce Map Tasks, Reduce Tasks and MapReduce Execution; Composing MapReduce for calculations and algorithms	**10**
Unit-IV **Machine learning Algorithms for Big Data Analytics** Introduction; estimating the relationships, outliers, variances and probability distributions Regression analysis: simple linear, multiple regression, predictions using regression, KNN regression analysis; Clustering Analysis; Classification: KNN classifier, Naïve Bayes classifier, SVM classifier	**10**
Unit-V **Introduction To R** What is R and Why R; Loading and handling data in R: expressions, variables and functions, vectors, matrices; probability distributions; statistical models in R; Linear regression; Logistic Regression; Decision tress	**10**

Course Outcomes

The students learning outcomes are designed to specify what the students will be able to perform after completion of the course:

- Ability to identify the characteristics of datasets and compare the trivial data and big data for various applications.
- Ability to select and implement machine learning techniques and computing environment that are suitable for the applications under consideration. 1
- Ability to solve problems associated with batch learning and online learning, and the big data characteristics such as high dimensionality, dynamically growing data and in particular scalability issues.
- Ability to understand and apply scaling up machine learning techniques and associated computing techniques and technologies.

- Ability to recognize and implement various ways of selecting suitable model parameters for different machine learning techniques.
- Ability to integrate machine learning libraries and mathematical and statistical tools with modern technologies like hadoop and mapreduce.

Text/Reference Books

1. Raj Kamal, Preeti Saxena, “Big data Analytics: Introduction to Hadoop, Spark, and Machine-learning”, Mc Graw Hill Education, 2019
2. Chris Eaton, Dirk deroos, “Understanding Big data”, McGraw Hill, 2012.
3. Mark Gardener, “Beginning R - The Statistical Programming Language”, John Wiley & Sons, Inc., 2012.
4. W. N. Venables, D. M. Smith and the R Core Team, “An Introduction to R”, 2013.
5. Seema Acharya, “Data Analytics using R”, Mc Graw Hill Education, 2018

Information Security

Course Code: PHMTH1E004T

Course Title: Information Security

Semester: Ph.D Course Work

Credits: 04

Course Overview

Information security is a set of strategies for managing the processes, tools and policies necessary to prevent, detect, document and counter threats to digital and non-digital information.
The course covers all relevant research areas of information and network security ranging from cryptography to the security issues in different networks.

Course Objectives

- To understand the fundamentals of Information Security and security issues.
- To Understand Cryptography.
- To acquire knowledge on standard algorithms used to provide confidentiality, integrity and authenticity.
- To understand the different security issues in different types of networks

Course Outlines

Contents	**No of Lectures**
Unit-I **Information Security Overview**-Services, Mechanisms, Attacks and its types, counter-measures, the OSI Security Architecture, A Model for Network Security, Trade-offs related to Information Security. Malicious Software: Viruses and Related Threats, Virus Countermeasures,	**8**
Unit-II **Cryptography**: Introduction to Cryptography, Symmetric key Cryptography, Asymmetric key Cryptography.	**10**

Data Encryption Standard: DES cipher, Block Cipher Principles, The Strength of DES, Differential and Linear Cryptanalysis, Block Cipher Design Principles, Block Cipher Modes of Operation. Advanced Encryption Standard: Evaluation Criteria for AES, The AES Cipher, Triple DES, Blowfish, RC5, RC4 Stream Cipher.	
Unit-III Key Management and Other Public-Key Cryptosystems: Key Management, Diffie-Hellman Key Exchange, Elliptic Curve Arithmetic, Elliptic Curve Cryptography. Message Authentication and Hash Functions: Authentication Requirements, Authentication Functions, Message Authentication Codes, Hash Functions, Security of Hash Functions and MACs.	**12**
Unit-IV **Network Security Practice:** Authentication Applications: Kerberos, X.509 Authentication Service, Electronic Mail Security: Pretty Good Privacy, S/MIME. IP Security: IP Security Overview, IP Security Architecture, Authentication Header, Encapsulating Security Payload, Combining Security Associations, Key Management, Web Security: Web Security Considerations, Secure Sockets Layer and Transport Layer Security, Secure Electronic Transaction.	**10**
Unit-V **System Security:** Intruders: Intruders, Intrusion Detection, Password Management, Firewalls: Firewall Design Principles, Trusted Systems. Security issues in Wireless networks, adhoc networks and peer-to-peer networks	**10**

Course Outcomes

As the course focuses on all the relevant domains of information security, the students would be able to develop basic understanding of security, cryptography, system attacks and defences against them.

The student will be able to identify the research areas in the field of network and information security.

Text/Reference Books

3. William Stallings, “Cryptography and Network Security: Principles and Practice”, Pearson Education.

4. Trappe & Washington, *"Introduction to Cryptography with Coding Theory*", Prentice-Hall 2001
5. D Stinson, "Cryptography: Theory and Practice", Second Edition Chapman & Hall 2002.
6. Kaufman, Perlman, and Speciner, "Network Security", Prentice-Hall Second Edition 2001.
7. Michael E. Whitman, "Principles of information Security" , Cengage Learning, New Delhi
8. Chwan-Hwa (John) Wu (Author), J. David Irwin "Introduction to Computer Networks and Cybersecurity"
9. Roberta Bragg "Network Security: The Complete Reference" McGraw Hill.

Data Mining Techniques

Course Code: PHMTH1E009T

Course Title: Data Mining Techniques

Semester: Ph.D Course Work

Credits: 04

Course Overview

This course gives an introduction to methods and theory for development of data warehouses and data analysis using data mining, data quality and methods and techniques for preprocessing of data. Mining of data streams, time series, pattern mining web mining and distributed data mining.

Course Objective

- To introduce Data Warehousing and Mining techniques.
- To give detailed application of data mining in web mining, pattern matching and cluster analysis.

Course Outlines

Contents	No of Lectures
Unit-I Introduction to Data Warehousing :Data mining, data mining versus knowledge discovery in databases, basic data mining tasks, process of data mining (CRISP-DM), data mining issues, data mining techniques for analysis.	**10**
Unit-II **Machine Learning and its relationship with Data Mining:**Statistical based: Logistic Regression, Bayes classification,Distance based, Simple approach, K Nearest Neighbour, Decision tree Induction, Rule based Classification, Support Vector Machine. Case Study: Prediction of Diabetes using Classification Algorithm.	**10**
Unit-III Clustering: K means Clustering, Agglomerative Hierarchial Clustering, Partitional Algorithms, Squared- Error Clustering, K means Clustering, Anomaly or Outlier Detection, Association Rules, Apriori Algorithm	**10**
Unit-IV Introduction, Working of Predictive analytics, Models: Predictive and Descriptive, Stages of Predictive Analysis, Data Collection, Data Analysis, Statistics, Modelling, Deployment and Monitoring, Graph Mining.	**10**

Data cubes and its operations	
Unit-V Recent trends in Data Mining: Web Mining, Temporal Mining/Spatial Mining, Distributed Data mining, Oracle Data mining, Data mining in Bio Informatics, Data mining as a service (DMaaS)	**10**

Course Outcomes

After completion of the course, students will be able to:

- Study different sequential pattern algorithms
- Study the techniques to extract the patterns from the time series data and its application in real world.

Text/Reference Books

1. Jiawei Han and M Kamber, Data Mining Concepts and Techniques, Second Edition, Elsevier Publication, 2011.
2. Vipin Kumar, Introduction to Data Mining - Pang-Ning Tan, Michael Steinbach, Addison Wesley, 2006.
3. Parteek Bhatia , Data Mining and Data Warehousing: Principles and Practical Techniques., Cambridge , 2019.

Machine Learning

Course Code: PHMTH1E003T

Course Title: MACHINE LEARNING

Semester: PhD Coursework

Credits: 04

Course overview

Machine Learning and mining of massive datasets are rapidly growing fields of data analysis. For many years data analysis and statistical community has been developing algorithms and methods for discovering patterns in datasets. Besides theoretical knowledge successful research in the areas depends on confided usage of common methods, algorithms and tools along with skills for developing new ones. The focus of the second course "Machine Learning and Data Mining" at "Data Science" Master Program is to introduce students to methods and modern programming tools and frameworks aimed for data analysis. Special attention is given to methods for handling massive datasets. The course is constantly being adopted to match current state-of-the-art in the area.

COURSE OBJECTIVES

- To introduce students to the basic concepts and techniques of Machine Learning.
- To become familiar with various types of regression, classification, clustering methods and dimensionality reduction methods.
- To design and analyse various machine learning algorithms and techniques with a modern outlook focusing on recent advances.
- Explore supervised and unsupervised learning paradigms of machine learning.
- To explore Deep learning technique and various feature extraction strategies.
- To learn the concept of how to learn patterns and concepts from data without being explicitly programmed in various IOT nodes

Contents
Unit - I
Definition of learning systems. Goals and applications of machine learning. Aspects of developing a learning system: training data, concept representation, function approximation. **Supervised Learning (Regression/Classification):** Basic methods: Distance-based methods, Nearest-Neighbours, Decision Trees, Naive Bayes, Linear models: Linear Regression, Logistic Regression, Generalized Linear Models, Support Vector Machines, Nonlinearity and Kernel Methods**,** Beyond Binary Classification: Multi-class/Structured Outputs, Ranking
Unit - II
Unsupervised Learning: Clustering: K-means/Kernel K-means**,** Dimensionality Reduction: PCA and

kernel PCA**,** Matrix Factorization and Matrix Completion**,** Generative Models (mixture models and latent factor models)
Unit -III
Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests)
Unit - IV
Sparse Modeling and Estimation, Modeling Sequence/Time-Series Data, Deep Learning and Feature Representation Learning. Introduction to Bayesian Learning and Inference. Scalable Machine Learning (Online and Distributed Learning), Semi-supervised Learning, Active Learning, Reinforcement Learning,
Unit - V
Language Learning : Classification problems in language: word-sense disambiguation, sequence labeling. Hidden Markov models (HMM's). Veterbi algorithm for determining most-probable state sequences. Forward-backward EM algorithm for training the parameters of HMM's. Use of HMM's for speech recognition, part-of-speech tagging, and information extraction. Conditional random fields (CRF's).

COURSE OUTCOMES

After completion of course, students would be able to:

- Gain knowledge about basic concepts of Machine Learning.
- Solve the problems using various machine learning techniques.
- To mathematically analyse various machine learning approaches and paradigms.
- Extract features that can be used for a particular machine learning approach in various IOT applications.
- To compare and contrast pros and cons of various machine learning techniques and to get an insight of when to apply a particular machine learning approach.

TEXT/REFERENCES BOOKS

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009 (freely available online)
3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007.
4. Peter Flach Machine Learning: The Art and Science of Algorithms that Make Sense of Data, Cambridge University Press, 2012.
5. Witten, E. Frank, M. Hall. Data Mining: Practical Machine Learning Tools and Techniques, 2011, Morgan Kaufmann Publishers
6. Trevor J.. Hastie, Robert John Tibshirani, and Jerome H Friedman. The elements of statistical learning: data mining, inference, and prediction. Springer, 2009

Digital Image Processing

Course Code: PHMTH1E011T

Course Title: DIGITAL IMAGE PROCESSING

Semester: PhD Coursework

Credits: 04

COURSE OBJECTIVES

- To describe and explain basic principles of digital image processing.
- To design and implement algorithms that perform basic image processing (e.g. noise removal and image enhancement).
- To study the image enhancement techniques.
- To design and implement algorithms for advanced image analysis (e.g. image compression, image segmentation).
- Assess the performance of image processing algorithms and systems.

Contents
Unit - I Overview of Digital Image Processing, Origin, Applications of Image processing, Types and representation of digital Images, Fundamental steps and component of image processing system, Introduction to Human Visual System, Elements of matrix theory, Digital Imaging Hardware & Software, Sampling & Quantization, Interpolation and correlation, Basic Image operations: Arithmetic, logical, geometrical operations.
Unit - II Image quality factors, Basic image pre-processing (contrast enhancement, simple noise reduction, colour balancing), spatial transformation Gray Level liner and non-linear transformation, Histogram Processing, Fourier transform, Hadamard and Walsh transformation. Image enhancement in spatial and frequency domain: Basics, smoothing and sharpening domain filters.
Unit -III Image Segmentation & Analysis, Implementation Feature extraction: Edges, Lines & corners detection, Texture & shape measures. Segmentation & thresholding, region extraction, edge (Canny) & region based approach, use of motion in segmentation.
Unit - IV Image Restoration & Reconstruction: Introduction, Model of Image degradation, Noise Models, Classification of image restoration techniques, Blind-deconvolution techniques, Lucy Richardson Filtering, Wiener Filtering.

Unit - V

Image Compression & Object Recognition: Introduction to Image Compression and its need, Coding Redundancy, Classification of Compression Techniques (Lossy and Lossless - JPEG, RLE, Huffman, Shannon fano), Scalar & Vector Quantization, Introduction to Object Recognition, Object Representation (Signatures, Boundary Skeleton), Overview of Multi-spectral image processing.

COURSE OUTCOMES

After completion of course, students would be able to:

- Analyze general terminology of digital image processing.
- Examine various types of images, intensity transformations and spatial filtering.
- Develop Fourier transform for image processing in frequency domain.
- Evaluate the methodologies for image segmentation, restoration etc.
- Implement image process and analysis algorithms.
- Apply image processing algorithms in practical applications.

REFERENCES

1. Anil Jain, "Fundamentals Of Digital Image Processing", Anil Jain PHI, ISBN-81-203- 0929-4
2. S. Sridhar: Digital Image Processing, Oxford University Press publication, 7th impression 2016.
3. W.K.Pratt.-Digital Image Processing ,3/e Edn., John Wiley & sons, Inc. 2006
4. M. Sonka et.al Image Processing, Analysis and Machine Vision, 2/e, Thomson, Learning, India Edition, 2007.
5. Digital Image Processing using MATLAB, R.C. Gonzalez, R.R. Woods(Person), 2nd Edition
6. Introduction to Digital Image Processing with MATLAB, Alasdair McAndrew, Cenage Learning.

Pattern Recognition

Course Code: PHMTH1E010T

Course Title: Pattern Recognition

Semester: PhD Coursework

Credits: 04

Course Objective

- To discuss and compare different methods for pattern recognition along with their strengths and weaknesses
- To expose parametric and linear models for classification
- To make the students understand pattern recognition theories such as Bayes classifier, HMM, etc.
- To learn the various Statistical, Syntactical and Neural Pattern recognition techniques.
- To learn the working of various biometrics pattern recognitions systems like fingerprint, face, hand geometry, iris.
- To familiarise with various types of biometrics attacks vectors.
- To learn how to use pattern recognition for biometrics system.

Course Outlines

Contents	**No of Lectures**
Unit-I Introduction to pattern recognition Learning paradigms, Supervised and unsupervised learning; Probability: independence of events, conditional and joint probability, Processes: Stationary and non-stationary processes, Expectation, Autocorrelation, Cross-Correlation, spectra. Introduction to Statistical, Structural and Neural Approaches.	**07**
Unit-II Artificial Neural Network (ANN) and their biological roots, Models of Neurons, Threshold Functions, ANN architecture, Feed forward Neural Networks, Linear separability, X-OR problem and solution. Perceptron, Applications of Artificial Neural Networks-Pattern Mapping, Pattern Recognition, Pattern Classification, Pattern Clustering, Learning rules, Learning Paradigms. Back propagation Networks : (BPN) Architecture of feed forward network, single layer ANN, multilayer Perceptron, back propagation learning, back propagation algorithm.	**13**
Unit-III Biometrics as a Pattern Recognition tool, Evolution, Biometric traits, Biometrics Vs traditional recognition techniques, Characteristics of a good biometrics, Benefits of biometrics, Key biometric processes: verification, identification and biometric matching, Performance measures in biometric systems: FAR, FRR, FTE, FTA rate, EER, ROC, DTE etc., Biometrics applications, Challenges to biometrics systems.	**07**

Unit-IV Overview of Uni biometric systems, Fingerprint, Fingerprint Classification, Overview and working of Iris, Hand geometry, Face recognition biometrics systems, comparison of various biometrics, Limitations of Uni-biometrics, Taxonomy of multi-biometrics, Issues in Designing a Multibiometric System, Normalization strategy, Fusion techniques.	**13**
Unit-V Biometrics vulnerabilities, Attacks, Ratha's framework, synthetic fingerprints: SFING, Feature template security, Classification of template security techniques, Liveness detection in biometrics, Spoof detection schemes, Biometrics databases, Biometrics standards, soft biometrics.	**10**

Course Outcomes

At the end of this course, students will be able to:

- Identify and describe existing pattern recognition approaches for different human interaction modalities (voice, gesture, etc.)
- Evaluate and select the best approach for the recognition and identification of various patterns.
- Compare and identify the best technological solution for designing and implementing a complete recognition system based on pattern matching approach
- Identify a set of business use--cases using pattern based technology and discuss related advantage and drawbacks.
- To understand the working of various biometrics systems.
- Design new template security and spoof detection schemes for biometrics systems.

Text/Reference Books

3. C. M. Bishop, Neural Networks for Pattern Recognition, Oxford University Press, 1995.
4. V. N. Vapnik, The Nature of Statistical Learning Theory, Springer, 2000.
5. N. Cristianini and J. Shawe-Taylor, An Introduction to Support Vector Machines, Cambridge University Press, 2000.
6. R. J. Schalkoff, Pattern Recognition: Statistical, Structural and Neural Approaches, Wiley, 1992.
7. Classification and Scene Analysis, Wiley, New York, 1973. L. Miclet, Structural Methods in Pattern Recognition North Oxford 3. Academic, London, 1986.
8. Anil K Jain, Patrick Flynn, Arun A Ross, "Handbook of Biometrics", Springer, 2008.
9. Arun A. Ross , Karthik Nandakumar, A.K.Jain, "Handbook of Multibiometrics", Springer, New Delhi, 2006.
10. Samir Nanavathi, Michel Thieme, and Raj Nanavathi, "Biometrics -Identity verification in a network", Wiley Eastern, 2002.
11. John Chirillo and Scott Blaul," Implementing Biometric Security", Wiley Eastern Publications, 2005

Modeling Simulation and Optimization

Course Code: PHMTH1E001T
Course Title: Modeling Simulation and Optimization
Semester: II
Credits: 04

Course Overview

The course provides introduction to simulation, its significance and important applications. It explains how simulation models can be classified and how simulation procedures can be developed based on the models. Students will learn the different methods to generate random numbers and the statistical techniques required for measuring the quality of generators. Further, students will be exposed to the different networking simulation tools.

Course Objectives

- Introduce computer simulation technologies and techniques, provides the foundations for the student to understand computer simulation needs, and to implement and test a variety of simulation and data analysis libraries and programs. This course focuses what is needed to build simulation software environments, and not just building simulations using pre-existing packages.
- Introduce concepts of modelling layers of society's critical infrastructure networks.
- Build tools to view and control simulations and their results.

Course Outlines

Contents	**No of Lectures**
Unit-I Introduction: Systems, models, deterministic and stochastic systems, static and dynamic systems, discrete event simulation, continuous simulation, Monte Carlo simulation. Discrete Event Simulation: Time-advance mechanisms, event modeling of discrete dynamic systems, event graphs, process oriented and event oriented approaches, single-server single queue model.	**10**
Unit-II GPSS: Program model, entities and transactions, blocks in GPSS, user defined functions, SNA, logic switches, save locations, user chains, tabulation of result, programming examples. Random Number Generation: Congruence generators, long period generators, statistical quality measures of generators, uniformity	**10**

and independence testing, chi-square and other hypotheses testing, runs testing	
Unit-III Random Variable Generation: random variable, probability density and distribution functions, Location, scale and shape parameters, discrete and continuous probability distributions; Inverse transform method, composition and acceptance-rejection methods, efficiency and quality measures of generators; Input Modelling, selection of distribution for a random source, fitting distributions to data, constructing empirical distributions from data.	**10**
Unit-IV Random Processes and Queuing Models: random process, discrete/continuous time processes, Markovian property, Markov chain, state transition diagrams, birth-death process, Little's theorem, steady state analysis of M/M/1 model; multi-server models, M/G/1 and other queuing models, Burke's theorem, network of queues, Jackson theorem.	**10**
Unit-V Network Simulation: SimEvent tool box in R/Python/Octave, general features of network simulation packages, case study of OMNET++/ns2/ns3/NetSim.	**10**

Course Outcomes

After completion of course, students would be able to:

- Understand the meaning of modeling and simulation.
- Know what is GPSS model and understand different statistical tests for measuring quality of generators
- Understand the concept of random numbers and the method to generate random numbers
- Understand random processes and different queuing models
- Network simulation tools.

Text/Reference Books

1. Network Simulation: SimEvent tool box in R/Python/Octave, general features of network simulation packages, case study of OMNET++/ns2/ns3/NetSim.
2. Banks, J., Carson, L.S., Nelson, B.L. and Nicol, D.M., "Discrete Event System Simulation", 4th Ed., Pearson Education
3. Law, A.M. and Kelton, W.D., "Simulation, Modeling and Analysis", 3rd Ed., Tata McGraw-Hill.
4. Alberto Leon-Garcia, "Probability and Random Processes for Electrical Engineers", 2nd Ed., Pearson Education

Optimization Techniques

Course Code: PHMTH1E012T

Course Title: Optimization Techniques

Semester: PhD Course Work

Credits: 04

Course Overview

The course provides introduction to simulation, its significance and important applications. It explains how simulation models can be classified and how simulation procedures can be developed based on the models. Students will learn the different methods to generate random numbers and the statistical techniques required for measuring the quality of generators. Further, students will be exposed to the different networking simulation tools.

Course Objectives

- Introduce computer simulation technologies and techniques, provides the foundations for the student to understand computer simulation needs, and to implement and test a variety of simulation and data analysis libraries and programs. This course focuses what is needed to build simulation software environments, and not just building simulations using pre-existing packages.
- Introduce concepts of modelling layers of society's critical infrastructure networks.
- Build tools to view and control simulations and their results.

Course Outlines

Contents	**No of Lectures**
Unit-I Overview: Introduction to Operation Research, techniques, tools, phases, limitations and applications in OR. Linear programming-I: (Graphical method) Introduction, Formulation of a linear programming problem with different types of constraints, requirements, assumptions, merits and demerits, applications of LP, Graphical analysis, Graphical solution, Multiple, unbounded solution and infeasible problems and its applications Linear programming-II: (Simplex method (SM)) Introduction, SM with several decision variables. Two phase simplex method, M-method, multiple, unbounded	**10**

solution, infeasible problems, Sensitivity and duality analysis in LP, Dual Simplex Problems.	
Unit-II Transportation Problem (TP): Structure and formulation of TP, Procedure for TP, Methods for finding initial feasible and optimal solution, Unbalanced TP, maximization TP, degeneracy problems in TP. Assignment Problem (AP): Approach, procedure and maximization, unbalanced assignment problems, Hungarian Method. Project Scheduling: Network analysis concept, CPM/PERT methods for scheduling of projects.	**10**
Unit-III Sequencing problems: Processing n-jobs through two, three, M machines, Processing of n-jobs through M machines. Replacement decisions: Replacement of items that deteriorate with time (with and without change in money value), Staff replacement problem.	**10**
Unit-IV Integer and dynamic programming: Integer programming, formulation techniques, unimodularity, cutting plane method, branch and bound method.	**10**
Unit-V Dynamic programming: Methodology and its programming applications. Game Theory: Basic terminology, solution methods of pure and mixed strategy games, principle of dominance, limitations.	**10**

Course Outcomes

After completion of course, students would be able to:

- Understand the meaning of modeling and simulation.
- Know what is GPSS model and understand different statistical tests for measuring quality of generators
- Understand the concept of random numbers and the method to generate random numbers
- Understand random processes and different queuing models
- Network simulation tools.

Text/Reference Books

1. V K KAPOOR, Operations Research, Techniques for Management, Edition 7, Publishers: Sultan Chand and sons, 2004.
2. S S Rao optimization theory and applications, Wiley Eastern Ltd., New Delhi.
3. S.D.Sharma: Operations research, Kedar nath, Ram Nath & co.
4. H.A.Taha, Operations Research-An introduction, Macmillan Publishing co.inc.New york
5. Kanti Swarup, P K Gupta and Man Mohan, Operations Research, Sultan chand and sons, New Delhi.

6. Prem Kumar Gupta and D.S, Hira, Operations Research-An introduction, S.Chand and Company Ltd, New Delhi.