Curriculum & Contents

M.Tech in Wireless Networks and Computing

ABV-Indian Institute of Information Technology & Management, Gwalior

July 2023

M. Tech. (Wireless Networks and Computing)

Semester wise core courses

Semester – 1

S.No.	Course Code	Course Name	L-T-P	Credits
1	IT 601	Probability and stochastic process	3-1-0	4
2	IT 602	Wireless networks	3-0-0	3
3	IT 603	Mobile computing	3-0-0	3
4	IT 604	Modelling and simulation	3-0-0	3
5	IT 606	Elective-I	3-0-0	3
6	IT 605	Network and computing lab	0-0-6	3
			Total	19

Semester - 2

S.No.	Course Code	Course Name	L-T-P	Credits
1	IT 607	Next generation networks	3-1-0	4
2	IT 608	Graphs and networks	3-0-0	3
3	IT 609	Machine learning	3-0-2	4
4	IT 610	Engineering research methodology	2-0-0	2
5	IT 611	Elective-II	3-0-0	3
6	IT 612	Elective-III	3-0-0	3
			Total	19

Semester - 3

S.No.	Course Code	Course Name	L-T-P	Credits
1	IT 613	Elective-IV/MOOC-I	3-0-0	3
2	IT 614	Elective-V/MOOC-II	3-0-0	3
3	IT 698	Thesis Part-I/ Internship	0-0-24	12
			Total	18

Semester - 4

S.No.	Course Code	Course Name	L-T-P	Credits
1	IT 615	Elective-VI/MOOC-III	3-0-0	3
2	IT 699	Thesis Part-II	0-0-30	15
			Total	18

Semester-1	Semester-1	Semester-3	Semester-4	Total Credits
19	19	18	18	74

M. Tech. (Wireless Networks and Computing)

Electives courses

S.No.	Subject Codes	Title of Courses	L-T-P
1		Network design and optimization	3-0-0
2		Grid and peer-to-peer computing	3-0-0
3		Cloud computing and security	3-0-0
4		IoT protocols and security	3-0-0
5		High speed network	3-0-0
6		Machine vision	3-0-0
7		Nature inspired computing	3-0-0
8		Computer graphics and multimedia	3-0-0
9		Advance machine learning	3-0-0
10		Special topics in AI	3-0-0
11		Information theory and coding	3-0-0
12		Detection and estimation theory	3-0-0
13		Adaptive signal processing	3-0-0
14		Queuing theory	3-0-0
15		Digital signal processing	3-0-0
16		Modern cryptography	3-0-0
17		Cognitive radio	3-0-0
18		Digital watermarking and steganalysis	3-0-0
19		Game theory and its application	3-0-0

Core courses contents

1	**Semester**	I
2	**Type of course**	Core
3	**Code of the subject**	IT 601
4	**Title of the subject**	Probability and stochastic process
5	**Any prerequisite**	None
6	**L-T-P**	3-1-0
7	**Learning objectives of the subject (in about 50 words)**	Many complex systems are modeled using stochastic processes. This course will introduce students to basic stochastic processes tools that can be utilized for performance analysis and stochastic modeling.
8	**Brief contents**	Axioms of probability, Probability space, Conditional probability, Independence, Baye's rule, Random variable, Some common discrete and continuous distributions, Distribution of functions of random variable, Moments, Generating functions, Two and higher dimensional distributions, Functions of random variables, Order statistics, Conditional distributions, Covariance, Correlation coefficient, Conditional expectation, Modes of convergences, Law of large numbers, Central limit theorem. Definition of stochastic process, Classification and properties of stochastic processes, Simple stochastic processes, Stationary processes, Discrete and continuous time Markov chains, Classification of states, Limiting distribution, Birth and death process, Poisson process, Steady state and transient distributions, Simple Markovian queuing models (M/M/1, M/M/1/N, M/M/c/N, M/M/N/N).
9	**Contents for lab (If applicable)**	N/A

1	**Semester**	I
2	**Type of course**	Core
3	**Code of the subject**	IT 602
4	**Title of the subject**	Wireless networks
5	**Any prerequisite**	Communication system
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	After successful completion of this course, students will come across various wireless technology evolved for wireless transmission/reception. This course also deals an overview of communication theory particularly different modulation schemes, fading due to environment, multiplexing techniques, and role of antennas.
8	**Brief contents**	Introduction to the course- Wireless network technology; Wireless LANs, Wireless WANs, and Wireless MANs. Wireless vs. wired networks. Antennas- types of antenna, Antenna models, Antenna diversity, Gain. Isotropic radiator vs. Directed radiator. Modes of signal propagation; Modulation schemes -ASK, FSK, PSK, AM, FM, and PM. Multiplexing methods - Frequency multiplex, Time multiplex, and CDMA. Bit error-rate (BER). TCP/IP basics, 802.11 (WiFi)-components and architecture, WLAN: IEEE 802.11b, 802.11a, and 802.16 (WiMaX), Mesh and adhoc networks, 802.16 internals. Frequency hopping spread spectrum (FHSS)-slow and fast hopping, FHSS transmit/receive, OFDM, ALOHA
9	**Contents for lab (If applicable)**	No lab is associated with the course.

1	**Semester**	I
2	**Type of course**	Core
3	**Code of the subject**	IT 603
4	**Title of the subject**	Mobile computing
5	**Any prerequisite**	Computer networks
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	We will cover interesting topics across a variety of mobile systems (wireless LANs, cellular systems, and sensor networks), and revisit the design of the various layers of the networking stack in the context of wireless communication. The course will comprise of lectures, four problem sets, exams (midsem and endsem), and a course project.
8	**Brief contents (module wise)**	Overview of wireless and mobile systems (wireless LANs, cellular systems, sensor networks, etc.) and the challenges therein. The radio channel and wireless physical layer design. Medium access, Multiplexing, Link adaptation. Multi-hop routing protocols, Routing metrics. Multicast, Multi-hop data forwarding, Opportunistic routing. Solutions to handle mobility at various layers of the networking stack. TCP behavior over wireless, Other transport layer issues. Energy efficiency, Localization, Security. Smartphone-based platform architectures and applications. Future directions: Dynamic spectrum access, Heterogeneous networks, Internet of things.
9	**Contents for lab (If applicable)**	N/A

1	**Semester**	I
2	**Type of course**	Core
3	**Code of the subject**	IT 604
4	**Title of the subject**	Modelling and simulation
5	**Any prerequisite**	Engineering mathematics, and Probability and statistics
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	To learn the application of mathematics and statistics in the real-life problems.
8	**Brief contents (module wise)**	Introduction concept of a system, Modeling and simulation of real world problems, Classification of models and examples, Static and dynamic models, Principles used in modeling. System studies subsystems, Corporate models, Block diagram of modeling and simulation, System analysis, System design. Mathematical models, Mathematical models in population dynamics, Epidemic. System simulation the technique of simulation, The Monte Carlo method, Types of system simulation, Continuous and discrete time simulation. Probability concepts in simulation stochastic variables, Discrete and continuous probability distributions, Measures of probability functions, Random numbers generation, Stochastic processes: Poisson process, Markov process, Queuing theory, Reliability. Linear programming in simulation introduction, Transportation problem, Assignment problem and other simulation techniques in operation research.
9	**Contents for lab (If applicable)**	No lab is associated with this course.

1	**Semester**	I
2	**Type of course**	Core
3	**Code of the subject**	IT 605
4	**Title of the subject**	Network and computing lab
5	**Any prerequisite**	No
6	**L-T-P**	0-0-6
7	**Learning objectives of the subject (in about 50 words)**	Understand basics of MATLAB, NS2, OPNET Able to perform basic computational techniques Understand types of computational method
8	**Brief Contents (module wise)**	Introduction to MATLAB, Vectors in MATLAB, Efficient programming techniques system of linear equations: Solution for a system of linear equations, Solving a system of linear equations, Inverse matrix, Decomposition (Factorization), Iterative methods to solve equations, Interpolation and curve fitting: Interpolation by Lagrange, Newton, and Chebyshev polynomial, Newton Raphson method, Secant method, Newton method for a system of nonlinear equations, Numerical differentiation/integration: Difference approximation for first derivative, Approximation error of first derivative, Numerical integration and quadrature, Trapezoidal method and Simpson method, Optimization: Unconstrained optimization, Constrained optimization, MATLAB built-In routines for optimization, Matrices and eigenvalues: Eigenvalues and eigenvectors, Power method, Jacobi method partial differential equations: Elliptic, Hyperbolic, and Parabolic PDE, Computer networks and the layering concept, Layering concept, OSI and TCP/IP reference models, System modeling, Basics of computer network simulation, Time-dependent simulation, A simulation example: A single channel queuing system. Introduction to network simulator 2 (NS2), Basic architecture, Installation, Directories and convention, Running NS2 simulation, A simulation example, Including C++ modules into NS2 and the make utility. Introduction of simulation and OPNET, Outline ways to study a system advantages of simulation OPNET modeler main features of OPNET simulator, A simulation example how to use this software for simulating and modeling computer networks.
9	**Contents for lab (If applicable)**	

1	**Semester**	II
2	**Type of course**	Core
3	**Code of the subject**	IT 607
4	**Title of the subject**	Next generation networks
5	**Any prerequisite**	It is desirable to have the knowledge of data networking and telecommunications principles.
6	**L-T-P**	3-1-0
7	**Learning objectives of the subject (in about 50 words)**	After successful completion of this course, students will able to learn emerging network technologies, their features, challenges, advantages, and disadvantages. To learn how broadband data and multimedia services are carried out to users over a common multi-service infrastructure.
8	**Brief contents**	Introduction To next generation networks (NGN): Communication and networking in coming era, Technologies influencing change, NGN services, Network infrastructure convergence, Services convergence etc., Overview of wireless network and technologies GSM, 1G, 2G, 3G and 4G, Bluetooth, Radio frequency, Overview of TCP/IP, LANs, WANs. Optical networks, Wire-line and wireless networks, General packet radio service (GPRS): GPRS and packet data network, Network architecture, Operation, and data services in GPRS. Applications of GPRS, Billing, and charging in GPRS, Ad-hoc network: Architecture and protocols, Wireless LAN, IEEE802.11a, 802.11b standards, Wireless LAN architecture, Mobile ad hoc networks, and Sensor network.
9	**Contents for lab (If applicable)**	No lab is associated with this subject.

1	**Semester**	II
2	**Type of course**	Core
3	**Code of the subject**	IT 608
4	**Title of the subject**	Graphs and networks
5	**Any prerequisite**	None
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	The objective of the course is, in addition to logical foundations, Theoretical developments and development of the basic skills to tackle problems in graph theory. It is also aimed at understanding how various problems arising from real life or sciences as well as recreational puzzles can be converted to graph theoretic problems like shortest paths, network flows, chromatic numbers, connectivity etc.
8	**Brief contents**	Introduction to graphs, Paths and circuits, Trees and fundamental circuits, Spanning tree, Matrix tree theorem, Euler graph, Hamiltonian graph, Isomorphism, Network flows, Ford-Fulkerson theorem. Cut-sets and cut vertices, Planar and dual graphs, Embedding, Kurtowski theorem, Euler identity, Matrix representation of graphs, Coloring, Edge coloring, Chromatic number, Brooks theorem, Five-color theorem, Matching, Directed graph, Underlying graph, Outdegree, In-degree, Connectivity, Orientation, Eulerian directed graphs, Hamilton directed graphs, Arborescence, Tournament, Acyclization, Applications of graph theory: In switching and coding theory, Electrical network analysis
9	**Contents for lab (If applicable)**	No lab is associated with this subject.

1	**Semester**	II
2	**Type of course**	Core
3	**Code of the subject**	IT 609
4	**Title of the subject**	Machine learning
5	**Any prerequisite**	Introductory courses on probability theory and linear algebra. Knowledge of basic programming languages such as python and MATLAB.
6	**L-T-P**	3-0-2
7	**Learning objectives of the subject (in about 50 words)**	After successful completion of this course, students will able to relate/understand/solve several day-to-day real-time with machine learning algorithms. The objective of this course is to familiarize the students with different machine learning algorithms ranging basic linear classifier/regression modeling problems to non-linear classification problems using deep neural network.
8	**Brief contents**	Introduction to the course of machine learning (ML): What and why? Classification, Regression, Sequence modeling. Introducing prerequisites of ML, Linear classifier and classification problem, Gradient descent algorithm, Underfitting vs. over-fitting problem, Training, Testing, and Validation process, Supervised vs. unsupervised classification, Bayesian classifier: Decision boundaries; Nearest neighbour methods, and Support vector machine (SVM); Unsupervised learning: k-means and hierarchical clustering, Feature extraction and feature selection; Dimensionality reduction techniques: PCA, LDA and ICA, Introduction to neural networks: Modelling and applications to logic gates. Backpropagation learning algorithm: Training and testing, Introduction to convolution neural network (CNN): AlexNet, VGG architectures. Introduction to auto-encoder and generative adversarial networks (GAN).
9	**Contents for lab (If applicable)**	Study and demonstration of data preprocessing on the dataset. The aim of this experiment is to illustrate some of the basic data preprocessing such as loading of the dataset, and use of various filters, Implement a project on data mining, which includes the demonstration of data collection and mining process, Building classification models, and performance evaluation of prediction models.

1	**Semester**	II
2	**Type of course**	Core
3	**Code of the subject**	IT 610
4	**Title of the subject**	Engineering research methodology
5	**Any prerequisite**	Basic mathematics
6	**L-T-P**	2-0-0
7	**Learning objectives of the subject (in about 50 words)**	To enable researchers (Ph.D. and M. Tech. students), irrespective of their discipline in developing the most appropriate methodology for their research studies. To make them familiar with the art of using different research methods and techniques.
8	**Brief contents**	Research, Types of research, Research vs. research methods, Research process, Relevant and quality research. Problem-solving in engineering, Identification of research topic, Problem definition, Literature survey, Literature review, Research design, Models in general, Mathematical models, Model classifications, Simulation models, Steps in a simulation study, Simulation software, Validation, Data collection, and Applications, Formulation of hypothesis, Testing of hypothesis, Analysis of variance, Design of experiments, Multivariate analysis, Simple regression and correlation, Measurement and scaling techniques, Data checking, Data analysis, Statistical, Graphical and numerical data analysis, Interpretation of results in research, need for interpretation, Accuracy, Precision, Uncertainty and variability, Repeatability and reproducibility, Error definition and classification, Analysis of errors, Statistical analysis of errors, Basic communication model, Preparing papers for journals, Synopsis of research work, Reference citation, Listing of references. Ethics in research, Intellectual property rights, Copyright laws, Patent rights.
9	**Contents for lab (If applicable)**	No lab is associated with this subject.

Electives courses contents

1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	
4	**Title of the subject**	Network design and optimization
5	**Any prerequisite**	Basics of wireless communications
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	Students will acquire knowledge of the planning and optimization of wireless networks and their specifications. The course will discuss the working principles of different types of wireless networks and their performance optimization
8	**Brief contents**	Fundamentals of wireless communications, Networks planning principals for cellular networks, 4G (LTE) architecture, Features and call flow, Network (RAN) performance and optimization, LTE introduction, LTE network design basics, Optimization principles, Coverage optimization, Capacity optimization, Capacity and latency optimization, Energy and spectrum efficient wireless network design and optimization
9	**Contents for lab (If applicable)**	

1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	
4	**Title of the subject**	Grid and peer to peer computing
5	**Any prerequisite**	Operating systems, Networks
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	This course is an advanced elective and covers material relating to distributed computing fundamentals, grid computing middleware, and high-performance applications. The prerequisites for the course are operating systems, and networks. A prior course on distributed systems is an added advantage.
8	**Brief contents**	Grid Computing: Introduction to grid computing, Classification of grids, Introduction to service oriented computing. Peer-to-Peer (P2P) concepts in grids: Introduction to P2P systems, Overlays unstructured P2P systems (Gnutella, Freenet), Structured P2P systems (distributed hash tables - chord, pastry), Integrating unstructured and structured P2P systems, Introduction to P2P security - sybil attacks. Grid computing middleware: Vishwa: a reconfigurable P2P middleware for grid computations. Grid security and resource management: grid security-a brief security primer-PKI-X509, Certificates-grid security, Grid scheduling and resource management-scheduling paradigms, Working principles of scheduling, A review of condor, SGE, TPBS and TLSF-grid scheduling with QoS. Current P2P systems: Napster, Gnutella, KazaA, FreeNet, Pastry, Tapestry.
9	**Contents for lab (If applicable)**	No lab is associated with the course

1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	
4	**Title of the subject**	Cloud computing and security
5	**Any prerequisite**	
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	The course objective is to familiarize the students with the fundamentals of cloud computing architectures, protocols, and best practices intended for delivering cloud based enterprise IT services and business applications.
8	**Brief contents**	Fundamentals of cloud computing and architectural characteristics: Cloud deployment, Infrastructure as a Service (IaaS), Cloud computing roles, etc. Risks and security concerns. Security design and architecture for cloud computing: Guiding security design principles for cloud computing - Secure isolation, Comprehensive data protection, End-to-end access control, Monitoring and auditing, Quick look at CSA, NIST and ENISA guidelines for cloud security, Common attack vectors and threats. Secure isolation of physical & logical infrastructure; Data protection for cloud infrastructure and service, Network and storage, Verified and measured boot, Firewalls, IDS, IPS and honeypots.
9	**Contents for lab (If applicable)**	No lab is associated with the course

1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	
4	**Title of the subject**	IoT protocols and security
5	**Any prerequisite**	Fundamentals of internet of things
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	To understand the architectural overview of IoT and analyse basic protocols in wireless sensor network. Design IoT applications in different domain and be able to analyse their performance. Implement basic IoT applications on embedded platform.
8	**Brief contents**	Overview of IoT, IoT-an architectural overview– Building an architecture, Main design principles and needed capabilities, Reference architecture IoT architecture-State of the art – introduction. Functional view, Information view, Deployment and operational view. Network & communication aspects Wireless medium access issues. Challenges in IoT design, Development challenges, Security challenges. Domain specific applications of IoT home automation, Industry applications, Surveillance applications, Other IoT applications. Developing IoTs introduction to python, Introduction to different IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementing IoT concepts with python. IoT data link layer & network layer protocols. Transport & session layer protocols. Service layer protocols & security service layer.
9	**Contents for lab (If applicable)**	No lab is associated with the course

1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	
4	**Title of the subject**	High speed network
5	**Any prerequisite**	Digital circuits and network technology
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	After successful completion of this course, students will able to learn high speed networks, traffic and congestion management system. Study of wireless network operations, resource allocation, service management.
8	**Brief contents**	Introduction to high-speed networks (HSNs), Congestion and traffic management, QOS in IP networks, Wireless network and its operations, Network management, configuration selection method-MIB-SNMP-XMLCORBA-COPS-VPNS-mobile IP-voice over IP.
9	**Contents for lab (If applicable)**	No lab is associated with the course

1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	
4	**Title of the subject**	Machine vision
5	**Any prerequisite**	Machine learning
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	In this course, students will gain a broad understanding of the algorithms used for image segmentation, feature extraction and object detection. They will also understand the challenges involved in end-to-end machine vision system along with image acquisition, model deployment and actuation. Students will be able to develop convolution neural network for object recognition and deploy them on the edge for manufacturing industry.
8	**Brief contents**	Introduction to image processing system- Thresholding, Image enhancement, Contrast stretching, Image histograms, Filters, Image sharpening, Gradient based edge detection, Finding corners, Using scale and orientation to build neighborhood, SIFT, SURF, HOG feature detection, Computing local features, and segmentation, Convolutional neural networks, Padding, Strided convolution, Convolution over volume, One layer convolution, Pooling, Object localization, Object detection, Classic networks, Transfer learning, ImageNet challenge, Feature extraction from videos and parallelization, Image acquisition.
9	**Contents for lab (If applicable)**	

1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	
4	**Title of the subject**	Nature inspired computing
5	**Any prerequisite**	Basic mathematics, Data structures, and Algorithms
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	It introduces a new paradigm of computing and solving problems. It has great applications in artificial intelligence, Data mining, Machine learning, and real-world design and optimization problems.
8	**Brief contents**	Introduction to evolutionary computation: Representation, Initial population, Fitness function, Selection, Reproduction operators, Stopping conditions, Evolutionary versus classical computation; Genetic algorithm: Canonical genetic algorithm, Crossover, Mutation, Control parameters, Genetic algorithm Variants, Applications; Differential evolution, Particle swarm optimization, Artificial bee colony algorithm. ANN introduction, Evolution, McCulloh-Pitts neuron, Linear separability, Hebb network; Perceptron networks, Adaptive linear neuron, Multiple Adaptive linear neuron, Back-propagation Network, Radial basis function network; Associative memory network, Heteroassociative memory network, Bidirectional associative memory, Hopfield network, Iterative autoassociative memory network, Temporal associative, Self-organizing maps, Linear vector quantization, Counter propagation network.
9	**Contents for lab (If applicable)**	

1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	
4	**Title of the subject**	Computer graphics and multimedia
5	**Any prerequisite**	
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	Computer graphics is the illustration field of computer science. Its use today spans virtually all scientific fields and is utilized for design, presentation, education and training. Computer graphics and its derivative, visualization, have become the primary tools by which the flood of information from computational science is analysed.
8	**Brief contents**	Introduction of computer graphics, Graphic displays, Mid-point circle generating algorithm, and parallel version of these algorithms. Three Dimensional: 3-D geometric primitives, 3-D object representation, 3-D transformation, 3-D viewing, Projections, 3-D clipping. Transformations: Basic transformation, Matrix representations and homogenous coordinates, Composite transformations, Windowing and clipping: Viewing pipeline, Viewing transformations, 2-D clipping algorithms- Cohen Sutherland line clipping algorithm, Liang Barsky algorithm, Line clipping against non-rectangular clip windows; Weiler and Atherton polygon clipping, Curve clipping, Text clipping; Hidden lines and surfaces: Back face detection algorithm, Depth buffer method. Multimedia basics – Multimedia applications – Multimedia system architecture – Evolving technologies for multimedia – Defining objects for multimedia systems – Multimedia data interface standards – Multimedia databases. Compression and decompression – Data and file format standards – Multimedia I/O technologies – Digital voice and audio – Video image and animation – Full motion video – Storage and retrieval technologies.
9	**Contents for lab (If applicable)**	Graphic displays, Viewing, Projections, 3-D clipping. Basic transformation, Matrix representations and homogenous coordinates, Composite transformations, 2-D clipping algorithms- Cohen Sutherland line clipping algorithm

1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	
4	**Title of the subject**	Advance machine learning
5	**Any prerequisite**	Linear algebra, Statistics and machine learning
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	
8	**Brief contents**	Convolutional neural networks, Recurrent neural networks, Timeseries processing, Transformer networks, Semantic segmentation, Generative models, Generative adversarial networks model interpretation: Introduction, Sample complexity bound for learning axis parallel rectangles. Definition of PAC learning. A Theory of the learnable – valiant PAC learnability of finite hypothesis classes, Empirical risk minimization, Agnostic PAC learnability of finite hypothesis class, Uniform convergence, No free lunch theorem, VC dimension, Sauer lemma, Growth function, Fundamental theorem of statistical learning theory, Nonuniform learnability, Structural risk minimization.
9	**Contents for lab (If applicable)**	

1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	
4	**Title of the subject**	Special topics in AI
5	**Any prerequisite**	Machine Learning.
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	The chief objective is to teach modern methods of probabilistic reasoning that are commonly used in many parts of computer science, including but not limited to artificial intelligence. Such methods have become extremely important and transforming the approach to a great variety of computational problems, in the field of computer science itself, and broadly across many application fields.
8	**Brief contents**	Overview of probability theory, Bayes networks, Independence, I-maps, Undirected graphical models, Bayes networks and Markov networks, Local models, Template based representations, Exact inference: Variable elimination; Clique trees, Belief propagation, Tree construction, Approximate inference: Sampling Markov chains, MAP inference, Inference in temporal models, Learning graphical models, Parameter estimation, Bayesian networks and shared parameters, Structure learning, Structure search, Partially observed data, Gradient descent, EM, Hidden variables, Undirected models, Undirected structure learning causality, Utility functions, Decision problems, Expected utility, Value of information
9	**Contents for lab (If applicable)**	

1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	
4	**Title of the subject**	Information theory and coding
5	**Any prerequisite**	Students should have brief idea about linear algebra.
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	This course gives brief knowledge about the basic algebraic relationships of entropy, relative entropy, and mutual information. In this course students are going to learn how to compress the data using source coding and how to make data transmission reliable using channel coding. It introduces the basic principles of encoding, decoding, error detecting and error correcting techniques.
8	**Brief contents**	Information theory: Introduction, Discrete memory less source, Binary source. Entropy, Relative entropy, and Mutual information, Channel capacity, Data compression Examples of codes, Kraft inequality, Optimal codes, Bounds on the optimal code length, Kraft inequality for uniquely decodable codes, Huffman codes, Shannon–Fano coding, etc. Error detecting and error correcting code, Block codes, Cyclic codes, Convolution codes.
9	**Contents for lab (If applicable)**	Nil

1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	
4	**Title of the subject**	Detection and estimation theory
5	**Any prerequisite**	Student must have basic knowledge about linear algebra, probability and random process.
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	Detection theory involves detecting one hypothesis from two or more than two hypotheses. This may be done based on Bayes detection, Minmax detection, NP test. Estimation theory is a branch of statistics that deals with estimating the values of parameters based on measured empirical data that has a random component using various estimators. In general, the information that one wishes to extract from such observation is unknown to the observer, it is useful to cast detection and estimation problems in a probabilistic framework in which unknown behaviour is assumed to be random. Applications of the theory of signal detection and estimation are in many areas, such as communications, automatic control, telecommunication, radar etc.
8	**Brief contents**	Review of Gaussian variables and processes, Statistical Decision Theory: Bayesian, Minimax, and Neyman-Pearson decision rules, Likelihood ratio, Composite hypothesis testing, Detection of Deterministic Signals: Matched filter detector and its performance. Detection of random signals: Estimator-correlator, Linear model, General Gaussian detection. Nonparametric detection: Detection in the absence of complete statistical description of observations. Estimation of signal parameters: Minimum variance unbiased estimation, Fisher information matrix, Cramer-Rao bound, Sufficient statistics. Signal estimation in discrete-time: Linear Bayesian estimation, Weiner filtering, Dynamical signal model, Discrete Kalman filtering.
9	**Contents for lab (If applicable)**	

1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	
4	**Title of the subject**	Adaptive signal processing
5	**Any prerequisite**	Digital signal processing
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	Development of various adaptation algorithms and assessing them in terms of convergence rate, computational complexity, robustness against noisy data, hardware complexity, numerical stability. The course will present several examples of adaptive filter applications like channel equalization, echo cancellation, noise cancellation, interference suppression.
8	**Brief contents**	Introduction to adaptive systems: Definitions, Characteristics, Applications, Example of an adaptive system. The adaptive linear combiner – Description, Weight vectors, Desired response performance function – Gradient & mean square error. Development of adaptive filter theory & searching the performance surface: Introduction to filtering – Smoothing and prediction – Linear optimum filtering, Problem statement, Principle of orthogonally – Minimum mean square error, Wiener-Hopf equations, Error performance – Minimum mean square error, Steepest descent algorithms: LMS algorithm & applications: Stability & performance analysis of LMS algorithms – LMS gradient & stochastic algorithms – Convergence of LMS algorithm, RLS algorithm. Statement of Kalman filtering problem, Innovation process, Estimation of state using the innovation process- Expression of Kalman gain, Filtering example estimation of state from observations of noisy observed narrow band signals. Target tracking using only DOA.
9	**Contents for lab (If applicable)**	No lab is associated with the course

1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	
4	**Title of the subject**	Queuing theory
5	**Any prerequisite**	Basic knowledge of engineering mathematics and statistics
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	To teach the applications of queuing theory related to computer networks.
8	**Brief contents**	Basics of probability and statistics, Random processes- introduction, Classification, Stationary process – Wide sense stationary, Strict sense stationary, Markov process, Markov chain, Problems based on Markov process. Transition probabilities, Limiting distributions, Poisson process - Properties, Poisson process - Problems Queuing system – Introduction, Markovian models, Birth and death Process, Little‘s formula, M/M/1, Infinite capacity, M/M/1, Finite capacity, M/M/c, Infinite capacity, M//M/c, Finite capacity and finite population, M/M/ queue. Non Markovian queues- M/G/1 queue, GI/M/1 queue, GI/M/m queue, GI/G/1 queue, M/G/m queue, GI/G/m queue, Pollaczek-Khinchine formula. Priority queues- Queues with preemption, Queues with time dependent priorities. Series queues, Open networks, Closed networks, Batch service, Batch arrival.
9	**Contents for lab (If applicable)**	No

1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	
4	**Title of the subject**	Digital signal processing
5	**Any prerequisite**	Signals & systems
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	In this course, we will mainly study the following topics: signal representation in time domain, Fourier transform, sampling theorem, linear time-invariant system, discrete convolution, z-transform, discrete Fourier transform, and discrete filter design. After this course, the students should be able to understand how to analyse a given signal or system using tools such as Fourier transform and z-transform; how to process signals to make them more useful.
8	**Brief contents**	Review of signals and systems: Discrete time complex exponentials and other basic signals-scaling of the independent axis and differences from its continuous-time counterpart-system properties (Linearity, Time-invariance, Memory, Causality, BIBO stability)-LTI systems, Convolution, Correlation, Continuous-time Fourier series and Fourier transform. Sampling discrete-time Fourier transform (DTFT) Z-transform. Frequency domain analysis of LTI systems. Discrete Fourier Transform (DFT), FIR, IIR, Filter Design.
9	**Contents for lab (If applicable)**	NA

1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	
4	**Title of the subject**	Modern cryptography
5	**Any prerequisite**	
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	To make the students understand the process of deciphering coded messages without being told the key. To study of codes and the art of writing and solving them. To give motivation towards recent research development in the field of cryptography, cryptanalysis, and steganography. Overall this course explores modern cryptographic (code making) and cryptanalytic (code breaking) techniques in detail.
8	**Brief contents**	Number theory basics, Modular arithmetic fields, Binary fields, Primes, GCD and Chinese reminder theorems, Pseudorandom bits and sequences, Extended Euclidean algorithm and application Fermat‘s Little theorem and application, Euler phi function, Block ciphers in mathematical way, DES historical ciphers, Public key cryptography, RSA, Two fish, Digital signatures, Key management techniques, Identification and entity authentication, Hash function and data integrity.
9	**Contents for lab (If applicable)**	

1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	
4	**Title of the subject**	Cognitive radio
5	**Any prerequisite**	Digital communication
6	**L-T-P**	3-0-0
7	**Learning Objectives of the subject (in about 50 words)**	The students will be enabled to understand and acquire knowledge in cognitive networks. To emphasis on knowledge-building to understand architectures for various networks. To provide a complete understanding on concepts, to identify the pros and cons of designing a cognitive network and SDR.
8	**Brief Contents**	Introduction of various generation of wireless communication, Spectrum scarcity, Cognitive radio (CR) architecture, Functions of cognitive radio, Fundamental challenges and issues in designing cognitive radio. Spectrum access models, Dynamic spectrum access (DSA), Underlay, Overlay, and hybrid cognitive radio, Potential applications of cognitive radio. Interference temperature/channel estimation, Detection of spectrum holes, Practical spectrum sensing approaches, Collaborative sensing, External sensing. Framework of trust in CRN; Trusted association and routing; Trust with learning; Security in CRN. Introduction to SDR. Evolution of SDR baseband requirements. SDR architectures - ideal SDR architectures, Realistic SDR architecture. SDR and cognitive radio relationship.
9	**Contents for lab (If applicable)**	No lab is associated with the course.

1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	
4	**Title of the subject**	Digital watermarking and steganalysis
5	**Any prerequisite**	No
6	**L-T-P**	3-0-0
7	**Learning Objectives of the subject (in about 50 words)**	The objective of the course makes students familiar about digital watermarking and steganography.
8	**Brief Contents**	Information hiding, Steganography, and watermarking, Importance of digital watermarking, Applications and properties. Models of watermarking: Communication-based models of watermarking, Geometric models of watermarking, Modelling watermark detection by correlation; Basic message coding: Mapping messages into message vectors, Error correction coding, Detecting multi-symbol watermarks; Watermarking with side information: Informed embedding, Watermarking using side information, Dirty-paper codes; Robust watermarking: Approaches, Robustness to volumetric distortions, Robustness to temporal and geometric distortions; Watermark security: Security requirements, Watermark security and cryptography, Some significant known attacks; Content authentication: Exact authentication, Selective authentication, Localization, Restoration; Notation and terminology, Information-theoretic foundations of steganography, Practical steganographic methods, Minimizing the embedding impact; Steganalysis: Steganalysis scenarios, Some significant steganalysis algorithms.
9	**Contents for lab (If applicable)**	No lab is associated with the course.

1	**Semester**	
2	**Type of course**	Elective
3	**Code of the subject**	
4	**Title of the subject**	Game theory and its application
5	**Any prerequisite**	Basic knowledge of engineering mathematics and statistics
6	**L-T-P**	3-0-0
7	**Learning objectives of the subject (in about 50 words)**	To teach the applications of game theory, auction and equilibrium.
8	**Brief contents**	Introduction to game theory, Dominant strategies and Nash equilibrium, Alternate strategies: Maximin, Maximax, and Minimax regret solvability, N-player games, Mixed strategy, Subgame perfection in discrete choice games, Continuous games and imperfect competition, Infinitely repeated games, Tacit collusion, Simultaneous-play, Bayesian games, Applications of Bayesian games: Auctions and voting, Cournot's duopoly with imperfect information, Radio spectrum, With arbitrary distribution of valuations, Extensive form game with perfect information, Stackelberg model of duopoly, Buying votes, Committee decision-making, Repeated games, The Prisoner's dilemma, General result, Supermodular game and potential game, Wireless networks: Resource allocations, Admission control, Routing in sensor and ad-hoc networks, Modeling network traffic and strategic network formation, Rubinstein bargaining model with alternating offers, Nash bargaining solution, Multi armed bandit problem.
9	**Contents for lab (If applicable)**	

****