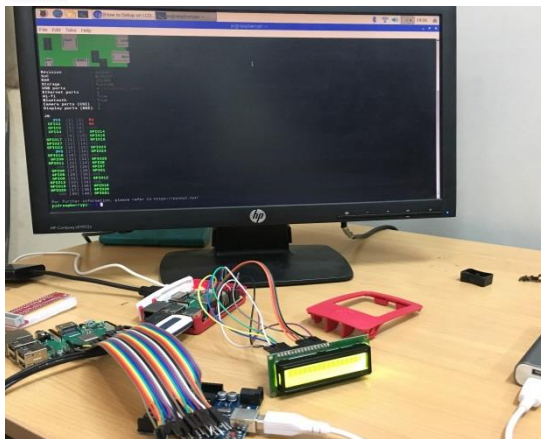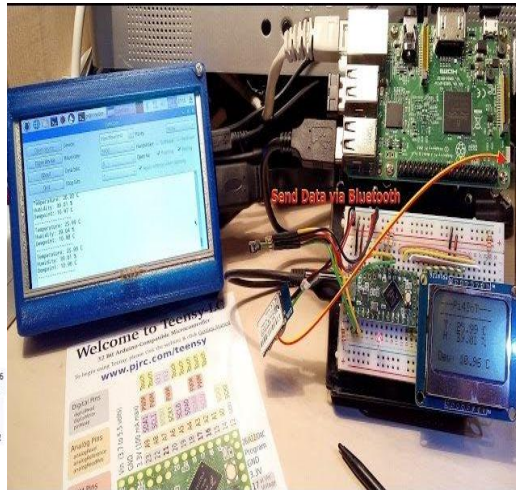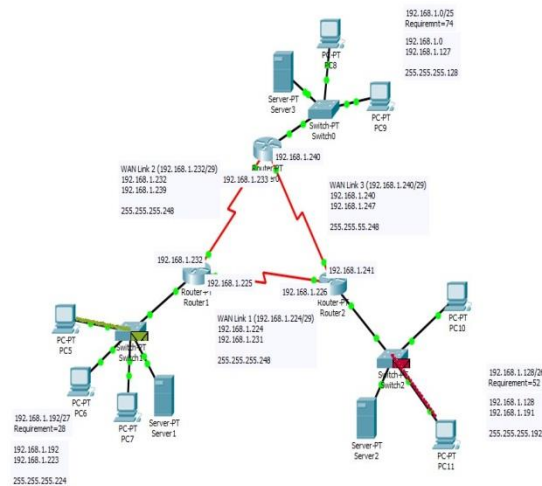# Curriculum & Contents

M Tech (Computer Networks)

ABV-Indian Institute of Information Technology & Management, Gwalior

June 2019

M. Tech. (Computer Networks)

Semester wise courses

S. No.	Subject Code	Title of the course	L-T-P	Credits
Semester I				
1.	MTAS-6101	Modelling and Simulation	3-1-0	4
2.	MTCN-6101	Advanced Network Technology	3-0-2	3
3.	MTCN-6102	Network Management and Security	3-0-0	3
4.		Elective-I	3-0-0	3
5.		Elective-II	3-0-0	3
6.	MTCN-6103	Scientific Computing Lab-I	0-0-6	3
7.	MTHS-6101	Professional Ethics	0-0-2	1
8.	MTCN-6104	Generic Computing Lab		Audit
		Total Credits		**20**

S. No.	Subject Code	Title of the course	L-T-P	Credits
Semester II				
1.	MTCN-6201	Wireless Network Technology	3-0-0	3
2.	MTCN-6202	Network design and Optimization	3-1-0	4
3.	MTHS-6201	Research Methodology	2-0-2	3
4.		Elective-III	3-0-0	3
5.		Elective-IV	3-0-0	3
6.	MTCN-6203	Scientific Computing Lab-II	0-0-6	3
		Total Credits		**19**

Semester III

S. No.	Subject Code	Title of the course	L-T-P	Credits
1.	MTHS-7101	Technical Report Writing	0-0-2	1
2.	MTCN-7102	Seminar	0-0-2	1
3.		Elective-V	3-0-0	3
4.	MTCN-7199	Major Project Part-I	0-0-12	6
		Total Credits		**11**

Semester IV

S. No.	Subject Code	Title of the course	L-T-P	Credits
1.	MTCN-7299	Major Project Part-II	0-0-24	12
		Total Credits		**12**

Electives (Semester Wise)

Semester I

S. No.	Subject Code	Title of the course	L-T-P	Credits
1.	**MTCN-9101**	Mobile Computing	3-0-0	3
2.	**MTCN-9102**	Stochastic Process and Queuing Theory	3-0-0	3
3.	**MTCN-9103**	Fibre Optic Networks	3-0-0	3
4.	**MTCN-9104**	Grid and Peer-to-peer Computing	3-0-0	3
5.	**MTCN-9105**	Parallel and Distributed Computing	3-0-0	3
6.	**MTCN-9106**	Advanced Graph Theory	3-0-0	3

Semester II

S. No.	Subject Code	Title of the course	L-T-P	Credits
1.	**MTCN-9201**	Cloud Computing and Cloud Security	3-0-0	3
2.	**MTCN-9202**	Cyber Physical Networks	3-0-0	3
3.	**MTCN-9203**	IoT Protocols and Security	3-0-0	3
4.	**MTCN-9204**	Storage Area Networks	3-0-0	3
5.	**MTCN-9205**	Next Generation Networks	3-0-0	3
6.	**MTCN-9206**	High Speed Networks	3-0-0	3

Semester III

S. No.	Subject Code	Title of the course	L-T-P	Credits
1.	**MTCN-9301**	Network Embedded System	3-0-0	3
2.	**MTCN-9302**	Convergent Networks	3-0-0	3
3.	**MTCN-9303**	Tactile Networks	3-0-0	3
4.	**MTCN-9304**	Machine Learning and Autonomous Systems	3-0-0	3

Please note:

a)   The course contents are indicative in nature. Actual contents followed may deviate based on students/faculty interests.

b)   Typically the evaluation is based on various components such as Minors (In-semester tests), Major examination (End-semester test), assignments, term papers, quizzes, presentations and class participation. The weightages for these components will be decided by the respective course instructors.

Semester-I

1	Code of the subject	MTAS-6101
2	Title of the subject	Modeling and Simulation
3	Any prerequisite	Engineering Mathematics, and Probability and Statistics
4	L-T-P	3-1-0
5	Name of the proposer	Dr. Ajay Kumar
6	Will this course require visiting faculty	No
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)	**Module 1: Introduction** Concept of a system, System Environment, Modeling and Simulation of Real world problems, Classification of Models and examples, Static and Dynamic models, Principles used in modeling. **Module 2: System Studies** Subsystems, Corporate models, Block diagram of modeling and simulation, System Analysis, System Design. **Module 3: Mathematical Models** Mathematical models in population dynamics, Epidemic Models, some mathematical modeling in Biology and Medicine Innovation diffusion models in marketing. **Module 4: System Simulation** The technique of simulation, the Monte Carlo Method, Types of system simulation, Continuous and Discrete time Simulation. **Module 5: 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. **Module 6: Linear programming in Simulation** Introduction, Transportation problem, Assignment problem and other simulation techniques in Operation research. **Module 7: Software in System Simulation** Numerical computation technique for continuous and discrete models (MATLAB)
9	Contents for lab (If applicable)	No lab is associated with this course.
10	List of text books/references	1. "Discrete-event system simulation", Banks, J., Carson, I. I., Nelson, B. L., and Nicol, D. M., Pearson, 2005. 2. "Probability and Statistics with Reliability, Queuing and Computer Science Applications", 2nd Ed, Kishor S Trivedi, Wiley, 2002. 3. "System Simulation", Geoffrey Gordon, Prentice-Hall, 1978.

1	Code of the subject	MTCN-6101

2	Title of the subject	Advanced Network Technology
3	Any prerequisite	Computer Networking, Distributed Systems, Operating system, Computer Architecture, Internet and Web Technologies.
4	L-T-P	3-0-2
5	Name of the proposer	Dr. K. K. Pattanaik
6	Will this course require visiting faculty	No
7	Learning Objectives of the subject (in about 50 words)	To understand the interconnection for high performance computing, protocols and techniques used for enhancing data delivery ratio, ensuring QoS. Wireless sensor networks and protocols to support cyber physical system interaction and components of IoT.
8	Brief Contents (module wise)	**Module 1: Gigabit Networking** High Performance Computing and Communications Program (HPCC) basics, Broadband networks, Gigabit testbeds worldwide, Network switching technologies: architecture and performance parameters, Gigabit network design preliminaries. **Module 2: Wireless Sensor Networks** Sensor network architecture, Design principles, Optimization goals and figures of merit, Communication protocols, Link layer protocols, Localization and positioning, Topology control, Routing protocols, Advanced application support. **Module 3: Content Delivery Networks** Early Days of Content Delivery over the Internet World Wide Web—Where It Came From and What It Is Evolution of Content Networking Diversity of Interests in Content Networking; Content Transport: Protocol Architecture and Design Paradigms of the Internet, Hypertext Transport Protocol—HTTP, Multicast Transport; Caching Techniques for Web Content; Caching Techniques for Streaming Media.
9	**Contents for lab (If applicable)**	Wireless Sensor Network setup in NS2/NS3. Basics of IoT programming using the Arduino Platform, Data gathering experiments, Case of Sensing audio data and interpreting results, Similar experiments, Data visualization.
10	**List of text books/references**	1. "Gigabit Networking" (Addison-Wesley Professional Computing Series), Craig Partridge, Addison Wesley, 1994. 2. "Protocol and Architectures for Wireless Sensor Networks", Holger Karl, Andreas Willig, Wiley, 2005. 3. "Content Networking Architecture, Protocols, and Practice", M. Hofmann, L. R. Beaumont, .Morgan Kaufmann, 2005.

1	Code of the subject	MTCN-6102
2	**Title of the subject**	Network Management and Security
3	**Any prerequisite**	Computer Networks
4	**L-T-P**	3-0-0
5	**Name of the proposer**	Dr. Saumya Bhadauria
6	**Will this course require visiting faculty**	No
7	**Learning Objectives of the subject (in about 50 words)**	To understand the principles of network management, different standards and protocols used in managing complex networks.
8	Brief Contents (module wise)	**Module 1: Network Management Overview** Goals, Organization, and Functions, Network and System Management, Network Management System Platform, Current Status and future of Network Management. **Module 2: SNMPv1** Communication and Functional Models, SNMPv2: Major Changes in SNMPv2, SNMPv2 System architecture, SNMPv2 Structure of Management Information, The SNMPv2 Management Information Base, SNMPv2Protocol, Compatibility with SNMPv1.SNMP MANAGEMENT: RMON. **Module 3: Network Security** Network Intrusion detection and prevention systems, Firewalls, DNS security issues and defenses, TLS/SSL, Internet Security Protocols and Standards
9	**Contents for lab (If applicable)**	No lab is associated with the course.
10	**List of text books/references**	1. "Network Management Principles and Practice", Mani Subrahmanian, 2nd Edition, Pearson Education, 2010. 2. "Network management", 1st Edition, Morris, Pearson Education, 2008. 3. "Computer Security: Principles and Practice", William Stallings and Lawrie Brown, 3rd Ed, Prentice Hall Press, 2014.

1	Code of the subject	MTCN-6103
2	Title of the subject	Scientific Computing Laboratory –I
3	Any prerequisite	No
4	L-T-P	0-0-6
5	Name of the proposer	Dr. Pinku Ranjan
6	Will this course require visiting faculty	No
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)	➢ MATLAB Usage and Computational Errors: Introduction to MATLAB, Types of Computer Errors, IEEE 64- bit Floating-Point Number Representation, 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, Hermite Interpolating Polynomial, Cubic Spline interpolation, Straight Line, Polynomial Curve, and Exponential Curve Fit, Fourier transform Nonlinear Equations: Bisection Method, Regula Falsi Method, 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, Romberg Integration,Adaptive and Gauss Quadrature. Ordinary Differential Equations: Euler's Method, Runge–Kutta Method, PredMEor–Corrector Method, Vector Differential Equations, Boundary Value Problem (BVP) ➢ 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, Finite Element Method (FEM) for solving 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)	No lab is associated with the course.
10	List of text books/references	1. "Applied Numerical methods using MATLAB", W. Y. Yang, Wiley Publications, 2005. 2. "Applied Numerical Methods with MATLAB," Steven C. Chapra, McGraw-Hill, 2005. 3. "Numerical Methods using MATLAB", John H. Mathews, Prentice Hall, 1998. 4. "Introduction to MATLAB for Engineers", W.J Palm, McGraw-Hill, 2008. 5. "Introduction to Network Simulator NS2", Teerawat Issariyakul, Ekram Hossain, 2 Ed., Springer. 6. "The Practical OPNET User Guide for Computer Network Simulation", Adarshpal S. Sethi , Vasil Y. Hnatyshin , 1 Ed., Chapman and Hall/CRC, 2012.

1	Code of the subject	MTHS-6101
2	Title of the subject	Professional Ethics
3	Any prerequisite	Nil
4	L-T-P	3-0-0
5	Name of the proposer	Prof. V.S.R. Krishnaiah
6	Will this course require visiting faculty	Yes
7	Learning Objectives of the subject (in about 50 words)	The primary objective of this course is to sensitize students on the concept of Ethics and Human Values and make them understand the relevance of these ideas in their day to day personal and professional lives. The Course aims to instill moral and social values as well as professional code of conduct in the students to make them good quality professionals so as to perform their professional responsibilities better in their future career.
8	Brief Contents (module wise)	**Module 1:** Definitions of Ethics, Engineering Ethics, and Morality. Categorization of Ethics, Differentiation of Morality and Ethics, Ten personal ethical behaviors which are globally acceptable, Definition of virtues, Elaboration of cardinal virtues, Definition of human values, Shalome H Shwartz value classification with examples. **Module 2:** Definition of Profession and Professional, Responsibilities of professionals, the objectives of any one professional association, ACM Code of Ethics and Professional Conduct, IEEE Code of Ethics. **Module 3:** Significance of ethics in ICT sector, Global Ethical Issues in ICT Sector with examples, Definitions of CSR, The stakeholders and their expectations from an organization, The Company Act 2013, Benefits of CSR in organization, Examples of CSR in ICT sector. **Module 4:** Definition of Emotional intelligence, Importance of Emotional intelligence for Professionals, Five elements of Emotional intelligence, Significance of EI for professional success with examples, Ethical Dilemmas, Main features of Whistle Blowing, Preparation for Professionals and CEOs for avoiding unethical issues in their organizations
9	Contents for lab	No lab is associated with the course.
10	List of text books/references	1. "Professional Ethics", R. Subramanian, Oxford University Press, 2013. 2. "Working with Emotional Intelligence" Daniel Goleman, Bloomsbury, 2004.

1	Code of the subject	MTCN-6104
2	Title of the subject	Generic Computing Lab
3	Any prerequisite	Nil
4	L-T-P	0-0-2
5	Name of the proposer	Dr. Sunil Kumar
6	Will this course require visiting faculty	No
7	Learning Objectives of the subject (in about 50 words)	This course is intended to familiarize the students with different programming languages with their practical applications in computer network, communication and machine learning. More specifically, the course is designed based on MATLAB and Python, however, the one can extent it into some other programming languages like C/C++ etc.
8	Brief Contents (module wise)	**Module 1:** Overview of Matlab programming - Basic operations, Variables, Data types, Array, Cells, Structure, Functions and Matlab Simulink-Toolbox. **Module 2:** Explore Communication System and Signal Processing Toolboxes in Matlab using simple examples, Plot BER-SNR and Bit Rate-SNR graphs for different fading channels. **Module 3:** Implement a PN Sequence Generation and Direct Sequence Spread Spectrum with Matlab. **Module 4:** Explore Python - numpy, tensorflow, keras, mat- plotlib. pyplot etc. libraries for machine learning. **Module 5:** Perform classification and regression problem using Python libraries. **Module 6:** Explore basic Networking Commands.
9	Contents for lab (If applicable)	It is a lab course.
10	List of text books/references	1. "Programming in Python 3: A Complete Introduction to the Python Language", Mark Summerfield, 2008. 2. "Getting Started with MATLAB 5: A Quick Introduction for Scientists and Engineers", Pratap, Rudra, Oxford University Press, 1998 3. http://www.deeplearningbook.org. 4. "Pattern Recognition and Machine Learning", Christopher Bishop, Second Edition, 2010.

Semester-II

1	**Code of the subject**	MTCN-6201
2	**Title of the subject**	Wireless Network Technology
3	**Any prerequisite**	Communication System
4	**L-T-P**	3-0-0
5	**Name of the proposer**	Dr. Sunil Kumar
6	**Will this course require visiting faculty**	No
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 (module wise)**	**Module 1**: Introduction to the course- Wireless Network technology; Wireless LANs, Wireless WANs, and Wireless MANs. Wireless vs Wired networks. **Module 2:** Antennas- Types of Antenna, Antenna models, Antenna diversity, Gain. Isotropic radiator vs Directed radiator. **Module 3**: 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). **Module 4**: TCP/IP Basics, 802.11 (WiFi)-Components and Architec- ture, WLAN: IEEE 802.11b, 802.11a, and 802.16 (WiMaX), Mesh and Adhoc Networks, 802.16 internals. **Module 5**: 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.
10	**List of text books/references**	1. "Computer Networks", A. S. Tanenbaum, Pearson Education, 2003. 2. "Wireless and Mobile Network Architectures", Y. B. Lin and I Chlamtac, Wiley, 2001. 3. 802.11 Wireless LAN, IEEE standards, www.ieee.org

1	Code of the subject	MTCN-6202
2	Title of the subject	Network Design and Optimization
3	Any prerequisite	Computer Networks and Graph Theory
4	L-T-P	3-1-0 (4 credit course)
5	Name of the proposer	Dr. W. Wilfred Godfrey
6	Will this course require visiting faculty	No
7	Learning Objectives of the subject (in about 50 words)	➢ To study optimization techniques for use in the domain of computer networks. ➢ To analyse network infrastructure requirements and to design and implement the infrastructure for business solutions.
8	Brief Contents (module wise)	**Module 1: Introduction** Graphs and Flows -Network Flow Models -Network Flow Algorithms - Shortest Path Problems - Label Setting (Dijkstra) Methods - Label Correcting Methods - Single Origin/Single Destination Methods - Auction Algorithms - Multiple Origin/Multiple Destination Methods **Module 2: Max-Flow and Min-Cost Flow Problem** Max-Flow and Min-Cut Problems - Ford-Fulkerson Algorithm - Price-Based Augmenting Path Algorithms - Transformations and Equivalences - Duality **Module 3: Simplex Methods for Min-Cost Flow** Main Ideas in Simplex Methods - Basic Simplex Algorithm - Extension to Problems with Upper and Lower Bounds -Implementation Issues **Module 4: Dual Ascent Methods for Min-Cost Flow** Dual Ascent -The Primal-Dual (Sequential Shortest Path) Method -The Relaxation Method -Sensitivity Analysis - Implementation Issues **Module 5: Auction Algorithms for Min-Cost Flow** The Auction Algorithm for the Assignment Problem - Extensions of the Auction Algorithm -The Preflow-Push Algorithm for Max-Flow -The Relaxation Method - The Auction/Sequential Shortest Path Algorithm - Nonlinear Network Optimization - Convex Separable Network Problems - Network Problems with Integer Constraints
9	Contents for lab (If applicable)	No lab is associated with the course.
10	List of text books/references	1. "Network Optimization: Continuous and Discrete Methods", Dimitri Bertsekas, 1998. 2. "Network Flows: Theory, Algorithms, and Applications", James B. Orlin, Ravindra K. Ahuja, and Thomas L. Magnanti, 1993. 3. "Network Optimization Problems: Algorithms, Applications And Complexity", Panos M. Pardalos, Ding-Zhu Du, 1993. 4. "Routing, Flow and Capacity Designing in Communication and Computer Networks", M. Pioro and D. Medhi, Morgan Kaufmann, 2004.

1	Code of the subject	MTHS-6201
2	Title of the subject	Research Methodology
3	Any prerequisite	No
4	L-T-P	3-0-0
5	Name of the proposer	Dr. Pankaj Srivastava
6	Will this course require visiting faculty	No
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 (module wise)	**Module 1: Research Fundamentals** 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 survey, Literature review, Research Design. **Module 2: Mathematical Modeling and Simulation** Models in general, Mathematical models, Model classifications, Modeling of engineering systems Theoretical models, Empirical models, Model evaluation, Limitations of mathematical models. Simulation models, Steps in a simulation study, Simulation software, Validation and data collection, Applications. **Module 3: Hypothesis Testing, Analysis and Scaling Techniques** Formulation of Hypothesis, Testing of hypothesis, Analysis of variance, Design of experiments, Multivariate analysis, Simple regression and correlation, measurement and scaling techniques. **Module 4: Analysis and Interpretation of Data** 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. **Module 5: Skills and Ethics in Research** Basic communication model, Preparing papers for journals, synopsis of research work, Reference citation, Listing of References. Thesis writing, Steps in writing the report, presentation of graphs, figures, tables, Structure of thesis report, main body of thesis, summary, references, Evaluation of a thesis, Ethics in research, Intellectual property rights, copyright laws, Patent rights.
9	Contents for lab (If applicable)	Though no lab is associated with the course, students shall be asked to do following lab/practical work: ➢ Introduction to LaTeX software. ➢ Practical applications of SPSS, ANOVA ➢ Applications and case studies of parametric and non-parametric tests
10	List of text books/references	1. "Research Methodology", C R Kothari, New Age International, 2019. 2. "Research Methodology: A step by step guide for beginners", Ranjit Kumar, Sage Publications, 2005. 3. "Guide to Research and Documentation", Kirk G. Rasmussen, Prentice Hall, 2002. 4. "Research Methods", R. Panneerselvan, Prentice Hall, 2004. 5. "Research Methodology for Engineers", R Ganeshan, MJP Publishers, 2011.

1	**Code of the subject**	MTCN-6203
2	**Title of the subject**	Scientific Computing Lab-II
3	**Any prerequisite**	Knowledge of Python
4	**L-T-P**	0-0-6
5	**Name of the proposer**	Dr. Vinal Patel
6	**Will this course require visiting faculty**	No
7	**Learning Objectives of the subject (in about 50 words)**	➢ To develop the ability to implement the most common numerical algorithms for solving a wide range of problems in computer network filed.
8	**Brief Contents (module wise)**	**Module 1:** Numerical methods for mathematical, computational, physical sciences and engineering: error analysis, floating-point arithmetic, nonlinear equations, numerical solution of systems of algebraic equations, banded matrices, least squares, unconstrained optimization, polynomial interpolation, numerical differentiation and integration, numerical solution of ordinary differential equations, truncation error, numerical stability for time dependent problems and stiffness. Implementation of numerical methods in Python programming assignments. **Module 2:** Concepts and techniques of data mining, including characterization and comparison, association rules mining, classification and prediction, cluster analysis, and mining complex types of data. **Module 3:** In this module research papers in the field of the computer network is assigned to the students. Students will learn to implement the techniques from the previous modules on the specific assigned research problems. **Module 4:** Presentation, documentation of methods and results from scientific computations in the form of technical reports, with suitable use of figures, tables, equations, cross-references, and bibliography.
9	**Contents for lab (If applicable)**	It is a lab course.
10	**List of text books/references**	1. "Programming for Computations-Python", S. Linge, H. P. Langtangen, Springer, 2016. 2. EuroScipy tutorial team: Python Scientific lecture notes. http://scipy-lectures.github.com.

Semester-III

1	**Code of the subject**	MTHS-7101
2	**Title of the subject**	Technical Report Writing
3	**Any prerequisite**	-
4	**L-T-P**	0-0-2
5	**Name of the proposer**	Dr. Arun Kumar
6	**Will this course require visiting faculty**	Yes
7	**Learning Objectives of the subject (in about 50 words)**	➢ To learn written communication skills in the wake of present day professional world ➢ To enhance the understanding of written communication with practice oriented approach ➢ To collect, analyze and report data ➢ To familiarize with grammar and usage ➢ To acquire higher order writing skills through project assignments
8	**Brief Contents (module wise)**	➢ Fundamentals of communication ➢ Elements of Report writing ➢ Types of reports such as memo, corrigendum ➢ Technical reports ➢ Sources of data ➢ Data analysis ➢ Illustrating data ➢ Mechanics of writing ➢ Report structure ➢ Oral presentation ➢ Issues related to plagiarism and ways to counter the same
9	**Contents for lab (If applicable)**	➢ Data Analysis ➢ Report writing ➢ Report presentation
10	**List of text books/references**	1. "Business Correspondence and Report Writing", Sharma, R.C. and K. Mohan, Tata McGraw Hill, 5th edition, 2016. 2. "Technical Writing: Process and Product", Gerson, Sharon J and Stern M. Gerson, Pearson, 3rd edition, 2000.

1	**Code of the subject**	MTCN-7102
2	**Title of the subject**	Seminar
3	**Any prerequisite**	NA
4	**L-T-P**	0-0-2
5	**Name of the proposer**	Dr. Somesh Kumar
6	**Will this course require visiting faculty**	No
7	**Learning Objectives of the subject (in about 50 words)**	➢ To expose students to the 'real' working environment and get acquainted with the organization structure, business operations and administrative functions ➢ To promote and develop presentation skills and import a knowledgeable society. ➢ To set the stage for future recruitment by potential employers. ➢ Students will be able to apply a multidisciplinary strategy to address current, real-world issues.
8	**Brief Contents**	**Broad areas :** Machine Learning, IoTs, Wired & Wireless Communication, Signal Processing, Cryptography & Network security, Wireless Intelligent Networking, Delay tolerant network, General System Layering, Novell Netware Protocol Layering, Distributed Processing and Networks, The ISO Layering Model, TCP/IP Protocol Layering, Mobile ADHOC Network, Microsoft Windows Protocol Layering, Bluetooth Based Smart Sensor Networks, Storage over IP: Challenge and Opportunities, Network Controller for 4G mobile and wireless network, Home networking, Application of Genetic Algorithms in Network routing, Hybrid Global-Local Indexing for Efficient Peer-to-Peer Information Retrieval, etc.
9	**Contents for lab (If applicable)**	It is a lab course.
10	**List of text books/references**	1. https://ieeexplore.ieee.org/Xplore/home.jsp 2. https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6210560 3. https://www.ieee.org/conferences/organizers/planning-presentation-of-papers.html

1	**Code of the subject**	MTCN-7199
2	**Title of the subject**	Major Project Part-I
3	**Any prerequisite**	Academic honesty, ethics and a deeper understanding of the topic under research
4	**L-T-P**	0-0-12
5	**Name of the proposer**	Dr. K. K. Pattanaik
6	**Will this course require visiting faculty**	No
7	**Learning Objectives of the subject (in about 50 words)**	The course will help understand the system level details of the Internetworking technology, issues, and approaches.
8	**Brief Contents (module wise)**	The purpose of this course is to enable the student to develop deeper knowledge, understanding, capabilities and attitudes in the context of the programme of study. Specific learning outcomes for a Master's thesis are for the student to demonstrate: ➢ Considerably more in-depth knowledge of the major subject/field of study, including deeper insight into current research and development work. ➢ Deeper knowledge of methods in the major subject/field of study. ➢ A capability to contribute to research and development work. ➢ The capability to create, analyse and critically evaluate different technical/architectural solutions. ➢ The capability to clearly present and discuss the conclusions as well as the knowledge and arguments that form the basis for these findings in written and spoken English. ➢ A consciousness of the ethical aspects of research and development work. Overall a Master's thesis for a 12 credit course must be considerably more ambitious with respect to the scientific level or technical/architectural realisation.
9	**Contents for lab (If applicable)**	No
10	**List of text books/references**	

Semester-IV

1	Code of the subject	MTCN-7299
2	Title of the subject	Major Project Part-II
3	Any prerequisite	Academic honesty, ethics and a deeper understanding of the topic under research
4	L-T-P	0-0-24
5	Name of the proposer	Dr. K. K. Pattanaik
6	Will this course require visiting faculty	No
7	Learning Objectives of the subject (in about 50 words)	The course will help understand the system level details of the Internetworking technology, issues, and approaches.
8	Brief Contents (module wise)	This shall be in continuation to the Major Project Part-I. A thesis should be written at the end of the programme and must delve more deeply into and synthesise knowledge acquired in previous studies. A thesis for M. Tech. should place emphasis on the technical/scientific/artistic aspects of the subject matter.
9	Contents for lab (If applicable)	No
10	List of text books/references	

Course Syllabus for electives

Semester I

1	Code of the subject	MTCN-9101
2	Title of the subject	Mobile Computing
3	Any prerequisite	Computer Networks
4	L-T-P	3-0-0
5	Name of the proposer	Dr. Prasenjit Chanak
6	Will this course require visiting faculty	No
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)	**Module 1:** Overview of wireless and mobile systems (wireless LANs, cellular systems, sensor networks, etc.) and the challenges therein. **Module 2:** The radio channel and wireless physical layer design. **Module 3:** Medium access, multiplexing, link adaptation. **Module 4:** Multihop routing protocols, routing metrics. **Module 5:** Multicast, multihop data forwarding, opportunistic routing. **Module 6:** Solutions to handle mobility at various layers of the networking stack. **Module 7:** TCP behavior over wireless, other transport layer issues. **Module 8:** Energy efficiency, localization, security. **Module 9:** Smartphone-based platform architectures and applications. **Module 10:** Future directions: dynamic spectrum access, heterogenuous networks, internet of things.
9	Contents for lab (If applicable)	No lab is associated with the course
10	List of text books/references	1. "Mobile Communications", J. Schiller,2nd ed, 2008.

1	Code of the subject	MTCN-9102
2	Title of the subject	Stochastic Process and Queuing Theory
3	Any prerequisite	Probability and Statistics
4	L-T-P	3-0-0
5	Name of the proposer	Prof. K. V. Arya
6	Will this course require visiting faculty	NO
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 (module wise)	**Module 1:** Review of probability, random variable and expectation **Module 2:** Stochastic processes **Module 3:** Discrete-Time Markov Chains **Module 4:** Continuous-Time Markov Chains **Module 5:** Queuing networks
9	Contents for lab (If applicable)	No lab is associated with the course
10	List of text books/references	1. "Introduction to Stochastic Processes" , E. Cinlar, Prentice-Hall, 1975. 2. "Stochastic Modelling of Queues", R. W. Wolf, Prentice-Hall, 1989. 3. "Probability & Statistics with Reliability, Queuing and Computer Science Application", 2nd ed., Wiley, 2008.

1	Code of the subject	MTCN-9103
2	Title of the subject	Fibre Optic Networks
3	Any prerequisite	Communication system
4	L-T-P	3-0-0
5	Name of the proposer	Dr. Sunil Kumar
6	Will this course require visiting faculty	
7	Learning Objectives of the subject (in about 50 words)	The motive of this course is to familiarize the students with operating principles of fiber optics and its characteristics. The other objectives include: data communication through optical fibre, modulation process, multiplexing and demultiplexing in fiber optic systems. Finally, advantages and limitations of optical transmission technology are also discussed.
8	Brief Contents (module wise)	**Module 1:** Introduction of Optical fibre and its various characteristics. Ligh t propagation through optical fibre, Fibre Losses, Dispersion, and Step Index. **Module 2:** Principles of Fiber Optics Communications, Modulation and Multiplexing, Fiber Optic Components, and Data Transmission. **Module 3:** Local Area Networks (LANs) and Wide Area Net- works (WANs), Fiber Optic Network: Local, regional, and metro-telecommunication. **Module 4:** Optical Layer-Circuit switched paradigm, Rings and mesh topologies, and OADMs, switches. **Module 5:** Optical Network Design-Client models, Routing and traffic grooming, Traffic models, routing algorithms, integer and mixed integer linear programming.
9	Contents for lab (If applicable)	No lab is associated with the course
10	List of text books/references	1. "Optical Networks", R. Ramaswami and K. Sivarajan, Second edition, Morgan Kaufmann Publishers, 2001 2. "Fiber optics communication", G.P Agrawal, 2002. 3. "Raman Amplifiers for communications", M.N. Islam (Ed) 4. "Optical Fiber Communication", G. Keiser, 2017.

1	Code of the subject	MTCN-9104
2	Title of the subject	Grid and Peer to Peer Computing
3	Any prerequisite	Fundamentals of Computer Networks
4	L-T-P	3-0-0
5	Name of the proposer	Dr. K. K. Pattanaik
6	Will this course require visiting faculty	No
7	Learning Objectives of the subject (in about 50 words)	The course will enable students to understand distributed computing in general and Grid Computing in particular. The underlying protocols, resource management, etc will be taken up.
8	Brief Contents (module wise)	**Module 1 Grid Computing** Introduction, Classifying grid systems, Grid applications, Grid architecture, Grid computing projects, Grid evolution. Synchronization protocols for sharing resources in grid environments Introduction, Token-based mutual exclusion algorithms, Mutual exclusion algorithms for large configurations, Composition approach to mutual exclusion algorithms, Composition properties and its natural effects, Performance evaluation. Data replication in Grid environments Introduction, Data, System, Selective-rank model for a replication system, Selective-rank replication algorithm, Evaluation. Data management in Grids Introduction, From data sources to databases to data sources, Positioning the data management in grids within distributed systems, Links with the other services of the middleware, Problems and some solutions, Toward pervasive, autonomic and on-demand data management. Load balancing algorithms for dynamic networks Introduction, A taxonomy for load balancing, Distributed load balancing algorithms for static networks, Distributed load balancing algorithms for dynamic, Implementation, A practical example of the advection diffusion application. **Module 2 Peer to Peer Computing** Introduction, P2P overlay types: Centralized (Napster), Unstructured (Flooding-Based systems, Gossip-based systems), Super-Peer networks (heterogeneous, Hybrid systems such as Kaaza), Structured (DHT, Chord, Dynamo).
9	Contents for lab (If applicable)	No
10	List of text books/references	1. Fr´ed´eric Magoul`es, Thi-Mai-Huong Nguyen, Lei Yu. Grid Computing. CRC Press, 2009. 2. Quang Hieu Vu, Mihai Lupu, Beng Chin Ooi. Peer-to-Peer Computing: Principles and Applications, Springer; 2014.

1	Code of the subject	MTCN-9105
2	Title of the subject	Parallel and Distributed Computing
3	Any prerequisite	Advanced Computer Architecture, Distributed Operating System
4	L-T-P	3-0-0
5	Name of the proposer	Dr. Neetesh Kumar
6	Will this course require visiting faculty	Yes/No
7	Learning Objectives of the subject (in about 50 words)	The course is intended to provide basic foundation with fundamental concepts and mechanisms of parallel and distributed computing systems. Most of the issues discussed in this course material are the essence of Advance computer architectures and advanced operating systems.
8	Brief Contents (module wise)	**Module 1:** Introduction to Parallel Processing: Evolution of Computer System, Parallelism in Uni-Processor, Parallel Computer Structures. **Module 2:** Architectural Classification Schemes, Multiprocessor Architectures Parallel Computing System Architectures **Module 3:** Principles of Pipelining and principals, Pipeline Computers, Introduction to parallel Programming **Module 4:** Basic Concepts of Distributed Systems: Computer architecture : CICS, RISC, Multi-core Computer networking : ISO/OSI Model Evolution of operating systems Introduction to distributed computing systems (DCS) **Module 5:** Distributed Coordination: Temporal ordering of events Lamport's logical clocks Vector clocks; Ordering of messages Physical clocks Global state detection, Distributed mutual exclusion algorithms Performance matrix. **Module 6:** Inter-process communication: Message passing communication Remote procedure call Transaction communication Group communication; Broadcast atomic protocols. **Module 7:** Deadlocks in distributed systems **Module 8:** Load scheduling and balancing techniques
9	Contents for lab (If applicable)	No lab is associated with the course
10	List of text books/references	1. "Distributed Systems Concepts and Design", G. Coulouris, J. Dollimore, Addison Wesley, 2011. 2. "Advanced Operating Systems", M. Singhal, N.G. Shivarathri, McGraw Hill, 2017. 3. "Distributed Operating Systems and Algorithms", R. Chow, T. Johnson, Addison Wesley, 1997. 4. "Distributed Operating Systems", A.S. Tanenbaum, Prentice Hall, 2017. 5. "Principles of Distributed Database Systems", M. Tamer Ozsu, Patrick Valduriez, Prentice Hall International, 2011. 6. "Computer Architecture and Parallel Processing", K. Hawang, McGraw-Hill, 2017.

1	Code of the subject	MTCN-9106
2	Title of the subject	Advanced Graph Theory
3	Any prerequisite	NIL
4	L-T-P	3-0-0
5	Name of the proposer	Dr Anuraj Singh
6	Will this course require visiting faculty	No
7	Objectives of the subject (in about 50 words)	➢ To develop ability to solve real life problems, translating them one form to another, using appropriate mathematical and computational techniques ➢ To prepare abstract and critical mathematical thinking, most directly related to computer science ➢ To foster rigorous thinking skills that can enhance the quality of work of computing professionals ➢ To relate and apply the concepts to practical applications of computer science
8	Brief Contents (module wise)	**Module 1:** Introduction to graphs, Paths and Circuits, Trees and Fundamental Circuits, Spanning Tree, Matrix Tree Theorem, Euler Graph, Hamiltonian Graph, Isomorphism **Module 2:** Cut-sets and Cut vertices, Planar and Dual graphs, Kurtowski Theorem, Euler Identity **Module 3:** Matrix representation of Graphs, Coloring, Chromatic Number, Brooks Theorem, Five-color theorem, Matching **Module 4:** Directed graph, Underlying graph, Outdegree, in-degree, Connectivity, Orientation, Eulerian directed graphs, Hamilton directed graphs, Arborescence,Tournament **Module 5:** Applications of Graph Theory: In Switching and Coding Theory, Electrical Network Analysis
9	Contents for lab (If applicable)	No lab is associated with the course
10	List of text books/references	1. "Graph Theory With Applications To Engineering And Computer Science", D. Narsingh, Prentice Hall of India, 1992 2. "Introduction to Graph Theory", West, Douglas B., Pearson Education, 2002. 3. "Discrete Mathematics for Computer Scientists and Mathematicians", Mott J.L., Kandel, A. and Baker T.P., Prentice Hall of India, 2001 4. "Graph Theory", R. Diestel, Springer International Edition, 2004

Semester II

1	Code of the subject	MTCN-9201
2	Title of the subject	Cloud Computing and Cloud security
3	Any prerequisite	No
4	L-T-P	3-0-0
5	Name of the proposer	Dr. Neetesh Kumar
6	**Will this course require visiting faculty**	Yes/No
7	**Learning Objectives of the subject (in about 50 words)**	Cloud computing is a scalable services consumption and delivery platform that provides on-demand computing service for shared pool of resources, namely servers, storage, networking, software, database, applications etc., over the Internet. It is a model for enabling ubiquitous, on-demand access to a shared pool of configurable computing resources, which can be rapidly provisioned and released with minimal management effort. This course will introduce various aspects of cloud computing, including fundamentals, management issues, security challenges and future research trends. This will help students (both UG and PG levels) and researchers to use and explore the cloud computing platforms.
8	**Brief Contents (module wise)**	**Module 1:** Introduction to Cloud Computing **Module 2:** Introduction to Parallel and Distributed Computing **Module 3:** Cloud Computing Architecture **Module 4:** Service Management in Cloud Computing **Module 5:** Data Management in Cloud Computing **Module 6:** Virtualization & Resource Management in Cloud **Module 7:** Cloud Security **Module 8:** Open Source and Commercial Clouds, Cloud Simulator **Module 9:** Research trend in Cloud Computing, Fog Computing
9	**Contents for lab (If applicable)**	No lab is associated with the course
10	**List of text books/references**	1. "Cloud Computing: Principles and Paradigms", Editors: R. Buyya, J. Broberg, A. M. Goscinski, Wiley,2011. 2. "Enterprise Cloud Computing - Technology, Architecture, Applications", G. Shroff, Cambridge University Press, 2010 3. "Cloud Computing Bible", B. Sosinsky, Wiley-India, 2010 4. "Cloud Security: A Comprehensive Guide to Secure Cloud Computing", R. L. Krutz, Russell Dean Vines, Wiley- India,2010 5. "Mastering in Cloud Computing", Editors: R. Buyya et. al.

1	Code of the subject	MTCN-9202
2	Title of the subject	Cyber Physical Networks
3	Any prerequisite	Computer Networks
4	L-T-P	3-0-0
5	Name of the proposer	Dr. Prasenjit Chanak
6	Will this course require visiting faculty	NA
7	Learning Objectives of the subject (in about 50 words)	The course provides an overview of the underlying principles of this future evolution towards cyber-physical networks, while also discussing open research problems and societal implications of such networks.

8	Brief Contents (module wise)	**Module 1: Introduction**
		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.
		
		Module 2: CPN - Platform components
		CPS HW platforms - Processors, Sensors, Actuators; CPS Network - WirelessHart, CAN, Automotive Ethernet; CPS Sw stack – RTOS; Scheduling Real Time control tasks.
		
		Module 3: Principles of Automated Control Design (basic control theory)
		Dynamical Systems and Stability; Controller Design Techniques; Stability Analysis: CLFs, MLFs, stability under slow switching; Performance under Packet drop and Noise.
		
		Module 4: 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
		
		Module 5: Formal Methods for Safety Assurance of Cyber-Physical Systems
		Advanced Automata based modeling and analysis; Analysis of CPS Software:
		
		Module 6: Secure Deployment of CPS
		  1. Attack models
		      i. Secure Task mapping and Partitioning
		      ii. State estimation for attack detection
		      iii. Automotive Case study : Vehicle ABS hacking
		      iv. Power Distribution Case study : Attacks on SmartGrids
		
		Module 7: CPS Case studies
		    Automotive : SW controllers for ABS, ACC, Lane Departure Warning, Suspension Control
		    Heathcare : Artificial Pancreas/Infusion Pump/Pacemaker
		    Green Buildings : automated lighting, AC control

9	Contents for lab (If applicable)	No lab is associated with the course
10	List of text books/references	1. Edward A. Lee and Sanjit A. Seshia, Introduction to Embedded Systems, A Cyber-Physical Systems Approach, Second Edition, http://LeeSeshia.org, ISBN 978-1-312-42740-2, 2015.

1	**Code of the subject**	MTCN-9203
2	**Title of the subject**	IoT Protocols and Security
3	**Any prerequisite**	Fundamentals of Internet of Things
4	**L-T-P**	3-0-0
5	**Name of the proposer**	Dr. Pinku Ranjan
6	**Will this course require visiting faculty**	No
7	**Learning Objectives of the subject (in about 50 words)**	➢ To Understand the Architectural Overview of IoT and analyze basic protocols in wireless sensor network ➢ Design IoT applications in different domain and be able to analyze their performance ➢ Implement basic IoT applications on embedded platform ➢ To Understand the IoT Reference Architecture and Real World Design Constraints. Understand the various IoT Protocols (Datalink, Network, Transport, Session, Service) and the security of IoT
8	**Brief Contents (module wise)**	**Module 1: Overview of IoT** IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations, M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service(XaaS), M2M and IoT Analytics, Knowledge Management **Module 2: Reference Architecture** IoT Architecture-State of the Art – Introduction, State of the art, Reference Model and architecture, IoT reference Model - IoT Reference ArchitectureIntroduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints- Introduction, Technical Design constraints-hardware is popular again, Data representation and visualization, Interaction and remote control. **Module 3: Network & Communication aspects** Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination **Module 4: Challenges in IoT** Design challenges, Development challenges, Security challenges, Other challenges **Module 5: Domain specific applications of IoT** Home automation, Industry applications, Surveillance applications, Other IoT applications **Module 6: 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. **Module 7: IoT Data Link Layer & Network Layer Protocols** PHY/MAC Layer(3GPP MTC, IEEE 802.11, IEEE 802.15), WirelessHART,Z-Wave,Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4, IPv6, 6LoWPAN, 6TiSCH,ND, DHCP, ICMP, RPL, CORPL, CARP **Module 8: Transport & Session Layer Protocols** Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)-(TLS, DTLS) – Session Layer-HTTP, CoAP, XMPP, AMQP, MQTT

		Module 9: Service Layer Protocols & Security Service Layer -oneM2M, ETSI M2M, OMA, BBF – Security in IoT Protocols – MAC 802.15.4 , 6LoWPAN, RPL, Application Layer
9	**Contents for lab (If applicable)**	No lab is associated with the course
10	**List of text books/references**	1. "Internet of Things, A Hands -on Approach", ArshdeepBahga, Vijay Madisetti, 1st Edition 2015, University Press. 2. "The Internet of Things", Oliver Hersent, David Boswarthick, Omar Elloumy, 1st Edition ,2015. 3. "The Internet of Things, How Smart TVs, Smart Cars, Smart Homes, and Smart Cities are changing the World", Michael Miller, First edition , 2015. 4. "Internet of Things Architecture and Design Principles", Raj Kamal, McGraw Hill Education (India) Private Limited, 2017. 5. "Fundamentals of Wireless Sensor Networks: Theory and Practice", Waltenegus Dargie,Christian Poellabauer, Wiely, 2010. 6. "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, 1st Edition, Academic Press, 2014. 7. "Learning Internet of Things", Peter Waher, PACKT publishing, BIRMINGHAM – MUMBAI, 2015. 8. "Architecting the Internet of Things", Bernd Scholz-Reiter, Florian Michahelles, Springer, 2011. 9. "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", Daniel Minoli, Willy Publications, 2013

1	**Code of the subject**	MTCN-9204
2	**Title of the subject**	Storage Area Networks
3	**Any prerequisite**	High-speed Networks
4	**L-T-P**	3-0-0
5	**Name of the proposer**	Dr. Vinal Patel
6	**Will this course require visiting faculty**	Yes
7	**Learning Objectives of the subject (in about 50 words)**	- To understand Storage Area Networks characteristics and components. - To become familiar with the SAN vendors and their products. - To learn Fibre Channel protocols and how SAN components use them to communicate with each other.
8	**Brief Contents (module wise)**	**Module 1:** Information Storage, Evolution of Storage Technology and Architecture, Data Center Infrastructure, Key Challenges in Managing Information, Information Lifecycle Components of Storage System Environment, Disk Drive Components, Disk Drive Performance, Fundamental Laws Governing Disk Performance, Logical Components of the Host, Application Requirements and Disk Performance. **Module 2:** Implementation of RAID, RAID Array Components, RAID Levels, RAID Comparison, RAID Impact on Disk Performance, Hot Spares Components of an Intelligent Storage System, Intelligent Storage Array. Types of DAS, DAS Benefits and Limitations, Disk Drive Interfaces, Introduction to Parallel SCSI, Overview of Fibre Channel, The SAN and Its Evolution, Components of SAN, FC Connectivity, Fibre Channel Ports, Fibre Channel Architecture, Zoning, Fiber Channel Login Types, FC Topologies **Module 3:** General – Purpose Service vs. NAS Devices, Benefits of NAS, NAS File I / O, Components of NAS, NAS Implementations, NAS File-Sharing Protocols, NAS I/O Operations, Factors Affecting NAS Performance and Availability. iSCSI, FCIP, Fixed Content and Archives, Types of Archive, Features and Benefits of CAS, CAS Architecture, Object Storage and Retrieval in CAS, CAS Examples Forms of Virtualization, SNIA Storage Virtualization Taxonomy, Storage Virtualizations Configurations, Storage Virtualization Challenges, Types of Storage Virtualization **Module 4:** Information Availability, BC Terminology, BC Planning Lifecycle, Failure Analysis, Business Impact Analysis, BC Technology Solutions. Backup Purpose, Backup Considerations, Backup Topologies, Backup in NAS Environments, Backup Technologies. Source and Target, Uses of Local Replicas, Data Consistency, Local Replication Technologies, Restore and Restart Considerations, Creating Multiple Replicas, Management Interface, Modes of Remote Replication, Remote Replication Technologies, Network Infrastructure. Securing the Storage Infrastructure, Managing the Storage Infrastructure.
9	**Contents for lab (If applicable)**	No lab is associated with the course
10	**List of text books/references**	1. "Storage Networks: The Complete Reference", Robert Spalding, Tata McGraw Hill, Osborne, 2003. 2. "Building Storage Networks", Marc Farley, Tata McGraw Hill, Osborne, 2001.

1	**Code of the subject**	MTCN-9205
2	**Title of the subject**	Next Generation Networks
3	**Any prerequisite**	Prior to this course, it is desirable to have the knowledge of Data networking and Telecommunications principles.
4	**L-T-P**	3-0-0
5	**Name of the proposer**	Dr. Sunil Kumar
6	**Will this course require visiting faculty**	No
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 (module wise)**	**Module 1: Introduction To Next Generation Networks (NGN)** Communication and Networking in coming Era, Technologies influencing change, NGN Services, Network Infrastructure convergence, services convergence etc. **Module 2: 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 **Module 3: 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. **Module 4: 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 the course
10	**List of text books/references**	1. "Next Generation Networks Services, Technologies and Strategies", Neill Wilkinson, Wiley, 2002. 2. "Next Generation Network Services", Robet Wood, Pearson, 2005. 3. "Wireless and Mobile Network Architectures", YB. Lin and I Chlamtac, Wiley, 2001 4. "Computer Networks", A.S. Tanenbaum, Pearson Education, 2003 5. "Wireless Communications and Networks, 3G and beyond", Iti Saha Misra, TMH, 2013

1	Code of the subject	MTCN-9206
2	Title of the subject	High Speed Networks
3	Any prerequisite	Wireless Communication Technologies
4	L-T-P	3-0-0
5	Name of the proposer	Dr. Vinal Patel
6	Will this course require visiting faculty	No
7	Learning Objectives of the subject (in about 50 words)	- To understand the basics of high speed networking technologies. - To demonstrate the knowledge of network planning and optimization. - To apply the concepts learnt in this course to optimize performance of high-speed networks. - To design and configure networks to support a specified set of applications.
8	Brief Contents (module wise)	**Module 1:** Frame Relay Networks-Asynchronous transfer mode-ATM Protocol Architecture, ATM logical Connection, ATM Cell-ATM Service Categories-AAL. High Speed LANs: Fast Ethernet, Gigabit Ethernet, Fiber Channel-Wireless LANs: applications, requirements - Architecture of 802.11 **Module 2:** Queuing Analysis- Queuing Models-Single Server Queues-Effects of Congestion-Congestion Control - Traffic Management-Congestion Control in Packet Switching Networks-Frame Relay Congestion Control. **Module 3:** TCP Flow control, TCP Congestion, Control-Retransmission-Timer, Management-Exponential, RTO back off-KARN's Algorithm-Window Management-Performance of TCP over ATM. Traffic and Congestion control in ATM-Requirements-Attributes-Traffic Management Framework, Traffic Control-ABR traffic Management-ABR rate Control, RM cell formats, ABR Capacity allocations-GFR traffic management. **Module 4:** Integrated Services Architecture-Approach, Components, Services- Queuing Discipline, FQ, PS, BRFQ, GPS, WFQ-Random Early Detection, Differentiated Services, RSVP-Goals & Characteristics, Data Flow, RSVP operations, Protocol Mechanisms-Multiprotocol Label Switching-Operations, Label Stacking, and Protocol details-RTP-Protocol Architecture, Data Transfer Protocol, RTCP.
9	Contents for lab (If applicable)	No lab is associated with the course
10	List of text books/references	1. "Principles of Wireless Network", K. P. Anand P. Krishnamoorthy, Prentice Hall Of India, 2010. 2. "The Internet and Its Protocols", A. Farrel, Elsevier Publications, 2011.

1	Code of the subject	MTCN-9301
2	Title of the subject	Network Embedded Systems
3	Any prerequisite	Wireless Sensor Networks
4	L-T-P	3-0-0
5	Name of the proposer	Dr. Vinal Patel
6	Will this course require visiting faculty	Yes
7	Learning Objectives of the subject (in about 50 words)	To introduce fundamentals of wireless sensor network, automotive networked embedded systems and trends in automotive communication systems.
8	Brief Contents (module wise)	**Module 1:Network Embedded Systems** An Introduction, Middleware Design and Implementation for Networked Embedded Systems, Wireless Sensor Networks, Introduction to Wireless Sensor Networks, Architectures for Wireless Sensor Networks. **Module 2:Overview of Time Synchronization Issues in Sensor Networks** Resource-Aware Localization in Sensor Networks, Power-Efficient Routing in Wireless Sensor Networks, Energy-Efficient MAC Protocols for Wireless Sensor Networks, Distributed Signal Processing in Sensor Networks, Sensor Network Security. **Module 3** Wireless Sensor Networks Testing and Validation, Developing and Testing of Software for Wireless Sensor Networks, Automotive Networked Embedded Systems, Trends in Automotive Communication Systems, Time-Triggered Communication, Controller Area Networks for Embedded Systems. **Module 4:** FlexRay Communication Technology, LIN Standard, Standardized System Software for Automotive Applications, Volcano: Enabling Correctness by Design, Networked Embedded Systems in Industrial Automation, Fieldbus Systems: Embedded Networks for Automation. **Module 5** Real-Time Ethernet for Automation Applications, Configuration and Management of Networked Embedded Devices, Networked Control Systems for Manufacturing: Parameterization, Differentiation, Evaluation, and Application, Wireless LAN Technology for the Factory Floor: Challenges and Approaches, Wireless Local and Wireless Personal Area Network Communication in Industrial Environments, Hybrid Wired/Wireless Real-Time Industrial Networks, Wireless Sensor Networks for Automation.
9	Contents for lab (If applicable)	No lab is associated with the course
10	List of text books/references	1. "Networked Embedded Systems: An Overview." Z. Richard, Boca Raton, CRC Press, 2009.

1	**Code of the subject**	MTCN-9302
2	**Title of the subject**	Convergent Networks
3	**Any prerequisite**	Computer Networks
4	**L-T-P**	3-0-0 (3 credit course)
5	**Name of the proposer**	Dr.W.Wilfred Godfrey
6	**Will this course require visiting faculty**	NO
7	**Learning Objectives of the subject (in about 50 words)**	➢ To study converging communications technologiessuch as Voice, Video, image, and data over Internet Protocol over wired and wireless networks that provide seamless and secure communication solutions for business, government, and home technology needs. ➢ To emphasize interoperability on the integration of disparate systems.
8	**Brief Contents (module wise)**	**Module 1: Teleworker solutions** Cable and DSL Technology, cable system components and benefits, DOCSIS ,HFC Cable Network Architecture; DSL Variants, DSL performance and distance limitations **Module 2: Real-time applications in a converged network** Review of Traditional Voice Networks; Codec/ Vocoder Technologies; VoIP Transport; Real-Time Concerns; RTP/RTCP; H.323 and SIP as signaling protocols; Cloud-based VoIP & Video services **Module 3: Qos for a converged network** IP QOS review of QoS; 802.1p/q; Queuing mechanisms –WFQ,CBWFQ,Low-Latency, Random Early Detection; Integrated Services; Reservation Protocol (RSVP); Differentiated Services (Diffserv); QoS issues in WANs; implementation of Diffserv QoS model **Module 4: Multiprotocol label switching** MPLS Header; MPLS forwarding basics; Quality of service with MPLS TE; MPLS VPN applications; implementation of MPLS and MPLS VPN **Module 5: IP Multicast** Multicast addressing; IGMP, IGMP snooping; Multicast routing protocols (PIM-DM, -SM, SDM); Configuration
9	**Contents for lab (If applicable)**	No lab is associated with the course
10	**List of text books/references**	1. "Voice and Video Conferencing Fundamentals", Scott Firestone, ThiyaRamalingam, Steve Fry, 1st Ed. Ed., Cisco Press , 2007 2. "MPLS Fundamentals", Luc De Ghein, 1st Ed. Ed., Cisco Press 2006. 3. "SIP Trunking", Christina Hattingh, Darryl Sladden, ATM ZakariaSwapan, Cisco Press 2010. 4. "Traffic engineering with MPLS", Eric Osborne, Ajay Simha, Cisco Press, 2003. 5. "CCNP ONT Official Exam Certification Guide", Amir Ranjbar, Cisco Press , 2007.

1	**Code of the subject**	MTCN-9303
2	**Title of the subject**	Tactile Networks
3	**Any prerequisite**	Computer Networks
4	**L-T-P**	3-0-0
5	**Name of the proposer**	Dr. Prasenjit Chanak
6	**Will this course require visiting faculty**	NA
7	**Learning Objectives of the subject (in about 50 words)**	It will have a marked impact on business and society, introducing numerous new opportunities for emerging technology markets and the delivery of essential public services. This is a research oriented course with wide applications in the fields of industry automation and transport systems to healthcare, education and gaming.
8	**Brief Contents (module wise)**	**Module 1:** Vision Tactile Internet, Impact on Society, Application Fields. **Module 2:** Sensors and protocols for next generation automobiles. **Module 3:** Automotive IoT, Speech to text processing, Air quality monitoring, Localization in IoT. **Module 4:** Smart energy monitoring, Cargo monitoring **Module 5:** Infrastructure Requirements: Latency and Reliability; Security; System Architecture; Access Networks; Mobile Edge-Cloud. **Module 6:** ITU Framework.
9	**Contents for lab (If applicable)**	No lab is associated with the course
10	**List of text books/references**	Papers from the ACM and IEEE digital libraries.

1	Code of the subject	MTCN-9304
2	Title of the subject	Machine Learning and Autonomous Systems
3	Any prerequisite	Introductory courses on probability theory and linear algebra. Knowledge of basic programming languages such as Python and MATLAB.
4	L-T-P	3-0-0
5	Name of the proposer	Dr. Sunil Kumar
6	Will this course require visiting faculty	No
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 other objective of this course is to familiarize the students with different machine learning algorithms ranging basic linear classifier/regression modelling problems to non-linear classification problem. At the end of this course, one can design a automatic system which can the human brain.
8	Brief Contents (module wise)	**Module 1: Introduction to the course** What and Why? Analogy of machine learning with human brain. Types of machine learning problems: classification, regression, sequence modelling. Introducing prerequisites of ML. **Module 2:** Linear classifier and classification problem, Gradient descent algorithm, Under-fitting vs Over-fitting problem, Training, Testing and Validation Process. **Module 3:** Supervised vs unsupervised classification, Bayesian classifier: decision boundaries; nearest neighbor methods, and support vector machine (SVM); Unsupervised learning: k-means and hierarchical clustering. **Module 4:** Feature extraction and feature selection; Dimensionality reduction techniques: PCA, LDA and ICA. **Module 5: Introduction to Neural Networks** Modelling and applications to logic gates. Back-propagation learning algorithm: training and testing **Module 6: Introduction to Convolution neural network (CNN)** AlexNet, VGG architectures.
9	Contents for lab (If applicable)	No lab is associated with the course
10	List of text books/references	1. "Pattern Recognition and Machine Learning", Christopher Bishop, Second Edition, 2010. 2. "Introduction to Machine Learning", Ethem Alpaydin, Second Edition, 2015. 3. "The Elements of Statistical Learning", T. Hastie, R. Tibshirani, J. Friedman, 2e, 2008.

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