
# MAHATMA GANDHI UNIVERSITY

# SCHOOL OF COMPUTER SCIENCES

# M. Tech in Computer Science and Technology

## Specialization: Communication and Network Technology

# Syllabus 2016

# MAHATMA GANDHI UNIVERSITY
# SCHOOL OF COMPUTER SCIENCES

FACULTY OF **ENGINEERING AND TECHNOLOGY**

PROGRAMME **:** **M. Tech in Computer Science and Technology**

***Specialization: Communication and Network Technology***

DURATION : **4 Semesters** Minimum Total Credits Required : **86**

**Revised Syllabus 2016**

**SEMESTER 1**

| Course Code | Course Title | Hours/Week | | | Credits |
|---|---|---|---|---|---|
| | | L | T | P | |
| SKS M I C1651 | Advanced Mathematical Structures | 3 | 1 | - | 4 |
| SKS M I C1652 | Operating System Design | 3 | 1 | - | 4 |
| SKS M I C1653 | Database Design | 3 | 1 | - | 4 |
| SKS M I C1654 | Compiler Design | 3 | 1 | - | 4 |
| SKS M I E1655 | Elective I | 3 | 1 | - | 4 |
| SKS M I C1656 | Seminar I | - | 2 | 2 | 2 |
| SKS M I C1657 | Advanced Computer Network Lab | - | - | 2 | 2 |

**SEMESTER II**

| Course Code | Course Title | Hours/Week | | | Credits |
|---|---|---|---|---|---|
| | | L | T | P | |
| SKS M II C1661 | Digital Communication Techniques | 3 | 1 | - | 4 |
| SKS M II C1662 | Algorithms and Complexity | 3 | 1 | - | 4 |
| SKS M II C1663 | Network Security | 3 | 1 | - | 4 |
| SKS M II E1664 | Elective II | 3 | 1 | - | 4 |
| SKS M II E1665 | Elective III | 3 | 1 | - | 4 |
| SKS M II C1666 | Seminar II | - | - | 2 | 2 |
| SKS M II C1667 | Network Simulation Lab | - | - | 2 | 2 |

**SEMESTER III**

| Course Code | Course Title | Hours/Week | | | Credits |
|---|---|---|---|---|---|
| | | L | T | P | |
| SKS M III C1671 | Research Methodology | 3 | 1 | - | 3 |
| SKS M III E1672 | Elective IV | 3 | 1 | - | 3 |
| SKS M III E1673 | Elective V | 3 | 1 | - | 3 |
| SKS M III C1674 | Industrial Training | - | - | - | 1 |
| SKS M III C1675 | Master Research Project Phase I | - | - | 12 | 10 |

**SEMESTER IV**

| Course Code | Course Title | Hours/Week | | | Credits |
|---|---|---|---|---|---|
| | | L | T | P | |
| SKS M IV C1681 | Master Research Project (Phase II) | - | - | 30 | 18 |

**LIST OF ELECTIVES**

| | |
|---|---|
| SKS M I E1655 (A) | Optical Communications |
| SKS M I E1655 (B) | Computational Intelligence |
| SKS M I E1655 (C) | Quantum Computing |
| SKS M II E1664 (A) | Data Compression |
| SKS M II E1664 (B) | Crypto complexity |
| SKS M II E1664 (C) | Game Theory |
| SKS M II E1665 (A) | Cloud Computing |
| SKS M II E1665 (B) | Big-Data Analytics |
| SKS M IIE1665 (C) | Soft Computing |
| SKS M III E1672 (A) | Wireless Sensor Networks |
| SKS M III E1672 (B) | Digital Image Processing |
| SKS M III E1672 (C) | Wireless Communication Technologies |
| SKS M III E1673 (A) | High Speed Networks |
| SKS M III E1673 (B) | Information Theory and Coding |
| SKS M III E1673(C) | Internet Models |

# MAHATMA GANDHI UNIVERSITY
# SCHOOL OF COMPUTER SCIENCES

PROGRAMME: **M. Tech**

## Semester I

### SKS M I C1651 ADVANCED MATHEMATICAL STRUCTURES

Prerequisite: Discrete Computational Structures

**Module I**

Essentials of probability Theory, Random variables, Probability mass function, Probability Distributions and Probability Densities, functions of random variables, Statistical Averages of Random Variables, Stochastic Process: types-Renewal Processes-Types, Renewal Equation, Reward and Cost Models, Renewal Theorems, Point Process Regenerative Processes, Poisson Process-Probability law for Poisson process-Properties.

**Module II**

Markov Process, Markov Chain, Chapman- Kolmogrov Theorem, Classification of states and chains, Discrete Time Markov Chain- Transition Probabilities Communication Classes- Irreducible and reducible Chains. Continuous Markov Chain, Pure Jump Continuous, Time Chains, Regular Chains, Birth and Death Process, Semi- Markov Processes, Hidden Markov Models.

**Module III**

Queues-Simple Markovian queues- M/G/1 queue- Single class Queuing Networks- Open Queuing Networks, Closed Queuing Networks- Mean Value Analysis, Multi class Queuing Networks- Service Time distributions– Types of service centre- Multi-class traffic Model- BCMP Networks and theorem- Priority Systems.

**Module IV**

Time delays in single server queue- time delays in networks of queues- Types of Blocking. Two finite queues in a closed network- aggregating Markovian States.

**References**


1. Robert G. Gallagher, "Stochastic Processes: Theory for applications", Cambridge University Press, 1st edition, 2014.
2. Sheldon M. Ross, "Introduction to Probability Models", Academic Press Inc, 10th edition, 2014.
3. James R. Kirkwood, "Markov Processes (Advances in Applied Mathematics)", CRC Press, 2015.
4. Giuseppe Modica, Laura Poggiolini, "A First course in Probability and Markov chain", Wiley; 1st edition, 2013.

**5.** Donald Gross, John F Shortle, James M Thompson, Carl M Harris, "Fundamentals of Queuing Theory", Wiley-Interscience, 4th edition, 2008.
**6.** Peter G. Harrison and Naresh M Patel, "Performance Modeling of Communication Networks and Computer Architectures", Addison Wesley, 1992.
**7.** A. Papoulis and S. U. Pillai, "Probability, Random Variables and Stochastic Processes", 4th edition, 2002, McGraw Hill.
**8.** Simonetta Balsamo, Raif Onvural, "Analysis of Queuing Networks with Blocking", Springer, 2010.
**9.** T. Veerarajan, "Probability, Statistics and Random Processes", Tata McGraw Hill Education Private Limited, 3rd Edition, 2008.
**10.** Ming Liao, "Applied Stochastic Processes", CRC Press, 2013.

**SKS M I C1652 OPERATING SYSTEM DESIGN**

Prerequisite: Operating Systems

**Module I**

Overview - Functions of an Operating System, Operating System Services, User and Operating System Interface, System Calls, Types of System Calls, Operating-System Design and Implementation, Operating-System Structure, Operating-System Debugging , Operating-System Generation , System Boot, Process, Threads, Process Synchronisation, CPU Scheduling, Deadlock.

**Module II**

Distributed Operating system: Introduction, Architecture, Flynn's Classification, OS design consideration, Issues, Distributed System model and Consideration, Time management and Considerations, Mutual Exclusion in Distributed system, Lamport's Algorithm - Token-Based Algorithms, Distributed Deadlock- Detection Algorithms, Real time OS- Scheduling in Real Time OS(RTOS), Microkernel and RTOS.

**Module III**

Memory Management: Main Memory – Swapping, Contiguous Memory Allocation, Segmentation, Paging, Structure of the Page Table. Virtual Memory- Demand Paging, Copy-on-Write, Page Replacement, Allocation of Frames, Thrashing, Memory-Mapped Files, Allocating Kernel Memory ,Design Techniques , Examples of Multiplexing and Late Binding.

**Module IV**

File-System Interface- File Concept, Access Methods, File-System Mounting, File Sharing, protection, File-System Structure, File-System Implementation, Directory Implementation, Allocation Methods, Free-Space Management, File System and its Type, Virtual File System

**References**


1. Abraham Silberschatz, Peter B. Galvin, G. Gagne, "Operating System Concepts", Wiley, Ninth Edition, 2013.
2. Mark E. Russinovich and David A. Solomon, "Microsoft Windows Internals", Microsoft Press, 4th Edition, 2004.
3. Andrew S. Tanenbaum, Herbert Bos, "Modern Operating Systems", Pearson, Fourth Edition, 2014.
4. Mukesh Singhal and N. G. Shivaratri, "Advanced Concepts in Operating Systems", McGraw-Hill, 2000.

## SKS M I C1653 DATABASE DESIGN

### Module I

Relational Database Design: Features of good database design, Enhanced ER tools, Subclasses Super class, and Inheritance, Specialization and Generalization, Constraints and Characteristics of Specialization and Generalization, Converting EER diagram to tables, Functional dependency Theory and normalization, Converting EER diagram to tables, functional dependency theory and Normalization.

### Module II

Overview of Object-Oriented Database Concepts – Complex Objects; Overview of the Object model of ODMG, Object Definition Language (ODL), Object Query Language (OQL),Object Database Conceptual Design.

### Module III

Distributed Database Concept, Techniques for Distributed database Design- Allocation, Data fragmentation & Replication, Types, Query Processing in Distributed Database, Overview of Concurrency Control and Recovery in Distributed Databases, An overview of client server architecture & Its Relationship to Distributed Databases.

### Module IV

Enhanced Data Models- Active database concepts, Spatial & Multimedia Databases- Data Warehousing, Data Mining, Emerging Database Technologies- Web Databases, Mobile Databases, Gnome databases.

### References


1. Ramez Elmasri, Shamkanth B. Navathe, "Fundamentals of Database Systems", Pearson, 6th Edition, 2010.
2. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, "Database System Concepts", McGraw Hill, 6th Edition, 2010.
3. Thomas M. Connolly, Carolyn E. Begg, "Database Systems", Addison Wesley, 4th Edition, 2004.
4. C.S.R. Prabhu, "Object-Oriented Database Systems: Approaches and Architectures", Prentice-Hall of India Pvt. Limited, 2nd Edition, 2005.

**SKS M I C1654 COMPILER DESIGN**

Prerequisite: Compiler Construction

**Module I**

Review of compiler phases-Introduction to Advanced Topics -Informal Compiler Algorithm Notation Symbol Table Structure – Intermediate Representations- Run Time Issues -Support for Polymorphic and Symbolic Languages.

**Module II**

Control Flow Analysis– Approaches to Control Flow Analysis, Dominators and Post Dominators, Interval Analysis, Structural Analysis-Data Flow Analysis- Dependency analysis-Alias analysis.

**Module III**

Introduction -Review of Early Optimizations– Constant Folding, Scalar Replacement of Aggregates, Algebraic Simplifications and Reassociation, Value Numbering, Copy Propagation, Sparse Conditional Constant Propagation– Redundancy Elimination-Loop Optimizations-Procedure Optimization.

**Module IV**

Register Allocation -Local and Global Instruction Scheduling -Advanced Topics in Code Scheduling-Low Level Optimizations-Introduction to Interprocedural analysis and scheduling.

**References**


1. Steven Muchnick.” Advanced Compiler Design Implementation”, Elsevier India, 3rd Edition, 2008.
2. Aho, A. V, Sethi, R. and ULLMAN, J. D. “Compilers: Principles, Techniques and Tools”, Pearson; 2nd Edition, 2006.
3. Appel A. W.” Modern Compiler Implementation in Java”, Cambridge University Press, 2nd Edition, 2002.
4. Kenneth. C. Louden, “Compiler Construction. Principles and Practice”, Delmar Cengage Learning, 2006.

## SKS M I C1656 SEMINAR I

Each student is expected to present a seminar on a topic of current relevance in Computer Science and Technology - They are expected to refer current research and review papers from standard journals like ACM, IEEE, JPDC, IEE etc. - at least three cross references must be used - the seminar report must not be the reproduction of the original paper.

**Sessional work assessment**

| | |
|---|---|
| Presentation | = 30 |
| Regularity | = 10 |
| Discussion | = 20 |
| Report | = 40 |
| Total marks | = 100 |

## SKS M I C1657 ADVANCED COMPUTER NETWORK LAB

1. Study of Architecture Characteristics Using Simulators (Like Simple Scalar).
2. TCP Client Server Program Using Sockets in Java.
3. Simulation of Congestion/ QoS Protocols.
4. Implementation of Heap Structures.
5. Implementation of Search Structures.
6. Implementation of Multimedia Data Structures.
7. Implementation of Data Structure Applications.
8. Study of Case Tools (Network related).

Note: All the above programs have to be implemented in High Performance Computing Network.

# Semester II

## SKS M II C1661 DIGITAL COMMUNICATION TECHNIQUES

Prerequisite: A first course in "Digital Communication" at the undergraduate level

**Module I**

Review of Random Process and Random variable: Moments and Moment generating function, Characteristic Function, Chernoff bound, Markov's inequality, Chebyshev's inequality, Central limit Theorem, Chi-square Distribution- central and noncentral, Rayleigh and Rician distributions, Correlation, Covariance matrix, Stationary processes, wide sense stationary processes, Ergodic process, cross-correlation and autocorrelation functions- Gaussian process.

**Module II**

Characterization of Communication Signals and Systems- Signal space representation- Connecting Linear Vector Space to Physical Waveform Space, Scalar Communication over Memory less Channels-Discrete Memory less channel, Continuous Memory less channel, Optimum Scalar Receivers, Error Probability Performance. Vector Communication over Continuous Memory less Channels. Optimum wave form receiver in additive white Gaussian noise (AWGN) channels– Correlation demodulator, Matched filter demodulator, Properties of Matched Filter. Optimum Receiver for Signals with random phase in AWGN Channels- Optimum receiver for Binary Signals-optimum detector, Optimum receiver for Mary orthogonal signals-Probability of error for envelope detection of Mary Orthogonal signals**.** Optimum wave form receiver in colored Gaussian noise channels- Karhunen Loeve expansion approach, whitening approach.

**Module III**

Carrier Recovery and Symbol Synchronization in Signal Demodulation- Signal Parameter Estimation- Likelihood function. Carrier Recovery and Symbol Synchronization in Signal Demodulation- Carrier Phase Estimation-Maximum Likelihood carrier phase estimation- Phase Locked Loop-Effect of additive noise on the phase estimate -Decision directed loops-Non decision directed loops- Comparison. Symbol Timing Estimation-Maximum Likelihood timing estimation-Non Decision directed Timing Estimation. Joint Estimation of Carrier phase and Symbol Timing- Performance characteristics of ML estimators.

**Module IV**

Communication over band limited Channels-Characterization of Band limited Channel-Optimum pulse shaping- Nyquist criterion for zero ISI, partial response signaling-Equalization Techniques-Need of equalization-Zero forcing linear Equalization- Adaptive Decision feedback equalizer.

**References**


1. J.G. Proakis, "Digital Communication", McGraw Hill Education, 5th Edition, 2007.
2. Robert G.Gallager, "Principles of Digital Communication", Cambridge University Press, 1st edition, 2008.
3. Marvin K. Simon, Sami M. Hinedi and William. C. Lindsey, "Digital Communication Techniques", Prentice Hall PTR, US edition, 1994.
4. Simon Haykin, "Digital Communication Systems", Wiley, 1st edition, 2013.
5. B.P Lathi, "Modern Digital and Analog Communication Systems (The Oxford Series in Electrical and Computer Engineering)", Oxford University Press, 4th edition, 2009.
6. Bernard Sklar, "Digital Communications: Fundamentals and Applications", Prentice Hall, 2nd edition, 2001.

**SKS M II C1662 ALGORITHMS AND COMPLEXITY**

Prerequisite: Design and Analysis of Algorithms

**Module I**

Analysis: RAM model–Notations, Recurrence analysis- Master's theorem and its proof-Amortized analysis-Advanced Data Structures: B-Trees, Binomial Heaps, Fibonacci Heaps, Disjoint Sets, Union by Rank and Path Compression

**Module II**

Graph Algorithms and complexity: Matroid Theory, All-Pairs Shortest Paths, and Maximum Flow and bipartite matching.

**Module III**

Randomized Algorithms: Finger Printing, Pattern Matching, Graph Problems, Algebraic Methods, Probabilistic Primality Testing, De-Randomization

**Module IV**

Complexity classes - NP-Hard and NP-complete Problems - Cook's theorem NP completeness reductions. Approximation algorithms– Polynomial Time and Fully Polynomial time Approximation Schemes. Probabilistic Complexity Classes, Probabilistic Proof Theory and Certificates.

**References**


1. T.H. Cormen, C.E. Leiserson, R.L. Rivest, "Introduction to Algorithms", MIT Press; 3rd edition, 2009.
2. Saara Basse, "Computer Algorithms: Introduction to Design and Analysis", Addison Wesley, 3rd Edition, 2001.
3. Peter Brass, "Advanced Data Structures", Cambridge University Press, 2008.


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## SKS M II C1663 NETWORK SECURITY

### Module I

Introduction-security Vulnerabilities-Threats- Classification of Security Services- Authentication, Password-Based Authentication, Address-Based Authentication, Certificates, Authentication Services- Email Security, Threats, PGP, S/MIME. Cryptography: Encryption Principles- Data Encryption Standard (DES), Advanced Encryption Standard (AES) IDEA, Algorithms- CBC-Location of Encryption Devices key Distribution.

### Module II

Message Authentication, Hash Functions and SHA, CRCs. Public Key Systems: RSA- Diffie-Hellman-DS-Key Management-Number Theory: Modular Arithmetic, Euclid Algorithm Euler Theorem- Chinese Remainder Theorem-Confidentiality, Integrity, Non-Repudiation, Mechanisms, Protocol Requirements, Options, Non-Repudiation- Process Non-Repudiation - Delivery.

### Module III

Ip Security: Overview, IP security Architecture, Authentication Header, Encapsulating Security Payload, Key Management, Network Management. Web Security: Web Security Threats, Web Security Requirements, Secure Socket Layer and Transport Layer Security, Secure Electronic Transactions.

### Module IV

Intruders: Intrusion Techniques, Intrusion Detection-Viruses, Access Control and Management, Access Control Policies, Access Control Mechanisms, Types of Viruses, Anti-virus Techniques, Firewalls-Firewalls, Design Principles, Packet Filtering, Access Control, Trusted Systems, Monitoring and Management.

### References


5. William Stallings, “Cryptography and Network Security”, Pearson Education, 6th edition, 2013.
6. William Stallings, “Network security Essentials: Applications and Standards”, Pearson Education, 4th Edition, 2011.
7. V.K. Pachghare, “Cryptography and Information Security”, PHI, 2008.

**SKS M II C1666 SEMINAR II**

Each student is expected to present a seminar on a topic of current relevance in Computer Science and Technology - They are expected to refer current research and review papers from standard journals like ACM, IEEE, JPDC, IEE etc. - at least three cross references must be used - the seminar report must not be the reproduction of the original paper.

| **Sessional work assessment** | |
|---|---|
| Presentation | =30 |
| Regularity | = 10 |
| Discussion | = 20 |
| Report | = 40 |
| Total marks | = 100 |

**SKS M II C1667 NETWORK SIMULATION LAB**

**List of Experiments**

**I.** STUDY OF GLOMOSIM AND NS 2 SIMULATORS

**II.** SIMULATION USING GLOMOSIM

**11.** Simulate Ad hoc network using AODV protocol.

**12.** Simulate Ad hoc network using DSDV protocol

**13.** Simulate Ad hoc network using DSR protocol.

**III.** SIMULATION USING NETWORK SIMULATOR -2

**1.** Simulate Ad hoc network using AODV protocol.

**2.** Simulate Ad hoc network using DSDV protocol.

**3.** Simulate Ad hoc network using DSR protocol.

**4.** Simulate a MPLS network using LDP protocol.

**5.** Simulate a MPLS network for differentiated Services.

**6.** Simulate a MPLS network providing alternate LSPs under protection scheme.

# Semester III

## SKS M III C1671 RESEARCH METHODOLOGY

**Module I**

Introduction, Research and Scientific methods, Objectives and Motivation of Research, Criteria of Good Research, Research Approaches, Significance of research, Type of Researches, Research Methods Vs Methodology, Research Problems, Defining a research problem, Research Design, Sampling Design.

**Module II**

Collection of Primary Data, Observation Method, Interview Method, Collection of data through Questionnaires and Schedules, Secondary Data, Processing operations, Statistics in Research, Measures of Central Tendency, Other methods of data collection, Collection of secondary data, Processing Operations, Types of Analysis, Statistics in Research, Dispersion, Asymmetry, relationship, Simple Regression Analysis, Partial Correlation.

**Module III**

Hypothesis-I: Introduction, Testing of Hypothesis, Procedure for hypothesis testing, Flow diagram for hypothesis testing, Measuring the power of hypothesis test, Tests of Hypothesis, Hypothesis testing of Means, Proportions, Correlation Coefficients, Chi- square test, Phi Coefficient, Hypothesis-II- Introduction, Non-parametric, Distribution- free Tests, Sign tests, Fisher-Irwin test, Spearman's Rank Correlation, Kendall's Coefficient of concordance.

**Module IV**

Report writing– Introduction and Significant, Interpretation–Meaning, Techniques and Precautions, Layout of research reports, Types of report, Mechanics and precautions of writing a research report, Computer role in research, computers and computer technology, computer system, Characteristics.

**References**


1. C.R Kothari, "Research Methodologies Methods and Techniques", New Age International, Second Edition, 2013.

2. John W Best and ,James V.Kahn, "Research in Education, PHI New Delhi , Fifth Edition, 2013.

## SKS M III C1674 INDUSTRIAL TRAINING

The students are expected to undergo two week's in-house training in a reputed firm and submit a report on the training at the end of the semester. The period of training can be adjusted at the end of the semester or at the beginning. This carries end semester evaluation of 50 marks for one credit.

## SKS M III C1675 MASTER RESEARCH PROJECT (PHASE I)

Each student is expected to do a Master Research work starting from the third semester onwards, on a topic of current relevance in Computer Science. They are expected to refer current research and review papers from standard journals like ACM, IEEE, JPDC, etc. and develop a research problem, which is to be implemented in its complete form by fourth semester.

In the third semester they have to analyse and design the project. An interim report in the standard format is to be submitted at the end.

**Sessional work assessment**

| | |
|---|---|
| System analysis and design | = 100 |
| Regularity | = 10 |
| Report | = 40 |
| Total Marks | = 150 |

## SKS M IV C1681 MASTER RESEARCH PROJECT PHASE-II

Masters Research Project Phase-II is a continuation of project phase-I started in the third semester. Before the end of the fourth semester, there will be two reviews, one at middle of the fourth semester and other towards the end. In the first review, progress of the project work done is to be assessed.

In the second review, the complete assessment (quality, quantum and authenticity) of the Thesis is to be evaluated. Both the reviews should be conducted by guide and Evaluation committee. This would be a pre-qualifying exercise for the students for getting approval for the submission of the thesis. At least one technical paper is to be prepared for possible publication in journal. The technical paper is to be submitted along with the thesis. The final evaluation of the project will be external evaluation.

| **Sessional work assessment** | |
|---|---|
| Implementation | =50 |
| Analysis of results and Testing | = 25 |
| Publication | = 25 |
| Regularity | = 10 |
| Report | = 40 |
| Total Marks | = 150 |

External evaluation for 150 marks is to be organized with an evaluation committee, containing at least two external experts and one internal.

**First review:**

Guide 50 marks

Evaluation committee 50 marks

**Second review:**

Guide 100 marks

Evaluation committee 100 marks

**End Semester Examination:**

Project Evaluation by external examiner: 150 marks

Viva Voce by external / internal examiner: 150 marks (75 each)

Total: 600 marks

## VIVA VOCE

The students are expected to undergo a comprehensive viva-voce covering the complete syllabus of M.Tech of 150 marks as per the details given below.

| | |
|---|---|
| Main Project | 50 Marks |
| Course Work | 50 Marks |
| Industrial Training | 25 Marks |
| Seminars | 25 Marks |

## Electives - SKS M I E1655(A) OPTICAL COMMUNICATIONS

**Module I**

Overview of Optical fiber communications, Electromagnetic mode theory for optical propagation, linearly polarized modes, single mode and multimode fibers, concept of V number, graded index fibers, total number of guided modes (no derivation), attenuation mechanisms in fibers, dispersion in single mode and multimode fibers, dispersion shifted and dispersion flattened fibers, Photonic Crystal Fibers, attenuation and dispersion limits in fibers, Polarization, Fiber Nonlinear effects, Solitons.

**Module II**

Optical sources - LED and LASER diode - Basic concepts, Principles of operation, concepts of line width, phase noise, switching and modulation characteristics. Optical detectors - pn detector, pin detector, avalanche photo diode - Principles of operation, concepts of responsivity, sensitivity and quantum efficiency, noise in detection, receiver noise, typical receiver configurations (low impedance front end, high impedance and trans-impedance receivers).

**Module III**

Coherent systems-Basic Concepts-Homodyne and heterodyne systems, coherent systems using PSK, FSK, ASK and DPSK modulations, related noise effects, performance degradation induced by laser phase and intensity noise, degradation due to fiber dispersion, degradation induced by nonlinear effects in fiber propagation, System Performance.

**Module IV**

Optical amplifiers - semiconductor amplifier, rare earth doped fiber amplifier (with special reference to erbium doped fibers), Raman amplifier, and Brillouin amplifier. Optical Networks-Network Concepts, Network Topologies, SONET/SDH, and High Speed Light wave Links, Optical Add/Drop Multiplexing, Optical Switching, WDM, and Optical CDMA.

**References**


1. John M Senior: “Optical Fiber Communications”, Pearson, 3rd Edition, 2010.
2. Gerd Keiser, “Optical Fibre Communications”, Science Engineering & Math”, 4th Edition, 2010.
3. Govind.P.Agrawal, “Nonlinear Fiber Optics”, Electronic Industry Press, 5th edition, 2014.
4. Rajiv Ramaswamy, “Optical Networks: A Practical Perspective”, Morgan Kaufmann”, 3rd edition, 2009.
5. Le Nguyen Binh, “Optical Fiber Communications Systems: Theory and Practice with MATLAB® and Simulink Models (Optics and Photonics)”, CRC Press, 2010.
6. John Gowar, “Optical Communication Systems”, Prentice Hall, 2nd Edition, 1993.
7. Le Nguyen Binh, “Advanced Digital Optical Communications", CRC Press; second edition, 2015.
8. Silvello Betti, Giancarlo De Marchis and Eugenio Iannone, “Coherent Optical Communications Systems”, John Wiley, 1995.
9. Hooshang Ghafouri-Shiraz, M. Massoud Karbassian, “Optical CDMA Networks: Principles, Analysis and Applications”,Wiley - IEEE, 2012.
10. Z. Ghassemlooy, W. Popoola, S. Rajbhandar**, “**Optical Wireless Communications: System and Channel Modelling with MATLAB Hardcover”, CRC Press, 1st edition, 2012.

## SKS M I E1655(B) COMPUTATIONAL INTELLIGENCE

**Module I**

Artificial Intelligence: History and Applications, Production Systems, Structures and Strategies for state space search- Data driven and goal driven search, Depth First and Breadth First Search, DFS with Iterative Deepening, Heuristic Search- Best First Search, A* Algorithm, AO* Algorithm, Constraint Satisfaction, Using heuristics in games-Minimax Search, Alpha Beta Procedure.

**Module II**

Knowledge representation - Propositional calculus, Predicate Calculus, Theorem proving by Resolution, Answer Extraction, AI Representational Schemes- Semantic Nets, Conceptual Dependency, Scripts, Frames, Introduction to Agent based problem solving.

**Module III**

Machine Learning- Symbol based and Connectionist, Social and Emergent models of learning, The Genetic Algorithm- Genetic Programming, Overview of Expert System Technology- Rule based Expert Systems, Introduction to Natural Language Processing.

**Module IV**

Languages and Programming Techniques for AI- Introduction to PROLOG and LISP, Search strategies and Logic Programming in LISP, Production System examples in PROLOG.

**References**


1. George.F.Luger, "Artificial Intelligence- Structures and Strategies for Complex Problem Solving", Pearson, 6th edition, 2008.

2. Jeff Heaton, **"**Artificial Intelligence for Humans, Fundamental Algorithms Create Space Independent Publishing Platform, 1st edition, 2013.

3. Ivan Bratko, "Prolog Programming for Artificial Intelligence", Addison Wesley; 3rd edition, 2000.

**SKS M I E1655(C) QUANTUM COMPUTING**

Prerequisite: Theory of Computation

**Module I**

Finite Dimensional Hilbert Spaces -Tensor Products and Operators on Hilbert Space -Hermitian and Trace Operators - Basic Quantum Mechanics necessary for the course.

**Module II**

Quantum Gates and operators and Measurement-Quantum Computational Model- Quantum Complexity Schemes for Physical realization (Only peripheral treatment expected).

**Module III**

Shor's Algorithm -Application to Integer Factorization-Grover's Algorithm-Quantum Complexity Classes and their relationship with classical complexity classes**.**

**Module IV**

Quantum Noise-Introduction to the theory of Quantum Error Correction-Quantum Hamming Bound-Coding Schemes-Calder bank- Shor- Steane codes-Stabilizer Codes.

**References**


1. Eleanor G. Rieffel, Wolfgang H. Polak, "Quantum Computing: A Gentle Introduction Scientific and Engineering Computation", MIT Press, 2014.

2. Nielsen M.A.and I. L.Chauang,"Quantum Computation and Quantum Information", Cambridge University Press, $10^{th}$ edition, 2011.

3. P. R Halmos, "Finite Dimensional Vector Spaces", Martino Fine Books, 2012.

## SKS M II E1664 (A) DATA COMPRESSION

**Module I**

Introduction- Lossless and Lossy Compression, Measures of Performance, Information theory concepts, Coding, Kraft- McMillan Inequality, Basic Techniques-Huffman Coding, Adaptive Huffman Coding, Arithmetic coding, Run Length Encoding. Dictionary Methods- LZ77, LZ78, LZW, Applications.

**Module II**

Image Compression- Introduction, Approaches, scalar and vector quantization. Transform based techniques-Orthogonal, Walsh Hadamard Transform, Karhunen Loeve Transform, DCT. JPEG, JPEG-LS, Progressive Image Compression, JBIG, JBIG2, CALIC. Wavelet Methods-Fourier Image Compression, Haar Transforms, CWT, DWT, IWT, SPIHT, EZW, JPEG2000. Adaptive Techniques-Adaptive Vector Quantization, Block Truncation Coding, Predictive Coding ,Differential Encoding Schemes.

**Module III**

Fractal techniques-Iterated function system, Encoding, Decoding, Video compression- Introduction, Analog and Digital Video, Sub optimal search methods, MPEG standards-MPEG-1, MPEG-2, MPEG-4, MPEG -7,H.261, H.264.

**Module IV**

Audio Compression- Wave Audio Format, μ-Law and A-Law Companding, ADPCM audio compression, MLP audio, Speech Compression, FLAC, MPEG-4 ALS, MPEG ½ Audio layers, AAC, Dolby AAC, Comparison of compression Algorithms.

**References**


1. Khalid Sayood,"Introduction to data compression", Morgan Kaufmann Publishers, Fourth Edition, 2012.
2. David Solomon, "Data compression: the complete reference", 2nd edition, Springer- Verlag, New York, 2000.
3. David Solomon, "A Guide to Data Compression Methods (Springer Professional Computing)", Springer, 1st Edition, 2002.
4. Stephen Welstead, "Fractal and wavelet Image Compression techniques", SPIE, 2005.
5. Feng Wu, "Advances in Visual Data Compression and Communication:Meeting the Requirements of New Applications",Auerbach Publications,2014.
6. Yuval Fisher, "Fractal Image Compression, Theory and Applications", Springer, 1996.
7. Irina Bocharova, "Compression for Multimedia", Cambridge University Press, 1st edition, 2010.

**SKS M II E1664 (B) CRYPTO COMPLEXITY**

Prerequisite: Analysis of Algorithms

**Module I**

Review of Relevant Mathematics, Complexity Theory, Foundations of Cryptology, Hierarchies based on NP.

**Module II**

Randomized algorithms and Complexity classes, probabilistic Polynomial time classes, Quantifiers, Graph Isomorphism and lowness.

**Module III**

RSA Cryptosystem, Primality and factoring, Primality Tests, Factoring Methods, Security of RSA**.**

**Module IV**

Diffie Hellman's, ElGamal's and other protocols, Arthur Merlin Games and Zero knowledge.

**References**


1. Jorg Roth, "Complexity Theory and Cryptology: An introduction to Cryptocomplexity", Springer, 2005.
2. H.Anton, Chriss Rorres,"Elementary Linear algebra", John Wiley and Sons New York, 11th edition, 2014.

## SKS M II E1664(C) GAME THEORY

**Module I**

Introduction to Non Co-operative Game Theory: Extensive Form Games, Strategic Form Games, Pure Strategy Nash Equilibrium.

**Module II**

Non co-operative Game Theory, Mixed Strategies, Existence of Nash Equilibrium, Computation of Nash Equilibrium, Two Player Zero- Sum Games, Bayesian Games.

**Module III**

Mechanism Design: An Introduction, Dominant Strategy Implementation of Mechanisms, Vickrey-Clorke- Groves Mechanisms, Bayesian Implementationof Mechanisms, Revenue Equivalence Theorem, Design of Optimal Mechanisms.

**Module IV**

Cooperative Game Theory, Correlated Strategies, Correlated Equilibrium, The Two Person Bargaining Problem, Games in Coalitional Form, The Core Shapley Value, Other Solution Concepts for Co-operative Games.

**References**


1. Michael Maschler, Eilon Solan, Shmuel Zamir, "Game Theory", Cambridge University Press, 1St Edition, 2013.

2. Paul Klemperer, "Auctions:Theory and Practice: the Toulouse Lectures in Economics", Princeton University Press, 2004.


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## SKS M II E1665 (A) CLOUD COMPUTING

**Module I**

Cloud computing, History of Cloud Computing, Cloud service providers, Properties, Characteristics - Benefits of Cloud Computing- Cloud Storage- Cloud computing vs. Cluster computing vs. Grid computing-Role of Open Standards- Companies in the Cloud Today.

**Module II**

Web-Based Application – Pros and Cons of Cloud Service Development- The NIST model-Cloud Delivery Models- SaaS, Paas, Iaas- Cloud deployment models- Private cloud, public cloud, community cloud, hybrid cloud-Alternative Deployment Models- The Linthicum Model, The Jericho Cloud Cube Model.

**Module III**

Security objectives- services- Security design principles- Secure development practice- Approaches to Cloud Software Requirements Engineering- Secure Cloud Software Testing, Testing for SQA, Conformance, functional, Performance & security testing.

**Module IV**

Threats to Infrastructure, Data, and Access Control- Cloud Service Provider Risks- Back-Door, Spoofing, Man-in-the-Middle, Replay, TCP Hijacking, Social Engineering, Dumpster Diving, Password Guessing, Trojan Horses and Malware.

**References**


1. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", TMH, 2009.
2. Ronald L. Krutz, Russell Dean Vines, "Cloud Security – A comprehensive Guide to Secure Cloud Computing", Wiley – India, 2010.
3. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing from Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
4. Michael Miller, "Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online", Que Publishing,first edition, 2008.
5. Haley Beard, "Cloud Computing Best Practices for Managing and Measuring Processes for On-demand Computing, Applications and Data Centers in the Cloud with SLAs", Emereo Pty Limited, 2008.

## SKS M II E1665 (B) BIG DATA ANALYTICS

**Module I**

Introduction to Big Data Platform– Challenges of Conventional Systems- Intelligent data analysis– Nature of Data- Analytic Processes and Tools - Review of the Basic Data Analytic Methods using R, Introduction to R – look at the data, Analyzing and Exploring the Data, Statistics for Model Building and Evaluation Analysis vs. Reporting -Modern Data Analytic Tools -Statistical Concepts: Sampling Distributions -Re-Sampling -Statistical Inference -Prediction Error.

**Module II**

Introduction to Streams Concepts –Stream Data Model and Architecture -Stream Computing - Sampling Data in a Stream –Filtering Streams –Counting Distinct Elements in a Stream Estimating Moments –Counting Oneness in a Window –Decaying Window- Introduction to Real time Analytics Platform (RTAP) Applications.

**Module III**

History of Hadoop-The Hadoop Distributed File System –Components of Hadoop-Analyzing the Data with Hadoop-Scaling Out- Hadoop Streaming-Design of Hadoob File System- Developing a Map Reduce Application -Anatomy of a Map Reduce Job run- Map Reduce Types and Formats-Map Reduce Features.

**Module IV**

Setting up a Hadoop Cluster - Cluster specification- Hadoop Configuration & Setup - Security in Hadoop - Administering Hadoop – HDFS –Monitoring - Maintenance- Hadoop benchmarks- Hadoop in the cloud- Applications on Big Data Using Pig and Hive – Data processing operators in Pig – Hive services – Hive QL –Querying Data in Hive - fundamentals of HBase and Zookeeper.

**References**


1. Vikram Dayal, "An Introduction to R for Quantitative Economics: Graphing, Simulating and Computing", Springer, 2015.
2. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
3. Tom White , "Hadoop: The Definitive Guide", O'reilly Media, Third Edition, 2012.
4. Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, Paul Zikopoulos, "Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data", McGraw Hill, 2012
5. Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets",Cambridge University Press, 2012.
6. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley& sons, 2012.
7. Glenn J. Myatt, "Making Sense of Data", John Wiley & Sons, 2007
8. Pete Warden, "Big Data Glossary", O'Reilly, 2011.

## SKS M II E1665 (C) SOFT COMPUTING

**Module I**

Evolution of Computing- Soft Computing Constituents–-From Conventional AI to Computational Intelligence- Adaptive Networks–-Feed forward Networks–-Supervised Learning Neural Networks-Radial Basis Function Networks- Reinforcement Learning–-Unsupervised Learning Neural Networks–-Adaptive Resonance architectures.

**Module II**

Fuzzy Sets – Operations on Fuzzy Sets–-Fuzzy Relations- Fuzzy Rules and Fuzzy Reasoning-Fuzzy Inference Systems-Fuzzy Logic- Fuzzy Expert Systems-Fuzzy Decision Making.

**Module III**

Adaptive Neuro- Fuzzy Inference Systems -Coactive Neuro- Fuzzy Modeling-Classification and Regression Trees-Data Clustering Algorithms-Rule base Structure Identification-Neuro-Fuzzy Control.

**Module IV**

Machine Learning Techniques – Machine Learning Using Neural Nets – Genetic Algorithms (GA) Applications of GA in Machine Learning - Machine Learning Approach to Knowledge Acquisition. Support Vector Machines for Learning-Linear Learning Machines- Support Vector Classification Support Vector Regression - Applications.

**References**


1. Samir Roy, “Introduction to soft computing:Neuro,-Fuzzy and Genetic algorithms”, Pearson Education, first edition, 2013.
2. Kumar S Ray, “Soft Computing and its Applications”, CRC Press, 2014.
3. James A. Freeman and David M. Skapura, “Neural Networks Algorithms, Applications, and Programming Techniques”, Pearson, 2003.
4. Michael Affenzeller, Stefan Wagner, Stephan Winkler, Andreas Beham, “Genetic Algorithms and Genetic Programming: Modern Concepts and Practical Applications”, CRC Press, 2009.

## SKS M III E1672 (A) WIRELESS SENSOR NETWORKS

**Module I**

Introduction – Type of applications and examples- challenges for WSN's - enabling technologies for wireless sensor networks single node architecture- Hardware Components, Energy Consumption of Sensor Nodes, Operating Systems and Execution Environments, Network Architecture - Sensor Network Scenarios, Optimization Goals and Figures of Merit, Design Principles for WSN- Gateway Concepts.

**Module II**

Wireless channels and communication fundamentals- Physical Layer and Transceiver Design Considerations- MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols and Wakeup Concepts- contention based and schedule based protocols- IEEE 802.15.4 MAC Protocol and ZigBee.

**Module III**

Link layer Protocol- Error control- Content based and geographic addressing- Topology control- clustering- Routing Protocols- Energy- efficient routing, broadcast and multicast, Geographic routing.

**Module IV**

Data Centric and content based networking- Data centric routing – Data aggregation- Data centric storage- Transport Layer and QoS in WSN-Coverage and deployment- Reliable data transport- Single and block packet delivery- Congestion control and rate control- Security.

**References**


1. Holger Kerl, Andreas Willig, "Protocols and Architectures for Wireless Sensor Network", JohnWiley and Sons, 2005.
2. Feng Zhao, Leonidas Guibas, " Wireless Sensor Network", Elsevier, 1st Ed. 2004
3. Waltenegus Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks Theory and Practice", John Wiley and Sons, 2010.
4. Kazem Sohraby, Daniel Minoli, Taieb Znati, "Wireless Sensor Networks, Technology, Protocols and Applications", John Wiley and Sons, 2007.
5. Ibrahiem M. M. El Emary ,S. Ramakrishnan , "Wireless Sensor Networks: From Theory to Applications", CRC Press,2013.
6. Jun Zheng, Abbas Jamalipour, B. Krishnamachari, "Networking Wireless Sensors Wireless Sensor Networks: A Networking Perspective", Wiley India Private Limited, 2014.

## SKS M III E1672 (B) DIGITAL IMAGE PROCESSING

**Module I**

Introduction-Steps in Image Processing Systems– Image Acquisition–Sampling and Quantization– Pixel Relationships– Colour Fundamentals and Models, File Formats, Image operations– Arithmetic, Geometric and Morphological.

**Module II**

Spatial Domain Gray level Transformations Histogram Processing Spatial Filtering– Smoothing and Sharpening. Frequency Domain: Filtering in frequency Domain– DFT, FFT, DCT– Smoothing and Sharpening filters– Homomorphic Filtering.

**Module III**

Detection of Discontinuities– Edge Operators– Edge Linking and Boundary Detection– Thresholding– Region Based Segmentation – Morphological Water Sheds– Motion Segmentation, Feature Analysis and Extraction. Multi Resolution Analysis: Image Pyramids – Multi resolution expansion – Wavelet Transforms. Image Compression: Fundamentals–Models– Elements of Information Theory–Error Free Compression– Lossy Compression – Compression Standards.

**Module IV**

Image Classification – Image Recognition – Image Understanding – Video Motion Analysis– Image Fusion– Steganography– Digital Composting–Mosaics– Colour Image Processing.

**References**


1. Rafael C.Gonzalez, "Digital Image Processing", Pearson Education, Third Edition, 2013.

2. Milan Sonka, Vaclav Hlavac and Roger Boyle, "Image Processing, Analysis and Machine Vision", Cengage, ThirdEdition, 2013.

3. Uvais Qidwai, C.H. Chen, "Digital Image Processing: An Algorithmic Approach with MATLAB, CRC Press,2009.

## SKS M III E1672 (C) WIRELESS COMMUNICATION TECHNOLOGIES

**Module I**

Wireless Channel Models-path loss and shadowing models- statistical fading models- Narrowband and wideband fading models- Review of performance of digital modulation schemes over wireless channels- Diversity- Repetition coding and Time Diversity- Frequency and Space Diversity- Receive Diversity- Concept of diversity branches and signal paths- Combining methods- Selective diversity combining- Switched combining- maximal ratio combining- Equal gain combining- performance analysis for Rayleigh fading channels.

**Module II**

Cellular Networks- Multiple Access: FDM/TDM/FDMA/TDMA- Spatial reuse- Co- channel interference Analysis- Handover Analysis- Erlang Capacity Analysis- Spectral efficiency and Grade of Service- Improving capacity – Cell splitting and sectorization.

**Module III**

Motivation- Direct sequence spread spectrum- Frequency Hopping systems- Time Hopping.- Anti- jamming- Pseudorandom(PN) sequence- Maximal length sequences- Gold sequences- Generation of PN sequences.- Diversity in DSSS systems- Rake Receiver-Performance analysis. Spread Spectrum Multiple Access- CDMA Systems- Interference Analysis for Broadcast and Multiple Access Channels- Capacity of cellular CDMA networks- Reverse link power control- Hard and Soft hand off strategies.

**Module IV**

Capacity of Wireless Channels- Capacity of flat and frequency selective fading channels- Multiple Input Multiple output (MIMO) systems- Narrowband multiple antenna system model- Parallel Decomposition of MIMO Channels- Capacity of MIMO Channels. Cellular Wireless Communication Standards, Second generation cellular systems: GSM specifications and Air Interface - specifications, IS 95 CDMA- 3G systems: UMTS&CDMA2000 standards and specifications.

**References**


8. Andrea Goldsmith, “Wireless Communications”, Cambridge University press, 2013.
9. Simon Haykin and Michael Moher, “Modern Wireless Communications”, Person Education, 2004.
10. David Tse and Pramod Viswanath,**“**Fundamentals of Wireless Communication**”,** Cambridge University Press, 2006.
11. Theodore S. Rappaport, “Wireless communications: Principles and Practice”, Pearson, Second Edition, 2010.

## SKS M III E1673 (A) HIGH SPEED NETWORKS

**Module I**

Frame Relay Networks, Asynchronous transfer mode ATM Protocol Architecture, ATM logical Connection, ATM Cell– ATM Service Categories– AAL. High Speed LAN's: Fast Ethernet, Gigabit Ethernet, Fibre Channel – Wireless LAN's. 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 II**

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 III**

Integrated Services Architecture– Approach, Components, Services- Queuing Discipline, FQ, PS, BRFQ, GPS, WFQ– Random Early Detection, Differentiated Services.

**Module IV**

RSVP– Goals and Characteristics, Dataflow, RSVP operations, Protocol Mechanisms– Multiprotocol Label Switching– Operations, Label Stacking, Protocol details– RTP– Protocol Architecture, Data Transfer Protocol, RTCP.

**References**


4. William Stallings, "High Speed Networks And Internet", Pearson Education, Second Edition, 2002.
5. Warland &PravinVaraiya, "High Performance Communication Networks", Jean Harcourt Asia Pvt. Ltd., 2nd Edition, 2001.
6. Irvan Pepelnjk, Jim Guichard and JeffApcar, "MPLS and VPN architecture", Cisco Press, Volume1 and 2, 2003.
7. William Stallings, "High-Speed Networks and Internets: Performance and Quality of Service", Pearson Education, Second Edition, 2001.

## SKS M III E1673 (B) INFORMATION THEORY AND CODING

**Module I**
Introduction to probability, information, noiseless coding, noisy coding, cyclic Redundancy checks.

**Module II**
Permutation of sets, finite fields, linear codes, bounds for codes.

**Module III:**
Primitive polynomials, RS and BCH codes.

**Module IV:**
Concatenated codes, curves and codes.

**References**


**9.** P.Garrett, " The Mathematics of Coding Theory: Information, Compression, Error Correction and Finite Fields", Pearson Education, 2004.

**10.** San Ling, Chaoping Xing,"Coding Theory A First Course", Cambridge University Press, 2010.

## SKS M III E1673(C)INTERNET MODELS

**Module I**
Definition and characteristics of mathematical models.

**Module II**
Modeling the network - queuing systems, modeling the QoS for improvement, Mathematical models of fairness and stability**.**

**Module III**
Modeling a self-managed internet, moving away from the end to end concept, Modeling required in an untrustworthy world.

**Module IV**
Modeling of an internet based application.

**References**


5. Harold Tipton, Micki Krause, "Information Security Management Handbook", Auerbach /CRC Press, 5th Edition, 2004.

6. Seymour Bosworth, ME Kabay, "Computer Security Handbook", John Wiley, 4th Edition, 2002.

7. Theo Dimitrakos, Fabio Martinelli, (Editors), "Formal Aspects in Security and Trust: Proceedings of IFIP Workshop on Formal Aspects in Security and Trust (FAST) 2004", Springer 2005.