School of Electrical Sciences

Curriculum and Syllabus for M.Tech (Computer Science and Engineering)

M.Tech. (Computer Science and Engineering)

Semester –I				
SL. No	Course Name	Code	L-T-P	Credit
1	Networks and Systems Security	CS6L002	3-1-0	4
2	Advanced Algorithms	CS6L007	3-1-0	4
3	Elective-I	CS6LXXX	3-0-0	3
4	Elective-II	CS6LXXX	3-0-0	3
5	Elective-III	CS6LXXX	3-0-0	3
6	Computer Systems Lab	CS6P001	0-0-3	2
7	Security & Forensics Lab-I/ML & DA Lab-I	CS6P002/CS6P003	0-0-3	2
8	Seminar-I	CS6S001	0-0-0	2
Total				23
Semester-II				
Sl. No	Course Name	Code	L-T-P	Credit
1	Cloud Computing	CS6L008	4-0-0	4
2	High Performance Computer Architecture	CS6L009	3-1-0	4
3	Elective-IV	CS6LXXX	3-0-0	3
4	Elective-V	CS6LXXX	3-0-0	3
	Elective-VI	CS6LXXX	3-0-0	3
5	Security & Forensics Lab-II/ML & DA Lab-II	CS6P004/CS6P005	0-0-3	2
6	Seminar-II	CS6S002	0-0-0	2
Total				21
Semester-III				
Sl. No	Course Name	Code	L-T-P	Credit
1	Research Review-I	CS6D001	0-0-0	4
2	Thesis (Part-I)	CS6D002	0-0-0	16
Total				20
Semester-IV				
Sl. No	Course Name	Code	L-T-P	Credit
1	Research Review-II	CS6D003	0-0-0	4
2	Thesis (Part-II)	CS6D004	0-0-0	16
Total				20

Total Credit: 84

Elective Courses

Electives I, II, and III

Group 1	Code	Group2	Code
Digital Forensics-I	CS6L010	Artificial Intelligence	CS6L019
Cryptography	CS6L005	**Machine Learning and Data Analytics-I**	
Web Technology	CS6L011	Fault Tolerant Systems	CS6L006
Complexity Theory	CS6L012	Complexity Theory	CS6L018
Multimedia Systems	CS6L013	**Advanced Data bases and Mining**	CS6L017
Principles of Mathematical Logic	CS6L014	Mathematical Foundations of Computer Science	CS6L015
Mathematical Foundations of Computer Science	CS6L015	Image and Video processing	**EC6L002**
VLSI circuits	CS6L016	VLSI circuits	CS6L016

Electives IV, V and VI

Group 1	Code	Group2	Code
Digital Forensics-II	CS6L020	**Machine Learning & Data Analytics-II**	
Enterprise and Network Forensics	CS6L021	Wireless Sensor Networks	CS6L026
Complex Networks	CS6L022	**Natural Language Processing**	CS6L027
Software Testing and Verification	CS6L023	Computational aspects of Smart Grids	CS6L028
Internet of Things	CS6L024	Complex Networks	CS6L022
Information theory and Coding	**EC6L003**	Software Testing and Verification	CS6L023
Object Oriented Systems Design	CS6L025	Object Oriented Systems Design	CS6L025

Cyber Forensics Specific courses: Cryptography, Digital Forensics-I, Digital Forensics-II, Enterprise and Network Forensics, Security & Forensics Labs

Data Analytics specific courses: Machine Learning & Data Analytics I&II, Advanced Data bases and Mining, Natural language processing and Machine Learning and Data Analytics Labs

Vertical Theory (Core Courses)

Code: CS6L008	Name: Cloud Computing	L-T-P: 3-1-0	Credits: 4

Introduction to Cloud Computing; Enabling Technologies and System Models for Cloud computing; Benefits, Challenges and Risks in Cloud Computing; Cloud Computing Service Models: Infrastructure/Platform/Software – as-a-service;

Cloud Architectures including Federated Clouds; Public, Private and Hybrid clouds; Cloud Operating System;

Scalability, Performance and QoS in Cloud Computing; Data-Center Architectures for Cloud Computing; Principles of Virtualization platforms; Virtual machine migration and Load balancing;

Security and Privacy issues in Cloud; VMWare ESX Memory Management; Capacity Planning and Disaster Recovery in Cloud Computing.

Simulation tools: CloudSim

Case studies: Cloud computing systems from Amazon, Microsoft and IBM

Text books:

Kai Hwang, Jack Dongarra, Geoffrey C. Fox, Distributed and Cloud Computing, 1st edition, Morgan Kaufmann, 2013.

Reference books:

Thomas Erl, Cloud Computing: Concepts, Technology & Architecture, Pearson.

John Rhoton, Cloud Computing Explained: Handbook for Enterprise Implementation.

Technical papers from major journals and major conferences on computing, networking, cloud computing.

Code: CS6L002	Name: Networks and Systems Security	L-T-P: 3-1-0	Credits: 4

Introduction to Networking principles: Introduction to networking, datalink layer, network layer and transport layer protocols, DNS, mail servers, web servers, peer-to-peer network Security, wireless communication protocol.

Overview of System Security: Exploiting bugs in programs. Buffer overflows, fuzzing, Certification, secure socket layer (SSL), Kerberos, SQL injection, concepts of vulnerability, risk management, worm, virus, malwares, IDS, anti-viruses.

Basics of Cryptography: Basic cryptography and techniques, block ciphers, message authentication, symmetric-key encryption, hash functions, public-key encryption, digital signatures.

Data Privacy: Privacy changing online, mathematical definitions of privacy, attacks on privacy and anonymity, K-anonymity, Differential privacy, Private information retrieval, basics of multiparty computation and relationship to privacy.

Network Security: Access control, sate full firewall, IPSec, modeling and analysis of various security violation in wireless and sensor networks, trusted computing techniques, ARP Poisoning, IP spoofing, hidden tunnels, denial of service attack, firewalls.

Prerequisite: none

Test Books

1. Network Security Essentials (Applications and Standards) by William Stallings Pearson Education.

2. Hack Proofing your network by Ryan Russell, Dan Kaminsky, Rain Forest Puppy, Joe Grand, David Ahmad, Hal Flynn Ido Dubrawsky, Steve W.Manzuik and Ryan Permeh, Wiley Dreamtech

Reference Books:

1. Network Security and Cryptography: Bernard Menezes, CENGAGE Learning.

2. Network Security - Private Communication in a Public World by Charlie Kaufman, Radia Perlman and Mike Speciner, Pearson/PHI.

3. Cryptography and network Security, Third edition, Stallings, PHI/Pearson

4. Principles of Information Security, Whitman, Cengage Learning.

Code: CS6L007	Name: Advanced Algorithms	L-T-P:3-1-0	Credits: 4

Data Structures: More Advanced Solutions to Basic Data Structuring Problems: Fibonacci Heaps. Van Emde Boas Priority Queues. Dynamic Data Structures for Graph Connectivity/Reachability. Bit Tricks: Word-level Parallelism. Transdichotomous Model. o(n \log n) Integer Sorting. String Algorithms: Rabin-Karp Fingerprinting Algorithm. Suffix Trees.

Maximum Flows: Augmenting Paths and Push-Relabel Methods. Minimum Cost Flows. Bipartite Matching. Linear Programming: Formulation of Problems as Linear Programs. Duality. Simplex, Interior Point, and Ellipsoid Algorithms. Online Algorithms: Ski Rental. River Search Problem. Paging. The k-Server Problem. List Ordering and Move-to-Front.

Approximation Algorithms: One Way of Coping with NP-Hardness. Greedy Approximation Algorithms. Dynamic Programming and Weakly Polynomial-Time Algorithms. Linear Programming Relaxations. Randomized Rounding. Vertex Cover, Wiring, and TSP.

Fixed-Parameter Algorithms: Another Way of Coping with NP-Hardness. Parameterized Complexity. Kernelization. Vertex Cover. Connections to Approximation.

Parallel Algorithms: PRAM. Pointer Jumping and Parallel Prefix. Tree Contraction. Divide and Conquer. Randomized Symmetry Breaking. Maximal Independent Set.

External-Memory Algorithms: Accounting for the Cost of Accessing Data from Slow Memory. Sorting. B-trees. Buffer Trees. Cache-oblivious Algorithms for Matrix Multiplication and Binary Search. Computational Geometry: Convex Hull. Line-segment Intersection. Sweep Lines. Voronoi Diagrams. Range Trees. Seidel's Low-dimensional LP Algorithm.

Streaming Algorithms: Sketching. Distinct and Frequent Elements.

Prerequisite: Designing and Analysis of Algorithms

Text Books:

1. Thomas H. Cormen, Charles E. Leiserson, R.L. Rivest.. Introduction to Algorithms, Prentice Hall of India Publications.
2. Algorithm Design by Kleinberg and Tardos, Pearson.
3. Merc De-Berg eta al. Computational Geometry: Algorithms and Applications, 3rd Edition, Springer.

Reference Books:

1. Sara Baase and Allen Van Gelder. Computer Algorithms: Introduction to Design and Analysis, Pearson education (Singapore) Pvt. Ltd, New Delhi 2007.
2. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman.. The Design and Analysis of Computer Algorithms, Pearson Education (Singapore) 2006.
3. Algorithmics: Theory and Practice by Brassard and Bratley, Prentice Hall.

Code: CS6L009	Name: High Performance Computing Architecture	L-T-P: 3-1-0	Credits: 4

Introduction: review of basic computer architecture, quantitative techniques in computer design, measuring and reporting performance. CISC and RISC processors.

Pipelining: Basic concepts, instruction and arithmetic pipeline, data hazards, control hazards, and structural hazards, techniques for handling hazards. Exception handling.

Pipeline optimization techniques. Compiler techniques for improving performance.

Hierarchical memory technology: Inclusion, Coherence and locality properties; Cache memory organizations, Techniques for reducing cache misses; Virtual memory organization, mapping and management techniques, memory replacement policies.

Instruction-level parallelism: basic concepts, techniques for increasing ILP, superscalar, superpipelined and VLIW processor architectures. Array and vector processors. Multiprocessor architecture: taxonomy of parallel architectures.
Centralized shared-memory architecture: synchronization, memory consistency, interconnection networks. Distributed shared-memory architecture. Cluster computers. Non von Neumann architectures: data flow computers, reduction computer architectures, systolic architectures.

GPU architectures: NVIDEA and AMD architectures, gem5 and GPGPU-sim simulators
GPU Computing: CUDA and OpenCL programming with case studies

Text Books:

1. John L. Hennessy and David A. Patterson, Computer Architecture -- A Quantitative Approach, Morgan Kaufmann
2. David Patterson and J.L. Hennessy, Computer Organization and Design MIPS: The hardware/software interface
3. Benedict Gaster, Lee Howes, David R. Kaeli, Heterogeneous Computing with OpenCL, Elsevier

Reference Books

1. P. Pacheco, Parallel Programming with MPI, Elsevier
2. Shane Cook, CUDA programming, Morgan Kaufmann

Elective Courses

Code: CS6L010	Name: **Digital Forensics-I**	L-T-P: 3-0-0	Credits: 3

Introduction: Understanding the need of Computer Forensics, Definitions

Computer Hardware: Analysis of sources for digital evidence, Digital Media, Hard disk basics, mobile phones

Forensic Tools: Forensic hardware, Hardware write/blockers, Hard drive acquisitions, Processing the scene

Files and File Systems: Windows file systems, Forensic file images, metadata, File signatures

Forensic software: Different software packages, Basic search queries, ASCII, UNICODE, Regular expressions, viewing and managing keywords and cases, Encryption, password protection, Password recovery tools

Physical evidence: fingerprints or other evidence on machines, keyboards

Forensic Reports: Proper report writing, Explaining forensics to the uneducated

Email analysis: IP tracking, Tracking and analysis of emails, Webmail, POP, IMAP

File signature analysis: File signatures, File extensions, Detecting file manipulation

Hash Analysis: Hashing files, Hash libraries

Window Artifacts: My documents, Recycle bin, Installed programs,Windows XP vs. Windows 7

Text book:

Davis, Philipp, and Cowen, Hacking Exposed: Computer Forensics, McGraw-Hill Education

Reference Books:

R. Boddington, Practical Digital Forensics, Packt Publishing

N. Jain, D. Kalbande, Digital Forensic: The Fascinating World of Digital Evidences, Wiley

M.J. Britz, Computer Forensics and Cyber Crime: An Introduction, Perason

A. J. Marcella, G. Guillossou, Cyber Forensics: from data to digital intelligence, Wiley

Code: CS6L020	Name: **Digital Forensics-II**	L-T-P: 3-0-0	Credits: 3

File Systems: FAT/NTFS file Systems, Parsing FAT/NTFS file systems, Prefetch and Superfetch, Shortcuts and Jumplists

Adversary and Malware hunting: Malware detection, Malware analysis

Memory Forensics: Memory acquisition, Memory analysis, memory analysis tools, Advanced Recycle bin, Server Logs, google forensics

Anti-Forensics Detection: detection methodologies, Volume shadow copy, ESE databases, Advanced Registry, Thumbnail cache

Computer crime and legal issues: Privacy issues, Intellectual property

Incident Response: Threat and Adversary Intelligence, Financial crime analysis

Live/Online Forenics: Live Digital Forensics Investigation

Tools: BitTorrent, Sleuthkit toolset, Windows Forensics Toolchest

Moot court: Moot court case

Text book:

H. Carvey, Windows Forensics Analysis DVD Toolkit, Syngress publishers

Reference books:

K. Mandia,M Pepe, J. Luttgens, Incident Response & Computer Forensics, Third Edition

M.H. Ligh, A. Case, J. Levy, A. waters, The art of memory Forensics: Detecting Malware and Threats in Windows, Linux, and Mac Memory, Wiley

Code: CS6L021	Name: **Enterprise and Network Forensics**	L-T-P: 3-0-0	Credits: 3

Introduction: Investigative Process, Analysis Methodologies, Tools and Techniques, File Systems

Networking overview: Windows Networks, Users and Groups, Introduction to Network investigations

Windows and Linux servers: Server roles, Server analysis, Windows Registry, Event logs

IIS and Microsoft Exchange server: IIS server, Mailserver, Windows rootkits, Compromised server analysis

SQL server and Data bases: Microsoft SQL server, SQL server permission and encryption,

SQL server Forensics Acquisition and analysis: SQL server forensics and traditional windows forensics, SQL server artifacts, Resident and non-resident artifact's Collecting SQL data bases, Creating an analysis database, Importing evidence, Activity Reconstruction, Data recovery, SQL server rootkits

Linux Forensics: Linux File systems, Linux server configurations, Linux artifacts, Apache server forensics, LAMP forensics, SMB and Linux file shares

Network Traffic Analysis: Network addressing, DNS poisoning, ARP table analysis, DHCP analysis, Wireshack analysis

Network Device Forensics: management of switches and routers, Diagramming physical networks, Securing and isolating physical devices, Collecting Volatile/Non-volatile evidences from the routers, Volatile/Non-volatile

Text Books:

S. Anson, S. Bunting, R. Johnson, S. Perason, Mastering Windows Network Forensics and Investigations, Sybex publishers

K. Fowler, SQL Server Forensic Analysis, Addison Wesley

Reference Books:

S. Davidoff, J. Ham, Network Forensics: Tracking Hackers through Cyberspace, Prentice Hall

Code: CS6L005	Name: Cryptography	L-T-P: 3-0-0	Credits: 3

Background and assumptions: Encryption, Signatures, Authentication, Notion and need for security proofs, probabilistic polynomial-time algorithms, polynomial-time indistinguishability, trapdoor one-way functions and suspected candidates (IFP, DLP, DHP, RSA, SQRTP, QRP), bit security of the trapdoor one-way functions.

Formal Security: Textbook encryption algorithms (RSA, Rabin, ElGamal), insecurity of textbook algorithms under active attacks, notion of semantic security and message indistinguishability (IND-CPA), semantically secure encryption algorithms (Goldwasser-Micali, ElGamal, cryptographically secure pseudo-random bit generator), security against chosen-ciphertext attacks (IND-CCA and IND-CCA2), attacks under message non-malleability (NM-CPA, NM-CCA, NM-CCA2), relations between indistinguishability and non-malleability.

Provably Secure Public-Key Cryptosystems: Optimal asymmetric encryption padding (OAEP), Cramer-Shoup cryptosystem, use of random oracles in security proofs.

Data Integrity: MAC and cryptographic hash functions, digital signatures, textbook versions (RSA, Rabin, ElGamal), signature forgery, adaptive chosen-message attack, provably secure digital signature schemes, forking reduction, heavy-row reduction, probabilistic signature schemes, secure variants of ElGamal, RSA and Rabin signatures.

Cryptographic Protocols: Needham-Schroeder and Woo-Lam authentication protocols, Bellare-Rogaway security model, interactive proof protocols, challenge-response protocols, zero-knowledge proofs, Schnorr and Fiat-Shamir protocols, non-interactive zero knowledge.

Symmetric Cryptography: One-way functions, hard-core predicates, pseudo-random permutations, construction of pseudo-random generators, Luby-Rackoff construction, construction of pseudo-random and strong pseudo-random functions, equivalence of symmetric encryption and MAC.

Text Books:

1. Wenbo Mao, Modern Cryptography: Theory and Practice, first edition, Pearson Education, 2004.
2. Jonathan Katz and Yehuda Lindell, Introduction to Modern Cryptography, Chapman and Hall/CRC Press, 2007.

Reference Books:

1. Hans Delfs and Helmut Knebl, Introduction to Cryptography: Principles and Applications, second edition, Springer-Verlag, 2007.
2. Shafi Goldwasser and Mihir Bellare, Lecture Notes on Cryptography, online document, 2008.
3. [This is an adaptation of Phillip Rogaway and Shafi Goldwasser's online lecture notes: Introduction to Modern Cryptography, 2005.]
4. Oded Goldreich, The Foundations of Cryptography, Volume 1 and Volume 2, Cambridge University Press, 2001 and 2004.

Code: CS6LXXX	Name: Natural Language Processing	L-T-P: 3-0-0	Credits: 3

NLP tasks in syntax, semantics and pragmatics; Applications such as information extraction, question answering, and machine translation, The problem of ambiguity, The role of machine learning, brief history of the field

POS-tagging, POS-tagging perspective, POS tagging and HMM, Hidden Markov models (Forward and Viterbi algorithm and EM training), POS-tag set, Machine translation, Parsing algorithms, Probabilistic parsing, Parser Comparison

Grammar, constituency and dependency, CYK algorithm, Parse tree construction, Semantics, Word sense disambiguation

Knowledge based and supervised WSD, Unsupervised EM based WSD, Multilingual Resource constrained WSD

Linear and logistic Regression, Dimensionality Reduction, PCA

Machine translation, Statistical Machine translation, Binding Theory and Merger, X-bar theory

Text Books:

James Allen, *Natural Language Understanding*, Benjamin/Cummins

E. Charniack, *Statistical Language Learning*, MIT Press

Daniel Jurafsky and J.H. Martin, *Speech and Language Processing*, Prentice Hall

Reference Books:

H. Lane, H. Hapke, C. Howard, Natural language processing in Action: Understanding, analyzing, and generating text with Python, Manning publications.

B. Bengfort, R. Bilbro, Applied Text Analysis with Python: Enabling Language Aware Data Products with Machine Learning, O"Reilly

Code: CS6L017	Name: Advanced Databases and Mining	L-T-P: 3-0-0	Credits: 3

Introduction: Concepts and Definitions, Relational models, Data Modeling and Query Languages, Database Objects

Normalization Techniques: Functional Dependency, 1NF, 2NF, 3NF, BCNF; Multivalued Dependency; Loss-less Join and Dependency Preservation

Transaction Processing: Consistency, Atomicity, Isolation and Durability, Serializable Schedule, Recoverable Schedule, Concurrency Control, Time-stamp based protocols, Isolation Levels, On-line Analytical Processing**Database performance Tuning and Query optimization**: Query Tree, Cost of Query, Join, Selection and Projection Implementation Algorithms and Optimization

Database Security: Access Control, MAC, RBAC, Authorization, SQL Injection Attacks

Data Mining: stages and techniques, knowledge representation methods, data mining approaches(OLAP, DBMS, Statistics and ML)

Data warehousing*:* data warehouse and DBMS, multidimensional data model, OLAP operations.

Data processing: cleaning, transformation, reduction, filters and discretization with weka.

Knowledge representation*:* background knowledge, representing input data and output knowledge, visualization techniques and experiments with weka.

Data mining algorithms: association rules, mining weather data, generating item sets and rules efficiently, correlation analysis.

Classification & Clustering: 1R algorithm, decision trees, covering rules, task prediction, statistical classification, bayesian network, instance based methods, linear models, Cluster/2, Cobweb, k-means, Hierarchical methods.

Mining real data: preprocessing data from a real medical domain, data mining techniques to create a comprehensive and accurate model of data.

Advanced topics: text mining, text classification, web mining, data mining software.

Text Books:

Ramez Elmasri, Shamkant B. Navathe, Fundamentals of Database Systems, Addison-Wesley.

Reference books:

1. C.J. Date, Database Systems, Pearson.
2. P. Valduriez, M. TamerOzsu, Principles of Distributed Database Systems, Prentice Hall.
3. C.M. Coronel, S. Morris, P. Rob, Database systems: Design, implementation, and Management, Boston: Cengage Learning.
4. J. Han and M. Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann.

Code: CS6LXXX	Name: Machine Learning and Data Analytics-I	L-T-P: 3-0-0	Credits: 3

Introduction: Fixed, Adaptive and Intelligent Systems; Adaptive Techniques: Prediction, Classification, Forecasting, Filtering, Direct and Inverse modeling.
Data Exploration and Pre-processing: Data Objects and Attributes; Statistical Measures, Visualization, Data Cleaning and Integration.
Dimensionality Reduction: Linear Discriminant Analysis; Principal Component Analysis, Independent Component Analysis; Transform Domain and Statistical Feature Extraction and Reduction.
Regression: Least Mean Square and Recursive Least Square Algorithms; and Support Vector Machine.
Clustering: K-Means, Hierarchical, and Density-based Clustering, Spectral Clustering.
Classification: Decision Tree Induction including Attribute Selection, and Tree Pruning, Random Forests, Support Vector Machine, Ensemble Classification
Artificial Neural Networks: Single Layer Neural Network, Multilayer Perceptron, Back Propagation Learning, Functional Link Artificial Neural Network, and Radial Basis Function Network, Recurrent Neural Networks, Deep Learning, Convolutional Neural Networks.
Association Analysis: Frequent Itemset Generation and Rule Generation, Apriori Algorithms
Time Series Analysis: Time Series clustering, Time series alignment, Dynamic Time Warping

%%Bio-Inspired Techniques: Genetic Algorithm, Schemata Theorem, Differential Evolution, Particle Swarm Optimization, Ant Colony Optimization, Convergence Analysis.

Textbooks:

Bishop, C., Pattern Recognition and Machine Learning, Springer, 2006.
Daumé, H. III, A Course in Machine Learning, 2015 (freely available online).
Hastie, T., R. Tibshirani, J. Friedman, The Elements of Statistical Learning, Springer 2009 (freely available online).
Haykin S., Neural Networks and Learning Machines, Third Edition, Prentice Hall, 2008.
Goodfellow I.,Bengio Y. and Courville A.; Deep Learning, MIT Press, 2016

Reference Books:

Shai Shalev-Shwartz and Shai Ben-David. Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press, 2014.
NPTEL lectures on Introduction to Machine Learning.

Subject Code: EC6L002	**Name: Image and Video Processing**	**L-T-P: 3-1-0**	**Credit: 4**

Introduction to digital image processing, intensity transformation, spatial filtering, frequency domain filtering, point and line detection, edge detection, Hough Transform, image restoration, color processing, thresholding, image segmentation, affine transformation, image transforms, multi-resolution image analysis, shape and texture representation and description, introduction to object

recognition, image compression, JPEG, introduction to digital video, video compression standards, motion estimation.

Prerequisite: None

Texts/References Books:

Digital Image processing, Gonzalez and Woods, 3rd edition, Pearson and Prentice Hall, 2009
W.K. Pratt: Digital image processing, 4th edition, Wiley India, 2007.
K.R. Castleman: Digital image processing, 2nd edition, Pearson, 2012.
A.K. Jain: Fundamentals of digital image processing, Prentice Hall, 1989.

Subject Code: EC6L003	**Name: Information Theory and Coding**	**L-T-P: 3-0-0**	**Credit: 3**

Introduction: entropy and mutual information theory: joint entropy, conditional entropy, relationship between entropy and mutual information, chain rules for entropy, relative entropy, mutual information, Jensen's inequality fano's inequality.

An introduction to codes: coding: kraft inequality, optimal codes, bounds on optimal code length, kraft inequality for uniquely decodable codes, shannon and huffman codes, shannon, fano, elias codes, block codes, linear block codes, cyclic codes

Efficient encoding, information sources; average code word length; huffman encoding; noiseless coding: the noiseless coding theorem

Channel capacity: discrete memoryless channels and capacity, examples of channel capacity, symmetric channels, properties of channel capacity, channel coding theorem

Theory and practice of error-control coding: trellis diagram and the viterbi algorithm, convolution coding in mobile communications and modern graph-based codes (turbo-codes and ldpc codes), the main coding theory problem.

Prerequisites: None

Text Books:

T. M. Cover and J. A. Thomas, Elements of Information Theory, 2nd ed. Wiley-Interscience, 2006. ISBN-13: 978-0471241959.
S. Lin and D. J. Costello, Error Control Coding, 2nd ed. Pearson Prentice Hall, 2004, ISBN-13: 978-0130426727.

Reference Books:

R. G. Gallager, Information Theory and Reliable Communication. Wiley, 1968, ISBN-13: 978-0471290483
I Csiszar and J. Korner, Information Theory: Coding Theorems for Discrete Memoryless Sys-tems. Akademiai Kiado, December 1981, ISBN-13: 978-9630574402.
T. S. Han, Information-Spectrum Methods in Information Theory. Springer, 2002, ISBN-13: 978-3642078125.
Andre Neubauer, Jurgen Freedenberg, Volker Kuhn, "Coding theory Algorithm, Architectures and Applications",Willey India Editions, ISBN: 978-81-265-3432-6, 2007

Ranjan Bose, "Information theory, Coding and Cryptography", TMH publication, ISBN: 978-0-07-0669017, 2008
Roman, Steven, "Introduction to Coding and Information Theory", Springer, ISBN 978-0-387-94704-4 Journal readings

Code: CS6LXXX	Name: Machine Learning and Data Analytics-II	L-T-P: 3-0-0	Credits: 3

Regression: Logistic Regression, Sparse Multi-Normal Regression, and Ridge Regression.

Probability-based Learning: Nearest Neighbor Methods; Bayesian Classification; Naïve Bayes; Bayesian and Markov Networks; Hidden Markov Model; Markov Random Fields; EM Algorithm; Probabilistic inference – Metropolis-Hastings Algorithm, Gibbs Sampling

Topic Models: PLSI, Latent Dirichlet Allocation, HMM-LDA, modern variants

Online Algorithms: Online Clustering, online learning, Frequent Itemset mining on streaming data

Reinforcement Learning: Markov Decision Processes, and Q-Learning.

Learning Theory: PAC Learning, Sample Complexity and VC Dimension, and Structural Risk Minimization.

Fuzzy Logic: Tagaki-Sugeno Fuzzy Logic;, Mamdani Fuzzy Logic, Fuzzy Bayesian Decision Method, Membership Functions, Fuzzification and Defuzzification, Fuzzy system Modeling.

Distributed Machine Learning: Incremental and Diffusion Learning Algorithms, Distributed Clustering, Robust Prediction and Classification.
Applications

Textbooks:

Bishop, C., Pattern Recognition and Machine Learning, Springer, 2006.
Murphy, K., Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
Koller D. and Friedman N. : Probabilistic Graphical Models: Principles and Techniques, MIT Press, 2009
Simon H., Neural Networks and Learning Machines Prentice Hall, Third Edition, 2008.
Timothy J. Ross, Fuzzy Logic with Engineering Applications, John Wiley & Sons, 2010.

Reference Books:

Montgomery, D. C., and G. C. Runger, Applied Statistics and Probability for Engineers. John Wiley & Sons, Sixth Edition, 2013.
Shai Shalev-Shwartz and Shai Ben-David. Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press, 2014.
NPTEL lectures on Introduction to Machine Learning.

Code: CS6L015	Name: Mathematical Foundations of Computer Science	L-T-P: 3-0-0	Credits: 3

Discrete Structures -- Sets, Relations and Functions; Algebraic Structures, Morphisms, Lattices and Boolean Algebras.

Logic -- Propositional calculus and Predicate Calculus, Satisfiabiliy and validity, Soundness and completeness

Languages & Automata Theory -- Chomsky Hierarchy of Grammars and language acceptors, Turing Machines, Recursive and Recursively Enumerable Languages

Computability -- Church-Turing Thesis, Decision Problems, Decidability and Undecidability, Halting Problem of Turing Machines

Computational Complexity -- Time Complexity, The class P, The class NP, NP-Completeness, Reduction, co-NP, Polynomial Hierarchy. Space Complexity -- Savich's Theorem, The class PSPACE.

Prerequisite: None

Text Books:

1. J.P. Trembley and R. Manohar -- Discrete Mathematical Structures with Applications to Computer Science, McGraw Hill Book Co.,
2. John E. Hopcroft, Motwani and J.D.Ullman -- Inrtroduction to Automata Theory, Languages and Computation, Narosa Pub. House, N. Delhi.
3. R.L. Graham, D. Knuth, O. Patashnik, Concrete Mathematics: A foundation to Computer Science, Addison Wesley

Reference Books:

1. Michael Sipser -- Introduction to The Theory of Computation, Thomson Course Technology.
2. H.R. Lewis and C.H.Papadimitrou -- Elements of the Theory of Computation, Prentice Hall International.

CS6L025	Object Oriented System Design	L-T-P: 3-0-0	Credits: 3

Fundamental concepts of object oriented programming: Introduction to the principles of object-oriented programming (classes, objects, messages, encapsulation, inheritance, polymorphism, exception handling, and object-oriented containers).

Object design implementation in a programming language, e.g., C++ or Java.

Object oriented analysis, modeling and design: UML, Use cases, use case driven analysis.

Structural modeling of classes, relationships, interfaces, class diagrams, and object diagrams, in UML.

Behavioral/Functional modeling using use-case diagrams, sequence diagrams, in UML.

Dynamic modeling: State charts, Architectural modeling, Analysis patterns, Design patterns.

Case studies.

Prerequisite: None

Text Books:

1. Grady Booch, Object Oriented Analysis and Design, Addison-Wesley.
2. Grady Booch, James Rumbaugh and Ivar Jacobson, Unified Modeling Language Guide, Addison-Wesley.

Reference Books**:**

2. Bertrand Meyer, Object Oriented Software Construction, Prentice-Hall.
3. Erich Gamma et al., Design Patterns: Elements of Reusable OO Software, Addison-Wesley.
4. Michael L. Scott, Programming Language Pragmatics, Morgan-Kaufmann.
5. Kim Bruce, Foundations of Object Oriented Languages, Prentice-Hall.
6. Benjamin C. Pierce, Types and Programming Languages, Prentice-Hall.
7. Bjarne Stroustrup, The Design and Evolution of C++, Addison-Wesley.
8. Bill Venners, Inside the JAVA 2 Virtual Machine, McGraw Hill.
9. James E. Smith and Ravi Nair, Virtual Machines, Elsevier/Morgan-Kaufmann.

Saba Zamir, Handbook of Object Technology, CRC Press.

Lab Courses

Subject Code: CS6P001	Name: Computer Systems Lab	L-T-P:0-0-3	Credits: 2
Object-oriented programming concepts and UML, Implementation of graph algorithms, Randomized and approximation algorithms, Numerical computing algorithms, Basics of System programming: process creation, Inter process communication (IPC), Implementation of scheduling algorithms, synchronization, shared memory and semaphore, shell programming and implementation of file management.. Prerequisite: Programming and Data Structures			

Code: CS6P002	Name: Security and Forensics Lab-I	L-T-P:0-0-3	Credits: 2
Experiments related to Digital Signatures and MITM attacks; Hashing, password cracking, and biometrics3 Memory Corruption Exploits: Buffer overflows, Format string attacks, Code injection attacks, Heap-spraying, Memory Protection with Page guards SQL injection, XSS, Cross-site scripting and CSRF attacks Bit-Torrent File Sharing, Torrent Attacks, Botnets, Malware Detection and Forensics IP Spoofing, Sniffing, SYN Flooding and DoS Attacks using Wireshark, TCPDump and Smurf Tools Stateful Firewalls, Network Intrusion Detection, Honeypots Penetration Testing Tools, Null-pointer dereference, code integrity, system call filters, Sandboxing Security and Forensics Tools: BitTorrent, Sleuthkit, WinHex **Reference Books:** William Stallings, Lawrie Brown, Computer Security - Principles and Practice, Addison Wesley Professional, 2008 Introduction to Computer Networks and Cybersecurity, Chwan-Hwa (John) Wu, J. David Irwin, CRC Press, Edition 2013			

Code: CS6P004	Name: Security and Forensics Lab-II	L-T-P:0-0-3	Credits: 2

Experiments related to

Hard drive acquisition, searching evidence, email analysis lab, Hash analysis lab, Recycle bin analysis, Parsing FAT, Parsing NFTS, Tracking Activity, Malware Analysis, Thumbnail cache analysis, Live/Online forensics, Reverse Engineering,

Forensics Tools: Sleuthkit, Splunk, FireWalk, Windows Forensics Toolchest (WFT), Computer Online Forensic Evidence (COFE)

Reference Books:

Davis, Philipp, and Cowen, Hacking Exposed: Computer Forensics, Second Edition, McGraw-Hill Education

H. Carvey, Windows Forensics Analysis DVD Toolkit, Syngress publishers

Code: CS6P003	Name: Machine Learning and Data Analytics Lab-I	L-T-P:0-0-3	Credits: 2

Softwares: Matlab/R/Python, Weka

Implementation of Clustering, Classification and Regression Algorithms

SVM toolboxes: SVMlight, SVMtorch etc

Deep Learning platforms: Tensorflow/Caffe/Theano, implementation of popular architectures related to CNN, RNN, LSTM, Auto-encoder etc

Implementation of Time Series clustering and alignment algorithms

Reference Books:

R.P. Deng, R Programming for Data Science, (https://leanpub.com/rprogramming)

J. Verzani, Using R for Introductory Statistics, Chapman & Hall/CRC .

H. Wickham, Advanced R, Chapman & Hall/CRC.

P.K. Janert, Data Analysis with Open Source Tools: A Hands-On Guide for Programmers and Data Scientists, O' Reilly

Dan Van Boxel, Hands-On Deep Learning with TensorFlow

Geron A., Hands-on Machine Learning with Scikit-learn and Tensorflow, O'Reilly

Code: CS6P005	Name: Machine Learning and Data Analytics Lab-II	L-T-P:0-0-3	Credits: 2

Probabilistic Modeling Toolboxes: GMM, HMM, MRF/CRF etc

Implementation of Topic Modeling Algorithms, Topic Modeling toolboxes

Implementation of Online learning and Reinforcement Learning algorithms

Reference Books:

Murphy, K., Machine Learning: A Probabilistic Perspective, MIT Press, 2012

Blei, D. (2014). Build, compute, critique, repeat: Data analysis with latent variable models. Annual Review of Statistics and Its Application, 1:203–232.

Project Seminar: SR1 and SR2

Subject Code: CS6S001	Name: Seminar I	L-T-P: 0-0-0	Credit: 4
Subject Code: CS6S002	Name: Seminar II	L-T-P: 0-0-0	Credit: 4

Thesis: Part 1

Subject Code: CS6D002	Name: Thesis: Part I	L-T-P: 0-0-0	Credit: 16

Thesis: Part 2

Subject Code: CS6D004	Name: Thesis: Part II	L-T-P: 0-0-0	Credit: 16

Compliance Report

Category	M.Tech Curriculum (Requirement)		Proposed M.Tech (CSE) Curriculum
	Subjects	Credits	Credits
1. Theory (8-10) numbers	Core (40-60%)	32-36	16 (4 numbers)
	Electives (60-40%)		18 (6 numbers)
2. Laboratories		6-8	6-8
3. Seminars		4	4
4. Thesis	3rd Semester	16	16
	4th Semester	16	16
5. Research Review paper	3rd Semester	4	4
	4th Semester	4	4
Total		82-88	84-86