Indian Institute of Technology Bhubaneswar
M. Tech (CSE) Curriculum

Table of contents

Compliance report

	Requirement	Implemented
Total Credit	82-88	84
Theory	32-36	34
Laboratories	6-8	6
Seminars	4	4
Thesis	32	32
Research Review Papers	8	8

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COMPUTER SCIENCE AND ENGINEERING

SEMESTER – I					
Subject Name	**Code**	**L-T-P**	**Credit**	**Contact Hour**	**Syllabus Page No.**
Networks and Systems Security	CS6L002	3-1-0	4		5
Advanced Algorithms	CS6L007	3-1-0	4		6
Elective-I		3-0-0	3		
Elective-II		3-0-0	3		
Elective-III		3-0-0	3		
Computer Systems Lab	CS6P001	0-0-3	2		34
Security & Forensics Lab-I/ML & DA Lab-I	CS6P002/CS6P003	0-0-3	2		35/36
Seminar-I	CS6S001	0-0-3	2		
		Total	23		
SEMESTER – II					
Subject Name	**Code**	**L-T-P**	**Credit**	**Contact Hour**	**Syllabus Page No.**
Cloud Computing	CS6L008	4-0-0	4		7
High Performance Computer Architecture	CS6L009	3-1-0	4		8
Elective-IV		3-0-0	3		
Elective-V		3-0-0	3		
Elective-VI		3-0-0	3		
Security & Forensics Lab-II/ML & DA Lab-II	CS6P004/CS6P005	0-0-3	2		37/38
Seminar-II	CS6S002	0-0-0	2		
		Total	21		
SEMESTER – III					
Subject Name	**Code**	**L-T-P**	**Credit**	**Contact Hour**	**Syllabus Page No.**
Thesis Part I	CS6D002	0-0-0	16	16	
Research Review I	CS6D001	0-0-0	4	4	
		Total	20	20	
SEMESTER – IV					
Subject Name	**Code**	**L-T-P**	**Credit**	**Contact Hour**	**Syllabus Page No.**
Thesis Part II	CS6D004	0-0-0	16	16	
Research Review Paper II	CS6D003	0-0-0	4	4	
		Total	20	20	

ELECTIVE Ⅰ to III					
Subject Name	**Code**	**L-T-P**	**Credit**	**Contact Hour**	**Syllabus Page No.**
Digital Forensics-I	CS6L010	3-0-0	3		9
Cryptography	CS6L005	3-0-0	3		10
Web Technology	CS6L011	3-0-0	3		11
Complexity Theory	CS6L012	3-0-0	3		12
Multimedia Systems	CS6L013	3-0-0	3		13
Principles of Mathematical Logic	CS6L014				14
Mathematical Foundations of Computer Science	CS6L015	3-0-0	3		15
VLSI circuits	CS6L016	3-0-0	3		16
Artificial Intelligence	CS6L019	3-0-0	3		17
Machine Learning and Data Analytics-I	ID6L004	3-0-0	3		18
Fault Tolerant Systems	CS6L006	3-0-0	3		19
Advanced Data bases and Mining	CS6L017	3-0-0	3		20
Image and Video processing	EC6L002	3-1-0	4		21
Advanced Digital System Design	EC6L033	3-1-0	4		22
ELCTIVES IV to V					
Subject Name	**Code**	**L-T-P**	**Credit**	**Contact Hour**	**Syllabus Page No.**
Digital Forensics-II	CS6L020	3-0-0	3		23
Enterprise and Network Forensics	CS6L021	3-0-0	3		24
Complex Networks	CS6L022	3-0-0	3		25
Software Testing and Verification	CS6L023	3-0-0	3		26
Internet of Things	CS6L024	3-0-0	3		27
Information theory and Coding	EC6L003	3-0-0	3		28
Object Oriented Systems Design	CS6L025	3-0-0	3		29
Machine Learning & Data Analytics-II	ID6L005	3-0-0	3		30
Wireless Sensor Networks	CS6L026	3-0-0	3		31
Natural Language Processing	CS6L027	3-0-0	3		32
Computational aspects of Smart Grids	CS6L028	3-0-0	3		33

Core course syllabus

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

Prerequisite: none

Syllabus: 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.

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.

Subject Code: CS6L007	**Name:** Advanced Algorithms	**L-T-P: 3-1-0**	**Credit: 4**

Prerequisite: None

Syllabus: 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.

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.

Subject Code: CS6L008	**Name:** Cloud Computing	**L-T-P: 4-0-0**	**Credit: 4**

Prerequisite: none

Syllabus: 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:

1. Thomas Erl, Cloud Computing: Concepts, Technology & Architecture, Pearson.
2. John Rhoton, Cloud Computing Explained: Handbook for Enterprise Implementation.
3. Technical papers from major journals and major conferences on computing, networking, cloud computing.

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

Prerequisite: None

Syllabus: 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, super pipelined 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

Electives Syllabus

Subject Code: CS6L010	**Name:** Digital Forensics-1	**L-T-P: 3-0-0**	**Credit: 3**

Prerequisite: None

Syllabus: Introduction: Understanding the need for computer forensics, digital investigations and evidence, digital crime scene investigation process, data analysis, an overview of sleuthkit toolkit, Computer foundations: Data organizations, booting process, Handling evidence: Hardware write/blockers, Hard drive acquisitions, Hard disk basics, Different ways of wiping and formatting the evidence, processing the scene, Forensically sound evidence collection, Forensic file images, Volume level analysis: Understanding dos partition table and Global partition table, File system analysis: FAT 12, FAT 16, FAT 32 basic concepts, FAT data Structures, Analysing the evidence with FAT file system, NTFS basics, NTFS data structures, analysing the evidence with NTFS file system, Window artifacts: My documents, Recycle bin, Installed programs, Windows analysis: Windows volatile data acquisition, Windows memory acquisition and analysis, cold boot dump attack for memory dump, Windows Registry, File signature analysis: File signatures, File extensions, Detecting file manipulation, Forensic software: Sleuthkit, Basic search queries, ASCII, UNICODE, Regular expressions, viewing and managing keywords and cases, Antiforensic techniques: Encryption, password protection, Password recovery tools, Forensic Reports: Proper report writing, Explaining forensics to the uneducated.

Text books:

1. Brian Carrier. File System Forensic Analysis, Addison-Wesley Professional..
2. Cory Altheide, Harlan Carvey. Digital Forensics with Open Source Tools, Syngress.

Reference books:

1. A. J. Marcella, G. Guillossou, Cyber Forensics: from data to digital intelligence, Wiley
2. R. Boddington, Practical Digital Forensics, Packt Publishing.

Subject Code: CS6L005	**Name:** Cryptography	**L-T-P: 3-0-0**	**Credit: 3**

Prerequisite: None

Syllabus: Introductory Concepts: Basic Cryptographic Goals (Confidentiality, Integrity, and Availability), Encryption, Decryption, Types of Cryptosystems, Active and Passive attacks, One Time Pad Mathematical Background: Shannon's Theory, Computational Complexity, Number Theory, Modular Arithmetic, Polynomial Arithmetic, Groups, Finite Fields, Rings, Fermat's Theorem, Euclidian Algorithm, Extended Euclidian Algorithms, Euler Totient Function, Chinese remainder Theorem, Discrete logarithm Problem, Primarily test, Factorization algorithms. Traditional Ciphers: Substitution Cipher (Hill cipher, Vigenere cipher, Playfair cipher) and Transposition Cipher Symmetric Cryptosystems: Stream ciphers (RC4 and LFSR), Block ciphers (DES and AES), Modes of Block ciphers. Attack Models for Block Ciphers: Linear and Differential Analysis and Interpolation attack Public Key Cryptosystems: One way and Trapdoor Functions, RSA cryptosystem, Elgamal Cryptosystems, and Elliptic Curve cryptography Key Exchange: The Diffie Hellman Case Hash Functions: SHA-1, MD4, Keyed Hash Functions Message Authentication and Signatures: Digital Signatures, RSA signature, Elgamal signature, MAC.

Text books:

1. Cryptography and Network Security: (7^{th} Edition) by William Stalling.

Reference books:

1. Cryptography: Theory and Practice: 4^{th} Edition by Douglas Robert Stinson, Maura Paterson.

Subject Code: CS6L011	**Name:** Web Technology	**L-T-P: 3-0-0**	**Credit: 3**

Prerequisite: None

Syllabus: Basic design and implementation of websites, Discussion of different navigation and organizational strategies, Client-side technologies including HTML5, CSS, JavaScript, JSON, and JQuery, Server-side technologies emphasizing implementations in PhP, Back-end data management, Security issues, Emerging technologies.

Text books:

1. Developing Web Applications, Ralph Moseley and M. T. Savaliya, Wiley-India.

Reference books:

1. Web Design, Joel Sklar, Cengage Learning Publishing.

Subject Code: CS6L012	**Name:** Complexity Theory	**L-T-P: 3-0-0**	**Credit: 3**

Prerequisite: None

Syllabus: Models of computation, resources (time and space), algorithms, computability, complexity; complexity classes, P/NP/PSPACE, reductions, hardness, completeness, hierarchy, relationships between complexity classes; Randomized computation and complexity; Logical characterizations, incompleteness; approximability; circuit complexity, lower bounds; parallel computation and complexity; counting problems; interactive proofs; probabilistically checkable proofs; communication complexity; Quantum computation.

Text books:

1. Michael Sipser, Introduction to the Theory of Computation, PWS Publishing.
2. John E. Hopcroft and Jeffrey D. Ullman, Introduction to Automata, Languages and Computation, Addison-Wesley, 1979.

Reference books:

1. J. Balcazar, J. Diaz, and J. Gabarro, Structural Complexity, Volumes I and II, Springer.
2. Christos H. Papadimitriou, Computational Complexity, Addison-Wesley Longman.
3. Sanjeev Arora and Boaz Barak, Computational Complexity: A Modern Approach.

Subject Code: CS6L013	**Name:** Multimedia system	**L-T-P: 3-0-0**	**Credit: 3**

Prerequisite: None

Syllabus: Fundamentals of multimedia, media and data streams, sound/audio, image, graphics, video and animation. Topics in data compression including coding requirements, source, entropy, and hybrid coding, JPEG, H.261 (px64), MPEG, MP3 and etc. Computer technology issues such as communication architecture, multimedia workstations, cache systems, storage systems and optical storage. Multimedia operating system issues such as real-time operation, resource management, process management, file systems, and Multimedia networking. Multimedia synchronization, presentation requirements, reference model, and synchronization techniques. Multimedia database issues such as data organization, indexing and retrieval. Multimedia applications including digital libraries, system software, toolkits, conferencing paradigms, structured interaction support, and examples from video/audio/graphics conferencing. Latest Web technologies, such as XML, X3D and Semantic Web.

Text books:

1. Fundamentals of Multimedia, Ze-Nian Li, and Mark S. Drew, Pearson Prentice Hall, October 2003.

Reference books:

1. Multimedia Database Management Systems", B. Prabhakaran, Kluwer Academic publishers.

Subject Code: CS6L014	**Name:** Principles of Mathematical Logic	**L-T-P: 3-0-0**	**Credit: 3**

Prerequisite: None

Syllabus: Propositional Logic: syntax and semantics, Proof theory for Propositional logic, Natural Deduction, Gentzen System, Resolution in Propositional Logic, Soundness and Completeness. First order Logic: Syntax and semantics, Free and bound variables, Substitution, First order structures, Satisfaction and validation of a model, Proof theory of first order languages, Gentzen System for first order languages, Soundness, Herbrand's theorem, Resolution in first order logic, undecidability and Incompleteness. Logic programming: Horn fragment of predicate logic, unification, top-down operational semantics, Prolog basics.

Textbooks:

1. Jean, H. Gallier, Logic for Computer Science: Foundations of Automatic Theorem Proving, Dover publications.

Reference books:

1. M.R. Huth and M.D. Ryan, Logic in Computer Science, Modelling and Reasoning about Systems, ,Cambridge University Press.
2. H. Enderton, A Mathematical Introduction to Logic, Academic Press.

Subject Code: CS6L015	**Name:** Mathematical Foundations of Computer Science	**L-T-P: 3-0-0**	**Credit: 3**

Prerequisite: None

Syllabus: Discrete Structures -- Sets, Relations and Functions; Algebraic Structures, Morphisms, Lattices and Boolean Algebras. Logic -- Propositional calculus and Predicate Calculus, Satisfiability 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.

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.

Subject Code: CS6L016	**Name:** VLSI Circuits	**L-T-P: 3-0-0**	**Credit: 3**

Prerequisite: None

Syllabus: Introduction: Design hierarchy, layers of abstraction, integration density and Moore's law, VLSI design styles, packaging styles, design automation principles; Fabrication Technology: Basic steps of fabrication, bipolar, CMOS and Bi-CMOS fabrication processes, layout design rules; MOS and Bi-CMOS characteristics and circuits: MOS transistor characteristics, MOS switch and inverter, Bi-CMOS inverter, latch-up in CMOS inverter, super-buffers, propagation delay models, switching delay in logic circuits, CMOS analog amplifier; Logic Design: switch logic, gate restoring logic, various logic families and logic gates, PLA; Dynamic Circuits: Basic concept, noise considerations, charge sharing, cascading dynamic gates, domino logic, clocking schemes; Sequential Circuits: Basic regenerative circuits, bi-stable circuit elements, CMOS SR latch, clocked latch and flip-flops; Low-power Circuits: low-power design through voltage scaling, estimation and optimization of switching activity, reduction of switched capacitance, adiabatic logic circuits; Subsystem Design: design of arithmetic building blocks like adders, multipliers, shifters, area-speed-power trade-off; Semiconductor Memories: SRAM, DRAM, non-volatile memories; Bipolar ECL Inverter: Features of ECL gate, logic design in ECL, single-ended and differential ECL gates; Testability of VLSI: Fault models, scan-based techniques, BIST, test vector generation; Physical Design: Brief ideas on partitioning, placement, routing and compaction.

Text Books:

1. CMOS VLSI Design: A Circuits and Systems Perspective, 4e, Neil Weste, David Harris, Pearson.
2. S. Kang and Y Leblebici, "CMOS Digital Integrated Circuits: Analysis and Design," 3rd Ed., Tata McGraw Hill, New Delhi, 2003.
3. J. P. Uyemura, "Introduction to VLSI circuits and Systems," John Wiley, New Delhi, 2002.

Reference Books:

1. L Wang, C.Wu and X. wen, VLSI Test Principles and Architecture, Morgan Kaufmann, San Francisco, 2006.

Subject Code: CS6L019	**Name:** Artificial Intelligence	**L-T-P: 3-0-0**	**Credit: 3**

Prerequisite: None

Syllabus: Introduction to Artificial Intelligence: What is AI? Related Fields, Agents and Environments. Problem Solving: problem representation paradigms, state space, satisfiability vs optimality. Search Techniques: Principles of search, uninformed search, informed search, constraint satisfaction problems, adversarial search and games. Knowledge representation : First order and non-monotonic logic; rule based, frame and semantic network approaches, mixed representations, Theorem Proving, knowledge bases and inference. Uncertainty Treatment : formal and empirical approaches including Bayesian theory, belief functions, certainty factors. Fuzzy Logic: Tagaki-Sugeno Fuzzy Logic;, Mamdani Fuzzy Logic, Fuzzy Bayesian Decision Method, Membership Functions, Fuzzification and Defuzzification, Fuzzy system Modeling Planning and making decisions Reinforcement learning: MDPs, Q-learning algorithm, applications, Bandits and Monte carlo tree search.

Text books:

1. Russell and Norvig. Artificial Intelligence: A Modern Approach. Pearson Education (Low Priced Edition), 2004.
2. Nils J. Nilsson, Artificial Intelligence - A New Synthesis, Morgan Kaufmann Publishers, 2000.
3. George F.Luger and William A. Stubblefield, AI: Structures and Strategies for Complex problem solving, 2nd edition, Benjamin Cummins Publishers.

Reference books:

1. Mark Stefik, Introduction to Knowledge Systems, Morgan Kaufmann.
2. E. Rich and K.Knight, Artificial Intelligence, Tata McGraw Hill.
3. E. Charniack and D. Mcdermott, Artificial Intelligence, Addison Wesley.

Subject Code: ID6L004	**Name:** Machine Learning and Data Analytics-I	**L-T-P: 3-0-0**	**Credit: 3**

Prerequisite: None

Syllabus: Introduction: Prediction, Classification, Forecasting, Filtering, Regression, Clustering. Review of Linear Algebra, Probability and Statistics. Data Exploration and Pre-processing: Data Objects and Attributes; Statistical Measures, Visualization, Data Cleaning and Integration. Dimensionality Reduction: Linear Discriminant Analysis; Principal Component Analysis; Transform Domain and Statistical Feature Extraction and Reduction. Regression: Least Mean Square Regression; Ridge Regression and LASSO regression; Support Vector Regression. Clustering: K-Means, Hierarchical, and Density-based Clustering, Spectral Clustering. Classification: K-nearest-neighbor, Bayesian and Naïve Bayes Classifier, Decision Tree Induction including Attribute Selection, and Tree Pruning, Random Forests, Logistic Regression; Support Vector Machine; Ensemble Classification including Adaboost. 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.

Text books:

1. Bishop, C., “Pattern Recognition and Machine Learning”, Springer, 2006.
2. Mitchell, T. “Machine Learning”, 1997 (freely available online)
3. Duda, Hart, Stork. “Pattern Classification”. Wiley
4. Daumé, H. III, “A Course in Machine Learning”, 2015 (freely available online).
5. Haykin S., “Neural Networks and Learning Machines”, Third Edition, Prentice Hall, 2008.
6. Goodfellow I.,Bengio Y. and Courville A.; “Deep Learning”, MIT Press, 2016

Reference books:

1 Hastie, T., R. Tibshirani, J. Friedman, “The Elements of Statistical Learning”, Springer 2009 (freely available online).
2 Shai Shalev-Shwartz and Shai Ben-David. “Understanding Machine Learning: From Theory to Algorithms”, Cambridge University Press, 2014.

Subject Code: CS6L006	**Name:** Fault-Tolerant Systems	**L-T-P: 3-0-0**	**Credit: 3**

Prerequisite: None

Syllabus: Introduction: Fault Classification, Types of Redundancy, Fault tolerant metrics Hardware Fault Tolerance: Fault rate, Reliability, MTTF, Canonical and Resilient structures, Reliability evaluation techniques, Processor level techniques, Byzantine failures, Information Redundancy: Coding techniques, Resilient Disk Systems, Data replication, Algorithm based fault tolerance, Fault tolerant Networks: Network topologies and their Resilience, Fault tolerant routing, Software Fault tolerance: Single version fault tolerance, N-version programming, Recovery blocks, Conditions and assertions, Exception handling, Fault tolerant remote procedure calls, Checkpointing: Checkpointing in Analytical model, shared memory systems, real-time systems, Case studies: Non-stop systems, Itanium, Defect tolerance in VLSI circuits: Basic yield models,Yield enhancement through redundancy, Faults in Cryptographic Systems: Security attacks, Countermeasures.

Text books:

1. I. Koren, C Mani Krishna, Fault tolerant systems, Morgan Kaufmann.

Reference books:

1. D. Pradhan, Fault tolerant Computer Design, Prentice Hall.
2. E. Dubrova, Fault tolerant Design, Springer, 2013.
3. K. Trivedi, Probability and statictics with reliability, queuing and computer science applications, John Wiley.

Subject Code: CS6L017	**Name:** Advanced Databases and Mining	**L-T-P: 3-0-0**	**Credit: 3**

Prerequisite: None

Syllabus: Transaction Processing: Consistency, Atomicity, Isolation and Durability, Serializable Schedule, Recoverable Schedule, Concurrency Control, Time-stamp based protocols, Isolation Levels, Online 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, Ontologies and knowledge graph. Mining real data: preprocessing data from a real medical domain, data mining techniques to create a comprehensive and accurate model of data. Parallel Databases: Avenues for parallelism: I/O parallelism, interquery, inter-query and intra operation parallelism, databases for multi-core machines. Distributed Databases: Distributed data storage, distributed transactions, commit protocols, concurrency control in distributed databases, heterogeneous and cloud-based databases.Information Retrieval: relevance ranking using terms and hyperlinks,page rank, indexing of documents, measuring retrieval effectiveness.XML and semi-structured data: necessity, XML document schema, querying: XPath and XQuery languages, applications.Advanced topics: text mining, text classification, web mining, data mining software.

Text books:

1. Michael Steinbach, Pang-Ning Tan, and Vipin Kumar. Introduction to Data Mining, Pearson Education
2. P. Valduriez, M. TamerOzsu. Principles of Distributed Database Systems, Prentice Hall
3. Bing Liu. Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data, Springer-Verlag Berlin and Heidelberg GmbH & Co. K.

Reference books:

1. J. Han and M. Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann.
2. Ramez Elmasri, Shamkant B. Navathe, Fundamentals of Database Systems, Addison-Wesley.
3. M. Stonebraker. Readings in Database Systems, Morgan Kaufmann.

Subject Code: EC6L015	**Name:** Image and Video processing	**L-T-P: 3-1-0**	**Credit: 4**

Prerequisite: None

Syllabus: 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.

Text books:

1. Gonzalez and Woods, "Digital Image processing," 3rd Ed., Pearson and Prentice Hall, 2009.

Reference books:

1. W.K. Pratt, "Digital image processing," 4th Ed., Wiley India, 2007.
2. K.R. Castleman, "Digital image processing," 2nd Ed., Pearson, 2012.
3. A.K. Jain, "Fundamentals of digital image processing," Prentice Hall, 1989.

Subject Code: EC6L033	**Name:** Advanced Digital System Design	**L-T-P**: 3-1-0	**Credit**: 4

Prerequisite: None

Syllabus:

Advanced topics in combinational and sequential design: Use of CAD, design methodologies, system decomposition, arithmetic modules, and design of complex sequential systems. Introduction to FPGA architectures: Overview, programming technologies, configurable logic block, FPGA routing architectures. Logic design with Verilog: Introduction to Verilog, logic design with behavioral models of combinational and sequential logic, synthesis of combinational and sequential logic, design and synthesis of data path controllers, programmable logic and storage devices, algorithms and architectures for digital processors, architectures for arithmetic processors, coding for FPGAs. Designing with FPGAs: Design flow for FPGAs, prototyping with FPGAs, and debugging. (Utilize commercial FPGA development tools for compilation, simulation, synthesis, implementation, and debugging).

Text Books:

1. Advanced Digital Design with the Verilog HDL (2nd Edition 2017) by Michael D.Ciletti. ISBN: 9789332584464, Publisher: Pearson.
2. Advanced FPGA Design: Architecture, Implementation, and Optimization by Steve Kilts. ISBN: 9780470054376, Publishers: Wiley, 2007
3. Verilog HDL (2nd Edition) by Samir Palnitkar. Publisher:Pearson, 2003.
4. Field-Programmable Gate Arrays: Reconfigurable Logic for Rapid Prototyping and Implementation of Digital Systems by Richard C. Dorf, John V. Oldfield. ISBN: 9788126516612, Publisher: Wiley, 2008.
5. Digital System Design with FPGA: Implementation Using Verilog and VHDL by Cem Unsalan, Bora Tar, ISBN: 9781259837906, McGrawHill Publications.
6. Designing with Xilinx FPGAs using Vivado, Editor, Sanjay Churiwala, Springer 2016.

Reference Books:

1. Verilog: Frequently Asked Questions: Language, Applications, and Extensions by Shivakumar S. Chonnad, Needamangalam B. Balachander. Publisher: Springer, 2007.
2. Advanced Digital Logic Design: Using VHDL, State Machines, and Synthesis for FPGAs by Sunggu Lee. ISBN: 978-0534466022, Nelson Engineering, 2005.
3. Programming FPGAs-Getting Started with Verilog by Simon Monk, ISBN: 978-1259643767, McGrawHill Publications. ISBN: 978-0982497098, LBE Books.
4. Digital Design Using Digilent FPGA Boards: Verilog / Vivado Edition by Richard EHaskell, Darrin M Hanna
5. Zynq-7000 SoC, Technical Reference Manual , https://www.xilinx.com/products/silicondevices/soc/zynq-7000.html
6. ZedBoard, https://www.xilinx.com/products/boards-and-kits/1-8dyf-11.html

Subject Code: CS6L020	**Name:** Digital Forensics-2	**L-T-P: 3-0-0**	**Credit: 3**

Prerequisite: Digital Forensics-1

Syllabus: Cyber Security Fundamentals: Overview of cybersecurity, Definition and types of cyberthreats, Usecases: Morris worm, DDos Attack. Definition and Types of Malwares: Malware Basics, Worms, Virus, Rootkits, Trojan Horses: Trojans, Ransomware, Spyware, Malware analysis tools, Advanced persistent threat . E-mail Analysis: Finding E-mail Artifcats, converting e-mail formats, Client-based e-mail, web-based e-mail, internet hosted mail, investigating e-mail header.Tracking User Activity: Tracking Web usage, Internet explorer forensics, firefox/mozilla forensics, operating system user logs. Memory Forensics: Memory acquisition, Memory analysis, memory analysis tools. Incident Response: Introduction to incident response, preparing for incident response, mac time analysis. Forensic Analysis of Mobile Devices: Collecting and analyzing mobile device, password-protected windows devices. Recent Advances in Digital Forensics: Discussing latest papers in the field.

Text books:

1. Davis, Philipp, and Cowen, Hacking Exposed: Computer Forensics, McGraw Hill Education.
2. K. Mandia, M Pepe, J. Luttgens, Incident Response & Computer Forensics, Third Edition.

Reference books:

1. M.H. Ligh, A. Case, J. Levy, A. waters, The art of memory Forensics: Detecting Malware and Threats in Windows, Linux, and Mac Memory, Wile.
2. A book from honeynet project. Know your enemy: Learning about security threats, Addison Wesley.

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

Prerequisite: None

Syllabus: Network forensic: collecting and analysing network-based evidence, reconstructing web browsing, e-mail activity, and windows registry changes, intrusion detection, tracking offenders, etc. Mobile network forensic: introduction, mobile network technology, investigations, collecting evidence, where to seek digital data for further investigations, interpretation of digital evidence on mobile network, network management tools. Enterprise forensic: Organizational relationship between activities directed toward policy enforcement, computer forensics, data recovery, incident response, and privacy protection. Information systems control governance and policy enforcement. Strategies for organizational readiness for computer incident response such that collection, preservation, presentation and preparation of computer-based evidence will optimally satisfy the requirements of business continuity, criminal law enforcement and civil litigation. Organizational information services policies for incident response and business continuity. Strategic and technical levels the organization's computer incident response systems, architecture, and staff capabilities. Organization's computer incident response processes and computer forensics investigation processes. Ethical, technical and economic rationale for specific organization information systems incident response and forensic capabilities.

Text books:

1. Digital Forensics with Open Source Tools. Cory Altheide and Harlan Carvey, ISBN: 978-1-59749-586-8, Elsevier publication, April 2011.
2. Computer Forensics and Cyber Crime: An Introduction (3rd Edition) by Marjie T. Britz, 2013.
3. Handbook of Digital Forensics and Investigation, Academic press Inc., Eoghan Casey.

Reference books:

1. Guide to Computer Forensics and Investigations 5th Edition, Nelson, Phillips, Steuart, Cengage Learning, 2015.

Subject Code: CS6L022	**Name:** Complex Networks	**L-T-P: 3-0-0**	**Credit: 3**

Prerequisite: None

Syllabus: Introduction: Overview of Network science, Motivation, Large scale dynamic networks, Challenges of graph theory, Basic Concepts related to Networks, Small world effect, transitivity and clustering, degree distribution, scale free networks, maximum degree; network resilience; mixing patterns; degree correlations; community structures; network navigation, Community Structure Analysis, Basic concepts of network communities, Modularity, various community finding approaches like Girvan-Newman Algorithm, Spectral Bisection Algorithm, Radicchi Edge Clustering Algorithm (for binary as well as weighted graphs), Wu-Hubermann Algorithm, and Random Walk based Algorithm, Louvain, InfoMap, Random Graphs, Poisson random graphs, generalized random graphs, the configuration model, generating functions, power-law degree distribution, directed graph, bipartite graph, degree correlations, Models of Network Growth, Price model, Barabasi & Albert model, other growth models, vertex copying models, Bipartite Network, Processes taking place on Networks.Percolation theory and network resilience, Epidemiological processes, Cascades and information spread, Social Network, Homophily, Cohesiveness, Cliques, Clans, Clubs, Plex, Equivalence of ties, Ego-centric networks, Cascade formation and information diffusion in Social media (say Twitter).Applications, Search on networks, exhaustive network search, guided network search, network navigation; network visualization and semantic zooming. Advanced topics, Temporal network, Multilayer networks, Interdependent networks, Controllability of complex networks, Economic and financial network analytics.

Text books:

1. Networks: An Introduction, Oxford University Press, Oxford, 2010.

Reference books:

1. Evolution of Networks, Oxford University Press, Oxford, 2003.
2. The structure and function of complex networks, SIAM Review 45, 167-256, 2003.
3. Statistical mechanics of complex networks, Rev. Mod. Phys., 74(1), 2002.
4. Papers from the ACM and IEEE digital libraries.

Subject Code: CS6L023	**Name:** Software Testing and Verification	**L-T-P: 3-0-0**	**Credit: 3**

Prerequisite: None

Syllabus: The course is about how to convince oneself that a program unit really does what it should. There are different methods for verifying programs that will be covered in this course. Testing: which has the purpose of finding errors in a program in a systematic way (terminology, coverage, unit tests, a unit test framework). Debugging which has the purpose to systematically trace and eliminate an error (control, workflow, localization, tools). Proving or formal verification: reasoning about the program in order to guarantee correctness (formal specifications (pre-/postconditions, invariants), automatic test case generation, formal verification (logics, tool support)). Verifying a program only makes sense if we can precisely specify what the program is supposed to do. Many specifications are written in natural language which might lead to imprecision and misunderstandings. In the course you will learn how to use precise methods for specifying functional requirements. Such precise specifications will then be our basis for the verification of programs. But they will also be useful to automatize the generation of test cases. Throughout, the course is concerned with imperative programs in general, and object-oriented programs in particular.

Text books:

1. Introduction to Software Testing by Paul Ammann, Jeff Offutt.

Reference books:

1. Why Programs Fail: A Guide to Systematic Debugging by Andreas Zeller A definitive and modern treatment of debugging.
2. The Art of Software Testing, 3rd Edition by Glenford J Myers, The second edition of what is considered to be THE classic book on testing.
3. The Science of Programming by David Gries. Covers topics related to program verification and the weakest pre-condition calculus.
4. Code Complete, 2nd Edition by Steve McConnell.

Subject Code: CS6L024	**Name:** Internet-of-Things	**L-T-P: 3-0-0**	**Credit: 3**

Prerequisite: None

Syllabus: Introduction to IoT: Sensing, Actuation, Basics of Networking, Communication Protocols, Sensor Networks, Machine-to-Machine Communications, Interoperability in IoT. Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino, Introduction to Python programming, Introduction to Raspberry Pi, Implementation of IoT with Raspberry Pi. Introduction to SDN, SDN for IoT Data Handling and Analytics, Cloud Computing, Sensor-Cloud , Fog Computing, Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Industrial IoT, Case Study: Agriculture, Healthcare, Activity Monitoring

Text books:

1. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press).

Reference books:

1. "Internet of Things: A Hands-on Approach", by Arshdeep Bahga and Vijay Madisetti (Universities Press).

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

Prerequisite: None

Syllabus: 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.

Text books:

1. T. M. Cover and J. A. Thomas, "Elements of Information Theory," 2nd Ed., Wiley-Inter Science, 2006.
2. S. Lin and D. J. Costello, "Error Control Coding," 2nd Ed., Pearson Prentice Hall, 2004.

Reference books:

1. R. G. Gallager, "Information Theory and Reliable Communication," Wiley, 1968.
2. I Csiszar and J. Korner, "Information Theory: Coding Theorems for Discrete Memoryless Systems," Akademiai Kiado, December 1981.
3. T. S. Han, "Information-Spectrum Methods in Information Theory," Springer, 2002.
4. Andre Neubauer, Jurgen Freedenberg, Volker Kuhn, "Coding theory Algorithm, Architectures and Applications," Willey India Editions, 2007.
5. Ranjan Bose, "Information theory, Coding and Cryptography," TMH publication, 2008.
6. Roman, Steven, "Introduction to Coding and Information Theory", Springer, 2000.

Subject Code: CS6L025	**Name**: Object Oriented Systems Design	**L-T-P: 3-0-0**	**Credit: 3**

Prerequisite: None

Syllabus: The purpose of this course is to familiarize students with concepts, methods, and tools for object oriented analysis and design of software systems, with emphasis on methods applied in large product development projects. The course introduces common design principles and patterns that support the development of maintainable, reusable and extensible software. The course gives an introduction to UML. Analysis- and design models are expressed using UML models such as use case diagrams, class diagram, sequence diagrams, and state diagrams. Furthermore,

techniques and guidelines are introduced for analysis of software domain and requirements.

Text books:

1. Systems Analysis and Design: an Object-oriented Approach with UML (5th edition), Alan Dennis, Barbara Haley Wixom, David Tegarden. ISBN-13: 978-1118804674 ISBN-10: 1118804678.

Reference books:

1. Some particularly practical are: 'UML Distilled' by Martin Fowler.
2. The Unified Modeling Language User Guide (2nd Edition) by Grady Booch, James Rumbaugh, Ivar Jacobson.
3. Design Patterns: Elements of Reusable Object-Oriented Software. By Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides.

Subject Code: ID6L005	**Name:** Machine Learning and Data Analytics-II	**L-T-P: 3-0-0**	**Credit: 3**

Prerequisite: MLDA-I

Syllabus: Probability-based Machine Learning: Review of statistics; Parameter Estimation by Maximum-Likelihood and Bayesian approach; Probabilistic classification and PCA; Random Projections. Generative Models: 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. Introduction to Bayesian Nonparametric: Chinese Restaurant Process and variants, Indian Buffet Process, Dirichlet Process, Gaussian Process. 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. Spectral Methods. Applications to Vision, text, climate, finance domains.

Text books:

1. Bishop, C., "Pattern Recognition and Machine Learning", Springer, 2006.
2. Murphy, K., "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
3. Koller D. and Friedman N.: "Probabilistic Graphical Models: Principles and Techniques", MIT Press, 2009.

Reference books:

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

Subject Code: CS6L026	**Name:** Wireless Sensor Networks	**L-T-P: 3-0-0**	**Credit: 3**

Prerequisite: None

Syllabus: Introduction: Overview, Broad application areas of WSN, Specialty and constrains; Hardware and software: Overview of hardware architecture of the sensor motes, Types of operating systems for WSN, Overview of event driven programming. MAC layer issues: Types of MAC protocols for WSN, Contention-based and reservation based protocols. Detailed study of specific protocols such as SMAC, RMAC, TMAC, DW-MAC, DMAC, Aloha, CSMA-CA, BMAC, LPL, LPP. Network layer issues: Routing, classification of the protocols, specific protocols such as SPIN, LEACH etc. Data collection, Data dissemination, Data aggregation, Time synchronization.

Text books:

1. Holger Karl, Andreas Willig, Protocols and Architectures for Wireless Sensor Network, John Wiley & Sons, 2005, ISBN 0470095105.

Reference books:

1. Ibrahiem M. M. El Emary, S. Ramakrishnan, Wireless Sensor Networks: From Theory to Applications, CRC Press, 2013, ISBN 9781466518100.
2. Ian F. Akyildiz, Mehmet Can Vuran, Wireless Sensor Networks, John Wiley & Sons, 2010, ISBN 9780470036013.
3. J Zheng, and A Jamalipour. Wireless sensor networks: a networking perspective, John Wiley & Sons, 2009, ISBN 9780470167632.
4. Anna Hac, Wireless Sensor Network Designs, John Wiley & Sons, 2003, ISBN 0470867361.

Subject Code: CS6L027	**Name:** Natural Language Processing	**L-T-P: 3-0-0**	**Credit: 3**

Prerequisite: None

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

Text books:

1. James Allen, “Natural Language Understanding” .
2. Benjamin/Cummins E. Charniack, “Statistical Language Learning”, MIT Press .
3. Daniel Jurafsky and J.H. Martin, “Speech and Language Processing”, Prentice Hall.

Reference books:

1. H. Lane, H. Hapke, C. Howard, “Natural language processing in Action: Understanding, analyzing, and generating text with Python”, Manning publications.
2. B. Bengfort, R. Bilbro, “Applied Text Analysis with Python: Enabling Language Aware Data Products with Machine Learning”, O”Reilly.

Subject Code: CS6L028	**Name:** Computational aspects of Smart-Grid	**L-T-P: 3-0-0**	**Credit: 3**

Prerequisite: None

Syllabus: Introduction: Introduction to Smart Grid, Introduction to Cloud Computing, Introduction to Big Data Analytics, Fundamental Mathematical Prerequisites, Cloud Computing Applications for Smart Grid: Demand Response, Geographical Load-Balancing, Dynamic Pricing, Virtual Power Plant, Advanced Metering Infrastructure, Cloud-Based Security and Privacy, Smart Grid Data Management and Applications: Smart Meter Data Management, PHEVs: Internet of Vehicles, Smart Buildings, Smart Grid Design and Deployment: Simulation Tools, Worldwide Initiatives .

Text books:

1. Smart Grid Technology: A Cloud Computing and Data Management Approach, Sudip Misra and Samaresh Bera, Publisher: Cambridge University Press ISBN:9781108475204, May 2018.

Lab Syllabus:

Subject Code: CS6P001	**Name:** Computer Systems Lab	**L-T-P: 0-0-3**	**Credit: 2**

Prerequisite: None

Syllabus: 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.

Text Books:

1. Avi Silberschatz, Peter Galvin, Greg Gagne, Operating System Concepts, Wiley Asia Student Edition.
2. William Stallings, Operating Systems: Internals and Design Principles, Prentice Hall of India.

Reference Books:

1. Systems Analysis and Design: an Object-oriented Approach with UML (5th edition), Alan Dennis, Barbara Haley Wixom, David Tegarden. ISBN-13: 978-1118804674 ISBN-10: 1118804678.

Subject Code: CS6P002	**Name:** Security and Forensics Lab-I	**L-T-P: 0-0-3**	**Credit: 2**

Prerequisite: None

Syllabus: Experiments related to Digital Signatures and MITM attacks; Hashing, password cracking, and biometrics, 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

Text books:

1. William Stallings, Lawrie Brown, Computer Security - Principles and Practice, Addison Wesley Professional, 2008.

Reference Books:

1. Introduction to Computer Networks and Cybersecurity, Chwan-Hwa (John) Wu, J. David Irwin, CRC Press, Edition 2013.

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

Prerequisite: None

Syllabus: 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.

Text Books:

1. R.P. Deng, R Programming for Data Science, (https://leanpub.com/rprogramming)
2. J. Verzani, Using R for Introductory Statistics, Chapman & Hall/CRC .

Reference Books:

1. H. Wickham, Advanced R, Chapman & Hall/CRC.
2. P.K. Janert, Data Analysis with Open Source Tools: A Hands-On Guide for Programmers and Data Scientists, O' Reilly.
3. Dan Van Boxel, Hands-On Deep Learning with TensorFlow.
4. Deron A., Hands-on Machine Learning with Scikit-learn and Tensorflow, O'Reilly.

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

Prerequisite: Security and Forensics Lab-I

Syllabus: 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).

Text Books:

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

Reference Books:

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

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

Prerequisite: Machine Learning and Data Analytics Lab-I

Syllabus: Probabilistic Modeling Toolboxes: GMM, HMM, MRF/CRF etc Implementation of Topic Modeling Algorithms, Topic Modeling toolboxes. Implementation of Online learning and Reinforcement Learning algorithms.

Text Books:

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

Reference Books:

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