COURSE STRUCTURE & SYLLABUS

FOR

2-YEAR M.TECH
IN
COMPUTER SCIENCE AND ENGINEERING

Effective from Academic Session 2019-2020

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY
(INDIAN SCHOOL OF MINES)
DHANBAD- 826 004, JHARKHAND

2-Year M. Tech.(CSE)Programme

SEMESTER - 1					
Course No.	**Course Name**	**L**	**T**	**P**	**C**
CSC501	Advanced Data Structures &Algorithms	3	0	0	9
CSC502	Advanced DBMS	3	0	0	9
CSC504	Computing Techniques and Mathematical Tools	3	0	0	9
CSC505	High Performance Computer Architecture	3	0	0	9
CSC503	Algorithmic Graph Theory	3	0	0	9
CSC506	Lab. on Advanced Data Structures & Algorithms	0	0	3	3
CSC507	Lab. on Computing Techniques and Mathematical Tools	0	0	3	3
	Total	**15**	**0**	**6**	**51**

SEMESTER -2					
Course No.	**Course Name**	**L**	**T**	**P**	**C**
CSD5 xx	D Elective 1	3	0	0	9
CSD5 xx	D Elective 2	3	0	0	9
CSD5 xx	D Elective 3	3	0	0	9
CSO5 xx	Open Elective 1	3	0	0	9
CSO5 xx	Open Elective 2	3	0	0	9
CSC508	Lab. on Computing1*	0	0	3	3
CSC509	Lab. on Computing2*	0	0	3	3
	Total	**12**	**0**	**6**	**51**

*Depending on offered elective courses in Semester 2/departmental core courses in Semester 1.

SEMESTER - 3					
Course No.	**Course Name**	**L**	**T**	**P**	**C**
CSC510	Thesis Unit 1	0	0	0	9
CSC511	Thesis Unit 2	0	0	0	9
CSC512	Thesis Unit 3	0	0	0	9
CSC513	Thesis Unit 4	0	0	0	9
	Total	**0**	**0**	**0**	**36**

SEMESTER - 4					
Course No.	**Course Name**	**L**	**T**	**P**	**C**
CSD5 xx / CSO5 xx	D Elective 4 / Open Elective 3	3	0	0	9
CSD5 xx / CSO5 xx	D Elective 5 / Open Elective 4	3	0	0	9
CSC514	Thesis Unit 5	0	0	0	9
CSC515	Thesis Unit 6	0	0	0	9
	Total	**0**	**0**	**0**	**36**

List of Subjects for Department Electives

Course No.	Course Name	L	T	P	C
CSD501	Algorithms for Bioinformatics	3	0	0	9
CSD502	Cloud Computing	3	0	0	9
CSD503	Computational Number Theory	3	0	0	9
CSD504	Computer Vision	3	0	0	9
CSD505	Cryptography and Network Security	3	0	0	9
CSD506	Cryptology	3	0	0	9
CSD507	Data Compression	3	0	0	9
CSD508	Distributed Systems	3	0	0	9
CSD509	Image and Video Processing	3	0	0	9
CSD510	Information Retrieval	3	0	0	9
CSD511	Information Theory and Coding	3	0	0	9
CSD512	Interactive Computer Graphics	3	0	0	9
CSD513	Internet of Things	3	0	0	9
CSD514	Mobile and Wireless Network Security	3	0	0	9
CSD515	Multimedia Systems & Security	3	0	0	9
CSD516	Optimization Techniques	3	0	0	9
CSD517	Parallel Computing	3	0	0	9
CSD518	Pattern Recognition	3	0	0	9
CSD519	Software Testing	3	0	0	9
CSD520	VLSI Design & Testing	3	0	0	9
CSD521	Wireless Networks	3	0	0	9

List of Subjects for Open Electives

Course No.	Course Name	L	T	P	C
CSO501	Artificial Intelligence	3	0	0	9
CSO502	Data Analytics	3	0	0	9
CSO503	Data Mining	3	0	0	9
CSO504	Machine Learning	3	0	0	9
CSO505	Soft Computing	3	0	0	9

COURSE DETAILS OF M. TECH (CSE)

List of Subjects for Departmental Core

Course No.	Course Name	L	T	P	C
CSC501	**Advanced Data Structures & Algorithms (40 Lectures)**	3	0	0	9

UNIT 1 (03 Lectures): Amortized Analysis: Aggregate Analysis, Accounting Method And Potential Method

UNIT 2 (03 Lectures):Dynamic Programming: Assembly Line Scheduling, Matrix Chain Multiplication

UNIT 3 (07 Lectures): Graph Algorithms: Topological Sorting, Strongly Connected Components, Single Source Shortest Paths In DAG, Johnson's Algorithm

UNIT 4 (03 Lectures):Computational Geometric Algorithms: Geometric Searching Algorithms, Segment Intersection Problems;

UNIT 5 (03 Lectures): Polynomials And FFT: Representation, DFT, FFT(Recursive & Iterative)

UNIT 6 (05 Lectures): String Matching Algorithms: Naïve Approach, Finite Automata Approach, Rabin-Karp And Knuth-Morris-Pratt Algorithm;

UNIT 7 (04 Lectures): Matrix Algorithms: LU Decomposition, LUP Decomposition, Linear System of Equations Solver, Matrix Inversion;

UNIT 8 (02 Lectures): Approximation Algorithms: Vertex Cover Problem, Travelling Salesman Problem, Set Cover Problem

UNIT 9 (05 Lectures): Randomized Algorithms: Randomized Quicksort, Minimum Cost Spanning Tree, Parallel Algorithms: Mesh Algorithms, Hypercube Algorithms

UNIT 10 (05 Lectures): Advanced Data Structures: kd-Tree, Binomial and Fibonacci Heaps.

Course Objective: To provide knowledge of advanced level computer algorithms with considerable depth, analysis and their applications. This course will also provide a strong foundation for research in many areas of computer science.

Outcome: Students will be learning advanced algorithm paradigm which will help them in campus placement and research work.

Text Books:

1.Cormen, Leiserson, Rivest and Stein, Introduction to Algorithms, Prentice Hall of India, 3rd Edition, 2010.

Reference Books:

1.Sartaj Sahni and Sanguthevar Rajasekaran Ellis Horowitz, Fundamentals of Computer Algorithms, Universities Press.

2.Mark De Berg et al., Computational geometry:Algorithms and Application, 3rd edition, Springer, 2008.

Course No.	Course Name	L	T	P	C
CSC502	**ADVANCED DBMS (36 Lectures)**	3	0	0	9

UNIT 1 (3 Lectures): Relational Databases: Integrity Constraints, Functional Dependency, Multi-valued Dependency;

UNIT 2 (8 Lectures): Query Processing and Optimization: Evaluation of Relational Operations, Transformation of Relational Expressions, Indexing and Query Optimization, Data access from disk, Index based access, Sort and Join Processing, Physical plan selection, Limitations of Relational Data Model;

UNIT 3 (4 Lectures): Parallel and Distributed Databases: Distributed Data Storage, Fragmentation & Replication, Location and Fragment Transparency,

UNIT 4 (6 Lectures): Distributed Query Processing and Optimization, Distributed Transaction Modeling and Concurrency Control, Distributed Deadlock, Commit Protocols, Design of Parallel Databases, Parallel Query Evaluation;

UNIT 5 (6 Lectures): Advanced Transaction Processing: Nested and Multilevel Transactions, Compensating Transactions and Saga, Long Duration Transactions, Weak Levels of Consistency, Transaction Work Flows, Transaction Processing Monitors;

UNIT 6 (5 Lectures): Objected Oriented and Object Relational Databases: Modeling Complex Data Semantics, Specialization, Generalization, Aggregation and Association, Objects, Object Identity, Equality and Object Reference, Architecture of Object Oriented and Object Relational Databases;

UNIT 7 (4 Lectures): NoSQL databases: Cassandra, MongoDB, etc.,

Course Objective: This course is intended to provide the students with an understanding of the current theory and practice of database management systems. To help the students more fully appreciate their nature, the course provides a solid technical overview of database management systems, using a current database product as a case study.

Outcome: Students will be learning advanced database management strategies which will help them in campus placement and research work.

Text Books:

1.Avi Silberschatz, Henry F. Korth & S. Sudarshan, "Database System Concepts", Tata Mc-Graw-Hill.

Reference Books:

1. W. Kim, "Modern Database Systems", Addison Wesley.
2. W. Kim, "Introduction to Object Oriented Databases", MIT Press.
3. J. D. Ullman, "Principles of Database and Knowledge Base Systems", Computer Science Press.

Course No.	Course Name	L	T	P	C
CSC504	**COMPUTING TECHNIQUES AND MATHEMATICAL TOOLS (42 Lectures)**	3	0	0	9

UNIT 1 (3 lectures): Sets, Fuzzy sets, Rough Sets

UNIT 2 (4 lectures): number theory

UNIT 3 (6 lectures): Statistics: Random number and random process, Queuing theory, Hidden Markov Model, Linear and nonlinear regression, multiple regression, partial regression,

UNIT 4 (4 lectures): Linear programming, optimization(golden section search, simulated annealing)

UNIT 5 (4 lectures): Solution of linear algebraic equations (Gaussian elimination, LU decomposition, SVD, sparse systems) Eigen systems.

UNIT 5 (5 lectures): Special functions (beta function, error function, hypergeometric function, Bessel, Legendre),

UNIT 6 (5 lectures): FFT, other integral transforms, Differential equation and partial difference equation based systems(like diffusion etc)

UNIT 7 (6 lectures): Numerical Techniques: Transcendental and polynomial equations, convergence and computational issues, System of linear algebraic equations, Interpolation and approximation, numerical differentiation/integration/differential equation/partial differential equations

UNIT 7 (5 lectures): Programming: Introduction to Python and R, shell programming, X-window programming. Solving problems using numerical methods and programming languages like C/C++ /MATLAB/Python.

Course Objective: Enhancement of mathematical, statistical and programming skills of the students with an objective to enable them to deal with other subjects with higher level of comfort.

Outcome: The knowledge and concepts in these topics are likely to help the students do better in future in job as well as in higher studies.

Text Books:

1.An Introduction to Numerical Methods and Optimization Techniques by Richard W Daniels, Elsevier

2.Probability, Statistics, and Queuing Theory with Computer Science Applications, Arnold O Allen, Academic Press

3.Special Functions for Scientists and Engineers, W.W.Bell, Courier Corporation

4.X Window Applications Programming,Eric Foster-Johnson, Kevin Reichard,Johnson, MIS Press, USA

5. Any text book on Python programming

Reference Books: Numerical recipes in C: the art of scientific computing,Press W.H., Teukolsky S.A., Vetterling W.T., Flannery B.P., Cambridge University Press

Course No.	Course Name	L	T	P	C
CSC505	**HIGH PERFORMANCE COMPUTER ARCHITECTURE(40 Lectures)**	**3**	0	0	9

UNIT 1 (06 Lectures): Introduction: Fundamental of Quantitative Design, Benchmark Programs, Review of Basic Organization and Architectural Techniques: RISC processors: Characteristics of RISC processors; RISC Vs CISC; Classification of Instruction Set Architectures; Review of performance measurements;

UNIT 2 (03 Lectures): Basic parallel processing techniques: instruction level,thread level and process level; Classification of parallel architectures,

UNIT 3 (03 Lectures): Instruction Level Parallelism (ILP): Pipelining, Pipeline Hazards,

UNIT 4 (06 Lectures): Advanced ILP: Advanced Compiler and Hardware Techniques for ILP, Branch Prediction Techniques, Loop Unrolling, Score boarding, Tomasula's Algorithm, Hardware-Based Speculation,

UNIT 5 (05 Lectures): Multi-Issue Processors: VLIW, Global Code Scheduling, Compiler Speculation, Classifying ILP Machines, Superscalar and Super-pipelined Architectures, and Limits on ILP.

UNIT 6 (05 Lectures): Data Level Parallelism: SIMD Vector Architecture, Graphics Processing Units, Systolic Arrays. Interconnection networks,

UNIT 7 (06 Lectures): Thread Level Parallelism: Multiprocessors: Introduction Symmetric and Distributed Shared Memory Architectures, Cache Coherence Issues, Performance Issues, Synchronization Issues, Models of Memory Consistency,

UNIT 8 (06 Lectures): Memory Hierarchy Design: Advanced Optimizations of Cache Performance, Memory Technology and Optimizations, Protection: Virtual Memory and Virtual Machines, Design of Memory Hierarchies, Case Studies.

Course Objective: This course deals with two interrelated issues in high-performance computing: (i) fundamental concepts and techniques in parallel computation structuring and design, including parallelization methodologies and paradigms, parallel programming models, their implementation, and related cost models; (ii) architectures of high-performance computing systems, including shared memory multiprocessors, distributed memory multicomputers, clusters, and others.

Outcome: Technical competence in computer architecture and high performance computing.Ability to describe the operation of modern and high performance computers.Ability to undertake performance comparisons of modern and high performance computers.Ability to improve the performance of applications on modern and high performance computers.Development of software to solve computationally intensive problems.

Text Books:

1.J. L. Hennessy, D. A. Patterson "Computer Architecture: A Quantitative Approach," 3rd edition.

Reference Books:

1.“Modern Processor Design: Fundamentals of Superscalar Processors” by John Paul Shen and Mikko H Lipasti

2.“Computer Architecture: Pipelined and Parallel Processor Design” by M J Flynn “High Performance Embedded Architectures And Compilers” by Soft Cover and J Emer

Course No.	Course Name	L	T	P	C
CSC503	**ALGORITHMIC GRAPH THEORY(40 Lectures)**	3	0	0	9

UNIT 1 (3 lectures): Graphs and algorithmic complexity, graph representation, graph traversals;
UNIT 2 (4 lectures):Spanning trees, branching, connectivity, circuits, cut-sets;
UNIT 3 (5 lectures):Planar graphs: genus, crossing numbers, thickness, characterization of planarity, planarity testing
UNIT 4 (6 lectures):Networks and flows: Menger's theorem, maximizing flow in graph networks, minimum cost flow;
UNIT 5 (6 lectures): Matching: maximum cardinality matching, maximum weight matching, perfect matching;
UNIT 6 (6 lectures): Euler tours and Hamiltonian cycles: counting Eulerian tours, finding all Hamiltonian cycles using matricial products, 2-factors
UNIT 7 (5 lectures): Graph coloring: dominating set, edge coloring, vertex coloring, chromatic polynomial, face coloring, 4-color theorem, 5-color theorem;
UNIT 8 (5 lectures): Graph problems and intractability: Cook's theorem, vertex covering, independent sets and cliques

Course Objective: Development of concepts of algorithms related to graphs

Outcome: Students are expected to be able to handle the combinatorial and graph problems with greater ease.

Text Books:

1. Algorithmic Graph Theory by Alan Gibbons,, Cambrige University Press

Reference Books:

1.Algorithmic Graph Theory and Perfect Graphs by Martin Charles Golumbic, North Holland
2.Graph Theoretic Algorithms, Therese Biedl, U of Waterloo
3.Advanced Topics in Graph Algorithms, Ron Shamir, Tel Aviv U.

List of Subjects for Departmental Core Lab

Course No.	Course Name	L	T	P	C
CSC506	**LAB. ON ADVANCED ALGORITHMS (14 Lab Days)**	0	0	3	3

UNIT 1 (2 Lab Days):
Lab. based on Dynamic Programming
UNIT 2 (4 Lab Days):
Lab. based on Graph Algorithms
UNIT 3 (2 Lab Days):
Lab. based on Polynomials and FFT
UNIT 4 (4 Lab Days):
Lab. based on String Matching Algorithms
UNIT 5 (2 Lab Days):
Lab. based on Matrix Algorithms

Course Objective: To make the students learn implementation of the algorithms discussed in the theory class of Advanced Algorithms.
Outcome: Coding skill, helpful for research work.
Text Books:
1. Cormen, Leiserson, Rivest and Stein, Introduction to Algorithms, Prentice Hall of India, 3rd Edition, 2010.
Reference Books:
1. Sartaj Sahni and Sanguthevar Rajasekaran Ellis Horowitz, Fundamentals of Computer Algorithms, Universities Press.

Course No.	Course Name	L	T	P	C
CSC507	**LAB. ON Computing Techniques andMathematical Tools (14 Lab Days)**	0	0	3	3

UNIT 1 (1 classes): lab on number theory
UNIT 2 (2 classes): lab on Statistics: Random number and random process, Queuing theory, Hidden Markov Model, Linear and nonlinear regression, multiple regression, partial regression,
UNIT 3 (1 class): lab on Linear programming, optimization(golden section search, simulated annealing)
UNIT 4 (1 class): lab on Solution of linear algebraic equations (Gaussian elimination, LU decomposition, SVD, sparse systems) Eigen systems.
UNIT 5 (1 class): lab on Special functions (beta function, error function, hypergeometric function, Bessel, Legendre),
UNIT 6 (2 classes): lab on FFT, other integral transforms, Differential equation and partial difference equation based systems(like diffusion etc)
UNIT 7 (2 classes): lab on Numerical Techniques: Transcendental and polynomial equations, convergence and computational issues, System of linear algebraic equations, Interpolation and approximation, numerical differentiation/integration/differential equation/partial differential equations
UNIT 8 (4 classes): lab on Python and R, shell programming, X-window programming. Matlab.

Course Objective: A better comprehension and command over the concepts taught in the theoretical classes

Outcome: Students will become expert in the subject

Text Books: As suggested in the theory

Reference Books: As suggested in the theory

Course No.	Course Name	L	T	P	C
CSC508	**LAB. ON COMPUTING 1**	0	0	3	3

This Lab. will be conducted based based on the offered elective courses in Semester 2/departmental core courses in Semester 1.

Course No.	Course Name	L	T	P	C
CSC509	**LAB. ON COMPUTING 2**	0	0	3	3

This Lab. will be conducted based based on the offered elective courses in Semester 2/departmental core courses in Semester 1.

List of Subjects for Departmental Electives

Course No.	Course Name	L	T	P	C
CSD505	**CRYPTOGRAPHY AND NETWORK SECURITY(40 Lectures)**	3	0	0	9

Unit 1 (3 Lectures): Cryptography: Introduction: Security requirements, Attacks, Security techniques.
Unit 2 (4 Lectures): Cryptographic mathematics: Modular Arithmetic, Group, Ring, Field, Prime numbers and primality tests.
Unit 3 (4 Lectures): Classical encryption techniques; Block ciphers; Public-key ciphers.
Unit 4 (3 Lectures): Elliptic curve cryptography.
Unit 5 (3 Lectures): Message authentication; Cryptographic hash algorithms.
Unit 6 (4 Lectures): Digital Signatures.
Unit 7 (3 Lectures): Key management.
Unit 8 (5 Lectures): Network Security: Network layer security (IPSec): Authentication header (AH), Encapsulated security payload (ESP), Security association (SA), Internet security protocol (IKE).
Unit 9 (4 Lectures): Transport layer security: Secure socket layer (SSL)- SSL architecture, Four protocols, SSL message formats, TLS.
Unit 10 (4 Lectures): E-mail security: Introduction to E-mail architecture, PGP (Pretty Good Privacy), S/MIME.
Unit 11 (3 Lectures): Secure Electronic transaction (SET), Digicash.

Course Objective: Knowing of cryptographic techniques and applying/understanding for securing networks (Internet) so that the applications developed are secure.

Outcome: For understanding of both theoretical and practical knowledge in information security aspects.

Text Books:

1.William Stallings, 'Cryptography and Network Security-Principles and Applications' Pearson Education

Reference Books:

2.B.A. Forouzan, 'Cryptography and Network Security' Tata McGraw-Hill

Course No.	Course Name	L	T	P	C
CSD520	**VLSI DESIGN & TESTING (36 Lectures)**	3	0	0	9

Unit 1(4 Lectures): MOS Technology: Transistor basics, Fabrication, Transistor theory, Design process,

Unit 2 (4 Lectures): Basic circuit concepts, MOS inverters and characteristics;

Unit 3 (5 Lectures): Combinational MOS logic circuits: nMOS logic designs, CMOS logic circuits;

Unit 4 (7 Lectures): Sequential MOS logic circuits: SR, JK, D flip-flops; Semiconductor memories: Static random access memory (SRAM), Dynamic access memory (DRAM);

Unit 5 (3 Lectures): Test and testability: Different abstraction levels in Circuits and fault models,

Unit 6 (4 Lectures): Testing combinational and sequential circuits,

Unit 7 (5 Lectures): DFT guidelines, Scan design technique,

Unit 8 (4 Lectures): BIST technique.

Course Objective: Almost all basic topics required for VLSI designs as well as for testing are taken into consideration.

Outcome: The basics of this subject would be well understood by students.

Text Books:

1. D.A. Pucknell and K. Eshraghian, 'Basic VLSI Design' Prentice-Hall of India.

Reference Books:

1. N.H.E. Weste, 'Principles of CMOS VLSI Design' Pearson Education,

2. S. Kang and Y. Leblebici, 'CMOS Digital Integrated Circuits' Tata McGraw-Hill

Course No.	Course Name	L	T	P	C
CSD517	**PARALLEL COMPUTING (38 Lectures)**	3	0	**0**	9

UNIT 1 (05 Lectures):Introduction to Parallel Computing, Applications; Parallel Computing Models: SIMD, MIMD, PRAMS, Multiprocessors; Shared Memory Architectures, Message Passing Architectures, Multi-Cores.

UNIT 2 (04 Lectures): Interconnection Networks: Linear Array, Meshes, Trees, Mesh Of Trees, Hypercubes, Butterfly Networks.

UNIT 3 (08 Lectures): Parallel Computing Techniques: Pointer Jumping, Divide and Conquer, Partitioning, Pipelining, Systolic Computation; Parallel Performance Analysis, Scalability, High Level Parallel Programming Models and Framework.

UNIT 4 (12 Lectures): Parallel Algorithms: Prefix Computation, List Ranking, Euler Tour, Sorting, Searching, Merging; Matrix Operations; Multiprocessor Algorithms.

UNIT 5 (04 Lectures): Message passing programming: Distributed memory model; Introduction to message passing interface (MPI).

UNIT 6 (05 Lectures): Synchronization as Send/Receive pair; Introduction to GPU Programming: GPU Architecture; Introduction to CUDA Programming.

Course Objective: This course is intended to cover a comprehensive introduction to parallel architecture and parallel computing techniques followed by in depth coverage of parallel algorithms. This is also supplemented by moden parallel programming paradigms through GPU and CUDA

Outcome: The course will provide a strong foundation of parallel architecture and parallel algorithms. Students will also learn modern parallel programming through GPU based system and CUDA.

Text Books:

1. Michael J. Quinn, Parallel computing : theory and practice, Singapore : McGraw-Hill, 1994.

Reference Books:

1.Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, Introduction to Parallel Computing, Second Edition, Addison Wesley, 2003.

2.Michael J. Quinn, Designing efficient algorithms for parallel computers, McGraw-Hill Ryerson, Limited, 1987.

3.Selim G. Akl , The Design and Analysis of Parallel Algorithms, Prentice Hall, Englewood Cliffs, New Jersey, 1989.

Course No.	Course Name	L	T	P	C
CSD514	**MOBILE AND WIRELESS NETWORK SECURITY(40 Lectures)**	3	0	**0**	**9**

Unit 1 (4 Lectures): Mobile and Wireless Communications: Overview, 1G-4G Cellular Systems, Cellular Communication Fundamentals.
Unit 2 (5 Lectures): Multiple Access Techniques- FDD, TDD, FDMA, TDMA, DS-CDMA, Spread Spectrum and CDMA, CSMA/CA,
Unit 3 (5 Lectures): Mobile Ad Hoc Routing Protocols- DSDV, AODV, DSR, CGSR,
Unit 4 (4 Lectures): Cellular Communication standards- GSM, IS-95 CDMA, WiMAX.
Unit 5 (4 Lectures): Wireless Security: Security and Privacy needs of Wireless System, Challenges of Broadcast Communication and Security Requirements,
Unit 6 (4 Lectures): TESLA Broadcast Authentication, Instant Key Disclosure, Time Synchronization, Denial-of-Service Protection,
Unit 7 (5 Lectures): BiBa Signature Algorithm and Broadcast Authentication, Merkle Hash Trees for Ball Authentication, Efficient Multicast Stream Signature (EMSS), MESS,
Unit 8 (5 Lectures): WLAN Standards, 802.11 Security, WEP Protocols, WAP Security Architecture, Comparison of TCP/IP, OSI and WAP models,
Unit 9 (4 Lectures): Bluetooth networking and Security protocols.

Course Objective: The students should understand and know the existing security mechanisms/techniques and new developments as well used for securing wireless communications along with wireless networking.

Outcome: The students would get well exposure in securing wireless applications.

Text Books:

1. William Stallings, 'Wireless Communications and Networks', Pearson Education
2. Different security based Journal research articles.

Reference Books:

1. Jochen Sciller, 'Mobile Communications' Addison Wesley, T.S. Rappaport, 'Wireless Communication- Principles and Practice' Prentice Hall

Course No.	Course Name	L	T	P	C
CSD509	**IMAGE AND VIDEO PROCESSING (40 Lectures)**	3	0	**0**	**9**

UNIT 1 (3 Lectures): Digital Image Fundamentals: Image Model, Sampling and Quantization, Image Geometry, Digital Geometry.

UNIT 2 (6 Lectures): Image Enhancement: Contrast Enhancement, Histogram Processing, Point Processing, Spatial Domain Filtering, Frequency Domain Filtering.

UNIT 3 (3 Lectures): Noise Models, Image Restoration Filtering, Motion Blur Removal, Geometric Corrections.

UNIT 4 (6 Lectures): Image Compression: Redundancy and Compression Models, Lossless and Lossy Compression Schemes–Run Length, Huffman, Arithmetic Coding, Block Truncation, Vector Quantization, JPEG Standard.

UNIT 5 (3 Lectures): Wavelets and Multiresolution Processing: Pyramidal Coding; Subband Coding; Application of Wavelets.

UNIT 6 (3 Lectures): Image Morphology: Fundamental Operations, Morphological Algorithms.

UNIT 7 (6 Lectures): Image Segmentation: Pixel-based Segmentation, Multilevel and Adaptive Thresholding, Optimal Thresholding, Region-based Segmentation, First and Second Order Edge Operators, Canny Edge Detector, Hough Transform, Edge Linking.

UNIT 8 (3 Lectures):Representation and Description:Chain Codes, Polygonal Approximation, Boundary Segments, Skeletons; Boundary, Regional and Relational Descriptors.

UNIT 9 (7 Lectures): Video Processing: Introduction, Video Formats, Motion Detection and Estimation, Video Enhancement and Restoration, Video Segmentation.

Course Objective: Describe different mathematical principles and current techniques used in image acquisition and image enhancement.Describe different methods used in image segmentation. Describe efficient storage and compression techniques to analyze the constraints in image processing when dealing with larger data sets. Describe and apply the concepts of image representation and description.Apply the knowledge primarily obtained by studying examples and cases in the field of Engineering disciplines. Describe in brief the fundamental knowledge on video processing.

Outcome: Upon successful completion of the course, the students should be able toExplain and apply the basic and fundamental methods on Digital Image processing and Video Processing.Use these methods in subsequent courses like Pattern Recognition and Computer Vision.Prepare for research interest using recent techniques for solving real life problems.

Text Books:

1.Digital Image Processing, R. C. Gonzalez and R. E. woods, Pearson Education.
2.Handbook of Image and Video Processing, AL Bovik, Academic Press.

Reference Books:

1.Digital Image Processing and Analysis, B. Chanda and D. Dutta Mazumdar, PHI.
2.Digital Image Processing, W. K. Pratt, Wiley-Interscience.
3.Fundamentals of Digital Image Processing, A. K. Jain, Pearson India Education.
4.Pattern Classification and Scene Analysis, R. O. Duda and P. E. Hart, Wiley.

Course No.	Course Name	L	T	P	C
CSD507	**DATA COMPRESSION (40 Lectures)**	3	0	**0**	**9**

Unit 1 (5 lectures): Introduction to information theory, entropy, information value, data redundancy; probability and random processes, statistical methods,

Unit 2 (8 lectures): Shannon-Fano algorithm, Huffman algorithm, adaptive Huffman coding, arithmetic coding, context based compression, dictionary methods: LZ77, LZ78, LZW algorithms,

Unit 3 (7 lectures): differential encoding, transforms, sub bands, transform coding, sub band coding,

Unit 4 (10 lectures): image compression, scalar quantization, vector quantization, discrete cosine transform, jpeg compression, wavelet methods, discrete wavelet transform, JPEG 2000,

Unit 5 (10 lectures): video compression: motion compensation, temporal and spatial prediction. MPEG and H.264, audio coding, analysis by synthesis schemes MPEG-1/2 audio layers.

Course Objective: To train the students about the key concepts and enable them to apply them in real life applications, to develop new schemes for data compression

Outcome: The knowledge and concepts in these topics are likely to help the students do better in future in job as well as in higher studies.

Text Books:

1. A concise introduction to data compression, David Salomon, Springer

Reference Books:

1.Introduction to Data Compression, Khalid Sayood, Morgan Kaufman

2. Data compression: The Complete Reference ,David Salomon, G. Motta, D. Bryant, Springer

Course No.	Course Name	L	T	P	C
CSD504	**COMPUTER VISION (42 Lectures)**	3	0	**0**	**9**

Unit 1 (2 lectures): Introduction, the challenges
Unit 2 (7 lectures): images and imaging operations in low level vision, edge detection, corner, interest point and invariant feature detection,
Unit 3 (5 lectures): texture analysis, binary shape analysis, boundary pattern analysis,
Unit 4 (5 lectures): detection of linear, circular and elliptic structures,the generalised Hough transform, pattern matching techniques,
Unit 5 (8 lectures): object segmentation and shape models, basic classification concepts,
Unit 6 (6 lectures): the three-dimensional world, invariants and perspective, image transformations and camera calibration andmotion,
Unit 7 (5 lectures): real time vision systems, face detection and recognition, surveillancein-vehicle vision systems,
Unit 8 (4 lectures): machine learning and deep learning concepts in vision.

Course Objective: To meet the requirement of the current trends in the industry and academic fields

Outcome: The students are expected to develop knowledge and expertise

Text Books:

1. Computer vision byDana H. Ballard, Christopher M. Brown, Prentice Hall

Reference Books:

1. 3D computer vision: efficient methods and applications by Christian Wohler, Springer Berlin Heidelberg

Course No.	Course Name	L	T	P	C
CSD512	**INTERACTIVE COMPUTER GRAPHICS(40 Lectures)**	3	0	**0**	**9**

Unit 1 (3 lectures): Introduction: graphics systems and models, images, imaging systems, camera models, graphics architecture, programmable pipelines
Unit 2 (3 lectures): Graphics programming: Sierpinski gasket, primitives and attributes, color, viewing, control functions, gasket programs, adding interaction, menus
Unit 3 (3 lectures): Geometric objects and transformation
Unit 4 (3 lectures): Viewing
Unit 5 (5 lectures): Lighting and shading
Unit 6 (3 lectures): Vertices to fragments
Unit 7 (3 lectures): Discrete techniques
Unit 8 (3 lectures): Modeling and hierarchy
Unit 9 (3 lectures): Procedural methods
Unit 10 (7 lectures): Curves and surfaces
Unit 11 (4 lectures): Advanced rendering

Course Objective: To train the students to develop the concepts and skill of graphics programming
Outcome: It will add more prospect in terms of job and research capability in the related fields
Text Books:
1. Interactive Computer Graphics, A top-down approach with OpenGL by Edward Angel, Dave Shreiner Addison Wesley
Reference Books: same as above

Course No.	Course Name	L	T	P	C
CSD521	**WIRELESS NETWORKS (38Lectures)**	3	0	**0**	**9**

UNIT 1 (1 Lectures):Introduction to Wireless Networks : Issues and Challenges.

UNIT 2 (6 Lectures):Radio wave propagation: Data and Signals; Analog and Digital Transmission; Antennas; Propagation Modes; LOS Transmission; Fading in the wireless Environment; Energy consumption and Delay.

UNIT 3 (7 Lectures):MAC Layer: Noisy channels and its protocols; Multiple Access Techniques; Control Access Mechanisms; Channelization methods - TDMA, FDMA, Spread Spectrum, CDMA, OFDMA.

UNIT 4 (7 Lectures):Mobility Management and GSM: Cellular Architecture, Cell splitting and sectoring concept; Frequency allocation and interference issues; Handoff techniques; Hierarchical Scheme; Mobile IP; Mobile TCP.

UNIT 5 (3 Lectures):Wireless LANs: Wireless LAN technologies, Wireless standards (IEEE 802.11, 802.15, 802.16 etc.), WiFi, Bluetooth and WiMAX.

UNIT 6 (6 Lectures):Ad-hoc Networks and Sensor Networks: Introduction, Challenges and Issues, AODV, DSR, DSDV Routing protocols; Architecture and factors influencing the sensor network design; Concept of MANET and VANET.

UNIT 7 (2 Lectures):Satellite Networks: Orbits; Footprint; Categories of Satellites; GPS.

UNIT 8 (6 Lectures):Advanced and selected topics in wireless networks, e.g., LTE, Software Defined Radio, Cognitive Radio Networks, Delay Tolerant Networks etc.

Course Objective: At the end of the course, the students will be able to:To study the evolving wireless technologies and standards, To understand the protocols, architectures and applications of various wireless networks.To gain expertise in some specific areas of wireless networking.

Outcome: On successful completion of this unit students will be able to: Identify the basic concept and understand the state-of-the-art in protocols, architectures and applications of wireless networks. Compare, contrast and analyse wireless networks; Classify and also develop new protocols in ad hoc networks. Understand how wireless networking research is done.

Text Books:

1.Wireless Communications and Networks by William Stallings, PHI
2.Wireless Networks by Clint Smith and Daniel Collins, McGrawHill
3.Mobile Communications by Jochen Schiller, Pearson Education

Reference Books:

1.Computer Networks by Andrew S. Tanenbaum, Pearson Education
2.Computer Networking by James F. Kurose and Keith W. Ross, Pearson Education
3.Data and Computer Communications by William Stallings, PHI.
4.Communication Networks Fundamental concepts and key architecture by Alberto Leon-Garcia and Indra Widjaja, Tata McGrawHil
5.Data Communications and Networking by Behrouz A. Forouzan, Tata McGrawHill
6.Wireless Communications Principles and Practice by Theodore E. Rapaport, PHI

Course No.	Course Name	L	T	P	C
CSD513	**Internet of Things (41 Lectures)**	3	0	0	9

UNIT 1 (6 Lectures): Internet of Things: An overview: Introduction, IoTs Definition Evolution, IoT Architectures, Resource Management, IoT Data Management & Analytics, Communication protocols, IoT applications. Open Source Semantic

UNIT 2 (5 Lectures): Web Infrastructure for Managing IoT Resources in the Cloud: Introduction, Background, OpenIoT Architecture for IoT/Cloud Convergence, Scheduling Process and IoT service lifecycle, Scheduling and Resource management.

UNIT 3 (6 Lectures):Programming Frameworks for Internet of Things: Introduction, Background, Survey of IoT programming frameworks.

UNIT 4 (5 Lectures):Virtualization on Embedded Boards as Enabling Technology for the Cloud of Things: Introduction, Background, Virtualization and Real-time.

UNIT 5 (6 Lectures): Stream Processing in IoT: Foundations, State-of-the-Art, and Future Directions: Introduction, The foundation of Stream processing in IoT, Continuous Logic processing system, challenges and future directions.

UNIT 6 (5 Lectures): A Framework for Distributed Data Analysis for IoT: Introduction, Preliminaries, Anomaly Detection, Problem statement and definitions, Distributed anomaly detection.

UNIT 7 (4 Lectures):Internet of Things—Robustness and Reliability: Introduction, IoT characteristics and Reliability Issues, Addressing Reliability. Applied Internet of Things: Introduction, Scenario, Architecture Overview, Sensors, The gateway, Data Transmission.

UNIT 8 (4 Lectures): Internet of Vehicles and Applications: Basics of IoV, Characteristics and Challenges, Enabling Technologies, Applications.

Course Objective:

This course teaches basic concepts and practices in development of IoT Prototypes for real world applications. It deals with connectivity, building systems to enable delivery of software services networked to the cloud platforms. At the end of the course the students will be in a position to launch an IoT product.

Outcome: Understand the usability of the IoTs across various real-world applications**,** Understand and design different application and communication protocols for IoTs Understand integration of IoTs with cloud platform.Understand the distributed data analysis for IoTs**.** Design solutions for several applications using IoTs

Text Books:

1.Internet of Things: Principles and Paradigms, Rajkumar buyya and Amir Vahid Dastjerdi, MK Elsevier

Reference Books:

1. Internet of Things: A Hands-on Approach, Arshdeep Bahga and Vijay K. Madisetti, Universities Press

Course No.	Course Name	L	T	P	C
CSD516	**OPTIMIZATION TECHNIQUES (40 Lectures)**	3	0	0	9

Unit 1 (2 Lectures): Introduction: General statement of optimization problem, Classification of optimization Problems.
Unit 2 (4 Lectures): Classical Optimization Techniques: single-variable and multi-variable optimization, Network Analysis,
Unit 3 (4 Lectures): Genetic algorithms: representation of design variables, objective function and constraints;
Unit 4 (5 Lectures): Particle Swarm Optimization, Jaya algorithm, TLBO,
Unit 5 (4 Lectures): Central force optimization (CFO): Main algorithm, basic components, issues and variations,
Unit 6 (5 Lectures): Chemical reaction optimization (CRO): Main algorithm, basic components, issues, Simulated Annealing;
Unit 7 (3 Lectures): Neural network based optimization
Unit 8 (5 Lectures): Most recent optimization techniques such as Gravitational Search, CRO and many others.
Unit 9 (4 Lectures): Practical and computational aspects of optimization.
Unit 10 (4 Lectures): Few applications based on nature inspired optimization techniques.

Course Objective: Understand the need of optimization methods**,** Get a broad view of the various applications of optimization methods used in engineering

Outcome: After successful completion of the course, student will be able to understand importance of optimization of industrial process management apply basic concepts of mathematics to formulate an optimization problem analyse and appreciate variety of performance measures for various optimization problems.

Text Books:

1. Optimization in operations research by Ronald L. Rardin

Reference Books:

1. Operation Research by Kanti Swarup, P. K. Gupta, Man Mohan

Course No.	Course Name	L	T	P	C
CSD506	**CRYPTOLOGY (36 Lectures)**	3	0	0	9

Unit 1 (2 Lectures): Introduction: Security goals, Attacks, Security services and mechanisms, Security techniques;
Unit 2 (4 Lectures): Classical encryption techniques: Additive ciphers, Monoalphabetic, Playfair cipher, Polyalphabetic; Block ciphers:
Unit 3 (6 Lectures): DES, AES,
Unit 4 (5 Lectures): Public-key ciphers: RSA, ElGamal, Elliptic curve cryptography;
Unit 5 (5 Lectures): Message authentication and cryptographic hash algorithms; MAC, MD5, SHA-1;
Unit 6 (4 Lectures): Digital Signatures: RSA, ElGamal, DSS;
Unit 7 (6 Lectures): Key management: Diffie-Hellman key exchange protocol, Shamir's secret sharing scheme, PKI (Public-Key Infrastructure);
Unit 8 (4 Lectures): Zero knowledge protocols: Fiat-Shamir, Feige-Fiat-Shamir.

Course Objective: To familiar the students about this subject so that they can gather enough knowledge about it.

Outcome: The students not only know the subject but they also develop the security techniques for practical applications.

Text Books:

1. William Stallings, 'Cryptography and Network Security- Principles and Practices' Pearson Education,

Reference Books:

1. B.A. Forouzan, 'Cryptography and Network Security' Tata McGraw-Hill,

Course No.	Course Name	L	T	P	C
CSD511	**INFORMATION THEORY AND CODING (40 Lectures)**	3	0	0	9

Unit 1 (6 Lectures): Introduction to Information Theory, Uncertainty and Information, Information Measure, Entropy of Markov Sources, Extensions of Sources; Channel Models, Channel Capacity, Information Capacity Theorem.

Unit 2 (4 Lectures): Source Coding: Instantaneous Codes, Kraft Inequality, Source Coding Theorem, Shannon Codes, Shannon-Fano Codes, Huffman Codes, Arithmetic Codes.

Unit 3 (6 Lectures): Fundamentals of Channel Coding: Decoding Rules, Definition of Block code, Single parity check codes, Product code, Hamming codes, Error-detection and error-correction capabilities of block codes. Bounds on size of codes.

Unit 4 (4 Lectures): Definition of linear codes, Parity Check Matrix, Decoding of Linear Block code.

Unit 5 (8 Lectures): Definition of Cyclic codes, Encoding and Decoding of Cyclic codes, LFSR based Cyclic code Encoding-decoding.

Unit 6 (6 Lectures): Definition of BCH codes, Encoding and Decoding of BCH codes, Peterson-Gorenstein-Zierler Decoder, Reed-Solomon codes.

Unit 7 (6 Lectures): Convolution codes: Encoding, State diagram, Trellis diagram, Viterbi Decoder, Turbo codes.

Course Objective: To provide knowledge of Information Theory and Coding. This course will also provide a strong foundation for research in this particular area.

Outcome: Students will be learning approaches how to transmit digital data reliably over a noisy channel as well as how to represent the data in concise form.

Text Books:

1.S. Lin and D. J. Costello, Error Control Coding, Prentice Hall

2.S. Gravano, Introduction to Error Control Codes, Oxford

Reference Books:

1.R. Togneri and C. J. S. deSilva, Fundamentals of Information Theory and Coding Design, CRC Press

2. K. Sayood, Introduction to Data Compression, Morgan Kaufmann

3. Todd K. Moon, Error Correction Coding, Wiley-Interscience

Course No.	Course Name	L	T	P	C
CSD519	**SOFTWARE TESTING (37 Lectures)**	3	0	0	9

Unit 1 (2 Lectures): Introduction to Software Testing: Fundamentals of Verification and Testing,

Unit 2 (4 Lectures): Review of software development models, Test Metrics, Software Testing Principles, Testing and Debugging

Unit 3 (6 Lectures):Software Quality Assurance and Quality control, Quality factors, Quality standards – TQM, ISO, SEI CMM, PCMM, Six sigma.

Unit 4 (3 Lectures): Requirement Behavior and Correctness, Fundamentals of Test Process, The Tester's Role in a Software Development Organization,

Unit 5 (7 Lectures): Static Testing: Structured examination, Control flow & Data flow, Determining Metrics; Dynamic Testing: Black Box Testing, Gray Box Testing, Intuitive and Experience Based Testing;

Unit 6 (4 Lectures):Test Management: Test Organization, Test Planning, Test Strategies, Testing Tools Automation of Test Execution: Types of test Tools, Selection and Introduction of Test Tools,

Unit 7 (6 Lectures):Testing Object Oriented Software: Introduction to Object Oriented testing concepts, Differences in Object Oriented testing.

Unit 8 (5 Lectures): Discussion on Reliability Models.

Course Objective:

Develop methods and procedures that can be used to consistently produce high-quality software at low cost. How to use available resources to develop software, reduce cost of software and how to maintain quality of software. Methods and tools of testing and maintenance of software.

Outcome: Types of errors and fault models, Methods of test generation from requirements.Test adequacy assessment using: control flow, data flow, and program mutations.Application of software testing techniques in commercial environments.

Text Books:

1.Fundamentals of Software Engineering by Rajib Mall

2.An integrated approach to Software Engineering by Pankaj Jalote, Narosha Publishing house.

Reference Books:

1.Software Engineering, 7th edition by Ian Sommerville,

2.Software Engineering: A Practitioner's Approach (Sixth Edition, International Edition). McGraw-Hill, 2005 by Roger S. Pressman.

Course No.	Course Name	L	T	P	C
CSD502	**CLOUD COMPUTING (35 Lectures)**	3	0	0	9

UNIT 1 (3 Lectures): Introduction to Cloud Computing: Overview of distributed computing, Cloud introduction and overview, Different types of cloud services, cloud deployment models, Advantages and Disadvantages of Cloud Computing, and Companies in the Cloud today;

UNIT 2 (8 Lectures): Infrastructure as a Service (IaaS): Introduction to Infrastructure as a Service (IaaS), CPU Virtualization/Resource Virtualization – Hypervisors, Storage Virtualization - SAN, ISCSI, Network Virtualization – VLAN;

UNIT 3 (6 Lectures): Platform/ Software as a Service (PaaS/ SaaS): From IaaS to PaaS, What is PaaS, PaaS properties and characteristics,

UNIT 4 (6 Lectures): PaaS Techniques: File System - GFS, HDFS, Programming Model-MapReduce, Storage System for Structured Data - BigTable, Hbase, Structure of NoSQL databases;

UNIT 5 (3 Lectures): SaaS: web service, web based applications, web portal;

UNIT 6 (6 Lectures): Security in Cloud computing environments: Cloud Computing threats, Security for Cloud Computing; Cloud security: Risks, Security, privacy, Trust. Security of OS, VM, VMM, shared image, management OS, Xoar,

UNIT 7(3 Lectures): Case studies: Amazon EC2, Google App Engine, IBM Clouds, Microsoft's Windows Azure etc.

Course Objective: To learn how to use Cloud Services. To implement Virtualization To implement Task Scheduling algorithms. Apply Map-Reduce concept to applications. To build Private Cloud, Broadly educate to know the impact of engineering on legal and societal issues involved.

Outcome:

Broadly educate to know the impact of engineering on legal and societal issues involved in addressing the security issues of cloud computing.

Design different workflows according to requirements and apply map reduce programming model.

Text Books:

1.Kai Hwang, Geoffrey C. Fox, Jack J. Dongarra "Distributed and Cloud Computing

MK Publishers

Reference Books:

1. Raj Kumar Buyya, "Cloud Computing: Principles and Paradigms", Wiley Press.

2. Barrie Sosinsky, "Cloud Computing Bible", Wiley India.

3. Borko Furht and Armando Escalante, "Hand Book of Cloud Computing", Springer.

Course No.	**Course Name**	**L**	**T**	**P**	**C**
CSD508	**DISTRIBUTED SYSTEMS (40 Lectures)**	3	0	0	9

Unit 1 (4 Lectures):Introduction to Distributed Systems: Introduction to Distributed Computing System Models, Distributed Operating System, Difference between Network and Distributed System, Goals of Distributed System, Hardware Concept;

Unit 2 (4 Lectures):Message Passing: Desirable features, Issues in IPC, Synchronization, Buffering, Encoding and Decoding, Process Addressing, Failure Handling, Group Communication;

Unit 3 (4 Lectures):Remote Procedure Calls: RPC Model, Transparency of RPC, Implementation of RPC Mechanism, RPC Messages, Marshalling, Server Management (Stateful and Stateless Server), Parameter-Passing Semantics (Call-by-Value, Call-by-Reference), Call-Semantics, Communication Protocols for RPCs, Client-Server Binding, Special Types of RPCs;

Unit 4 (6 Lectures):Distributed Shared Memory: General Architecture of DSM Systems, Design and Implementation Issues of DSM, Structure of Shared-Memory Space, Consistency Models, Replacement Strategy, Thrashing, Advantages of DSM;

Unit 5 (6 Lectures):Synchronization: Clock Synchronization, Event Ordering, Mutual Exclusion, Deadlock, Election Algorithms;

Unit 6 (4 Lectures):Resource Management: Task Assignment Approach, Load-Balancing Approach, Load-Sharing Approach;

Unit 7 (6 Lectures):Process Management: Process Migration, Threads;

Unit 8 (4 Lectures):Distributed File Systems: File Models, File-Accessing Models, File-Sharing Semantics, File-Caching Schemes, File Replication;

Unit 9 (2 Lectures):Security: Potential Attacks to Computer Systems, Cryptography, Authentication, Access Control, Digital Signatures.

Course Objective:

This Subject provides students with an in-depth knowledge about the distributed operating system. It covers distributed operating system in detail, including communication process, file system and memory management synchronization and so on but this time in the context of distributed systems. The students will able to understand the desirable features along with associated issues to design the best distributed operating system.

Outcome: Knowledge and understanding: Outline the potential benefits of distributed systems, Summarize the major issues associated with distributed systems along with the range of techniques available for increasing system transparency. Apply standard design principles in the construction of these systems. Select appropriate approaches for building a range of distributed systems, including some that employ middleware.

Text Books:

1. "Distributed Operating Systems – Concepts and Design", by Pradeep K. Sinha (PMH)

Reference Books:

1."Distributed Systems – Principles and Paradigms", by Andrew S. Tanenbaum and Maarten Van Steen (PHI)

2."Distributed Systems – Concepts and Design", by G. Coulouris, J Dollimore and T. Kindberg (Pearson Education)

Course No.	Course Name	L	T	P	C
CSD503	**COMPUTATIONAL NUMBER THEORY (40 Lectures)**	3	0	0	9

Unit 1 (6 Lectures): Introduction, Prime Number Theorem, Goldbach and Twin Primes conjectures, Fermat primes, Mersenne primes, Euler primes, Miller-Robinson primes.
Unit 2 (5 Lectures): Euclid's algorithm, LCM, Theorem of arithmetic, Canonical prime factorization, Dirichlet's Theorem on primes in arithmetic progressions.
Unit 3 (7 Lectures): Algebraic Structure: Groups, Ring, Field, Extension field.
Unit 4 (6 Lectures): Modular arithmetic, Congruence: Linear congruence in one variable, CRT, Wilson theorem, Fermat's theorem, Pseudoprimes, Carmichael numbers.
Unit 5 (5 Lectures): Arithmetic functions: Multiplicative functions, Moebius function, Euler phi function, Perfect numbers, Legendre symbol, Jacobi symbol;
Unit 6 (2 Lectures): Continued Fractions.
Unit 7 (5 Lectures): Quadratic residue: Quadratic congruence with primes and composites, Exponentiation and Logarithm.
Unit 8 (4 Lectures): Elliptic Curves: Curve over real numbers and GF(2^n)

Course Objective:
To give students a detailed description of the main modern algorithms in computational number theory

Outcome:
To use the modern algorithms in computational number theory for searching information in targeted areas such as cryptography, coding theory

Text Books:
1. Elementary Number Theory: Primes, Congruences, and Secrets: A Computational Approach By William Stein

Reference Books:
1.A Computational Introduction to Number Theory and Algebra By Victor Shoup
2.Computational Number Theory and Modern Cryptography By Song Y. Yan
3.Elementary Number Theory with Applications By Thomas Koshy

Course No.	Course Name	L	T	P	C
CSD515	**MULTIMEDIA SYSTEMS & SECURITY(38 Lectures)**	3	0	0	9

Unit 1 (8 Lectures): Multimedia Fundamentals and Representation: Introduction to Multimedia, Multimedia Data Representation, Classification of Multimedia Systems, Image Representation and Enhancement, Color Models, Fundamental Concepts in Video, Basics of Digital Audio.

Unit 2 (12 Lectures): Multimedia Coding Techniques: Lossless Compression Algorithms: Run-Length Coding, Variable-Length Coding (Huffman Coding, Adaptive Huffman Coding), Arithmetic Coding, Adaptive Arithmetic Coding, Dictionary-Based Coding, Context-based Coding, CALIC, Lossy Compression Algorithms: Vector Quantization, Standard Image Compression Techniques (JPEG, JPEG 2000), Video Compression Technique (MPEG), Audio Coding.

Unit 3 (06 Lectures): Multimedia Communication and Retrieval: Media Distribution across Internet, Mobile Multimedia Service over Wireless Networks, Content Based Image Retrieval.

Unit 4 (12 Lectures): Multimedia Security: Performance Requirement of Multimedia Content Encryption, Modes of Block Ciphers, Complete, and Partial Encryption, Compression-Combined Encryption, Perceptual Encryption, Key Management, Typical Attacks on Multimedia Encryption, Multimedia Encryption in Typical Applications, Steganography, Digital Image Watermarking, Image Authentication, Visual Cryptography, Multimedia Forensics.

Course Objective: To provide knowledgeof Multimedia Systems and Security. This course will also provide a strong foundation for research in this particular area.

Outcome: The basics of this subject would be well understood by students.

Text Books:

1.Ze-Nian Li, and Mark S. Drew, “Fundamentals of Multimedia”, PHI Learning.

2.Fred Halsall, “Multimedia Communications: Applications, Networks, Protocols and Standards”, Pearson.

3.Shiguo Lian, “Multimedia Content Encryption: Techniques and Applications”, CRC Press

Reference Books:

1.Khalid Sayood, “Introduction to Data Compression”, Elsevier Publication.

2.Latest publications in multimedia related conferences and journals.

Course No.	Course Name	L	T	P	C
CSD501	**ALGORITHMS FOR BIOINFORMATICS(40 Lectures)**	3	0	0	9

Unit 1(5 Lectures): Introduction to bioinformatics, biological sequence/structure, Central dogma of Molecular Biology, Genome Projects, Pattern recognition and prediction, Folding problem, Sequence Analysis, Homology and analogy,

Unit 2(8 Lectures): Classical algorithms, exact matching problem, suffix trees, dynamic programming, fundamental preprocessing, Naive method, Boyer-Moore and Knuth-Morris-Pratt, keyword trees, linear-time construction of suffix trees,

Unit 3(8 Lectures): Pairwise alignment, scoring model, dynamic programming algorithms, Hidden Markov Models, Multiple sequence alignment,

Unit 4(8 Lectures): Motif finding, Secondary database searching, Advanced topics in phylogenetic tree,

Unit 5(8 Lectures): Biological databases, Primary sequence databases, Protein classification databases. DNA databases, Specialized Genomic Resources, Importance of DNA analysis, Gene structure and DNA sequences, protein sequence and structure,

Unit 6(3 Lectures): Gene expression analysis using microarray data, Application of Computational techniques on gene expression data, EST searches.

Course Objective:

To provide knowledge of applications of computational methods in biological problems. This course will provide a scope for research in many areas of computer science to apply them in biology.

Outcome:

Students will learn advanced algorithms especially suited for bioinformatics research.

Text Books:

1.Algorithms on Strings, Trees and Sequences: Computer Science and Computational Biology (28 May 1997) by Dan Gusfield

2.Introduction to Bioinformatics By T. K. Attwood, Pearson education**.**

Reference Books:

1. An Introduction to Bioinformatics Algorithms By Neil C. Jones, Pavel A. Pevzner, Pavel Pevzner

Course No.	Course Name	L	T	P	C
CSD518	**PATTERN RECOGNITION (42 Lectures)**	3	0	0	9

Unit 1 (2 lectures): Introduction, fundamentals and definitions
Unit 2 (10 lectures): features: types and traits, scaling, ordering, measurements , normalization, invariance, dimensionality reduction of feature space, dimensionality reduction by feature selection, PCA,KPCA, ICA, MDA;
Unit 3 (6 lectures): Bayesian decision theory;
Unit 4 (5 lectures): Parameter estimation: MLE, LSE;
Unit 5 (5 lectures): Parameter free methods:KNN, Clustering,
Unit 6 (10 lectures): special classifiers: linear regression, LDA, SVM, deep learning, CNN;
Unit 7 (4lectures): classification with nominal features : decision tree, random forest; classifier independent concepts.

Course Objective: To train the students about the key concepts and enable them to apply them in real life applications in various related fields like AI, Multi-biometric processing for security, authenticity, data and knowledge engineering

Outcome: The knowledge and concepts in these topics are likely to help the students do better in future in job as well as in higher studies.

Text Books:

1. Pattern Recognition and Machine Learning Christopher M Bishop, Springer
2. Pattern recognition bySergios Theodoridis, Konstantinos Koutroumbas, Academic Press

Reference Books:

1. A Probabilistic Theory of Pattern Recognition by Luc Devroye, László Györfi, Gábor Lugosi , Springer Verlag

Course No.	Course Name	L	T	P	C
CSD510	**INFORMATION RETRIEVAL (39 Lectures)**	3	0	0	9

UNIT 1 (3 Lectures): Introduction: Basic IR system structure
UNIT 2 (4 Lectures): Retrieval techniques: Boolean retrieval, term-vocabulary, postings-lists, Dictionaries and tolerant retrieval: Wildcard queries, Spelling correction, Phonetic correction;
UNIT 3 (4 Lectures): Inverted indices: Preprocessing steps, tokenization, stemming, stopword removal, term weighting;
UNIT 4 (3 Lectures): Models: vector space model, probabilistic model, language models;
UNIT 5 (3 Lectures): Evaluation: standard test collection, concept of relevance, precision-recall based metrics, reciprocal rank;
UNIT 6 (3 Lectures): Relevance feedback and query expansion: Rocchio algorithm;
UNIT 7 (3 Lectures): Text classification: Naïve Bayes;
UNIT 8 (4 Lectures): Text clustering: Flat Clustering, Hierarchical Clustering;
UNIT 9 (3 Lectures): XML Retrieval: Basic concepts, Challenges, Evaluation;
UNIT 10 (3 Lectures): Web search: Structure of Web, web graph, Hidden Web, User intent, Web crawl.
UNIT 11 (3 Lectures): Link Analysis: Web as a graph, PageRank, Hubs and Authorities;
UNIT 12 (3 Lectures): Social search: Community-based search activities, Question Answering, Collaborative Searching.

Course Objective: This Subject provides students with an in-depth knowledge about the Information Retrieval. The students will able to understand the various Retrieval Models, Link Analysis, Social Search techniques and related applications.

Outcome: Knowledge and understanding: Outline the potential benefits Information Retrieval.

Text Books:

1. An Introduction to Information Retrieval, By Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, Cambridge University Press.

Reference Books:

1. Information Retrieval: Algorithms and Heuristics, By David A. Grossman, Ophir Frieder

List of Subjects for Open Electives

Course No.	Course Name	L	T	P	C
CSO503	**DATA MINING (39 Lectures)**	3	0	0	9

UNIT 1 (4 Lectures): Introduction: Data mining functionalities, classification and integration, major issues in data mining
UNIT 2 (4 Lectures): Data preprocessing: data summarization, data cleaning, data integration and transformation and data reduction;
UNIT 3 (4 Lectures): Data warehouse and OLAP Technology: a multidimensional data model, data warehouse architecture;
UNIT 4 (6 Lectures): Mining Frequent Patterns; Associations and correlations: efficient and scalable frequent item-set mining methods, mining various kinds of association rules, constraints based association mining;
UNIT 5 (6 Lectures): Classification: Basic concepts and advanced Methods, Prediction, Accuracy and Error Measures, Evaluating the accuracy of a classifier or Predictor, Ensemble Methods,
UNIT 6 (7 Lectures): Clustering: Partitioning Methods, Hierarchical Methods, Density-Based Methods, Model-Based Clustering Methods, Clustering High-Dimensional Data,
UNIT 7 (3 Lectures): Outlier Detection, Mining Stream,
UNIT 8 (3 Lectures): Time-Series, and Sequence Data, Text Mining,
UNIT 9 (2 Lectures): Applications and Trends in Data Mining

Course Objective: This Subject provides students with an in-depth knowledge about the Data Mining. The students will able to understand the various Techniques like Associations, Classification and Clustering and related applications.
Outcome: Knowledge and understanding: Outline the potential benefits of Data Mining.
Text Books:
1. Data Mining: Concepts and Techniques,By Jiawei Han, Jian Pei, Micheline Kamber, Elsevier
Reference Books:
1. Data Mining: The Textbook, By Charu C. Aggarwal, Springer International

Course No.	Course Name	L	T	P	C
CSO505	**SOFT COMPUTING (35 Lectures)**	3	0	0	9

UNIT 1 (3 Lectures):Artificial Neural Networks (ANN): Basics Characteristics of artificial neural networks, Comparison with conventional computing and biological neural networks, Advantages and Disadvantages of ANNs, Synaptic dynamics, Applications of ANNs,

UNIT 2 (3 Lectures): Basic Models: Mc-Culloch Pitt's model, Rossenblat's Perceptron model of neural networks

UNIT 3 (6 Lectures):Learning: Supervised, unsupervised, Reinforcement Law of learning; Differences among learning laws; LMS and Delta Learning, Hebb's Learning Laws; Gradient descent method, Multilayer Perceptron Model (MLP), Back propagation algorithm for weight updates, classification problem using MLP; Architecture for complex pattern recognition tasks; Deep Learning

UNIT 4 (4 Lectures):Fuzzy Logic: Fuzzy sets, basic operations, membership functions, Fuzzy Relations, Fuzzification, Defuzzification

UNIT 5 (5 Lectures):Genetic Algorithm: working Principle, Crossover mutation, roulette wheel selection, tournament selection, population, binary encoding and decoding for any optimization problem, Schema/ Similarity Template, Effect of Selection, Crossover, and Mutation operator over schemas

UNIT 6 (3 Lectures):Particle Swarm Optimization, Working principle, velocity and position Updation rules. Tunable Parameters in PSO and its application(s)

UNIT 7 (3 Lectures):Multi-objective GAs, Concepts on Non-domination, tournament selection, crowding distance operator, ranking.

UNIT 8 (3 Lectures): Rough Sets: basic operations, lower and upper approximations, discernibility matrix, distinction table; Accuracy of Approximations etc.

UNIT 9 (5 Lectures):Hybridization of Soft Computing such as Neuro-fuzzy, Rough fuzzy, Rough-Fuzzy-GA etc.

Course Objective: To make familiarise the students with basic understanding of the subject under one common platform and making them capable enough to solve any real life problem using Soft computing tools.

Outcome: Basic understanding of the subject and to prepare for research interest using recent techniques for solving real life problems.

Text Books: Principles of Soft Somputing, S.N.Sivanandam & S.N.Deepa, John Wiley & Sons, 2007

Reference Books:

1.Artificial Neural Networks, B. YEGNANARAYANA, Prentice-Hall of India Pvt. Ltd.

2.Neural Networks Algorithms, Applications, and Programming Techniques, James A. Freeman David M. Skapura, Addison-Wesley Publishing Company

3.Genetic Algorithms, in Search, Optimization & Machine Learning, D. E. Goldberg, Pearson Education

4.Multi-Objective Optimization Using Evolutionary Algorithms, K. Deb, John Wiley & Sons Ltd.

5.J. C. Bezdek, Pattern Recognition with Fuzzy Objective Function Algorithm. New York: Plenum, 1981.

6.Z. Pawlak, Rough Sets, Theoretical Aspects of Reasoning About Data. Dordrecht, The Netherlands Kluwer, 1991.

Course No.	Course Name	L	T	P	C
CSO504	**MACHINE LEARNING (39 Lectures)**	3	0	0	9

UNIT 1 (2 Lectures): Introduction: Well Defined Learning Problems, Designing A Learning System, Issues In Machine Learning.
UNIT 2 (3 Lectures): Learning Tasks: General-To-Specific Ordering Of Hypotheses, Candidate Elimination Algorithm, Inductive Bias.
UNIT 3 (4 Lectures): Decision Tree Learning: Decision Tree Learning Algorithm-Inductive Bias- Issues In Decision Tree Learning.
UNIT 4 (3 Lectures): Evaluating Hypotheses – Estimating Hypotheses Accuracy Basics Of Sampling Theory, Comparing Learning Algorithms,
UNIT 5 (4 Lectures): Bayesian Learning – Bayes Theorem, Concept Learning, Bayes Optimal Classifier, Naïve Bayes Classifier, Bayesian Belief Networks, EM Algorithm,
UNIT 6 (4 Lectures): Computational Learning Theory – Sample Complexity For Finite Hypothesis Spaces.
UNIT 7 (4 Lectures): Artificial Neural Networks: Perceptrons, Gradient Descent And The Delta Rule, Adaline, Multilayer Networks, Derivation Of Backpropagation Rule backpropagation Algorithm- Convergence, Generalization.
UNIT 8 (4 Lectures): Genetic Algorithms – An Illustrative Example, Hypothesis Space Search, Genetic Programming, Models Of Evolution And Learning;
UNIT 9 (3 Lectures): Learning First Order Rules-Sequential Covering Algorithms-General To Specific Beam Search-Foil;
UNIT 10 (4 Lectures): Reinforcement Learning - The Learning Task, Q Learning,
UNIT 11 (4 Lectures): Instance-Based Learning – K-Nearest Neighbor Learning, Locally Weighted Regression, Radial Basis Function Networks, Support Vector Machines (SVM), Case-Based Learning.

Course Objective: To make familiarise the students with basic understanding of the subject under one common platform and making them capable enough to solve any real life problem using Soft computing tools.
Outcome: Basic understanding of the subject and to prepare for research interest using recent techniques for solving real life problems.
Text Books:
1.Machine Learning by Tom M. Mitchell, Tata McGraw Hill, 2017
2.The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Second Edition (Springer Series in Statistics) 2nd Edition. Springer.
Reference Books:
1.Pattern Recognition and Machine Learning (Information Science and Statistics)
by Christopher M.Bishop, 2006.
2. Machine Learning by Andrew N G.

Course No.	Course Name	L	T	P	C
CSO501	**ARTIFICIAL INTELLIGENCE (40 Lectures)**	3	0	0	9

UNIT 1 (5 Lectures): Artificial Intelligence Introduction, Brief history, Problem solving by search: state space, Search and Knowledge representation. Uninformed search : Breadth First Search, Depth First Search, Depth First with Iterative Deepening and Uniform Cost Search,

UNIT 2 (5 Lectures): Heuristic Search: Hill climbing, Simulated Annealing, A*, problem reduction, Algorithm, Minimax search

UNIT 3 (5 Lectures): Binary and Higher order CSP, Constraint Satisfaction Graph,MRV,Degree,Least Constraining, Forward Checking and Arc Consistency General purpose heuristics for CSP

UNIT 4 (4 Lectures): Introduction to genetic algorithm, operations : selection,crossover,mutation examples

UNIT 5 (5 Lectures): Logic based representations (PL, FoL) and inference, Logic Programming: Prolog. Rule based representations, forward and backward chaining, matching algorithms.

Unit 6 (4 Lectures): Planning Techniques: Goal Stack Planning, Constraint posting

Unit 7 (3 Lectures): Probabilistic Reasoning: Bayesian Network and reasoning.

UNIT 8 (7 Lectures): Learning: Neural Network models, Statistical methods: Naive-Bayes, Nearest Neighbour, Decision trees, Inductive Learning

UNIT 9 (2 Lectures): Introduction to Natural Language Processing

Course Objective: Course will introduce the basic principles in artificial intelligence, which covers blind and heuristic search strategies, simple knowledge representation schemes, introduction to CSP problems and use for general purpose heuristic for constraint propagation, genetic algorithm, rule based system, Introduction to probabilistic reasoning, planning and learning neural networks models, Areas of application, natural language processing, will be explored. The PROLOG programming language will also be introduced.

Outcome: Understanding of following :Problem as Search - Converting real world problems into AI search problems and explain important search concepts, such as the difference between informed and uninformed search, the definitions of admissible and consistent heuristics and completeness and optimality. Understanding of various heuristic search techniques, MiniMax search for game playing.Constraint Satisfaction - Formulation of real world problem as CSP problem and solution for CSP using general purpose heuristics, Genetic Algorithm for optimization. Knowledge representation using First order logic, proofs in first order using techniques such as resolution, unification. Rule based system and logic programming using Prolog programming language, Planning techniques, Bayesian network and reasoningFundamentals of learning using neural net, decision tree, naïve- Bayes, nearest neighbour,inductive learning, Fundamentals of NLP

Text Books:

1.Artificial Intelligence Modern Approach Third Edition by S. Russell,P. Norvig,PHI

Reference Books:

1.Artificial Intelligence Third Edition byKevin Knight,Elaine Rich

2.Artificial Intelligence, Structures and Strategies for Complex Problem Solving George F Luger,SIXTH EDITION, Pearson

3.Machine Learning by Mitchell, Tom M. Indian Edition

Course No.	Course Name	L	T	P	C
CSO502	**DATA ANALYTICS (36 Lectures)**	3	0	0	9

UNIT 1 (3 Lectures): Introduction, Big Data; Descriptive Statistics: Descriptive Statistics and Probability Distributions

UNIT 2 (4 Lectures): Inferential Statistics: Inferential Statistics through hypothesis tests Permutation & Randomization Test.

UNIT 3 (3 Lectures): Regression & ANOVA: Regression and ANOVA (Analysis of Variance).

UNIT 4 (3 Lectures): Machine Learning: Introduction and Concepts: Differentiating algorithmic and model based Frameworks;

UNIT 5 (5 Lectures): Regression: Ordinary Least Squares, Ridge Regression, Lasso Regression, K Nearest Neighbours Regression & Classification.

UNIT 6 (7 Lectures): Supervised Learning with Regression and Classification techniques -1: Bias-Variance Dichotomy; Model Validation Approaches; Logistic Regression; Linear Discriminant Analysis; Quadratic Discriminant Analysis;

UNIT 7 (8 Lectures): Regression and Classification Trees Support Vector Machines; Ensemble Methods: Random Forest; Neural Networks; Deep learning; Unsupervised Learning and Challenges for Big Data Analytics: Clustering, Associative Rule Mining Challenges for big data analytics;

UNIT 8 (3 Lectures): Scalable Computing: Hadoop and Map Reduce.

Course Objective: The main goal of this course is to help students learn, understand, and practice big data analytics and machine learning approaches, which include the study of modern computing big data technologies and scaling up machine learning techniques focusing on industry applications. Mainly the course objectives are: conceptualization and summarization of big data and machine learning, trivial data versus big data, big data computing technologies, machine learning techniques, and scaling up machine learning approaches.

Outcome: The students learning outcomes are designed to specify what the students will be able to perform after completion of the course:

Ability to identify the characteristics of datasets and compare the trivial data and big data for various applications.

Ability to select and implement machine learning techniques and computing environment that are suitable for the applications under consideration.

Ability to recognize and implement various ways of selecting suitable model parameters for different machine learning techniques.

Ability to integrate machine learning libraries and mathematical and statistical tools with modern technologies like Hadoop and Mapreduce.

Text Books:

1.Data Analytics Made Accessible, by A. Maheshwari

2.Big Data Analytics, By Seema Acharya, Wiley

Reference Books:

1.Machine Learning and Big Data by Kareem Alkaseer

2.Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die by E. Siegel

3.Too Big to Ignore: The Business Case for Big Data, by award-winning author P. Simon, Wiley.