National Institute of Technology Srinagar

COURSES & SYLLABI

Master of Technology (M.Tech.)

Computer Science & Engineering Department

Department of Computer Science & Engineering

National Institute of Technology, Srinagar

Course Structure

Master of Technology (M.Tech.) in Computer Science & Engineering

Semester: 1st

S No.	Subject	Code	L	T	P	Credits	Remarks
1	Next Generation Networks	CST501	3	0	0	3	
2	Next Generation Networks Lab	CSP502	0	0	2	1	
3	System Architecture	CST503	3	0	0	3	
4	Elective – I	CSTXXX	3	0	0	3	
5	Elective – II	CSTXXX	3	0	0	3	
6	Elective – III	CSTXXX	3	0	0	3	
	Total					**16**	

Semester: 2nd

S No.	Subject	Code	L	T	P	Credits	Remarks
1	Advanced Algorithms	CST 550	3	0	0	3	
2	Real Time Operating Systems	CST 551	3	0	0	3	
3	Seminar	CSS 552	0	0	2	1	
4	Practical Training	CSI 553		-		1	
5	Elective – IV	CSTXXX	3	0	0	3	
6	Elective – V	CSTXXX	3	0	0	3	
7	Elective – VI	CSTXXX	3	0	0	3	
	Total					**17**	

Semester: 3rd

S No.	Subject	Code	L	T	P	Credits	Remarks
1	Advanced Automata and Theory of Computation	CST 604	3	0	0	3	
2	Research Methodology	CST 605	3	0	0	3	
3	Project Dissertation – I	CSP 606	0	0	6	3	
4	Elective – VII	CSTXXX	3	0	0	3	
5	Elective – VIII	CSTXXX	3	0	0	3	
	Total					**15**	

Semester: 4th

S No.	Subject	Code	L T P	Credits	Remarks
1	Project Dissertation – II	CSP 654	0 0 24	12	
	Total			**12**	

- **Total Number of Electives: 8**
- **For a particular stream, at least 4 electives should be chosen from that group offered.**
- **The courses of M.Tech will be offered for Pre-PhD as well, with Research Methodology (CST 605) and Seminar (CSS 552) as compulsory courses.**

S. No.	Subject	Code
COMMON COURSES		
1.	Simulation & Modelling	CST801
2.	Discrete Mathematics	CST802
3.	Advanced Graph Theory	CST803
4.	Green Computing	CST804
5.	Parallel & Distributed Algorithms	CST805
6.	Internet of Things	CST806
7.	Computer Vision	CST807
8.	Advanced Computer Graphics	CST808
9.	Optimization Techniques	CST809
10.	Advanced Numerical Methods	CST810
11.	Image Processing and Pattern Recognition	CST811
12.	Multimedia and Virtual Reality	CST812
13.	Natural Language Processing	CST813
14.	Advanced Neural Networks	CST814
15.	Advanced Database Systems	CST815
16.	Database Implementations	CST816
17.	Expert Systems	CST817
18.	Quantum Computing	CST818
SYSTEM AND HARDWARE		
19.	Digital Signal Processing	CST819
20.	Reconfigurable Computing	CST820
21.	Embedded Systems	CST821
22.	System on Chip (SoC)	CST822
23.	Fault Tolerant Computing	CST823

24.	Architecture of High Performance Computers	CST824
25.	System Level Design & Modelling	CST825
26.	Embedded Systems Design Lab	CSL826
27.	Real Time Systems	CST827
28.	VLSI Digital Signal Processing Core	CST828
29.	Special Topics in Hardware Systems	CST829
NETWORK AND SECURITY		
30.	Pervasive Computing	CST830
31.	High Speed Networks	CST831
32.	Cyber Law and Forensics	CST832
33.	Network Management	CST833
34.	Network Programming	CST834
35.	Network and System Security	CST835
36.	Distributed and Parallel Computing	CST836
37.	Advanced Cryptography	CST837
38.	Advances in Wireless Communication	CST838
39.	Multimedia Communication	CST838
40.	Mobile Computing	CST840
41.	Special Topics in Networks	CST841
DATA SCIENCE		
42.	Introduction to Data Science	CST842
43.	Big Data	CST843
44.	Data Mining	CST844
45.	Deep Learning	CST845
46.	Systems for Data Analytics	CST846
47.	Artificial Intelligence and Fuzzy Logic	CST847
48.	Machine Learning	CST848
49.	Data Visualization	CST849
50.	Ethics for Data Science	CST850
51.	Data Warehousing	CST851
52.	Information Retrieval	CST852
53.	Advanced Topics in Data Processing	CST853
SOFTWARE AND PROGRAMMING		
54.	Software Project Management	CST854
55.	Advanced Java & Android Programming	CST855
56.	Unix and Shell Programming	CST856
57.	Advanced Programming in Java	CST857
58.	Logic Programming	CST858
59.	Special Topics in Programming	CST859
60.	Special Topics in Software Engineering	CST860
61.	Advanced Internet Technologies	CST861
62.	Advanced Compilation Techniques	CST862
63.	Special Topics in Theoretical Computer Science	CST863

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Next Generation Networks	**Semester**	M.Tech 1st Sem	
Department	Computer Science & Engineering	**Course Code**	CST501	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. A working knowledge of emerging network technologies, how they are used, what their advantages or disadvantages are, and what their future offers.
2. A comfortable understanding of applicable terminology, which is critical to a successful learning experience.
3. An appreciation that appropriate network performance is always the result of deliberate, continuing management and reengineering efforts never a one-time design initiative.

Learning Outcomes

On completion of this course, students should be able to:

CO1. Understand and explain the drivers of service conversion and explain the logic behind it.

CO2. Understand the concept of Voice over IP (VoIP) and explain how full featured telephony can be provisioned over an IP network

CO3. Understand the portfolio of broadband access mechanisms in a fixed network and be able to explain the relative merits of each type.

CO4. Understand the principles of connection-orientated and connectionless packet switching and the protocols available to enable such networks.

Course Outline / Content

Unit	Topics	Week
1.	**Convergence and Integration:** What is convergence and why is it now possible, Service convergence, Network integration, The service stack model, Drivers for network integration & Service convergence. **Next Generation Networks (NGN):** Principles and definition of an NGN, The NGN architecture, Outline of technology choices, Network and implementation issues with NGN, Numbering & Addressing	2
2.	**Broadband Access:** Review of broadband access systems –Relative merits of the various systems and their enabling role in NGNs. **Next Generation Core Network:** The role of the core network**,** Enabling Control and Re-configurability.	4
3	**Packet Switching:** ATM, IP,MPLS, Ethernet, **IP Multi-Media System(IMS):** Principles of control for IP networks, Concept of IMS, The architectural principles and the key components, Service aspects	4
4.	**VoIP and SIP:** VoIP principles, How telephony is provided over an IP network, The various VoIP scenarios, The principles of SIP, Comparison of SIP with other signaling systems (e,g. SS7), SIP encapsulation in ISUP	2

5.	**Mobile IP & Mobile Systems:** The concept of mobile IP, Mobile IP application and limitations, Brief review of the principles of mobile networks, Relationship of mobile developments to NGN	2
Text Books		
1.	VALDAR, A R: 'Understanding Telecommunications Networks', IET Telecommunications Series 52, 2006.	
2.	Next Generation Networks Services, Technologies and Strategies, Neill Wilkinson, Wiley.	
References		
1.	Carugi, M.; Hirschman, B.; Narita, A.; , "Introduction to the ITU-T NGN focus group release 1:target environment, services, and capabilities," Communications Magazine, IEEE , vol.43, no.10,pp. 42- 48, Oct. 2005 doi: 10.1109/MCOM.2005.1522123.	
2.	Chae-Sub Lee; Knight, D.; , "Realization of the next-generation network," Communications Magazine, IEEE , vol.43, no.10, pp. 34- 41, Oct. 2005 doi:10.1109/MCOM.2005.1522122.	
3.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	System Architecture	**Semester**	M.Tech 1st Sem	
Department	Computer Science & Engineering	**Course Code**	CST503	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course will enable students to

1. Discover recent trends in the field of Computer Architecture and identify performance related parameters
2. Explain pipelining, thread –level parallelism and Memory hierarchy design

Course Outcomes

After completion of this course, students will be able to:

CO1. Implement Pipelining concepts, Identify the limitations of ILP
CO2. Demonstrate an ability to apply theory and techniques to unseen problems.
CO3. Interpret the thread–level parallelism concepts.
CO4. Explain concepts of vector process super computers and Cray X1

Course Outline / Content

Unit	Topics	Week
1.	Data-Level Parallelism in vector, SIMD, and GPU Architectures: Introduction, Vector Architecture, SIMD Instructions Set Extensions for Multimedia, Graphics Processing Units, Detecting and Enhancing Loop-level Parallelism, Crosscutting Issues, Putting it All Together: Mobile versus Server GPUs and Tesla versus Core i7, Fallacies and Pitfalls, Concluding Remarks, Historical Perspective and References Case Study and Exercises by Jason D. Bakos.	2
2.	Thread-Level Parallelism: Introduction, Centralized Shared-Memory Architectures, Performance of Symmetric Shared-Memory Multiprocessors, Distributed Shared-Memory and Directory-Based Coherence, Synchronization: The Basics, Models of Memory Consistency: An Introduction, Crosscutting Issues, Putting it All Together: Multicore Processors and Their Performance, Fallacies and Pitfalls, Concluding Remarks, Historical Perspective and References Case Studies and Exercises by Amr Zaky and David A. Wood	3
3.	Warehouse-Scale Computers to Exploit Request-Level and Data-Level Parallelism: Introduction, Programming Models and Workloads for Warehouse-Scale Computers, Computer Architecture of Warehouse-Scale Computers, Physical Infrastructure and Costs of Warehouse-Scale Computers, Cloud Computing: the Return of Utility Computing, Crosscutting Issues, Putting it All Together: A Google Warehouse-Scale Computer, Fallacies and Pitfalls, Concluding Remarks, Historical Perspective and References Case Studies and Exercises by Parthasarathy Ranganathan.	3
4.	Vector Processors in More Depth : Why Vector Processors?, Basic Vector Architecture, Two Real-World Issues: Vector Length and Stride,	3

	Enhancing Vector Performance, Effectiveness of Compiler Vectorization, Putting it All Together: Performance of Vector Processors, a Modern Vector Supercomputer: The Cray X1 Fallacies and Pitfalls, Concluding Remarks, Historical Perspective and References Exercises	
5.	Hardware and Software for VLIW and EPIC: Introduction: Exploiting Instruction-Level Parallelism Statically, Detecting and Enhancing Loop-Level Parallelism, Scheduling and Structuring Code for Parallelism, Hardware Support for Exposing Parallelism: Predicated Instructions, Hardware Support for Compiler Speculation, The Intel IA-64 Architecture and Itanium Processor, Concluding Remarks.	3
Text Books		
1.	Hennessey and Patterson: "Computer Architecture A Quantitative Approach", 5th Edition, Elsevier, 2013.	
2.	A. Tannenbaum, "Structured Computer Organization", Pearson Education, 2002.	
References		
1.	Kai Hwang: Advanced Computer Architecture - Parallelism, Scalability, Programmability, 2nd Edition, Tata McGraw Hill, 2013	
2.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Advanced Algorithms	**Semester**	M. Tech 2nd Sem	
Department	Computer Science & Engineering	**Course Code**	CST 550	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. To analyze the asymptotic performance of algorithms.
2. To develop an understanding of various algorithmic techniques which includes: searching, sorting, greedy algorithms, and dynamic programming and approximation algorithms.
3. To develop an understanding of various geometric algorithms and Linear Programming.
4. To develop an understanding of Probabilistic based algorithms, an approach to estimate the computational complexity of an algorithm or a computational problem.

Course Outcomes

Upon completion of this course ,the students will be able to:

CO1. Enhance their expertise in algorithmic analysis and algorithm design techniques.
CO2. Analyze, design, apply and use data structures and algorithms to solve engineering problems and evaluate their solutions
CO3. Understand and apply amortized analysis on data structures, including binary search trees, merge able heaps and graphs.
CO4. Have an idea of applications of algorithms in a variety of areas including string matching, and databases etc.

Course Outline / Content

Unit	Topics	Week
1.	**Analysis of Algorithms:** Elementary Data Structures and Complexity Analysis, Overview of Basic Data Structures: Arrays, Linked List, Stack, Queues. Implementation of Sparse Matrices, Algorithm Complexity: Average, Best and worst case analysis, asymptotic notations, Simple Recurrence Relations and use in algorithm analysis	2
2.	Search Structures: Binary search trees, AVL trees, 2-3 trees, 2-3-4 trees, Red-black trees, B-trees. Graph Algorithms: Representation of Graphs, Traversals, Single-source shortest path Algorithms, All-pairs shortest path algorithms, Sub graphs, Disjoint Graphs, Connected Components, Articulation Points, Spanning tree, Minimum Spanning Trees Algorithms, Topological sort	4
3.	**Approximation Algorithms:** Introduction, Absolute approximation, Epsilon approximation, Polynomial time Approximation schemes, probabilistically good algorithms.	2
4.	String Matching Algorithms: Introduction, The Brute-Force- Algorithm, Rabin-Karp Algorithm, String Matching with Finite automata, Knuth-Marries-Pratt Algorithm.	3
5.	Heap Structures: Min-max heaps, Deaps, Leftist heaps, Binomial heaps, Fibonacci heaps, Skew heaps Multimedia Structures: Segment trees, k-d	

	trees, Point Quad trees, MX-Quad trees, R-trees	3
Text Books		
1.	Kishore S. Trivedi, “Probability & Statistics with Reliability, Queing, and Computer Science Applications” PHI	
2.	Cormen, Leiserson, Rivest, “Algorithms”, PHI	
References		
1.	Horowitz, Sahni, “Fundamentals of Computer Algorithm”, Galgotia.	
2.	S. Baase, S and A. Van Gelder, "Computer Algorithms: Introduction to Design and Analysis", 3rd edition. Addison Wesley,2000.	
3.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Real Time Operating System	**Semester**	M. Tech 2nd Sem	
Department	Computer Science & Engineering	**Course Code**	CST 551	
Credits	3	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. Syllabus deals with issues in real time operating systems, importance of deadlines and concept of task scheduling.
2. Student will be able to understand and design real time operating systems which are backbone of embedded industry.

Course Outcomes

This course has the following program learning outcomes:

CO1. Student will be able to explain and give examples of real time operating systems.
CO2. Student will be able to solve scheduling problems and can apply them in real time applications in industry.
CO3. Student can also design an RTOS and will be able to interpret the feasibility of a task set to accomplish or not.
CO4. Analyse the situation of fault occurrence and will be able to apply solutions accordingly.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction to Real time systems:** Issues in real time computing, Structure of real time system, Need for RTOS Task classes, Performance measures for real time system: Properties, traditional performance measures, perform ability, cost functions and hard deadlines, and Estimating program run times. Introduction LINUX/ UNIX OS.	2
2.	**Embedded software and Task Scheduling:** Examples of embedded system, their characteristics and their typical hardware components, embedded software architectures, Scheduling algorithms: round robin, round robin with interrupts, function queue scheduling, real time operating system selection, CPU scheduling algorithms: Rate monotonic, EDF, MLF. Priority Scheduling, Priority Ceiling and Priority inheritance, Real time operating system: Tasks and task states, shared data and reentrancy, semaphores and shared data, use of semaphores, Protecting shared data.	3
3.	**Features of Real Time Operating System:** Messages, queues, mailboxes, pipes, timer function, events, memory management, Interrupt basic system design using an RT (OS design principles, interrupt routines, task structures and priority.) Current research in RTOS. Case Studies: Vx Works and Micro OS-II	3
4.	**Real Time Databases:** Real time v/s general purpose databases, main memory databases, transaction priorities, transaction aborts, concurrency control issues: pessimistic concurrency control and optimistic concurrency control, Disk scheduling algorithms.	2
5.	**Fault Tolerance Techniques:** Causes of failure, Fault types, Fault	2

	detection, Fault and error containment .Redundancy: hardware redundancy, software redundancy, Time redundancy, information redundancy, Data diversity, Integrated failure handling.	
Text Books		
1.	An Embedded Software Prime r, David E. Simon Pearson Education Asia Publication ISBN-13: 978020161569.	
2.	Real Time Systems, C.M. Krishna and Kang G. Shin, TMH Publication ISBN 13:9780070701151	
References		
1.	Real-time Operating Systems: Book 1 – The Theory (The engineering of real-time embedded systems)" by Jim Cooling	
2.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Advanced Automata and Theory of Computation.	**Semester**	M.Tech 3rd sem	
Department	Computer Science & Engineering	**Course Code**	CST 604	
Credits	3	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. To give an overview of the theoretical foundations of computer science from the perspective of formal languages
2. To illustrate finite state machines to solve problems in computing
3. To explain the hierarchy of problems arising in the computer sciences.
4. To familiarize Regular grammars, context frees gramma

Course Outcomes

CO1. To use basic concepts of formal languages of finite automata techniques
CO2. To Design Finite Automata's for different Regular Expressions and Languages
CO3. To Construct context free grammar for various languages
CO4. To solve various problems of applying normal form techniques, push down automata and Turing Machines

Course Outline / Content

Unit	Topics	Week
1.	**Finite State Automata** Kleene's Theorem, Myhill-Nerode Theorem, Pumping Theorem, Closure and decidability properties of regular languages, Markov models and hidden Markov models, Proof that natural languages are not regular	2
2.	**Push down Automata and Context Free Grammar**: Right linear and left linear grammars and regular languages, Equivalence of Pushdown Automata and Context Free Grammars, Nonequivalence of deterministic and nondeterministic pushdown automata, Closure and decidability properties of context free languages, Pumping theorem, Parikh's Theorem, Applications to natural languages and programming languages	3
3.	**Turing Machines** Decidable and semidecidable languages, Turing machines as computers of functions, Equivalent formulations of Turing machines, The Church-Turing Thesis, The Universal Turing machine, Unsolvability of the Halting Problem for Turing machines, Other unsolvable problems – reductions to the Halting Problem, Closure properties of the decidable and semi decidable languages, Unrestricted grammars – generation of semi decidable languages	3
4.	**P and NP** NP-completeness and the Cook-Levin Theorem ,Reduction in complexity proofs, Other NP-complete problems	2

Text Books

1.	Automata, Computability, and Complexity, by Elaine Rich, Pearson-Prentice Hall, 2008.
2.	Michael Sipser. Introduction to the Theory of Computation, Second Edition, Cenage Learning, India

3.	**Reference Books**
1.	Green Law, Hoover, “Fundamentals of the Theory of Computation – Principles and practice”, Morgan & Kauffman Publishers, 1998
2.	Daniel I.A. Cohen, "Introduction to Automata Theory Languages and Computations”, Pearson Education Asia, Second Edition.
3.	Latest Relevant Research Papers

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Research Methodology	**Semester**	M-Tech 3rd Sem	
Department	Computer Science & Engineering	**Course Code**	CST 605	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. Understand research terminology.
2. Be aware of the ethical principles of research, ethical challenges and approval processes.
3. Describe quantitative, qualitative and mixed methods approaches to research.
4. Identify the components of a literature review process.
5. Critically analyze published research.

Course Outcomes

By the end of the module, the student will be able to:

CO1. Apply a range of quantitative and / or qualitative research techniques to business and management problems / issues.

CO2. Understand and apply research approaches, techniques and strategies in the appropriate manner for managerial decision making.

CO3. Demonstrate knowledge and understanding of data analysis and interpretation in relation to the research process.

CO4. Develop necessary critical thinking skills in order to evaluate different research approaches utilised in the service industries.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction:** Definition and objectives of Research, Various Steps in Research process. Types of research: Descriptive *vs*. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, and Conceptual vs. Empirical.	2
2.	**Research Formulation:** Defining and formulating the research problem, Selecting the problem, Necessity of defining the problem, Importance of literature review in defining a problem. Literature review: Primary and secondary sources, reviews, treatise, monographs, patents, web as a source, searching the web. Critical literature review: Identifying gap areas from literature review, Development of working hypothesis.	3
3.	**Research design and methods:** Research design, Basic Principles, Need of research design, Features of good design, Observation and Facts, Laws and Theories, Prediction and explanation, Induction, Deduction, Development of Models. Developing a research plan - Exploration, Description, Diagnosis and Experimentation. Determining experimental and sample designs.	3
4.	**Data Collection and analysis:** Execution of the research, Observation and Collection of data. Methods of data collection: Sampling Methods, Data Processing and Analysis strategies, Data Analysis with Statistical Packages, Hypothesis-testing, Generalization and Interpretation.	3

5.	**Reporting and thesis writing:** Structure and components of scientific reports, Types of report, Technical reports and thesis, Significance. Different steps in the preparation: Layout, structure and Language of typical reports, Illustrations and tables, Bibliography, referencing and footnotes.	3
Text Books		
1.	Kothari, C.R., 1990. Research Methodology: Methods and Techniques.	
2.	B.L.Garg,R.Karadia, F.Agarwal. An introduction to Research Methodology, RBSA Publishers.	
References		
1.	Donald H.McBurney, Research Methods, 5th Edition, Thomson Learning	
2.	Donald R. Cooper, Pamela S. Schindler, Business Research Methods, 8/e, Tata McGraw-Hill Co.Ltd., 2006.	
3.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Simulation & Modelling	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST801	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. This course will expose students to the fundamental ideas of system modelling and computer simulation.
2. The technique and methodology of using simulation to solve problems and make decisions are highlighted.
3. Students will be encouraged to apply modelling principles to a real-world problem.
4. Students will be exposed to different simulators like MATLAB to explore a range of programming and modelling concepts while acquiring those skills.

Course Outcomes

This course has the following Course outcomes:

CO1. Describe, investigate and analyse complex engineering systems and associated issues (using systems thinking and modelling techniques)

CO2. Comprehend and apply advanced theory-based understanding of engineering fundamentals to predict the effect of engineering activities

CO3. Develop creative and innovative solutions to engineering challenges.

CO4. Apply model simulation technology for problem solving in business and industry.

Course Outline / Content

Unit	Topics	Week
1.	Introduction to Simulation, Concept of system, model and simulation, Components of discrete event simulation Advantages and disadvantages of simulation	1
2.	Statistical models in simulation, Probability distribution functions, Estimation of statistical parameters	1
3.	Characteristic of a queueing system, Simulation of single server queueing system, Generation of Random number and Random number Variates , Testing of random numbers	3
4.	Input modeling: Estimation of parameters, Fit tests of distributions, Output data analysis for single system: Statistical analysis for terminating and non-terminating simulations, Comparing alternative system configurations	3
5.	Verification, validation and credibility of simulation models, Simulation of manufacturing and material handling systems Monte Carlo simulation, Case studies	4

Text Books

1.	Averill, M. L., and Kelton, W.D., "Simulation Modeling and Analysis", 2006 , McGraw Hill.
2.	Francis Neelamkavil, Computer Simulation and Modeling, Wiley

Reference Books

1.	Banks, J. and Carson, J. S., "Discrete Event System Simulation", 2009, Prentice

	Hall.
2.	Bernard P. Zeigler, Theory of modeling and simulation
3.	Latest Relevant Research Papers

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Discrete Mathematics	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST802	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. The course objective is to provide students with an overview of discrete mathematics.
2. The purpose of the course is to provide the students with several concepts and methods of the number theory, graph theory and their applications in engineering and computer science.

Course Outcomes

Upon successful completion of this course, a student will be able to:

CO1. Write and interpret mathematical notation and mathematical definitions,

CO2. Formulate and interpret statements presented in Boolean logic. Apply truth tables and the rules of propositional and predicate calculus,

CO3. Formulate short proofs using the following methods: direct proof, indirect proof, proof by contradiction, and case analysis,

CO4. Demonstrate a working knowledge of set notation and elementary set theory, recognize the connection between set operations and logic.

Course Outline / Content

Unit	Topics	Week
1.	Introduction to Propositional Calculus: Propositions, Logical Connectives, Conjunction, Disjunction, Negation and their truth table. Conditional Connectives, Implication, Converse, Contrapositive, Inverse, Conditional statements with truth table, Logical Equivalence, Tautology, Normal forms-CNF, DNF; Predicates and Logical Quantifications of propositions and related examples.	3
2.	Theory of Numbers: Well Ordering Principle, Divisibility theory and properties of divisibility; Fundamental theorem of Arithmetic; Euclidean Algorithm for finding G.C.D and some basic properties of G.C.D with simple examples; Congruences, Residue classes of integer modulo $( )_n$n Z and its examples; Order, Relation and Lattices: POSET, Hasse Diagram, Minimal , Maximal, Greatest and Least elements in a POSET, Lattices and its properties, Principle of Duality, Distributive and Complemented Lattices.	3
3.	Counting Techniques: Permutations, Combinations, Binomial coefficients, Pigeon- hole Principle, Principles of inclusion and exclusions; Generating functions, Recurrence Relations and their solutions using generating function, Recurrence relation of Fibonacci numbers and it's solution, Divide-and-Conquer algorithm and its recurrence relation and its simple application in computer.	3

4.	Graph Theory; elements of graph theory, Euler graph, Hamiltonian path, trees, tree traversals, spanning trees.	2
5.	Graph Coloring: Chromatic Numbers and its bounds, Independence and Clique Numbers, Perfect Graphs-Definition and examples, Chromatic polynomial and its determination, Applications of Graph Coloring. Matchings: Definitions and Examples of Perfect Matching, Maximal and Maximum Matching, Hall's Marriage Theorem (Statement only) and related problems.	3
Text Books		
1.	Russell Merris, Combinatorics, WILEY-INTERSCIENCE SERIES IN DISCRETE MATHEMATICS AND OPTIMIZATION.	
2.	N. Chandrasekaran and M. Umaparvathi, Discrete Mathematics, PHI.	
References		
1.	J.K. Sharma, Discrete Mathematics, Macmillan	
2.	Winfried Karl Grassmann and Jean-Paul Tremblay, Logic and Discrete Mathematics, PEARSON.	
3.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Advanced Graph Theory	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST803	
Credits	3	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

On completion of this course, the student will be able to:

1. Understand and apply the fundamental concepts in graph theory
2. Apply graph theory-based tools in solving practical problems
3. Improve the proof writing skills.

Course Outcomes

On completion of this course, the student will be able to:

CO1. Model problems in different types of basic graphs like trees, bipartite and planar graphs.
CO2. Identify special graphs like Euler graphs and Hamiltonian graphs.
CO3. Appreciate different graph-colouring problems and their solutions.
CO4. Model simple problems from real life as graph-colouring problems.

Course Outline / Content

Unit	Topics	Week
1.	Introduction to Graphs & its Applications, Basics of Paths, Cycles, and Trails, Connection, Bipartite Graphs, Eulerian Circuits, Vertex Degrees and Counting, Degree-sum formula, The Chinese Postman Problem and Graphic Sequences.	2
2.	Trees and Distance, Properties of Trees, Spanning Trees and Enumeration, Matrix-tree computation, Cayley's Formula, Prufer code, Matchings and Covers, Hall's Condition, Min-Max Theorem, Independent Sets, Covers and Maximum Bipartite Matching, Augmenting Path Algorithm, Weighted Bipartite Matching, Hungarian Algorithm.	4
3.	Stable Matchings and Faster Bipartite Matching, Factors & Perfect Matching in General Graphs, Matching in General Graphs: Edmonds' Blossom Algorithm, Connectivity and Paths: Cuts and Connectivity, k-Connected Graphs, Network Flow Ford-Fulkerson Labeling Algorithm, Max-Flow Min-cut Theorem, Menger's Proof using Max-Flow Min-Cut Theorem.	4
4.	Vertex Coloring and Upper Bounds, Brooks' Theorem and Color-Critical Graphs, Counting Proper Colorings, Planar Graphs, Characterization of Planar Graphs, Kuratowski's Theorem, Wagner's Theorem.	2
5.	Line Graphs and Edge-coloring, Hamiltonian Graph, Traveling Salesman Problem and NP-Completeness, Dominating Sets.	2

Text Books

1.	D.B. West, Introduction to Graph Theory, Prentice Hall, 2001
2.	Jon Kleinberg and Eva Tardos, Algorithm Design, Addison-Wesley, 2005

3.	J.A.Bondy and U.S.R.Murty: Graph Theory, Springer, 2008.
References	
1.	R.Diestel: Graph Theory, Springer(low price edition) 2000.
2.	F.Harary: Graph Theory, Narosa, (1988)
3.	Latest Relevant Research Papers

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Green Computing	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST804	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

The objective of this course is to:

1. To equip students with the knowledge and skills to decrease IT systems' energy use, waste, and other environmental consequences while lowering life cycle costs and boosting competitive advantage.
2. To enable the students to learn how to measure computer power consumption, reduce power consumption, acquire sustainable hardware, construct green data centres, recycle computer equipment, configure computers to reduce power consumption, use virtualization to reduce the number of servers, and other green technologies.
3. Enable the students to learn how to integrate green IT into business culture and strategy in order to support long-term information technology sustainability.

Course Outcomes

By the end of this course, the student will be able to:

CO1. Give an account of the concept green IT
CO2. Give an account of standards and certifications related to sustainable IT products
CO3. Evaluate IT use in relation to environmental perspectives;
CO4. Discuss how the choice of hardware and software can facilitate a more sustainable operation, and use methods to measure energy consumption.

Course Outline / Content

Unit	Topics	Week
1.	**Origins**, Regulations and industry initiatives-Government, Industry. Approaches. **Virtualization**: Green maturity model for virtualization, Virtualization level: Level 0, Level 1, Level 2, Level 3.	3
2.	**Terminal servers**, Power management, Operating system support, Power supply, Storage, video card, Display. Web, temporal and spatial data mining materials recycling, Tele-computing. Thin clients: Introduction of thin clients, Characteristics of thin clients, Thin client variants.	3
3.	**Middleware support** for green computing, Tools for monitoring, HPC computing, Green Mobile, Embedded computing and networking, Management frameworks, Standards and metrics for computing green. **Environmentally Sustainable Infrastructure Design:** Sustainable technology, Sustainable intelligence, decomposing infrastructure environment. **Profiling Energy Usages for Efficient Consumption:** Profiling energy usages for the application. Profiling energy usages for the operating system and Extra energy usages profile.	4

4.	**Green Networking:** Where to save energy in wired networking, Taxonomy of green networking research: Adaptive link rate, Interface proxying, Energy ware infrastructure, Energy ware application. **Efficient-Efficient Data Canters:** Reason for over power consumption in data centers, Data center management architecture in greener perspective.	3
5	**Green Cellular Networking:** Survey, Measuring greenness metrics, Energy saving in base stations, Research issues, Challenges, Future generation wireless systems, Wireless sensor network for green networking.	1
Text Books		
1.	Bud E. Smith, "Green Computing: Tools and Techniques for Saving Energy, Money, and Resources", Auerbach Publications.	
2.	Toby Velte, Anthony Velte, Robert Elsenpeter, "Green IT: Reduce Your Information System's Environmental Impact While Adding to the Bottom Line", MC-Graw Hill.	
References		
1.	John Lamb, "The Greening of IT-How Companies Can Make a Difference for the Environment", Pearson Education.	
2.	Greg Schulz, "The Green and Virtual Data Center", CRC Press.	
3.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Parallel & Distributed Algorithms	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST805	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. To provide an in-depth understanding of the fundamentals of parallel and distributed
2. Algorithms.
3. To introduce several important parallel computing models that capture the essence of existing and proposed types of synchronous and asynchronous parallel computers.
4. To study typical models for distributed computing.

Course Outcomes

Upon completion of this course, the students will be able to do the following:

CO1. Understand and account for models, limitations, and fundamental concepts in the area of message passing and shared memory concurrency, and apply this understanding to example systems and algorithms.

CO2: Adapt, and design algorithms for execution in parallel and distributed settings, and analyze the algorithms for correctness, reliability, security, and performance.

CO3: apply techniques and methods presented along the course aiming to design efficient parallel and distribute algorithms

CO4: to analyse required computational resources, in order to assess performance and correctness of algorithms.

Course Outline / Content

Unit	Topics	Week
1.	Introduction to data and control parallelism. PRAM model and its variants, EREW, ERCW, CRCW, PRAM algorithms, cost optimality criterion, Brent's theorem and its Importance.	2
2.	Processor organizations such as mesh and hypercube, embedding of problem graphs into processor graphs. Parallel algorithms for matrix multiplication, merging and sorting for different processor organizations such as mesh and hypercube.	4
3.	Introduction to Distributed Algorithms, Kinds of Distributed Algorithm, Timing Models. Synchronous Network Algorithms: Synchronous Network Model, Leader Election in asynchronous Ring,	3
4.	Algorithms in a General Synchronous Networks, Distributed Consensus with Link Failures, Distributed Consensus with Process failures, More Consensus problems.	2
5.	Algorithms for BFS, DFS, shortest paths and spanning trees in distributed systems. Asynchronous networks: Broadcast and multicast, logical time, global snapshot and stable properties; Network resource allocation.	3

Text Books

1.	Quinn, M. J., "Parallel Computing Theory & Practice",McGraw-Hill.

2.	Horowitz, E., Sahni, S. and Rajasekaran, S., "Computer Algorithms: C++", Galgotia Publications
References	
1.	Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers, by Barry Wilkinson, Michael Allen. Prentice Hall.
2.	Algorithms and Systems", Cambridge University Press
3.	Latest Relevant Research Papers

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Internet Of Things	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST806	
Credits	03	**L**	**T**	**P**
Course Type	Theory			

Course Objectives

This course will enable students to

1. Define and explain basic issues, policy and challenges in the IOT
2. Illustrate Mechanism and Key Technologies in IOT
3. Explain the Standard of the IOT
4. Explain resources in the IOT and deploy of resources into business
5. Demonstrate data analytics for IOT

Course Outcomes

At the end of this course the students will be able to:

CO1. Develop schemes for the applications of IOT in real time scenarios
CO2. Manage the Internet resources and Model the Internet of things to business
CO3. Understand the practical knowledge through different case studies
CO4. Understand data sets received through IOT devices and tools used for analysis

Course Outline / Content

Unit	Topics	Week
1.	What is The Internet of Things? Overview and Motivations, Examples of Applications, IPV6 Role, Areas of Development and Standardization, Scope of the Present Investigation. Internet of Things Definitions and frameworks-IOT Definitions, IOT Frameworks, Basic Nodal Capabilities. Internet of Things Application Examples-Overview, Smart Metering/Advanced Metering Infrastructure-Health/Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards, Tracking, Over-The-Air-Passive Surveillance/Ring of Steel, Control Application Examples, Myriad Other Applications.	2
2.	Fundamental IOT Mechanism and Key Technologies-Identification of IOT Object and Services, Structural Aspects of the IOT, Key IOT Technologies. Evolving IOT Standards-Overview and Approaches, IETF IPV6 Routing Protocol for RPL Roll, Constrained Application Protocol, Representational State Transfer, ETSI M2M,Third Generation Partnership Project Service Requirements for Machine-Type Communications, CENELEC, IETF IPv6 Over Low power WPAN, Zigbee IP(ZIP),IPSO	4
3.	Layer ½ Connectivity: Wireless Technologies for the IOT-WPAN Technologies for IOT/M2M, Cellular and Mobile Network Technologies for IOT/M2M,	2
4.	Layer 3 Connectivity: IPv6 Technologies for the IOT: Overview	2

	and Motivations. Address Capabilities, IPv6 Protocol Overview, IPv6 Tunnelling, IPSec in IPv6, Header Compression Schemes, Quality of Service in IPv6, Migration Strategies to IPv6.	
5.	Case Studies illustrating IOT Design-Introduction, Home Automation, Cities, Environment, Agriculture, Productivity Applications. Data Analytics for IOT –Introduction, Apache Hadoop, Using Hadoop Map Reduce for Batch Data Analysis, Apache Oozie, Apache Spark, Apache Storm, Using Apache Storm for Real-time Data Analysis, Structural Health Monitoring Case Study.	4
Text Books		
1.	Daniel Minoli,"Building the Internet of Things with IPv6 and MIPv6:The Evolving World of M2M Communications", Wiley, 2013.	
2.	Arshdeep Bahga, Vijay Madisetti, "Internet of Things: A Hands on Approach" Universities Press., 2015	
References		
1.	Michael Miller," The Internet of Things", First Edition, Pearson, 2015.	
2.	Claire Rowland,Elizabeth Goodman et.al.," Designing Connected Products", First Edition,O'Reilly, 2015.	
3.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Computer Vision	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST807	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course includes:

1. To provide a glimpse of what computer vision is about.
2. To give an understanding of image processing for computer vision.
3. Focus on early processing of images and the determination of structure: edges, lines, shapes.

Course Outcomes

After completion of course students will be able to:

CO1. Be familiar with both the theoretical and practical aspects of computing with images

CO2. Understand the geometric relationships between 2D images and the 3D world.

CO3. Gain exposure to object and scene recognition and categorization from images.

CO4. Grasp the principles of computer vision, and develop the practical skills necessary to build computer vision applications.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction:** History about computer vision, Introduction to vision, computer graphics, image processing, human and computer vision. Image Formation Models: Monocular imaging system, Orthographic & Perspective Projection, Camera model and Camera calibration, Binocular imaging systems.	2
2.	**Recognition Methodology:** Conditioning, Labelling, Grouping, Extracting and Matching. Morphological Image Processing: Introduction, Dilation, Erosion, Opening, Closing, Hit-or-Miss transformation, Morphological algorithm operations on binary images, Morphological algorithm, Operations on gray-scale images, Thinning, Thickening, Region growing, region shrinking.	3
3.	**Image Representation and Description:** Representation schemes, Boundary descriptors, Region descriptors. Binary Machine Vision: Thresholding, Segmentation, Connected component labelling, Hierarchal segmentation, spatial clustering, Split & merge, Rule-based Segmentation, Motion-based segmentation. Area Extraction: Concepts, Data-structures, Edge, Line-Linking, Hough transform, Line fitting, Curve fitting (Least-square fitting).	4
4.	**Region Analysis:** Region properties, External points, spatial moments, mixed spatial gray-level moments, Boundary analysis: Signature properties, Shape numbers. Classification of shapes by	

	labeling of edges, Recognition of shapes, Consisting labelling problem, Back-tracking Algorithm Perspective Projective geometry, Inverse perspective Projection, Photogrammetric - from 2D to 3D.	3
5	**Object Models And Matching:** 2D representation, Global vs. Local features. General Frame Works for Matching: Distance relational approach, ordered structural matching; View class matching, Models database organization	2
Text Books		
1.	"Computer and Robot Vision", Robert Haralick and Linda Shapiro, Addison Wesley.	
2.	"Computer Vision: A Modern Approach", David A. Forsyth, Jean Ponce.	
References		
1.	"Image Processing, Analysis, and Machine Vision", Milan Sonka, Vaclav Hlavac, Roger Boyle, Thomson Learning	
2.	“Robot Vision”, by B. K. P. Horn, McGraw-Hill.	
3.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Advanced Computer Graphics	**Semester**		M.Tech
Department	Computer Science & Engineering	**Course Code**		CST808
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This includes:

1. Analyze the basic ray tracing algorithm and explain its limitations.
2. Design and implement a rendering algorithm based on Monte Carlo path tracing.
3. Assess / evaluate the performance and conceptual limits of the implemented simulation code for computer graphics based applications.

Course Outcomes

After completion of course students will be able to:

CO1. Understand knowledge, techniques, skills, and modern tools of advanced computer graphics.

CO2. Understand the graphics programming, and Introduce various Graphics Applications in real world scenario

CO3. Learn more about 2D, 3D and Curve applications

CO4. Apply efficient graphics technique to solve engineering problems

Course Outline / Content

Unit	Topics	Week
1.	**Introduction:** computer graphics, Co-ordinate representation, Pixel, Raster Scan & Random Scan methods, CRT Raster, scan basics, video basics, interactive devices, graphics input and output devices, mouse, track ball, light pen, digitizer, thumb wheel, raster scan graphics, applications.	2
2.	**Line Generation:** Points and lines generation algorithm, DDA lines drawing algorithm, Bresenham's lines drawing algorithm, circle generating algorithm, midpoint circle algorithm, midpoint ellipse generating algorithm, other curves, conic sections, polynomial and spline curves, Pixels addressing, filled- area primitives, scan-line polygon filled algorithms, inside-outside tests, scan-line fill of curved boundary algorithms, boundary fill algorithms, flood-fill algorithms, fill-area functions, character generation. Segments: Segments table, Creating, Deleting and renaming a segment Visibility, Image transformation. Transformation: 2D Transformation, An introduction to 3D transformation, Projections, Light, color and shading.	4
3.	**Windowing and Clipping:** Rendering and Illumination: Introduction to curve generation, Bezier, Hermite and B-spline algorithms and their Comparisons. Viewing transformation, Clipping. Generalized clipping IN 2D. Hidden line and surfaces: Back-face Removal Algorithms, Hidden line methods.	4

	Advanced Rendering Techniques: Photorealistic rendering, Global Illumination, Participating media rendering, Ray tracing, Monte Carlo algorithm, Photon mapping.	
4.	**Texture Synthesis and Image Processing:** Environmental mapping, Texture synthesis, anisotropic image smoothing. **Volume Rendering:** Volume graphics overview, Marching cubes, Direct volume rendering.	2
5.	**Surfaces and Meshes:** Subdivision, Distance fields and level sets. **Physically-based Modelling:** Stable fluid solver, Lattice Boltzmann method.	2
Text Books		
1.	Computer Graphics (Principles and Practice) by Foley, van Dam, Feinerand Hughes, Addisen Wesley.	
2.	Computer Graphics by D Hearn and P M Baker, Printice Hall of India.	
References		
1.	Alan H. Watt and Mark Watt, Advanced Animation and Rendering Techniques: Theory and Practice, Addison-Wesley, 1992.	
2.	Matt Pharr and Greg Humphreys, Physically based rendering, Morgan Kaufmann, 2004.	
3.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Optimization Techniques	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST809	
Credits	3	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

To enable the student to

1. Enumerate the fundamental knowledge of Linear Programming and Dynamic Programming problems.
2. Learn classical optimization techniques and numerical methods of optimization.
3. Know the basics of different evolutionary algorithms.
4. Explain Integer programming techniques and apply different optimization techniques to solve various models arising from engineering areas.

Course Outcomes

On successful completion of the course, the student will be able to:

CO1. Model engineering minima/maxima problems as optimization problems.
CO2. Learn efficient computational procedures to solve optimization problems.
CO3. Enumerate fundamentals of Integer programming technique and apply different techniques to solve various optimization problems arising from engineering areas
CO4. Be able to use MATLAB to implement optimization algorithms.

Course Outline / Content

Unit	Topics	Week
1.	**Mathematical preliminaries:** Linear algebra and matrices, Vector space, eigen analysis, Elements of probability theory, Elementary multivariable calculus	2
2.	**Linear Programming:** Introduction to linear programming model, Simplex method, Duality, Karmarkar's method **Unconstrained optimization:** One-dimensional search methods, Gradient-based methods, Conjugate direction and quasi-Newton methods	3
3.	**Constrained Optimization:** Lagrange theorem, FONC, SONC, and SOSC conditions. **Non-linear problems:** Non-linear constrained optimization models, KKT conditions, Projection methods	4
4.	**Advanced Topics in Optimization:** Piecewise linear approximation of a nonlinear function, Multi objective optimization – Weighted and constrained methods;	3
5	Multi-level optimization, Direct and indirect search methods, Evolutionary algorithms for optimization and search, Applications in civil engineering	2

Text Books

1.	An introduction to Optimization by Edwin P K Chong, Stainslaw Zak

2.	Nonlinear Programming by Dimitri Bertsekas
References	
1.	S.S. Rao,"Engineering Optimization: Theory and Practice", New Age International P)Ltd., New Delhi, 2000
2.	G. Hadley,"Linear programming", Narosa Publishing House, New Delhi, 1990.
3.	Latest Relevant Research Papers

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Advanced Numerical Methods	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST810	
Credits	3	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

By the end of the course, the student will be able to:

1. Apply the numerical methods to find a root of algebraic and transcendental equations
2. Solve linear equations using Jacobi method and Gauss-Seidal method
3. Explain the concepts of Numerical Differentiation and Integration.
4. Be familiar with numerical solution of ordinary differential equations
5. Be familiar with numerical solution of partial differential equation

Course Outcomes

On completion of the course, the student should be able to:

CO1. apply fundamental theory for mathematical modelling with partial differential equations;

CO2. choose, formulate and implement appropriate numerical methods for solving science and engineering;

CO3. interpret, analyse and evaluate results from numerical computations;

CO4. Use common software to solve application problems formulated as more complicated partial differential equations, such as linear elasticity and transport problems.

Course Outline / Content

Unit	Topics	Week
1.	**Numerical solutions to algebraic and transcendental equations:** Introduction, Solutions of Algebraic and Transcendental equations , Bi-Section method ,Method of False-Position, Newton-Raphson method , Useful deduction from the Newton Raphson formula.	3
2.	**Iterative methods of solution of system of equations:** Solution of Linear simultaneous equations: Jacobi's iteration method, Gauss-Seidel iteration method, Relaxation method.	2
3	**Numerical differentiation and integration:** Numerical Differentiation–Formulae for derivatives–Maxima and Minima of a Tabulated Function–Numerical Integration–Newton-Cotes Quadrature Formula–Trapezoidal rule–Simpson's One-Third rule , Simpson's Three-Eighth rule.	3
4.	**Numerical solutions of ordinary differential equations:** Numerical solution of Ordinary Differential equations: Picard's Method, Taylor's series method, Euler's Method, Runge-Kutta Method, Predictor-Corrector Methods, Milne's Method.	3
5.	**Numerical solutions of partial differential equations:** Introduction, Classification of Second order equations, Finite Difference approximation to derivatives, Solutions of Laplace	3

	equation, Poisson's equations, Heat equation and Wave equation.	
Text Books		
1.	Dr. B.S. Grewal, Higher Engineering Mathematics, 43rd Edition, Khanna Publishers, New Delhi, 2014.	
2.	N.P. Bali Etal, A Text book on Engineering Mathematics, Laxmi pub. (p)Ltd, 2001.	
References		
1.	S.S.Sastry, Introductory methods of Numerical solutions, 4th Edition, Prentice Hall of India.	
2.	R.K.Jain & S.R.K.Iyengar, Numerical Methods by, New Age International (P) Limited, 2008.	
3.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Image Processing and Pattern Recognition	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST811	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. Adequate background knowledge about image processing and pattern recognition.
2. Practical knowledge and skills about image processing and pattern recognition tools.
3. Necessary knowledge to design and implement a prototype of an image processing and pattern recognition application.

Coruse Outcomes

After completion of this course, students will be able to:

CO1. Identify and describe operation of different smoothing and sharpening filters.
CO2. To analyze the different segmentation techniques
CO3. To apply different de-noising models to recover original image.
CO4. Identify different pattern recognition methods and apply them in problem areas.

Course Outline / Content

Unit	Topics	Week
1.	**Image Enhancement:** Spatial Domain Methods: Arithmetic and logical operations, pixel or point operations. **Histogram based image enhancement**: Histogram modelling, and equalization. Basics of spatial filtering, smoothening and sharpening spatial filters. Image Enhancement in the Frequency Domain. Gaussian filters, Homomorphic filtering **Fundamental of color image processing:** color models, RGB, CMY, YIQ, HIS. Pseudo Color Image processing	3
2.	**Image Segmentation:** Some Basic Relationships between pixels, point, line and edge detection. SOBEL, PREWITT, ROBERT, Gradient operators, canny edge detection and Chain codes. Thresholding, Region based segmentation, Region growing, region splitting and merging. Morphological Image Processing: Dilation, Erosion, Opening, Closing on Binary Images	3
3.	**Image Restoration and Image Compression:** Restoration Process, Noise Models, Restoration in Presence of Noise Only, Periodic Noise, Reduction by Frequency Domain Filtering, Estimating the Degradation Function, Degradation model, Algebraic Approach to Restoration Inverse filtering, Wiener filter, Constrained Least Square Restoration Data redundancies, Elements of information, variable-length coding, predictive coding, Transform coding, Huffman Coding.	3

	Image compression using DCT	
4.	**Introduction to Pattern Recognition:** Elements of Image Analysis, Introduction to pattern classification, Feature selection and extraction, Supervised and Unsupervised Parameter estimation Basic concepts- Structure of a typical pattern recognition system: Feature vectors, Feature spaces, Pattern classification by distance functions - Minimum distance classification - Cluster algorithms	3
5.	**Pattern Classification:** Pattern classification using Statistical classifiers and Bayes' classifier, Classification performance measures: Risk and error probabilities. Fuzzy classification - Fuzzy clustering - Fuzzy pattern recognition - Syntactic pattern recognition. Application of pattern recognition	2
Text Books		
1.	Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", Pearson Reprint, 2001	
2.	S. Theodoridis, K. Koutroumbas, Pattern Recognition, 4th edition, Academic Press, 2009.	
References		
1.	R. O. Duda, P. E. Hart, D. G. Stork, Pattern Classification, 2nd edition, John Wiley & Sons, Inc., 2000	
2.	Anil K. Jain, "Fundamentals of Digital Image Processing", Prentice-Hall of India, New Delhi, 2001.	
3.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Multimedia and Virtual Reality	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST812	
Credits	3	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. Demonstrate knowledge and understanding of the concepts, principles and theories of Multimedia Applications and Virtual environments
2. Demonstrate knowledge and understanding of the current issues involved with development and deployment of multimedia system
3. Analyse and solve problems related to their expertise in Multimedia Applications and Virtual Environments.

Course Outcomes

Students will learn about:

CO1. Virtual reality technologies, design issues, and applications, especially applications in education and training. Students will obtain hands-on experience designing non-immersive virtual reality walkthroughs.

CO2. The basic categories of virtual reality technology, and the historical development of virtual reality.

CO3. Existing and potential virtual reality applications in education training.

CO4. The emerging virtual reality industry and technologies.

Course Outline / Content

Unit	Topics	Week
1.	**INTRODUCTION:** Concept of Non- Temporal and Temporal Media. Basic Characteristics of Non-Temporal Media; Images, Graphics, Text. Basic Characteristics of Temporal Media: Video, Audio, and Animation. Hypertext and Hypermedia. Presentations: Synchronization, Events, Scripts and Interactivity, Introduction to Authoring Systems.	1
2.	**COMPRESSION TECHNIQUES**: Basic concepts of Compression. Still Image Compression: JPEG Compression. Features of JPEG2000. Video Compression: MPEG- 1&2 Compression Schemes, MPEG-4 Natural Video Compression. Audio Compression: Introduction to speech and Audio Compression, MP3 Compression Scheme. Compression. Of synthetic. Graphical objects.	2
3.	**MULTIMEDIA SYSTEMS ARCHITECTURE**: General Purpose Architecture for Multimedia Support: Introduction to Multimedia PC/Workstation Architecture, Characteristics of MMX instruction set, I/O systems: Overview of USB port and IEEE 1394 interface, Operating System Support for Multimedia Data: Resource Scheduling with real-time considerations, File System, I/O Device Management. **MULTIMEDIA INFORMATION MANAGEMENT**:	4

	Multimedia Database Design, Content Based Information Retrieval: Image Retrieval, Video Retrieval, Overview of MPEG-7, Design of video-on-Demand Systems.	
4.	**Introduction to Virtual Reality and Virtual Reality Systems, Related Technologies**: Teleoperation and Augmented Reality Systems Interface to the Virtual World-Input; Head and hand trackers, data globes, hap tic input devices. Interface to the Virtual World- Output, Stereo display, head mounted display, auto-stereoscopic displays, holographic displays, hap tic and force feedback.	4
5.	**VRML Programming**: Modeling objects and virtual environments Domain Dependent applications: Medical, Visualization, Entertainment, etc.	3
Text Books		
1.	Multimedia System Design, And leigh and Thakarar , PHI	
2.	Multimedia Technology & Application, David Hillman, Galgotia Publications.	
References		
1.	Multimedia Computing Communication and Application, Steinmetz, Pearson Edn	
2.	Virtual Reality Systems, John Vince, Pearsn Education.	
3.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Natural Language Processing	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST813	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. This course is about a variety of ways to represent human languages (like English and Chinese) as computational systems, and how to exploit those representations to write programs that do useful things with text and speech data, like translation, summarization, extracting information, question answering, natural interfaces to databases, and conversational agents.
2. This field is called Natural Language Processing or Computational Linguistics, and it is extremely multidisciplinary. This course will therefore include some ideas central to Machine Learning (discrete classification, probability models) and to Linguistics (morphology, syntax, semantics).

Course Outcomes

The students will be able to:

CO1. grasp the significance of natural language processing in solving real-world problems.

CO2. map the appropriate processing technique to a problem and implement the technique.

CO3. to demonstrate required design skills for large collection sets.

CO4. to comprehend the state-of-the-art advanced NLP research articles and present them to an audience. They will also be able to propose extension of existing NLP techniques for solving a range of problems.

Course Outline / Content

Unit	Topics	Week
1.	Introduction- Human languages, models, ambiguity, processing paradigms; Phases in natural language processing, applications. Text representation in computers, encoding schemes. Linguistics resources- Introduction to corpus, elements in balanced corpus, TreeBank, PropBank, WordNet, VerbNet etc. Resource management with XML, Management of linguistic data with the help of GATE, NLTK.	2
2.	Regular expressions, Finite State Automata, word recognition, lexicon. Morphology, acquisition models, Finite State Transducer. N-grams, smoothing, entropy, HMM, ME, SVM, CRF. Part of Speech tagging- Stochastic POS tagging, HMM, Transformation based tagging (TBL), Handling of unknown words, named entities, multi word expressions.	3
3.	A survey on natural language grammars, lexeme, phonemes, phrases and idioms, word order, agreement, tense, aspect and mood and agreement, Context Free Grammar, spoken language syntax	4

4.	Parsing- Unification, probabilistic parsing, TreeBank. Semantics- Meaning representation, semantic analysis, lexical semantics, WordNet Word Sense Disambiguation- Selectional restriction, machine learning approaches, dictionary based approaches. Discourse- Reference resolution, constraints on co-reference, algorithm for pronoun resolution, text coherence, discourse structure	3
5.	Applications of NLP- Spell-checking, Summarization Information Retrieval- Vector space model, term weighting, homonymy, polysemy, synonymy, improving user queries. Machine Translation– Overview.	3
Text Books		
1.	Daniel Jurafsky and James H Martin. Speech and Language Processing, 2e, Pearson Education, 2009	
2.	James A.. Natural language Understanding 2e, Pearson Education, 1994	
References		
1.	Bharati A., Sangal R., Chaitanya V.. Natural language processing: a Paninian perspective, PHI, 2000	
2.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Advanced Neural Networks (ANN)	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST814	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

Students will able to:

1. To introduce the fundamental techniques and principles of Neural Networks
2. To study the different models in ANN and their applications
3. To familiarize deep learning concepts with Convolutional Neural Network case studies.

Course Outcomes

Students will able to:

CO1. Understand the overview of Neural Networks concepts.
CO2. Interprets the main factors involved in achieving good learning and generalization performance in neural Networks.
CO3. Describes the optimization methods and apply them to different problems.
CO4. Designs new fuzzy neural network models.

Course Outline / Content

Unit	Topics	Week
1.	Biological neuron, artificial neuron as a computational model of a neuron, activation functions, architectures for ANNs, linear neural networks, Hebbs learning law.	2
2.	Non-linear neural networks: Perceptron- learning law, convergence theorem; multilayer feed forward neural networks-structure, activation functions, error back propagation learning, delta learning law, generalized delta rule, learning factors, convergence criteria, momentum factor in learning, conjugate gradient method for learning, universal approximation theorem, cross validation method for selecting the architecture, bias-variance dilemma.	3
3.	Statistical learning theory, principle of empirical risk minimization, Radial basis function networks: RBF networks for function approximation, RBF networks for pattern classification, Support vector machines: SVM for linearly separable classes, SVM for linearly non-separable classes, SVM for nonlinearly separable classes using kernels, multi-class pattern classification using SVMs,	4
4.	Feedback neural networks: Problem of pattern storage and retrieval, discrete Hopfiled networks, dynamical systems, energy function of hopfield model, energy analysis of hopfiled model.	3
5.	Introduction to deep neural networks, convolution neural networks, recurrent neural networks, Boltzman machine.	3

Text Books	
1.	B. Yegnanarayana, Artificial Neural Networks, Printice Hall India Learning Pvt. Ltd, 2009.
2.	Sathish Kumar, Neural Networks: A Classroom Approach, 3rd Edition, Tata McGraw Hill, 2011.
References	
1.	Simon S. Haykin, Neural Networks and Learning Machines, 3rd Edition, Prentice Hall, 2009
2.	Latest Relevant Research Papers

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Advanced Database Systems	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST815	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

Effective collection, analysis, and maintenance of data is key to achieve rapid progress in almost all disciplines of science and engineering.

The objectives of this course is to:

1. To provide a strong foundation in advanced database concepts from an industry perspective.
2. To covers advanced data modeling concepts like OOD Modeling and ORD Modeling
3. To learn query processing and transaction management concepts for object-relational database and distributed database.

Course Outcomes

By the end of this module, students should be able to:

CO1. Explain and evaluate the fundamental theories and requirements that influence the design of modern database systems

CO2. Assess and apply database functions and packages suitable for enterprise database development and database management

CO3. Critically evaluate alternative designs and architectures for databases and data warehouses

CO4. Discuss and evaluate methods of storing, managing and interrogating complex data

Course Outline / Content

Unit	Topics	Week
1.	**Distributed Databases:** Introduction, Design Framework, Design of database fragmentation, The Allocation of Fragments, Translation of global queries to fragment queries, Optimization of access queries, Distributed Transaction Management, Concurrency Control, and Reliability	3
2.	**Introduction to Different Database Systems:** Multimedia Database Systems, Deductive Database Systems, Spatial Database Systems. Hierarchical, Network, Relational and Object-Oriented Databases.	2
3.	**Semi-Structured Data and XML:** Semi-Structured Data, Introduction to XML, XML hierarchical Model, DTD & XML schema, XML Namespace, XML query & Transformation: Xpath, XSLT, XQuery, Storage of XML data, XML Technologies: DOM &SAX Interfaces X pointer, Xlink, XHTML, SOAP, WSDL, UDDI, XML database Application	4
4.	**Real time Databases:** Transaction priorities – Concurrency control issues – Disk scheduling algorithms – Two phase approach to improve predictability.	2

5.	**Advanced Application Development in Databases:** Performance Tuning, Performance Benchmarks, Standardization, E-Commerce, Legacy Systems, Large-scale Data Management with HADOOP, Semi structured database COUCHDB: Introduction, Architecture and principles, features.	3
Text Books		
1.	Database system Concept by Silberschatz and Korth 6th Edition	
2.	Distributed Databases principles & systems by Stefano Ceri, Giuseppe Pelagatti	
References		
1.	Web Data Management, Abiteboul, Loana, Philippe et.al Cambridge publication.	
2.	Database Management Systems by Raghu Ramakrishnan and Johannes Gehrke	
3.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Database Implementations	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST816	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

The objectives of this course is to

1. learn the architecture of a database management system (DBMS)
2. Learn specific algorithms of some of its primary components, specifically buffer management, B+-tree index management, query evaluation, query optimization, concurrency control, and recovery.
3. Provide a strong foundation in advanced database concepts from an industry perspective.

Course Outcomes

At the end of this course, students should

CO1. have a good insight into how DBMSs function internally
CO2. understand how to analyse the performance of data-intensive systems
CO3. be familiar with a variety of programming techniques for large-scale data manipulation
CO4. apply the insights achieved to build the major components of a mini-DBMS

Course Outline / Content

Unit	Topics	Week
1.	**Introduction:** Hardware: Secondary-storage devices, disk access time, Input/output model of computation, optimized disk access; File and System Structure: page layout and access; buffer management; file organizations (heap, sorted, clustered); row stores versus column stores, Page Layout and File of Records. Operating systems issues and buffer management.	4
2.	**Indexes:** Tree-structured (ISAM, B+tree); hash-based (static, extendible, linear); multi-dimensional (UB-tree, k-d-b tree, R-tree) External Sorting: external n-way merge sort; sorting based on B+trees; Dynamic hashing, Multidimensional indexes.	2
3.	**Query Evaluation:** Selection (index-based, hash-based, arbitrary selection predicates), Projection (duplicate elimination; hash-based, sorting-based); Joins (nested-loops, index nested, block nested, sort-merge, hash joins); Set operations; Aggregation; impact of buffering, pipelining, blocking; evaluation techniques in existing systems;	3
4.	**Query Optimization:** Cardinality estimation for all query operators, histograms ; equivalences of relational algebra; query plans; cost estimation; nested queries; join optimization algorithms (dynamic programming and greedy join	2

	enumeration approaches); optimization techniques in existing systems;	
5.	**Transaction Management:** ACID properties; concurrency control (Serializability criteria); locking (two-phase locking, index locking, multiple granularity locks, intention locks); deadlock detection; isolation levels; concurrency control in existing systems;	3
Text Books		
1.	Database system Concept by Silberschatz and Korth 6th Edition	
2.	Database Systems: The Complete Book H. Garcia-Molina, J.D. Ullman, and J. Widom; Prentice Hall.	
References		
1.	Coronel and Morris, "Database Systems – Design, Implementation and Management", Course Technology Inc. Publishers	
2.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Expert Systems	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST817	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

Students will be:

1. Able to explain and describe the concepts central to the creation of knowledge bases and expert systems.
2. Knowledgeable about the tools and the processes used for the creation of an expert system.
3. Able to know methods used to evaluate the performance of an expert system.
4. Able to conduct an in-depth examination of an existing expert system with an emphasis on basic methods of creating a knowledge base.
5. To examine properties of existing systems in a case-study manner, comparing differing approaches.

Course Outcomes

After completing this course, the student should be able to:

CO1. Apply the methodology to transfer human knowledge into an expert system
CO2. Apply knowledge representation, and design a knowledge base.
CO3. Implement a rule-based expert system
CO4. Evaluate Expert System tools.

Course Synopsis

In this course the student will learn the methodology used to transfer the knowledge of a human expert into an intelligent program that can be used to solve problems.

Course Outline / Content

Unit	Topics	Week
1.	Overview; introduction to rule-based expert systems Background, general introduction. Forward and backward chaining, conflict resolution. Uses: structured selection, configuration, diagnosis and business rules	3
2.	Rule-based expert systems Uncertainty, fuzzy logic and belief nets. Expert System Shells	2
3.	Other expert system paradigms: PIES example system (Pan and Tenenbaum) OOPs, frames, Case-based reasoning and help desks, Recommendor systems (CDNow Case Study). Scheduling (Steelmaking example: Dorn and Slany)	3
4.	Building expert systems: CLUES example system (Talebzadeh, Mandutianu and Winner), Building expert systems Discussion of shells. Knowledge Management (Wiki web case study)	3
5.	Machine learning and data-base mining, Data Mining Decision Trees, Neural Networks, Text Mining, Web mining Current trends in AI	3

Text Books

1.	The Engineering of Knowledge-based Systems, A.J. Gonzalez and D. D. Dankel, Prentice Hall, 1993.
2.	A Guide to Expert Systems, Donald A. Waterman, Pearson publications.
References	
1.	Giarratano J. Riley G. , Expert Systems, Principles and Programming, PWS Publising Company
2.	Introduction to Knowledge Systems, Stefik M., Morgan Kaufmann.
3.	Latest Relevant Research Papers

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Quantum Computing	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST818	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course is designed:

1. To enable students with non-physics backgrounds to 'think quantumly'
2. To recognize which classical assumptions fall apart at the quantum level
3. To begin to reintegrate the strange results of quantum theory into the broader framework of classical computer science

Course Outcomes

Enable the student to:

CO1. Translate fluently between the major mathematical representations of quantum operations.
CO2. Learn Quantum mechanics as applied in Quantum computing
CO3. Implement basic quantum algorithms.
CO4. To acquire a working knowledge of quantum information theory.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction and Background:** Overview, Computers and the Strong Church–Turing Thesis, The Circuit Model of Computation, A Linear Algebra Formulation of the Circuit Model, Reversible Computation, A Preview of Quantum Physics, Quantum Physics and Computation. **Linear Algebra and The Dirac Notation**: The Dirac Notation and Hilbert Spaces, Dual Vectors, Operators, The Spectral Theorem, Functions of Operators, Tensor Products, The Schmidt Decomposition Theorem, Some Comments on the Dirac Notation.	2
2.	**Qubits and The Framework of Quantum Mechanics:** The State of a Quantum System, Time-Evolution of a Closed System, Composite Systems, Measurement, Mixed States and General Quantum Operations. **A Quantum Model of Computation:** The Quantum Circuit Model, Quantum Gates, Universal Sets of Quantum Gates, Efficiency of Approximating Unitary Transformations, Implementing Measurements with Quantum Circuits.	2
3.	**Superdense Coding and Quantum Teleportation:** Superdense Coding, Quantum Teleportation, An Application of Quantum Teleportation. **Introductory Quantum Algorithms:** Probabilistic Versus Quantum Algorithms, Phase Kick-Back, The Deutsch Algorithm, The Deutsch–Jozsa Algorithm, Simon's Algorithm.	2

4.	**Algorithms With Superpolynomial Speed-Up:** Quantum Phase Estimation and the Quantum Fourier Transform, Eigenvalue Estimation, Finding-Orders, Finding Discrete Logarithms, Hidden Subgroups, Related Algorithms and Techniques. **Algorithms Based on Amplitude Amplification:** Grover's Quantum Search Algorithm, Amplitude Amplification, Quantum Amplitude Estimation and Quantum Counting, Searching Without Knowing the Success Probability, Related Algorithms and Techniques	4
5.	**Quantum Computational Complexity Theory and Lower Bounds:** Computational Complexity, The Black-Box Model, Lower Bounds for Searching in the Black-Box Model: Hybrid Method, General Black-Box Lower Bounds, Polynomial Method, Block Sensitivity, Adversary Methods. **Quantum Error Correction:** Classical Error Correction, The Classical Three-Bit Code, Fault Tolerance, Quantum Error Correction, Three- and Nine-Qubit Quantum Codes, Fault-Tolerant Quantum Computation.	4
Text Books		
1.	Eleanor G. Rieffel and Wolfgang H. Polak, "Quantum Computing: A Gentle Introduction"	
2.	Pittenger A. O., An Introduction to Quantum Computing Algorithms, 2000	
References		
1.	Michael A. Nielsen and Isaac L. Chuang, "Quantum Computation and Quantum Information".	
2.	Phillip Kaye, Raymond Laflamme, and Michele Mosca (2007). An Introduction to Quantum Computing. Oxford University Press.	
3.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Digital Signal Processing	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST819	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. To understand the fundamentals of DSP.
2. To learn various DSP structures and their implementation.
3. To know designing constraints of various filters.

Course Outcomes

Students will able to:

CO1. Understand the overview of DSP concepts.
CO2. Improve the speed of digital system through transformation techniques.
CO3. Perform Pipelining and parallel processing in FIR systems to achieve high speed and low power.
CO4. Perform optimization using pipelining and parallel processing in IIR systems and adaptive filters.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction to Digital Signal Processing:** Linear System Theory-Convolution-Correlation-DFT-FFT-Basic concepts in FIR Filters and IIR Filters- Filter Realizations. **Representation of DSP Algorithms**: Block diagram-SFG-DFG-design examples and their reduction.	2
2.	**Iteration Bound:** Data-Flow Graph Representations- Loop Bound and Iteration Bound Algorithms for Computing Iteration Bound-LPM Algorithm. **Pipelining and Parallel Processing of Fir Filter:** Pipelining and Parallel Processing: Pipelining of FIR Digital Filters-Parallel Processing Pipelining and Parallel Processing for Low Power. Retiming: Definitions Properties and problems- Solving Systems of Inequalities.	2
3.	**Fast Convolution and Arithmetic Strength Reduction in Filters:** Cook-Toom Algorithm- Modified Cook-Toom Algorithm-Design of Fast Convolution Algorithm by Inspection. Parallel FIR filters-Fast FIR algorithms-Two parallel and three parallel. Parallel architectures for Rank Order filters-Odd Even Merge sort architecture-Rank Order filter architecture-Parallel Rank Order filters-Running Order Merge Order Sorter-Low power Rank Order filter.	2
4.	**Pipelined and Parallel Recursive Filters:** Pipeline Interleaving in Digital Filters- Pipelining in 1st Order IIR Digital Filters-Pipelining in Higher- Order IIR Filters-Clustered Look ahead and Stable Clustered Look ahead- Parallel Processing for IIR	2

	Filters and Problems.	
5.	**Scaling and Round-off Noise:** Introduction to Scaling and Round-off Noise- State Variable Description of Digital Filters- Scaling and Round-off Noise Computation-Round Off Noise Computation Using State Variable Description- Slow-Down-Retiming and Pipelining.	2
Text Books		
1.	K.K Parhi: "VLSI Digital Signal processing", John-wiley, 2nd Edition Reprint, 2008.	
2.	John G.Proakis, Dimitris G.Manolakis, "Digital Signal Processing", Prentice Hall of India, 1st Edition, 2009.	
References		
1.	Avatar sigh, Srinivasan S, Digital signal processing implementations using DSP microprocessors with examples, Thomson 4th reprint, 2004.	
2.	U. Meyer -Baese," Digital Signal Processing with FPGAs", Springer, 2004	
3.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Reconfigurable Computing	**Semester**	M. Tech	
Department	Computer Science & Engineering	**Course Code**	CST820	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course will enable students to:

1. To offer an introduction in the theory and engineering design principles of the modern Reconfigurable Computing Systems (RCS).
2. To emphasis on Reconfigurable Computing Architectures.
3. To give importance in understanding the concepts of architecture re-configurability, programmable logic devices and optimization of the RCS architecture.
4. To learn languages and compilers for the RCS.

Course Outcomes (COs)

By the end of this course, the student will be able to:

CO1: Understand the basics of the reconfigurable computing and reconfigurable architectures

CO2: Articulate the design issues involved in reconfigurable computing systems with a specific focus on FPGAs both in theoretical and application levels

CO3: Understand the performance trade-offs involved in designing a reconfigurable computing platform.

CO4: Understand both how to architect reconfigurable systems and how to utilize them for solving challenging computational problems.

Course Outline/ Content

Unit	Topics	Week
1.	Reconfigurable Computing Hardware: Device Architecture, Reconfigurable Computing Architectures, Reconfigurable Computing Systems, Reconfiguration Management.	2
2.	Programming Reconfigurable Systems: Compute Models and System Architectures, Programming FPGA Applications in VHDL, Compiling C for Spatial Computing, Stream Computations Organized for Reconfigurable Execution, Programming Data Parallel FPGA Applications Using the SIMD/Vector Model, Operating System Support for Reconfigurable Computing.	3
3.	Mapping Designs to Reconfigurable Platforms: Technology Mapping, FPGA Placement Placement for General-purpose FPGAs, Data-path Composition, Specifying Circuit Layout on FPGAs, Retiming, Re-pipelining, and *C*-slow Retiming, Configuration Bit-stream Generation, Fast Compilation Techniques.	3

4.	Application Development: Implementing Applications with FPGAs, Instance-specific Design, Precision Analysis for Fixed-point Computation, Distributed Arithmetic, CORDIC Architectures for FPGA Computing, Hardware/Software Partitioning.	3
5.	Case Studies of FPGA Applications: SPIHT Image Compression, Automatic Target Recognition Systems on Reconfigurable Devices, Boolean Satisfiability: Creating Solvers Optimized for Specific Problem Instances, Multi-FPGA Systems: Logic Emulation, Finite Difference Time Domain: A Case Study Using FPGAs, Network Packet Processing in Reconfigurable Hardware.	3
Text Books		
1.	Scott Hauck and Andre DeHon, "Reconfigurable Computing – The Theory and Practice of FPGA-based Computation", ELSEVIER 2008	
References		
1.	Christophe Bobda "Introduction to Reconfigurable Computing: Architectures, Algorithms, and Applications" SPRINGER 2007.	
2.	JariNurmi, "Processor Design: System-On-Chip Computing for ASICs and FPGAs". SPRINGER 2008.	
3.	Latest Relevant Research Papers.	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Embedded Systems	**Semester**	M. Tech	
Department	Computer Science & Engineering	**Course Code**	CST821	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course will enable students to:

1. To provide the student with a detailed understanding of Microcontrollers and Embedded systems.
2. To cover fundamentals of The 8051 Architecture, Assembly Language Programming, Instruction set, Serial Communication.
3. To expose the interfacing techniques of 8051 Microcontroller.
4. To learn PIC microcontroller and ARM.

Course Outcomes (COs)

By the end of this course, the student will be able to:

CO1: Acquire knowledge about microcontrollers embedded processors and their applications.

CO2: Understand the internal architecture and interfacing of different peripheral devices with Microcontrollers.

CO3: Write programs using assembly language programming.

CO4: Apply concepts on microcontroller interfacing.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction**: Concept of Real time Systems, Challenges in Embedded System Design, Introduction to Microcontrollers and Embedded Processors , Microcontrollers survey-four bit, eight bit, sixteen bit, thirty two bit Microcontrollers, Comparing Microprocessors and Microcontrollers, Overview of the 8051 family.	2
2.	**The 8051 Architecture**: Hardware, Oscillator and clock program counter, data pointer, registers, stack and stack pointer, special function registers.	3
3.	**Memory organization**: program memory, data memory, Input / Output Ports, External memory counter and timer, serial data Input / output, Interrupts.	3
4.	**8051 Assembly Language Programming**: Structure of Assembly language, Assembling and running an 8051 program, Addressing modes, Accessing memory using various addressing modes. Instruction set, 8051 Serial Communication.	3
5.	**Microcontroller Interfacing**: Key Board, Displays Pulse Measurement, D/A and A/D conversion, Stepper Motor. **Basic concept of PIC microcontroller and ARM**: Microcontroller Architecture, PIC16F Processor examples: AVR, ARM, And DSP.	3

Text Books	
1.	The 8051 Microcontrollers and Embedded Systems: Muhammed Ali Mazidi.
2.	The 8051 Microcontrollers Architecture, Programming & Applications Kenneth J. Ayala.
References	
1.	Design with PIC Microcontroller: John Petman.
2.	R. Bryndza Mikrokontrolery z rdzeniem ARM w przykładach, Wydawnictwo BTC, Warszawa 2009 (in Polish).
3.	Latest Relevant Research Papers

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	System on Chip	**Semester**	M. Tech	
Department	Computer Science & Engineering	**Course Code**	CST822	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course will enable students to:

1. Understand the process of designing highly integrated System on Chip (SoC) following systematic hardware/software co-design & co-verification principles.
2. Explore the state-of-the-art synthesis and verification tools and design flows.
3. Model and specify embedded systems at high levels of abstraction.
4. Analyze the functional and nonfunctional performance of the system early in the design process to support design decisions.

Course Outcomes (COs)

By the end of this course, the student will be able to:

CO1: Understand the insights of System on Chip and describing architectures for control-dominated and data-dominated systems and real-time systems.

CO2: Understand hardware, software and issues in interface design.

CO3: Use co-simulation to validate system functionality.

CO4: Explore examples on SoC which emphasizes the issues in system-on-a-chip design associated with co-design, reuse, and verification.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction**: Architecture of the present-day SoC – Design issues of SoC- Hardware-Software Co-design – Core Libraries – EDA Tools.	3
2.	**Design Methodology for Logic Cores:** SoC Design Flow – Guidelines for design reuse – Design process for soft and firm cores – Design process for hard cores – System Integration.	3
3.	**Design Methodology for Memory and Analog Cores:** Embedded memories – Design methodology for embedded memories – Specification of Analog circuits – High speed circuits.	3
4.	**Design Validation:** Core-Level validation – Core Interface verification - SoC design validation.	3
5.	**Core and SoC Design Examples :** Microprocessor Cores – Core Integration and On-chip bus – Examples of SoC.	2

Text Books

1.	Rochit Rajsuman, 'System-on-a-Chip: Design and Test', Artech House, 2000.
2.	Steve Furber, ARM System-on-Chip Architecture, 2nd ed, Addison-Wesley Professional, 2000.

References	
1.	Ricardo Reis & Jochen A.G. Jess, 'Design of System on a Chip: Devices & Components', Kluwer, 2004
2.	Laung-Terng Wang, Charles E. Stroud, Nur A. Touba, "System-on-Chip Test Architectures", Morgan Kaufmann, 2007.
3.	Latest Relevant Research Papers

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Fault Tolerant Computing	**Semester**	M. Tech	
Department	Computer Science & Engineering	**Course Code**	CST823	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course will enable students to:

1. Realise the widely applicable area of reliable and fault-tolerant computing.
2. Explore fault-tolerant design techniques.
3. Learn the characteristics of architectures of fault tolerant computers.
4. Uderstand the principles behind Fault Tolerant Parallel/Distributed Architectures.

Course Outcomes (COs)

By the end of this course, the student will be able to:

CO1: Understand the analysis and design of high reliability and availability systems.
CO2: Realize the fault types, reliability techniques, and maintenance techniques.
CO3: Address security and fault tolerant issues in mobile networks and internet.
CO4: Practice fault diagnosis of digital circuits and systems.

Course Outline / Content

Unit	Topics	Week
1.	**Fundamental Concepts:** Definitions of fault tolerance, fault classification, fault tolerant attributes, reliability, availability and other dependability measures, organization of fault tolerance and system structure. Dependability modelling: combinatorial and non-combinatorial languages.	2
2.	**Fault-Tolerant Design Techniques:** Introduction to redundancy theory; decision theory in redundant systems. Time redundancy. Hardware fault tolerance, redundancy techniques, detection of faults, Error detection mechanisms in hardware and software, replication and compression techniques, self-repairing techniques, concentrated and distributed voters. Recovery and atomic transactions in concurrent and distributed systems.	3
3.	**Architecture of Fault-Tolerant Computers (case study):** General-purpose systems, high-availability systems, long-life systems, critical systems. Examples of commercial systems: general-purpose, transaction-processing systems, applications in process control, telecommunications and safety systems, choice of the level (application, platform, hardware) and degree of fault tolerance.	3
4.	**Fault diagnosis of digital circuits and systems:** Fault modelling, test generation, design for testability, signature analysis, built in self-test. Testing of embedded systems. **Software Fault Tolerance:** Software faults and their	3

	manifestation, design techniques, reliability models, software defence, protective redundancy.	
5.	**Fault Tolerant Parallel/Distributed Architectures:** Shared bus and shared memory architectures, fault tolerant networks. Fault recovery techniques. Coding theory: application to fault tolerant system design. Fault Detection in Cryptographic Systems , Simulation Techniques	3
Text Books		
1.	Parag Lala: "Fault tolerant and Fault Testable Digital Design" (Prentice Hall International).	
2.	Pankaj Jalote: "Fault Tolerance in Distributed Systems" (Prentice Hall)	
References		
1.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Architecture of High Performance Computers	**Semester**	M. Tech	
Department	Computer Science & Engineering	**Course Code**	CST824	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course will enable students to:

1. Learn how to improve the quality of the programs written for execution on high performance computer systems.
2. Explore various activities that happen during program execution.
3. Understand principles of computer organization.
4. Uncover the internals of parallel architecture.

Course Outcomes (COs)

After completion of this course students will be able to:

CO1: Transform algorithms in the computational area to efficient programming code for modern computer architectures.

CO2: Write, organise and handle programs for scientific computations.

CO3: Exhibit knowledge on components of computer organization.

CO4: Realize the notion of responsibilities of operation system.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction:** Introduction, history, applications and components of high performance computing. Basic optimization techniques for serial code Scalar profiling, The role of compilers, C++ optimization. Programming in C/C++ for high performance computing Program execution: Program, Compilation, Object files, Function call and return, Address space, Data and its representation.	3
2.	**Parallel Processing:** Concepts, Levels of parallelism (instruction, transaction, task, thread, memory, and function), Single computer parallelism, and Multi-computer parallelism.	3
3.	**Computer organization:** Memory, Registers, Instruction set architecture, Instruction processing Pipelined processors Pipelining, Structural, data and control hazards, Impact on programming. **Virtual memory:** Use of memory by programs, Address translation, Paging Cache memory Organization, impact on programming, virtual caches.	3
4.	**Operating systems:** Processes and system calls, Process management. **File systems:** Disk management, Name management, Protection.	2
5.	**Parallel architecture:** Inter-process communication, Synchronization, Mutual exclusion, Basics of parallel architecture, Parallel programming with message passing using MPI.	3

Text Books

1.	Introduction to High Performance Computing for Scientists and Engineers. Georg Hager and Gerhard Wellein.
2.	"Highly Parallel Computing",George S. Almasi and Alan Gottlieb
References	
1.	Introduction to High-Performance Scientific Computing, Victor Eijkhout, 2016.
2.	Latest Relevant Research Papers

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	System Level Design and Modeling	**Semester**	M. Tech	
Department	Computer Science & Engineering	**Course Code**	CST825	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course will enable students to:

1. Understand the principles of modelling and design of complex embedded systems with both hardware software components.
2. Explore System-Level Design Languages.
3. Learn the capabilities of application specific processors.
4. Give emphasis on mathematical models for optimization.

Course Outcomes (COs)

By the end of this course, the student will be able to:

CO1: Define appropriate systems architecture for the product, in accordance with best practice framework standards.

CO2: Define the requirements of testing and evaluation during both the development progress of the product.

CO3: Tailor a system engineering process to fit the specific needs of a project.

CO4: Exhibit the knowledge on Application Specific Systems.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction to embedded systems:** Embedded system components, Embedded system Design Issues, Classifications, Applications ,Trends and Directions	2
2.	**Models of Computation, Languages:** Overview, Models of Computation (MoCs), Process models, State machine models. Parallel programming models, threads, dataflow, process networks– Hierarchical and concurrent finite state machine (FSM) models System-Level Design Languages (SLDLs): Goals, requirements, Communication and computation.	3
3.	**System synthesis:** Design space exploration and optimization – Mapping and scheduling algorithms, exploration heuristics – System-level design tools: SCE.	3
4.	**Application specific processors:** Classification, Application Specific Systems. Application-Specific Instruction Set Processors: Background, Instructions Set, Network Processors, Application Specific memory, Low power design and Applications.	3
5.	**Mathematical Model, types of Mathematical models and properties, Procedure of modelling, Graphical method:** Barterning model, Basic optimization, Basic probability: Monte-Carlo simulation, Approaches to differential equation: Heun	3

	method, Local stability theory: Bernoulli Trials, Classical and continuous models, Case studies in problems of engineering and biological sciences.	
Text Books		
1.	D. Gajski, S. Abdi, A. Gerstlauer, G.Schirner, Embedded System Design: Modeling, Synthesis, Verification,Springer, 2009	
2.	Jeffrey Whitten, Lonnie Bentley, "Systems Analysis & Design Methods (SIE)". McGraw Hill Education (India) Private Limited; 7 edition (2006).	
References		
1.	Chiang Roger H. L., SiauKeng, Hardgrave Bill C. "Systems Analysis and Design: Techniques, Methodologies, Approaches, and Architectures". PHI Publishers.	
2.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Embedded Systems Design Lab	**Semester**		M. Tech
Department	Computer Science & Engineering	**Course Code**		CSL826
Credits	02	**L**	**T**	**P**
Course Type	Lab	1	0	2

Course Objectives

This course will enable students to:

1. Understand the concepts and architecture of Embedded Systems
2. Get hands-on practices in interfacing ADC and DAC.
3. Learn and practice interfacing of peripherals.
4. Practice the design of ZigBee protocol with ARM microcontroller.

Course Outcomes (COs)

By the end of this course, the student will be able to:

CO1: Demonstrate interfacing of ADC and DAC.
CO2: Analyse Interrupt performance characteristics of ARM and FPGA.
CO3: Work with flashing of LEDs, stepper motor and temperature sensor.
CO4: Implement ZigBee protocol with ARM.

Course Outline / Content

Unit	Topics	Week
1.	Study of ARM evaluation system	1
2.	Interfacing ADC and DAC.	1
3.	Interfacing LED and PWM.	1
4.	Interfacing real time clock and serial port.	1
5.	Interfacing keyboard and LCD.	1
6.	Interfacing EPROM and interrupt.	1
7.	Mailbox	1
8.	Interrupt performance characteristics of ARM and FPGA.	1
9.	Flashing of LEDs.	2
10.	Interfacing stepper motor and temperature sensor.	2
11.	Implementing ZigBee protocol with ARM.	2

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Real Time Systems	**Semester**	M. Tech	
Department	Computer Science & Engineering	**Course Code**	CST827	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course will enable students to:

1. Learn fundamental concepts on Real Time Systems.
2. Understand the functionalities of real time operating system (RTOS).
3. Realize the tasks of RTOS.
4. Understand the principles of Real Time Communication and Real Time databases.

Course Outcomes (COs)

After completion of course students will be able to:

CO1: Evaluate the real time computing systems.
CO2: Acquire the knowledge on real time operating systems.
CO3: Implement task assignment and scheduling for real time systems.
CO4: Infer knowledge on Network topologies and protocols for Real Time Communication.

Course Outline / Content

Unit	Topics	Week
1.	Introduction to real time computing - Concepts; Example of real-time applications – Structure of a real time system – Characterization of real time systems and tasks - Hard and Soft timing constraints, Design Challenges - Performance metrics - Prediction of Execution Time : Source code analysis, Micro-architecture level analysis, Cache and pipeline issues- Programming Languages for Real-Time Systems.	3
2.	Real time OS – Threads and Tasks – Structure of Microkernel – Time services – Scheduling Mechanisms Communication and Synchronization – Event Notification and Software interrupt.	3
3.	Task assignment and Scheduling - Task allocation algorithms - Single-processor and Multiprocessor task scheduling - Clock-driven and priority-based scheduling algorithms- Fault tolerant scheduling.	2
4.	Real Time Communication -Network topologies and architecture issues – protocols – contention based, token based, polled bus, deadline based protocol, Fault tolerant routing. RTP and RTCP.	3
5.	Real time Databases – Transaction priorities – Concurrency control issues – Disk scheduling algorithms – Two phase approach to improve predictability.	3

Text Books

1.	C.M. Krishna, Kang G. Shin, Real Time Systems, International Edition, McGraw Hill Companies.

References	
1.	Jane W.S. Liu, Real-Time Systems, Pearson Education India, 2000.
2.	Philip A. Laplante and Seppo J. Ovaska, "Real-Time Systems Design and Analysis: Tools for the Practitioner'' IV Edition IEEE Press, Wiley. 2011.
3.	Latest Relevant Research Papers

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	VLSI Digital Signal Processing Core	**Semester**	M. Tech	
Department	Computer Science & Engineering	**Course Code**	CST828	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course will enable students to:

1. Understand the fundamentals of VLSI and DSP.
2. Learn various DSP structures and their implementation.
3. Know design constraints of various filters.
4. Study the characteristics of Pipelined and Parallel Recursive Filters.

Course Outcomes (COs)

After completion of course students will be able to:

CO1: Understand the overview of DSP concepts.

CO2: Improve the speed of digital system through transformation techniques.

CO3: Perform Pipelining and parallel processing in FIR systems to achieve high speed and low power.

CO4: Use Fast Convolution and Arithmetic Strength Reduction in Filters.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction to Digital Signal Processing:** Linear System Theory-Convolution-Correlation-DFT-FFT-Basic concepts in FIR Filters and IIR Filters- Filter Realizations.	2
2.	**Representation of DSP Algorithms**: Block diagram-SFG-DFG-design examples and their reduction. **Iteration Bound:** Data-Flow Graph Representations- Loop Bound and Iteration Bound Algorithms for Computing Iteration Bound-LPM Algorithm.	3
3.	**Pipelining and Parallel Processing of Fir Filter:** Pipelining and Parallel Processing: Pipelining of FIR Digital Filters-Parallel Processing Pipelining and Parallel Processing for Low Power. Retiming: Definitions Properties and problems- Solving Systems of Inequalities.	3
4.	**Fast Convolution and Arithmetic Strength Reduction in Filters:** Cook-Toom Algorithm- Modified Cook-Toom Algorithm-Design of Fast Convolution Algorithm by Inspection. Parallel FIR filters-Fast FIR algorithms-Two parallel and three parallel. Parallel architectures for Rank Order filters-Odd Even Merge sort architecture-Rank Order filter architecture-Parallel Rank Order filters-Running Order Merge Order Sorter-Low power Rank Order filter.	3
5.	**Pipelined and Parallel Recursive Filters:** Pipeline Interleaving in Digital Filters- Pipelining in 1st Order IIR Digital Filters-Pipelining in Higher- Order IIR Filters-Clustered Look ahead	3

	and Stable Clustered Look ahead- Parallel Processing for IIR Filters and Problems. Scaling and Round-off Noise.	
Text Books		
1.	K.K Parhi: "VLSI Digital Signal processing", John-wiley, 2nd Edition Reprint, 2008.	
2.	John G.Proakis, Dimitris G.Manolakis, "Digital Signal Processing", Prentice Hall of India, 1st Edition, 2009.	
References		
1.	Avatar sigh, Srinivasan S, Digital signal processing implementations using DSP microprocessors with examples, Thomson 4th reprint, 2004.	
2.	U. Meyer -Baese," Digital Signal Processing with FPGAs", Springer, 2004	
3.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Special Topics in Hardware Systems	**Semester**	M. Tech	
Department	Computer Science & Engineering	**Course Code**	CST829	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course will enable students to:

1. Learn various types of coprocessors and design suitable co-processor interface to ARM processor.
2. Compare various Network architectures.
3. Define metrics used for designing storage area networks.
4. Illustrate Mechanism and Key Technologies in IoT.

Course Outcomes (COs)

By the end of the course, the students will be able to:

CO1: Analyse the characteristics of ARM processors.
CO2: Implement routing protocols used in computer networks.
CO3: Realize the need of storage area networks.
CO4: explore the applications of embedded computing systems and IoT.

Course Outline / Content

Unit	Topics	Week
1.	**ARM Processors**: An Introduction to Processor Design: Processor architecture and organization. Abstraction in hardware design. ARM Assembly Language Programming, The ARM Instruction Set, and The Thumb Instruction Set: The Thumb bit in the CPSR, ARM Processor Cores: ARM7TDMI. ARM8. ARM9TDMI.ARM10TDMI Memory Hierarchy: Memory size and speed. On-chip memory	3
2.	**Advances in Computer Networks**: Foundation: Building a Network, Requirements, Perspectives, Scalable Connectivity, Internetworking I: Switching and Bridging, Internetworking- II: Network as a Graph, Distance Vector (RIP), Link State (OSPF), Metrics, The Global Internet, Routing Areas, Routing among Autonomous systems (BGP), IP Version 6 (IPv6), Mobility and Mobile IP, End-to-End Protocols: Simple De-multiplexer (UDP), Reliable Byte Stream(TCP), End-to End Issues, Congestion Control and Resource Allocation Congestion-Avoidance Mechanisms, DEC bit, Random Early Detection (RED).	3
3.	**Advances in Storage Area Networks**: Introduction: Server Centric IT Architecture and its Limitations; Storage – Centric IT Architecture and its advantages, I/O Techniques: The Physical	3

	I/O path from the CPU to the Storage System, Storage Virtualization: Definition of Storage virtualization; Implementation Considerations; Storage virtualization on Block or file level; SAN Architecture and Hardware device; System Management, Requirement of management System, Support by Management System, Management Interface,	
4.	**Embedded Computing Systems**: Introduction to embedded systems: Embedded systems, Processor embedded into a system, Embedded hardware units and device in a system, Embedded software in a system, Examples of embedded systems.	2
5.	**Internet of Things**: What is The Internet of Things? Overview and Motivations, Examples of Applications, IPV6 Role, Areas of Development and Standardization, Fundamental IoT Mechanism and Key Technologies, Layer ½ Connectivity: Wireless Technologies for the IoT-WPAN Technologies for IoT/M2M, Cellular and Mobile Network Technologies for IoT/M2M, Layer 3 Connectivity:IPv6 Technologies for the IoT, Case Studies illustrating IoT Design-Introduction, Data Analytics for IoT – Introduction.	3
Text Books		
1.	Larry Peterson and Bruce S Davis "Computer Networks: A System Approach" 5th Edition, Elsevier -2014.	
2.	Raj Kamal, "Embedded Systems: Architecture, Programming, and Design" 2nd edition, Tata McGraw hill-2013.	
3.	Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", Wiley, 2013.	
References		
1.	Marilyn Wolf, "Computer as Components, Principles of Embedded Computing System Design" 3rd edition, Elsevier-2014.	
2.	Robert Spalding: "Storage Networks The Complete Reference", Tata McGraw-Hill, 2011	
3.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Pervasive Computing	**Semester**		M.Tech
Department	Computer Science & Engineering	**Course Code**		CST830
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course will enable students to:

1. Learn the basic architecture and concepts till Third Generation Communication systems.
2. Understand the latest 4G Telecommunication System Principles.
3. Explore the HCI in Pervasive environment
4. Apply the pervasive concepts in mobile environment

Course Outcomes (COs)

Upon completion of this course the students should be able to:

CO1: Obtain a thorough understanding of Basic architecture and concepts of till Third Generation Communication systems.

CO2: Explain the latest 4G Telecommunication System Principles.

CO3: Work on the pervasive concepts in mobile environment.

CO4: Implement the HCI in Pervasive environment.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction:** History – Wireless communications: GSM – DECT – TETRA – UMTS – IMT – 2000 – Blue tooth, WiFi, WiMAX, 3G, WATM - Mobile IP protocols -WAP push architecture-WML scripts and applications. Data networks – SMS – GPRS – EDGE – Hybrid Wireless100 Networks – ATM – Wireless ATM.	2
2.	**Overview of 4G Telecommunications System:** Introduction. LTE-A System Architecture. LTE RAN. OFDM Air Interface. Evolved Packet Core. LTE Requirements. LTE-Advanced. OFDMA – Introduction. OFDM Principles. LTE Uplink—SC-FDMA. Summary of OFDMA.	3
3.	**Pervasive Concepts and Elements:** Technology Trend Overview - Pervasive Computing: Concepts - Challenges - Middleware - Context Awareness - Resource Management - Human–Computer Interaction - Pervasive Transaction Processing - Infrastructure and Devices - Wireless Networks - Middleware for Pervasive Computing Systems - Resource Management - User Tracking- Context Management -Service Management - Data Management - Security Management.	3
4.	**HCI in Pervasive Computing:** Prototype for Application Migration - Prototype for Multimodalities - Human–Computer Interface in Pervasive Environments - HCI Service and	3

	Interaction Migration - Context- Driven HCI Service Selection - Interaction Service Selection Overview - User Devices - Service-Oriented Middleware Support - User History and Preference - Context Manager - Local Service Matching - Global Combination - Effective Region - User Active Scope - Service Combination Selection Algorithm.	
5.	**Pervasive Mobile Transactions:** Pervasive Mobile Transactions - Introduction to Pervasive Transactions - Mobile Transaction Framework - Unavailable Transaction Service - Pervasive Transaction Processing Framework - Context-Aware Pervasive Transaction Model - Context Model for Pervasive Transaction Processing - Context-Aware Pervasive Transaction Model - A Case of Pervasive Transactions - Dynamic Transaction Management - Context-Aware Transaction Coordination Mechanism - Coordination Algorithm for Pervasive Transactions - Participant Discovery - Formal Transaction Verification - Petri Net with Selective Transition.	3
Text Books		
1.	Alan Colman, Jun Han, and Muhammad Ashad Kabir, Pervasive Social Computing Socially-Aware Pervasive Systems and Mobile Applications, Springer, 2016.	
2.	J.Schiller, ―Mobile Communication‖, Addison Wesley, 2000.	
References		
1.	Juha Korhonen, ―Introduction to 4G Mobile Communications‖ , Artech House Publishers, 2014	
2.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	High Speed Networks	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST831	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course will enable students to:

1. Understand the overview of High speed computer networks and TCP/IP protocols.
2. Learn the concept of Congestion and Traffic Management.
3. Explore the Integrated and Differentiated Services in the context of high speed networks.
4. Realize the Quality of Service metrics in the context of high speed networks.

Course Outcomes (COs)

Upon completion of this course the students should be able to:

CO1: Express the insights of high speed networks.
CO2: Understand congestion and traffic management principles.
CO3: Realise the TCP and ATM congestion control.
CO4: Understand the various integrated and differentiated services and correlate the Protocols for QoS Support.

Course Outline / Content

Unit	Topics	Week
1.	**High Speed Networks:** Frame Relay Networks – Asynchronous transfer mode – ATM Protocol Architecture, ATM logical Connection, ATM Cell – ATM Service Categories – AAL, High Speed LANs: Fast Ethernet, Gigabit Ethernet, Fiber Channel – Wireless LANs: applications, requirements – Architecture of 802.11	2
2.	**Congestion And Traffic Management:** Queuing Analysis-Queuing Models – Single Server Queues – Effects of Congestion – Congestion Control – Traffic Management – Congestion Control in Packet Switching Networks – Frame Relay Congestion Control.	3
3.	**TCP And ATM Congestion Control:** TCP Flow control – TCP Congestion Control – Retransmission – Timer Management – Exponential RTO backoff – KARN's Algorithm – Window management – Performance of TCP over ATM. Traffic and Congestion control in ATM – Requirements – Attributes – Traffic Management Frame work, Traffic Control – ABR traffic Management – ABR rate control, RM cell formats, ABR Capacity allocations – GFR traffic management.	3
4.	**Integrated And Differentiated Services:** Integrated Services Architecture – Approach, Components, Services- Queuing Discipline, FQ, PS, BRFQ, GPS, WFQ – Random Early Detection, Differentiated Services	3

5.	**Protocols For QoS Support:** RSVP – Goals & Characteristics, Data Flow, RSVP operations, Protocol Mechanisms– Multiprotocol Label Switching – Operations, Label Stacking, Protocol details – RTP – Protocol Architecture, Data Transfer Protocol, RTCP.	3
Text Books		
1.	William Stallings, "High Speed Networks and Internet", Pearson Education, Second Edition, 2002.	
References		
1.	IrvanPepelnjk, Jim Guichard, Jeff Apcar, "MPLS and VPN architecture", Cisco Press, Volume 1 and 2, 2003.	
2.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Cyber Law and Forensics	**Semester**		M.Tech
Department	Computer Science & Engineering	**Course Code**		CST832
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course will enable students to:

- Understand Cyber Law and Forensics
- Get insights and understanding of Cyber-crimes, cyber rights Computer forensics fundamentals.
- Analyse various computer forensics technologies.
- Identify methods for data recovery and to apply the methods for preservation of digital evidence.

Course Outcomes (COs)

By the end of this course, the student will be able to:

CO1: Understand the principles of cyber law followed across the world.
CO2: Realize the use of Cyber Forensics and physical evidence.
CO3: Be aware of Cyber Crimes.
CO4: Explore about digital forensics and different offences under IT Act, 2000.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction:** Computers and its Impact in Society, Overview of Computer and Web Technology, Need for Cyber Law, Cyber Jurisprudence at International and Indian Level. **Cyber Law** - International Perspectives UN & International Telecommunication Union (ITU) Initiatives Council of Europe - Budapest Convention on Cybercrime, Asia-Pacific Economic Cooperation (APEC),Organization for Economic Co-operation and Development (OECD),World Bank, Commonwealth of Nations	3
2.	**Cyberspace Rights:** Constitutional & Human Rights Issues in Cyberspace Freedom of Speech and Expression in Cyberspace, Right to Access Cyberspace – Access to Internet, Right to Privacy, Right to Data Protection. **Cyber Forensics:** Introduction and Forensic Types **Physical Evidence:** Finger prints on devices.	2
3.	**Cyber Crimes:** Cyber Crimes & Legal Framework Cyber Crimes against Individuals, Institution and State, Hacking, Digital Forgery, Cyber Stalking/Harassment, Cyber Pornography, Identity Theft & Fraud ,Cyber terrorism.	3
4.	**Cyber Defamation:** Cyber Defamation, Different offences under IT Act, 2000, Cyber Torts Cyber Defamation, Different Types of Civil Wrongs under the IT Act, 2000, Electronic Evidence.	3

	Intellectual Property Issues in Cyber Space Interface with Copyright Law, Interface with Patent Law, Trademarks & Domain Names Related issues	
5.	**System Forensics:** File signatures, volatile/non-volatile data, File formats, Metadata, existing system forensics tools **Network Forensics:** Firewalls, Intrusion Detection System, Security event management software **Google Forensics:** analysis of search data/information gathered from various google services. **An Indian perspective on digital forensics:** Indian IT act, Cyber laws, Case studies. Indian Context of Jurisdiction and IT Act, 2000. International Law and Jurisdictional Issues in Cyberspace.	3
Text Books		
1.	Chris Reed & John Angel, Computer Law, OUP, New York, (2007).	
2.	Sudhir Naib, The Information Technology Act, 2005: A Handbook, OUP, New York (2011)	
References		
1.	Justice Yatindra Singh, Cyber Laws, Universal Law Publishing Co, New Delhi, (2012)	
2.	S. R. Bhansali, Information Technology Act, 2000, University Book House Pvt. Ltd.	
3.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Network Management	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST833	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course will enable students to:

1. Assess the need of interoperable network management.
2. Understand the concepts and architecture behind standards based network management.
3. Illustrate the concepts and terminology associated with SNMP.
4. Learn the applications of Network Management.

Course Outcomes (COs)

By the end of the course, the students will be able to:

CO1: Analyse the current status of network management principles.
CO2: Learn the components in Network Management Model.
CO3: Evaluate the importance of SNMP Network Management.
CO4: Identify the various components of Broadband Network Management and explore the applications of network management.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction:** Analogy of Telephone Network Management, Data and Telecommunication Network, Distributed computing Environments, TCP/IP-Based Networks: The Internet and Intranets, Communications Protocols and Standards-Communication Architectures, Protocol Layers and Services; Network and System Management, Network Management System platform, Current Status and Future of Network Management.	3
2.	**Basic Foundations:** Standards, Models, and Language: Network Management Standards, Network Management Model, Organization Model, Information Model – Management Information Trees, Managed Object Perspectives, Communication Model.	2
3.	**SNMPv1 Network Management:** Managed Network: The History of SNMP Management, Internet Organizations and standards, Internet Documents, The SNMP Model, The Organization Model and System Overview. The Information Model – Introduction, The Structure of Management Information, Managed Objects, Management Information Base. The SNMP Communication Model – The SNMP Architecture, Administrative Model, SNMP Specifications, SNMP Operations.	3
4.	**Broadband Network Management:** Broadband Access Networks and Technologies: Broadband Access Networks,	3

	Broadband Access Technology; HFCT Technology: The Broadband LAN, The Cable Modem and CMTS Management, HFC Link Management, RF Spectrum Management, DSL Technology; Asymmetric Digital Subscriber Line Technology – Role of the ADSL Access Network in an Overall Network, ADSL Architecture, ADSL Channeling Schemes, ADSL Encoding Schemes;	
5.	**Network Management Applications:** Configuration Management- Network Provisioning, Inventory Management, Network Topology, Fault Management- Fault Detection, Fault Location and Isolation Techniques, Performance Management – Performance Metrics, Data Monitoring, Problem Isolation, Performance Statistics; Event Correlation Techniques – Rule-Based Reasoning, Model-Based Reasoning, Case Based Reasoning, Codebook correlation Model, State Transition Graph Model, Finite State Machine Model.	3
Text Books		
1.	J. Richard Burke: Network management Concepts and Practices: a Hands-On Approach, PHI, 2008	
References		
1.	Benoit Claise, Ralf Wolter. "Network Management: Accounting and Performance Strategies".Cisco Press, 2007.	
2.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Network Programming	**Semester**	M. Tech	
Department	Computer Science & Engineering	**Course Code**	CST834	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course will enable students to:

1. Focus on the programming aspects of computer networks.
2. Introduce practical aspects of computer network programming, with emphasis on the Internet.
3. Understand the TCP/IP protocol stack and some of its important protocols.
4. Expose to multi-tier application development and RPC technologies including: RMI, CORBA, EJB, and Web Services.

Course Outcomes (COs)

By the end of the course, the students will be able to:

CO1: Understand the concepts and foundations of network programming
CO2: Develop sockets based network programs.
CO3: Build concurrent programming models that are used for building web servers.
CO4: Design server application using Server-Side Programming and develop web applications by incorporating MVC pattern.

Course Outline / Content

Unit	Topics	Week
1.	Overview of multi-tier enterprise applications, review of web technologies (HTML, XHTML, CSS, JavaScript, HTML DOC. NetBeans IDE, J2SE, J2ME, and Design Patterns Review of Computer Networks, OSI Model, TCP/IP protocol suite	2
2.	User Datagram Protocol, Internet Control Protocol, UDP Programming in Java. Transmission Control Protocol, Multithreading & TCP Sockets Programming in Java	3
3.	Security Overview, Java Cryptography Extension (JCE), and Java Secure Socket Extension (JSSE), Email (Java Mail): SMTP, POP, IMAP, HTTP, Cookies & HTTP Proxies, URL Programming	3
4.	Asynchronous JavaScript and XML (AJAX), Common Gateway Interface (CGI), Introduction to Server-Side Programming using Java Servlets, Creating Servlet Based Web Applications. Servlet Session Management. Java Naming and Directory Interface (JNDI).	3
5.	Introduction to Enterprise Java Beans (EJB), Session Beans, Entity Beans, Java Server Pages (JSP), JSP vs. Servlets, Handling HTML Forms using JavaBeans, MVC pattern, Java	3

	Server Faces (JSF), Input Validation, Site Navigation, Database, Connectivity. Web Services (Clients and Servers), SOAP, UDDI, Remote Method Invocation (RMI), Common Object Broker Architecture (CORBA).	
Text Books		
1.	David Reilly and Michael Reilly, *Java Network Programming and Distributed Computing*, Addison-Wesley (ISBN: 0-201-71037-4).	
2.	W. Richard Stevens, *TCP/IP Illustrated, Volume 1: The Protocols*, Addison-Wesley, 1994 (ISBN: 0201633469).	
References		
1.	Unix Network Programming, The Sockets Networking API, Volumes 1, by W Richard Stevens, Bill Fenner, Andrew M. Rudoff, published by Addison-Wesley	
2.	*Java Network programming* 2'nd ed., by Hugues, Shoffner, and Hamner,	
3.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Network and System Security	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST835	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course will enable students to:

1. Understand the issues related to security in modern networked computer systems.
2. Exposed to learn security-relevant decisions in designing IT infrastructures, techniques to secure complex systems and practical skills in managing a range of systems, from personal laptop to large-scale infrastructures.
3. Learn web security essentials.
4. Explore network defences and Mobile platform security models.

Course Outcomes (COs)

By the end of the course, the students will be able to:

CO1: Identify vulnerabilities of IT systems.

CO2: Use basic security tools to enhance system security and can develop basic security enhancements in stand-alone applications.

CO3: Evaluate web Application Security metrics.

CO4: Understand malicious Software and Software Security and explore Security Risk Management principles.

Course Outline / Content

Unit	Topics	Week
1.	**Computer Security Concepts**- Introduction to Information Security, Introduction to Data and Network Security, Integrity, and Availability, NIST FIPS 199 Standard, Assets and Threat Models, Examples. **Control Hijacking–** Attacks and defenses, Buffer overflow and control hijacking attacks **Network Protocols and Vulnerabilities**- Overview of basic networking infrastructure and network protocols, IP, TCP, Routing protocols, DNS.	2
2.	**Exploitation techniques and fuzzing**- Finding vulnerabilities and exploits **Dealing with Legacy code**- Dealing with bad (legacy) application code: Sandboxing and Isolation. **Least privilege, access control, operating system security**- The principle of least privilege, Access control concepts, Operating system mechanisms, Unix, Windows, Chromium, and Android.	3
3.	**Basic web security model**- Browser content, Document object model (DOM), Same-origin policy. **Web Application Security**- SQL injection, Cross-site request forgery, Cross-site scripting, Attacks and Defenses, Generating and storing session tokens, Authenticating users, The SSL protocol, The lock icon, User interface attacks, Pretty Good Privacy.	3

4.	**Network Defenses-** Network defense tools, Secure protocols, Firewalls, VPNs, Tor, I2P, Intrusion Detection and filters, Host-Based IDS vs Network-Based IDS, Dealing with unwanted traffic: Denial of service attacks. **Malicious Software and Software Security-** Malicious Web, Internet Security Issues, Types of Internet Security Issues, Computer viruses, Spyware, Key-Loggers, Secure Coding, Electronic and Information Warfare.	3
5.	**Mobile platform security models-** Android, iOSMobile platform security models, Detecting Android malware in Android markets. **Security Risk Management-** How Much Security Do You Really Need, Risk Management, Information Security Risk Assessment: Introduction, Information Security Risk Assessment: Case Studies, Risk Assessment in Practice. **The Trusted Computing Architecture-** Introduction to Trusted Computing, TPM Provisioning, Exact Mechanics of TPM.	3
Text Books		
1.	William Stallings, Network Security Essentials: Applications and Standards, Prentice Hall, 4th edition, 2010.	
2.	. Michael T. Goodrich and Roberto Tamassia, Introduction to Computer Security, Addison Wesley, 2011.	
References		
1.	William Stallings, Network Security Essentials: Applications and Standards, Prentice Hall, 4th edition, 2010.	
2.	Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone, Handbook of Applied Cryptography, CRC Press, 2001	
3.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Distributed and Parallel Computing	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST836	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course will enable students to:

1. Gain knowledge on principles and practice underlying in the design of distributed systems.
2. Learn the algorithms and applications in distributed computing.
3. Know the insights of Distributed operating systems.
4. Understand the principles of Distributed resource management.

Course Outcomes (COs)

By the end of the course, the students will be able to:

CO1: Realize the foundations of Distributed Systems.
CO2: Explore the algorithms and components of distributed systems.
CO3: Understand in detail the functionalities of Distributed operating systems.
CO4: Gain knowledge on Distributed resource management, load balancing and use protocols for Failure recovery and fault tolerance.

Course Outline / Content

Unit	Topics	Week
1.	**An overview of parallel computing**: Languages and programming environments, Message passing computing, Partitioning and divide-and-conquer strategies, Pipelined computations, Synchronous computations, Load balancing and termination detection, Programming with shared memory.	3
2.	**Algorithms and applications**: Components of distributed systems, Communication technologies, communication services. Distributed algorithms and protocols: examples of distributed algorithms, clock synchronization, logical and vector clocks, election algorithms, consensus algorithms, proof of correctness, complexity analysis.	3
3.	**Distributed operating systems**: system models, file services, name services, process synchronization and coordination, case studies. Distributed shared memory: algorithms for implementing DSM, coherence protocols.	3
4.	**Distributed resource management**: load sharing, load balancing, resource monitoring.	2
5.	**Failure recovery and fault tolerance**: check-pointing, recovery, fault-tolerant models and protocols. Research issues in distributed systems, real-time protocols, standardization issues, cluster and grid computing.	3

Text Books

1.	George Coulouris, Jean Dellimore and Tim KIndberg, “Distributed Systems Concepts and Design”, Pearson Education.
2.	Ajay D. Kshemkalyani and MukeshSinghal, “Distributed Computing – Principles”.
3.	Andrew S. Tanenbaum and Maarten van Steen. “Distributed Systems: Principles and Paradigms” (DSPD), Prentice Hall
References	
1.	Mukesh Singhal and N. G. Shivaratri, “Advanced Concepts in Operating Systems”
2.	Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers, by Barry Wilkinson, Michael Allen. Prentice Hall.
3.	Latest Relevant Research Papers

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Advanced Cryptography	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST837	
Credits	3	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course will enable students to:

1. Learn fundamental concepts of computer security and cryptography and utilize these techniques in computing systems.
2. Use pseudo random number generation algorithm in practice.
3. Implement cryptography algorithms such as Message Authentication Codes (MACs) and Public Key Signature Schemes.
4. Explore the use cases of Network Security Internet security protocols.

Course Outcomes (COs)

By the end of the course, the students will be able to:

CO1: Realize the applications of Cryptography in the current scenario.

CO2: Acquire knowledge on standard algorithms used to provide confidentiality, integrity and authenticity.

CO3: Implement the various key distribution and management schemes.

CO4: Design security applications in the field of Information technology.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction** :Attacks on computers and computer security, need for security, approaches , principles, types of attacks ,operational model of network security Cryptography concepts and techniques, substitution, transposition, encryption and decryption, symmetric, Asymmetric key cryptography, key range size, possible type of attacks.	2
2.	**Symmetric-Key Cryptography**: DES Block ciphers modes, feistel ciphers DES. working of DES ,cracking des ,problems on des., 2DES, 3DES, des design ,Side channel attacks, Differential cryptanalysis. AES, overview of Rijndael - comparison with others. Symmetric ciphers, Blowfish in practice ,RC4, RC5,RC6,IDEA. **Asymmetric-Key Cryptography**: RSA, Elliptic curve cryptography ECC, Digital certificates.	3
3.	**Cryptographic Hash Functions Hashing schemes**: SHA-family, MAC, Digital Signature RSA El Gomel , DSS DSA, Authentication Protocols , applications Kerberos, X.509 Directory services	3
4.	**Network Security Internet security protocols**: SSL,TLS TSP WAP security, SET Hashing Authentication & Signature Schemes E-mail security, Email architecture SSL, PGP, MIME, S/MIME Internet Protocol Security (IPSec) IPSec architecture,	3

	IPSec verses other layers security Mobile IPSec, VPN, Web security SSL, TLS, SET etc	
5.	**System Security**: Intruders, types of attacks, protecting against Intruders honeypots, scanning and analysis tools, Viruses and worms, types of viruses, protection, Firewall architecture implementing firewalls, xml firewalls, trusted systems, trusted system applications, multi-level security, trusted products. Security implementation, wireless security, securities in Adhoc-networks.	3
Text Books		
1.	Cryptography And Network Security Principles and Practices William Stallings, Prentice Hall	
2.	Cryptography and Network Security Behrouz A. Forouzan, Tata McGraw-Hill	
3.	Wade Trappe, Lawrence C Washington, "Introduction to Cryptography with coding theory", Pearson Education.	
References		
1.	W. Mao, "Modern Cryptography – Theory and Practice", Pearson Education	
2.	Charles P. Pfleeger, Shari Lawrence Pfleeger – Security in computing – Prentice Hall of India.	
3.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Advances in Wireless Communication	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST838	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course will enable students to:

1. Study the different channel models in wireless communications.
2. Analyse the capacity of different wireless channels.
3. Compare the various multiple access techniques.
4. Explore Multiuser detection techniques.

Course Outcomes (COs)

By the end of the course, the students will be able to:

CO1: Understand the wireless channel characteristics and its statistical models.

CO2: Be well versed with the popular wireless communications technologies.

CO3: Understand the achievable capacity of digital communications over time-varying fading channels.

CO4: Formulate adaptive power and rate control in OFDM and MIMO systems.

Course Outline / Content

Unit	Topics	Week
6.	**Mathematical preliminaries**: Review of probability theory, Essentials of (convex) optimization theory, Essentials of information theory.	2
7.	**Wireless channel models and latest multiple access Technologies**: Introduction to various channel models (namely frequency flat, frequency selective, Rayleigh and Rician fading models).	3
8.	**Introduction to CDMA and associated standards**: Introduction to OFDM, Capacity of scalar wireless channels: Introduction to the notion of channel capacity, Capacity of time invariant channels, Capacity of time varying (or fading) channels.	3
9.	**Capacity of vector (MISO, SIMO, MIMO) channels and spatial Multiplexing**: Capacity of MISO and SIMO channels for both time varying and time invariant cases, Capacity of MIMO systems, V-BLAST and D-BLAST, STBC and STTC.	3
10.	**Multiuser detection (MUD)**: Introduction to MUD, Linear decorrelator, MMSE MUD, Adaptive MUD, Application of convex optimization to wireless design: Minimizing PAPR in OFDM systems via convex optimization, Applications of convex optimization to MAC and flow control problems.	3

Text Books

1.	David Tse and Pramod Viswanath, Fundamentals of wireless communications,

	Cambridge University Press, First Edition, 2012
2.	Henrik Schulz And Christian L¨uders, Theory and Applications of OFDM and CDMA Wideband Wireless Communications, , John Wily & Sons, First Edition, 2005
References	
3.	Goldsmith Andrea, Wireless Communications, CAMBRIDGE UNIVERSITY PRESS, First Edition ,2005
4.	L.Hanzo,M.Munster, B.J.Choi and T.Keller, OFDM and MC-CDMA for Broadband Multi-user Communications, WLANs and Broadcasting, John Wiley & Sons,2003
3.	Latest Relevant Research Papers

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Multimedia Communications	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST839	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course will enable students to:

1. Understand the fundamentals of the technologies in Multimedia Communication.
2. Learn the principled design of effective media for entertainment, communication.
3. Analyse various compression schemes.
4. Explore the multimedia Systems Architecture.

Course Outcomes (COs)

After completion of this course students will be able to:

CO1: Compare Non- Temporal and Temporal Media.
CO2: Understand the applications of Multimedia Communication Technology.
CO3: Analyse the various compression techniques for image, audio and video.
CO4: Explore various application of Multimedia Information Management.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction:** Introduction to Multimedia and its Applications, Concept of Non- Temporal and Temporal Media. Non-Temporal Media: Images, Graphics, Text. Temporal Media: Video, Audio, and Animation. Hypertext and Hypermedia. Presentations: Synchronization, Events, Scripts and Interactivity, Introduction to Authoring Systems.	2
2.	**Multimedia Communication Technology:** Multimedia Communications, multimedia communication protocols (UDP, RTP, RTCP, XTP, TELNET, IP Multicast etc), network performance parameters, streaming. Multimedia input and output technologies, storage and retrieval technologies.	3
3.	**Compression Techniques:** Basic concepts of Compression, Text Compression. Still Image Compression**:** JPEG and other Image Compressions. Features of JPEG2000. Video Compression**:** MPEG- 1&2 Compression Schemes, MPEG-4 Natural Video Compression. Audio Compression**:** Introduction to speech and Audio Compression, MP3 Compression Scheme.	3
4.	**Multimedia Systems Architecture:** General Purpose Architecture for Multimedia Support: Introduction to Multimedia PC/Workstation Architecture, Characteristics of MMX instruction set. I/O systems: Overview of USB port and IEEE 1394 interface, Operating System Support for Multimedia. Data: Resource Scheduling with real-time considerations, File System, I/O Device Management.	3

5.	**Multimedia Information Management and Virtual Reality:** Multimedia Database Design, Content Based Information Retrieval: Image Retrieval, Video Retrieval, Overview of MPEG-7, Design of video-on-Demand Systems. Introduction to Virtual Reality and Virtual Reality Systems, Related Technologies.	3
Text Books		
1.	Multimedia System Design, Andleigh and Thakarar , PHI	
2.	Multimedia Technology & Application, David Hillman, Galgotia	
3.	Multimedia Communications by Fred Halsall	
References		
1.	Multimedia Computing Communication and Application, Steinmetz, Pearson Edn.	
2.	Virtual Reality Systems, John Vince, Pearson Education.	
3.	Latest Relevant Research Papers	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Mobile Computing	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST840	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course will enable students to:

1. Learn the basics of mobile telecommunication system.
2. Be familiar with the network layer protocols and Ad-Hoc networks.
3. Know the basis of transport and application layer protocols.
4. Gain knowledge about different mobile platforms and application development.

Course Outcomes (COs)

After completion of this course students will be able to:

CO1: Correlate the basics of mobile telecommunication systems

CO2: Illustrate the generations of telecommunication systems in wireless networks

CO3: Determine the functionality of MAC, network layer and Identify a routing protocol for a given Ad hoc network

CO4: Realise the functionality of Transport and Application layers

Course Outline / Content

Unit	Topics	Week
1.	**Introduction:** Introduction to Mobile Computing – Applications of Mobile Computing- Generations of Mobile Communication Technologies- Multiplexing – Spread spectrum -MAC Protocols – SDMA- TDMA- FDMA- CDMA.	2
2.	**Mobile Telecommunication Systems:** Introduction to Cellular Systems - GSM – Services & Architecture – Protocols – Connection Establishment – Frequency Allocation – Routing – Mobility Management – Security – GPRSUMTS – Architecture – Handover – Security.	3
3.	**Mobile Network Layer:** Mobile IP – DHCP – AdHoc– Proactive protocol-DSDV, Reactive Routing Protocols – DSR, AODV , Hybrid routing –ZRP, Multicast Routing- ODMRP, Vehicular Ad Hoc networks (VANET) –MANET Vs VANET – Security.	3
4.	**Mobile Transport And Application Layer:** Mobile TCP– WAP – Architecture – WDP – WTLS – WTP –WSP – WAE – WTA Architecture – WML.	3
5.	**Mobile Platforms and Applications:** Mobile Device Operating Systems – Special Constraints & Requirements – Commercial Mobile Operating Systems – Software Development Kit: iOS, Android, BlackBerry, Windows Phone – M-Commerce – Structure – Pros & Cons – Mobile Payment System – Security Issues.	3

Text Books

1.	Jochen Schiller, *Mobile Communications*, Pearson Education, 2nd Edition, 2009.
2.	Kurnkum Garg, *Mobile Computing*, Pearson Education , 2010
3.	Asoke K Talukder, Roopa R Yavagal, *Mobile Computing*, TMH 2008.
References	
1.	Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, "Principles of Mobile Computing", Springer, 2003
2.	William.C.Y.Lee, "Mobile Cellular Telecommunications-Analog and Digital Systems", Second Edition,TataMcGraw Hill Edition ,2006.
3.	Latest Relevant Research Papers

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Special Topics in Networks	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST841	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course will enable students to:

1. Learn the basics of wireless physical layer.
2. Explore wide range of applications of sensor networks.
3. Understand the characteristics of mesh networks and WiMAX.
4. Study important research issues in wireless networking.

Learning Outcomes

After completion of this course students will be able to:

CO1: Understand the concepts of wireless physical layer.
CO2: Illustrate the applications of wireless sensor networks.
CO3: Explore the applications and issues in wireless mesh networks and WiMAX.
CO4: Analyze security issues in wireless networks.

Course Outline / Content

Unit	Topics	Week
1.	**Wireless Physical Layer**: wireless propagation channels, transceivers and signal processing, multiple access and advanced transceiver schemes, and standardised wireless systems.	2
2.	**Sensor Networks**: Single-Node Architecture, Network Architecture, Physical Layer, MAC Protocols, Link-Layer Protocols, Naming and Addressing, Time Synchronization, Localization and Positioning, Topology Control, Routing Protocols, Data-Centric and Content-Based Networking.	3
3.	**Mesh Networks**: Architectures and Deployment Strategies for Wireless Mesh Networks, End-to-End Design Principles for Broadband Cellular Mesh Networks, Medium Access Control and Routing Protocols for Wireless Mesh Networks, Channel Assignment Strategies for Wireless Mesh Networks.	3
4.	**WiMAX**: Cognitive radio, cooperative communications and relaying, video coding, 3GPP Long Term Evolution, and WiMax; plus significant new sections on multi-user MIMO, 802.11n, and information theory.	3
5.	**Security for wireless networks**: Pair-Wise Key Establishment, Clone Detection, Secure Data Aggregation.	3

Text Books

1.	Wireless Communications - Andreas F. Molisch, John Wiley and Sons, 2005
2.	Protocols and Architectures for Wireless Sensor Networks - Holger Karl and Andreas Willig, John Wiley and Sons, 2005
3.	Wireless Mesh Networks -Architectures and Protocols, Hossain, Ekram, Leung, Kin K, Springer Signals & Communication, 2008.

References	
1.	“Information Theory and Coding” by N Abramson
2.	Information Security: Principles and Practice - Mark Stamp, John Wiley and Sons, 2005
3.	Latest Relevant Research Papers

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Introduction to Data Science	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST842	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course will enable students to:

1. Learn the fundamentals of statistics and probability required for data science.
2. Apply statistical methods to formulate and test data hypotheses
3. Apply statistical inference to uncover relationships within data-sets
4. Understand the role of ML and DL in the data science pipeline

Learning Outcomes

After completion of this course students will be able to:

CO1: Describe and visualize the data that is used by data science applications.
CO2: Demonstrate skills in inferential statistics.
CO3: Model the data using statistical tools
CO4: Design and develop data science systems.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction:** what is data science? Are AI and Data Science related? Knowledge Representation & Reasoning, Decision Making, Data collection, Processing and storing data.	2
2.	**Describing Data and Visualizations:** Descriptive statistics, different types of data, describing relationship between variables. Measures of Centrality and Spread, Effect of Transformations on the measures of centrality. Visualizations: Histogram, Stem and Leaf Plots, Box plots.	3
3.	**Inferential Statistics:** sample spaces, events, random variables, distribution and sampling strategies, Central Limit Theorem, Chi-square distribution, Point and Interval estimators. Problems in Data Science - Handling missing data, case study.	3
4.	**Modeling Data:** statistical modeling - Hypothesis Testing, Two tailed & one tailed z- test, two tailed & one tailed t- test. Algorithmic modelling - Machine Learning Algorithms.	3
5.	**Engineering Data Science Systems**: Engineering Aspects of Data Science, System Perspective of Data Science, Business Understanding, Data Understanding, Preparation & Modelling, Evaluation & Deployment, and Programming Tools.	3

Text Books

1.	Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O'Reilly. 2014.
2.	Jure Leskovek, Anand Rajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press. 2014.

3.	Foster Provost and Tom Fawcett. Data Science for Business: What You Need to Know about Data Mining and Data-analytic Thinking. ISBN 1449361323. 2013.
References	
1.	Foster Provost and Tom Fawcett. Data Science for Business: What You Need to Know about Data Mining and Data-analytic Thinking. ISBN 1449361323. 2013.
2.	Latest Relevant Research Papers

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Big Data	**Semester**	M. Tech	
Department	Computer Science & Engineering	**Course Code**	CST843	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. To gain an insight into development and consequences with Big Data Concepts.
2. To learn big data analysis tools and techniques to foster better business decision-making.
3. To gain deep insight of Big Data for specific products like Hadoop training.
4. To learn ways to query data using pig and hive.

Course Outcomes

By the end of course, students will be able to:

CO1. Store, manage, and analyse unstructured data.
CO2. Realise data analytic life cycle, patterns and design map reduce programs.
CO3. Assess the big data analytic architecture and Hadoop environment.
CO4. Querying data with Pig and Hive and analyse difference between Hive and Pig.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction:** Big Data Overview - State of the practice in analytics - The role of the Data Scientist - Big Data Analytics in Industry Verticals, Big data sources.	2
2.	**Data Analytic patterns:** Key roles for a successful analytic project - Main phases of the lifecycle. Introduction to MapReduce/Hadoop for analyzing unstructured data-design patterns- Filtering Patterns-Join Patterns-Meta Patterns - Hadoop ecosystem of tools - In-database Analytics - NoSQL, JSON store.	3
3.	**Big data analytic architecture and Hadoop:** Big Data From Technology Perspective- Hadoop: Components of Hadoop, Application Development in Hadoop, The Distributed File System: HDFS, Hadoop Cluster Architecture.	3
4.	**MapReduce Algorithm Design:** MapReduce Basics - Functional Programming Roots - Mappers and Reducers -The Execution Framework - Partitioners and Combiners- MapReduce Algorithm Design - Local Aggregation - Pairs and Stripes - Computing Relative Frequencies - Secondary Sorting- Relational Joins.	3
5.	**Pig and Hive**: **Pig**: Need of Pig, Pig high level commands, Pig vs. Map Reduce, Use cases of Pig, Pig's execution, Data analytic task using Pig, Conceptual data flow, Pig latin program, Pig data models. **Hive**: Use cases of Hive, Pig vs. Hive, Hive architecture and components, Primitive and complex types in Hive, Hive data model, Basic hive operations, executing Hive scripts and Hive UDFs.	4

Text Books

1.	Noreen Burlingame ,"Little Book of Big Data" Ed. 2012
2.	Tom White, "Hadoop , the definitive guide", O'Reilly Media, 2010

References	
1.	Donald Miner, “Map Reduce Design Patterns: Building Effective Algorithms and Analytics for Hadoop and Other Systems”, O'Reilly Media, 2012
2.	Nathan Marz , “Big Data: Principles and best practices of scalable real-time data systems”, Manning Publications, 2012 6. Big Data Now: Current Perspectives, O’Reilly Radar [kindle Edition], 2011.
3.	Refer latest relevant research papers.

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Data Mining	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST844	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. To understand data warehouse concepts, architecture, business analysis and tools
2. To understand data pre-processing and data visualization techniques
3. To study algorithms for finding hidden and interesting patterns in data
4. To understand and apply various classification and clustering techniques using tools.

Course Outcomes

Upon completion of the course, the students should be able to:

CO1. Design a Data warehouse system and perform business analysis with OLAP tools.
CO2. Apply frequent pattern and association rule mining techniques for data analysis
CO3. Apply appropriate classification and clustering techniques for data analysis
CO4. Use Weka tool to apply ML algorithms on real life dataset.

Course Outline / Content

Unit	Topics	Week
1.	**Data warehouse and OLAP**: Basic Concepts – Data Warehousing Components – Building a Data Warehouse – Database Architectures for Parallel Processing – Parallel DBMS Vendors – Multidimensional Data Model – Data Warehouse Schemas for Decision Support, Concept Hierarchies -Characteristics of OLAP Systems – Typical OLAP Operations, OLAP and OLTP.	3
2.	**Introduction to Data Mining**: Knowledge Discovery Process – Data Mining Techniques – Issues – applications- Data Objects and attribute types, Statistical description of data, Data Preprocessing – Cleaning, Integration, Reduction, Transformation and discretization, Data Visualization, Data similarity and dissimilarity measures.	3
3.	**Frequent Pattern Analysis**: Mining Frequent Patterns, Associations and Correlations – Frequent Pattern Mining Methods- Pattern Evaluation Method – Pattern Mining in Multilevel, Multi-Dimensional Space – Constraint Based Frequent Pattern Mining, Classification using Frequent Patterns	3
4.	**Classification, Clustering, outlier analysis**: Decision Tree Induction – Bayesian Classification – Rule Based Classification – Classification by Back Propagation – Support Vector Machines — Lazy Learners – Model Evaluation and Selection-Techniques to improve Classification Accuracy. Clustering Techniques – Cluster analysis-Partitioning Methods – Hierarchical Methods – Density Based Methods – Grid Based Methods – Evaluation of clustering – Clustering high dimensional data- Clustering with constraints, Outlier analysis-outlier detection methods.	3
5.	**WEKA Tool**: Datasets – Introduction, Iris plants database, Breast	3

	cancer database, Auto imports database – Introduction to WEKA, The Explorer – Getting started, Exploring the explorer, Learning algorithms, Clustering algorithms, Association–rule learners.	
Text Books		
1.	Kamber and Han, “Data Mining Concepts and Techniques”, Hart Court India P. Ltd. Elsevier Publications Second Edition, 2012.	
2.	Alex Berson and Stephen J.Smith, ―Data Warehousing, Data Mining & OLAP‖, Tata McGraw – Hill Edition, 35th Reprint 2016.	
References		
1.	Ian H.Witten and Eibe Frank, ―Data Mining: Practical Machine Learning Tools and Techniques, Elsevier, Second Edition.	
2.	Refer latest relevant research papers.	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Deep Learning	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST845	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. Able to introduction deep learning and application of modern neural networks.
2. Understand the Deep learning algorithms & extract layered representations of data.
3. Analysis Deep neural network to represent image pixels first with edges.
4. Deep learning is behind many recent advances in AI.

Course Outcomes

Upon completion of the course, the students should be able to:

CO1. Exposed to basics of neural network models & algorithms for deep neural networks.
CO2. Characterize of optimization algorithms and non-linear activation functions.
CO3. Learn various initialization methods and regularization techniques.
CO4. Build convolutional networks and use them to classify images.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction to Neural Networks**: 6 elements of machine learning/deep learning – Data, task, model, loss function, learning algorithm, evaluation. MP Neuron, Perceptron, Sigmoid Neuron, Gradient Descent, Feedforward Neural networks, Back propagation algorithm. Loss functions: Squared Error loss, Cross Entropy.	3
2.	**Optimization algorithms and activation functions**: Gradient Descent (GD), Momentum based GD, Nesterov's accelerated GD, stochastic GD, mini-batch GD, Adagrad, RMSProp, Adam. Epochs, Learning rate. Activation functions: sigmoid, ReLU, tanh.	3
3.	**Initialization techniques and regularization:** Initialization techniques: Xavier and He initialization. Analyzing the behaviour of the simple and complex models, Bias and Variance, Overfitting in deep neural networks, Hyper parameter tuning, L2 regularization, data augmentation and early stopping.	3
4.	**Convolutional Neural Networks (CNN)**: Convolution operation (1D/2D), 2D convolution with 3D filter, Padding and Stride. Convolution operation related to Neural Network, Sparse Connectivity and Weight Sharing, Max Pooling and Non-Linearities, Training CNNs. CNN architectures: AlexNet, ZFNet, VGGNet, GoogleNet, ResNet. Batch Normalization, Dropout.	3
5.	**Recurrent Neural Networks (RNN)**: Sequence Learning problems, Intuition behind RNN, sequence classification, sequence labelling, Model, Loss function, Learning algorithm, Evaluation. Vanishing and Exploding gradient. LSTMs and	3

	GRUs, Encoder Decoder models, Attention mechanism.	
Text Books		
1.	Bengio, Yoshua, Ian J. Goodfellow, and Aaron Courville. "Deep learning." An MIT Press book in preparation. (2015)	
2.	Bengio, Yoshua. "Learning deep architectures for AI." Foundations and trends in Machine Learning 2.1 (2009): 1127.	
References		
1.	Hochreiter, Sepp, and Jargen Schmidhuber. "Long short-term memory." Neural computation 9.8 (1997): 17351780.	
2.	Refer latest relevant research papers.	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Systems for Data Analytics	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST846	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. To understand the concept of Big Data.
2. Able to use the information, both structured and unstructured for Analysis.
3. To understand the volume, variety and velocity of information that forms Big Data.
4. Hadoop is the core platform for structuring Big Data.

Course Outcomes

Upon completion of the course, the students should be able to:

CO1. To explore the fundamental concepts of data analytics.
CO2. To learn to analyse the big data using intelligent techniques
CO3. To learn to use various techniques for mining data stream.
CO4. Able to implement big data for Medical problems.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction to big data**: Introduction to Big Data Platform, Challenges of Conventional Systems, Intelligent data analysis, Nature of Data, Analytic Processes and Tools, Analysis vs Reporting	2
2.	**Mining data streams** Introduction To Streams Concepts, Stream Data Model and Architecture, Stream Computing, Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream, Estimating Moments, Counting Oneness in a Window, Decaying Window, Real time Analytics Platform (RTAP) Applications, Case Studies - Real Time Sentiment Analysis- Stock Market Predictions.	3
3.	**Hadoop: History of Hadoop**- the Hadoop Distributed File System, Components of Hadoop Analysing the Data with Hadoop- Scaling Out, Hadoop Streaming, Design of HDFS-Java interfaces to HDFS Basics, Developing a Map Reduce Application, How Map Reduce Works, Anatomy of a Map Reduce Job run, Failures-Job Scheduling-Shuffle and Sort – Task execution, Map Reduce Types and Formats, Map Reduce Features Hadoop environment.	4
4.	**Frameworks**: Applications on Big Data Using Pig and Hive , Data processing operators in Pig, Hive services, HiveQL, Querying Data in Hive, fundamentals of HBase and Zookeeper , IBM Infosphere Big Insights and Streams.	3
5.	**Predictive Analytics-** Simple linear regression, Multiple linear regression, Interpretation 5 of regression coefficients. Visualizations - Visual data analysis techniques- interaction techniques - Systems and applications.	3

Text Books	
1.	Michael Berthold, David J. Hand, “Intelligent Data Analysis”, Springer, 2007.
2.	Tom White “Hadoop: The Definitive Guide” Third Edition, O’reilly Media, 2012
References	
1.	Anand Rajaraman and Jeffrey David Ullman, “Mining of Massive Datasets”, CUP, 2012.
2.	Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, Paul Zikopoulos, “Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data”, McGrawHill Publishing, 2012.
3.	Refer latest relevant research papers.

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	**Artificial Intelligence & Fuzzy Logic**	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST847	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. Ability to understand the modern view of AI
2. The major challenges facing AI and the complexity of typical problems within the field.
3. Able to develop real live projects.
4. To understand the concepts of Expert System.

Course Outcomes

Upon completion of the course, the students should be able to:

CO1. Exhibits number of important AI techniques, searching techniques, knowledge representation,
CO2. Understand the constraint management to Real-world problems.
CO3. Will be able to Competent to emulate the techniques presented.
CO4. To able to develop expert System.

Course Outline / Content

Unit	Topics	Week
1.	Introduction to AI: Philosophy of artificial intelligence, Course structure and policies,History of AI, Proposing and evaluating AI applications.	2
2.	Search and Planning: Fundamental and advanced search techniques Problem spaces and search, Heuristic search strategies, Search and optimization (gradient descent) ,Adversarial search, Planning, and scheduling (A*, local search, suboptimal heuristic search, search in AND/OR graphs),Constraint optimization.	3
3.	Knowledge Representation and Reasoning: Logic and inference Temporal reasoning, Knowledge representation and reasoning through propositional and first-order logic, modern game playing. Ontologies, Bayesian reasoning, Fuzzy Logic: Crisp set and Fuzzy set, Basic concepts of fuzzy sets, membership functions. Basic operations on fuzzy sets, Properties of fuzzy sets, Fuzzy relations. Propositional logic and Predicate logic, fuzzy If-Then rules, fuzzy mapping rules, and fuzzy implication functions	4
4.	Neural Networks: Basic concepts of neural networks ,Neural network architectures, Learning methods,The architecture of a back propagation network, Applications.	2
5.	Applications in Machine learning: Supervised and Unsupervised methods machine learning, Supervised vs. unsupervised learning ,Regression -- linear, logistic, ridge, Classification – decision trees, SVM, random forests Reinforcement learning, Introduction to probabilistic graphical models (Bayesian networks, Hidden Markov models, Conditional random fields), Introduction to information systems (information retrieval, information extraction).	4

Text Books	
1.	Rich, E. and Knight, K., “Artificial Intelligence”, Tata McGraw-Hill. 2006
2.	Nilsson, N. J., “Artificial Intelligence: A New Synthesis”, Morgan Kaufmann. 1998
References	
1.	Bratko, I., “Prolog Programming for Artificial Intelligence”, 3rd Ed., Pearson Education. 2001
2.	Refer latest relevant research papers.

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Machine Learning (ML)	**Semester**	M. Tech	
Department	Computer Science & Engineering	**Course Code**	CST848	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. To develop ML solutions for various business problems.
2. To expose fundamental elements in building ML solutions.
3. To build ML applications using real world data.
4. To characterize ML models for solving problems.

Course Outcomes

Upon completion of the course, the students should be able to:

CO1. Acquire knowledge on machine learning skills.
CO2. Build and deploy ML applications using SVMs, Ensemble Learning methods.
CO3. Apply the knowledge on biological neuron using artificial neural networks.
CO4. Predict a real-valued output based on an input value using linear regression.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction to Machine Learning (ML)**: Supervised, Semi supervised, unsupervised machine learning, Types of datasets, Introduction to classification. Decision trees - Hunt's algorithm, GINI index, ID3, C4.5, Tree pruning. KNN, Naïve Bayes (Multinomial NB, Gaussian NB).	2
2.	**SVMs and Ensemble Learning**: SVM – Linear classifier, Margin of SVM, SVM parameter tuning, handling class imbalance in SVM. Ensemble Learning – Majority voting, Bagging, Random forest, Boosting, Stacking. Gradient boosted machines (GBM).	3
3.	**Artificial Neural Networks (ANNs)**: MP Neuron, Perceptron, Sigmoid neuron, decision boundary for a single neuron, 6 elements of ML – Data, task, model, loss function, learning algorithm, evaluation. Feedforward Neural Networks, Backpropagation. Optimization algorithms: GD, Momentum based GD, SGD, Mini-batch GD.	3
4.	**Linear regression and Logistic Regression**: Linear regression: regression task, regression vs. classification. Multiple linear regression. Ridge regularization, Lasso regularization, Elastic net regularization, evaluation metrics and practical considerations for regression. Logistic regression: regression for classification. decision boundary.	3
5	**Clustering, Dimensionality Reduction and ML case studies:** Clustering: K-means, hierarchical agglomerative clustering, applications of clustering, evaluation of cluster quality, ensemble methods for clustering. Dimensionality Reduction: PCA, LDA.	3

	ML case studies.	
Text Books		
1.	Bishop, C., Pattern Recognition and Machine Learning, Berlin: Springer-Verlag, 2006.	
2.	Tom Mitchell, Machine Learning, McGraw Hill, 1997.	
References		
1.	Hastie, Tibshirani, Friedman, The Elements of Statistical Learning, Springer, 2001.	
2.	Sergios Theodoridis, Konstantinos Koutroumbas, Pattern Recognition, Academic Press, 2009.	
3.	Refer latest relevant research papers.	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Data Visualization	**Semester**	M. Tech	
Department	Computer Science & Engineering	**Course Code**	CST849	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. To better understand data.
2. Able to analysis the data stories that clearly depict the points for making decisions.
3. To make all through data graphics.
4. Able to make proper decision making using Data Visualization.

Course Outcomes

By the end of this course, the student will be able to:

CO1. Experiment with and compare different visualization tools.
CO2. Identify appropriate data visualization techniques.
CO3. Analyse, critique, and revise data visualizations.
CO4. Make the student to understand the depth of Data Visulization.

Course Outline / Content

Unit	Topics	Week
1.	Overview of Data Visualization: Why Visualize Data? Introduction to SVG and CSS, Introduction to JavaScript, Introduction to VizHub, Making a Face with D3.js.	3
2.	The Shapes of Data: Input for Visualization: Data and Tasks, Loading and Parsing Data with D3.js	2
3.	Marks and Channels: Encoding Data with Marks and Channels, Rendering Marks and Channels with D3.js and SVG. , Introduction to D3 Scales, Creating a Scatter Plot with D3.js	3
4.	Common Visualization Idioms Reusable Dynamic Components using the General Update Pattern: Reusable Scatter Plot, Common Visualization Idioms with D3.js, Bar Chart, Vertical & Horizontal, Pie Chart and Coxcomb Plot, Line Chart, Area Chart	3
5.	Visualization of Spatial Data, Networks, and Trees Making Maps, Visualizing Trees and Networks, Using Color and Size in Visualization Encoding Data using Color, Encoding Data using Size, Stacked & Grouped Bar Chart, Stacked Area Chart & Streamgraph, Line Chart with Multiple Lines	4

Text Books

1.	Visualization Analysis & Design by Tamara Munzner (2014).
2.	Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures, Claus O Wilke, Shroff/O'Reilly.

References

1.	Anand Rajaraman and Jeffrey David Ullman, “Mining of Massive Datasets”, CUP, 2012.
2.	Refer latest relevant research papers.

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Ethics for data science	**Semester**	M. Tech	
Department	Computer Science & Engineering	**Course Code**	CST850	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. To provide strong foundation for data science
2. Able to develop application area related to data Science.
3. To understand the core concepts and emerging technologies in data science.
4. Able to implement the concepts for developing projects.

Course Outcomes

By the end of this course, the student will be able to:

CO1. Understand the fundamental concepts of data science.
CO2. Evaluate the data analysis techniques for applications handling large data.
CO3. Demonstrate the various machine learning algorithms used in data science process.
CO4. Understand the ethical practices of data science.

Course Outline / Content

Unit	Topics	Week
1.	**INTRODUCTION TO DATA SCIENCE:** Definition – Big Data and Data Science Hype – Why data science – Getting Past the Hype – The Current Landscape –	3
2.	**Data Science Ethics:** Need of Ethics in Data science, History, Concept of Informed Consent, Data Ownership, Privacy ,Anonymity ,Data Validity, Algorithmic Fairness, Societal Consequences, Code of Ethics	3
3.	**ETHICS AND RECENT TRENDS:** Doing good data science – Owners of the data - Valuing different aspects of privacy - Getting informed consent - The Five Cs – Diversity – Inclusion – Future Trends**.**	4
4.	**Data Scientist** - Data Science Process Overview – Defining goals – Retrieving data – Data preparation – Data exploration – Data modeling – Presentation	3
5.	**Big Data:** Overview. Characteristics, challenges and applications.	2

Text Books

1.	Ethics and Data Science, D J Patil, Hilary Mason, Mike Loukides, O' Reilly, 1st edition, 2018
2.	Data Science from Scratch: First Principles with Python, Joel Grus, O'Reilly, 1st edition, 2015

References

1.	Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", CUP, 2012.
2.	Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, Paul Zikopoulos, "Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data", McGrawHill Publishing, 2012.
3.	Refer latest relevant research papers.

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Data Warehousing	**Semester**	M. Tech	
Department	Computer Science & Engineering	**Course Code**	CST851	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. To understand the corporate decision making system.
2. To provide comprehensive analysis of the organization.
3. To facilitate type of analysis, data warehouses from several sources.
4. This course will involve an in-depth study of various concepts of tools like OLAP.

Course Outcomes

By the end of this course, the student will be able to:

CO1. Understand the importance of data warehouse and the business intelligence.
CO2. Understand schema designs, information delivery techniques and architectures.
CO3. Understand processes, management for building data warehouse.
CO4. Understand evolution of data warehouse with the presence of big data.

Course Outline / Content

Unit	Topics	Week
1.	Introduction to Database Warehousing, Data Warehouse definitions, Business need for Data Warehouse, Comparison of Data Warehouse with other business software,	3
2.	Data Warehouse Architecture, Concepts of software architecture, DW architectural components, Data Mart vs DW vs ODS, DW architectural types, Inman's DW 2.0 architecture, DW vs. Hadoop	2
3.	Data Warehouse Design, Dimensional Modeling, Star, Snowflake, Star flake schemas, Design steps, Extraction, Transformation, Load, ETL overview, Data Extraction, Data Transformation, Data Loading	3
4.	OLAP & Multidimensional Analysis, Limitations of spreadsheets and SQL, Features and functions, ROLAP, MOLAP, and HOLAP, Multidimensional databases	3
5.	Query performance enhancement techniques, Aggregations, Partitioning, View materialization, Indexing techniques, Metadata, Role of metadata in DW, Types of metadata, Metadata management, DW infrastructure, Capacity Planning, Security for DW, Hardware for DW.	4

Text Books

1.	Ponniah P, "Data Warehousing Fundamentals", Wiley Student Edition, 2012.
2.	Kimball R, "The Data Warehouse Toolkit", 3e, John Wiley, 2013

References

1.	Anahory S, & Dennis M, "Data Warehousing in the Real World", Pearson Education, 2008
2.	Kimball R, Reeves L, Ross M, & Thornthwaite, W, "The Data Warehouse Lifecycle Toolkit", John Wiley, 2e, 2012
3.	Refer latest relevant research papers.

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Information Retrieval	**Semester**		M.Tech
Department	Computer Science & Engineering	**Course Code**		CST852
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. To enhance the basic concepts in information retrieval,techniques of multimodal based IS.
2. To understand the underlined,problems related to IR.
3. Tobuild the necessary experience to design, and implement,real applications usingIR.
4. Able to provide to solve real application using IR System.

Course Outcomes

By the end of this course, the student will be able to:

CO1. Students will get an insight into the components, organization and basics of IRS.

CO2. Will acquire knowledge about the different types of IR models like Boolean, Dictionaries

CO3. Will understand the issues and solutions on Cross Lingual IR systems.

CO4. Will get the knowledge about Multimedia IR systems.

Course Outline / Content

Unit	Topics	Week
1.	Introduction to Information Retrieval, Basic Search Model, Basic Information Retrieval Concepts, Boolean Retrieval, Dictionaries and Tolerant Retrieval, Index Construction and Compression.	3
2.	Vector Space Model, Scoring, Term Weighting, The Vector Space Model for Scoring.	3
3.	Cross Lingual Retrieval, Language Problems in IR, Translation Approaches for CLIR, Handling many Languages, Using manually constructed Translation systems and resources for CLIR.	3
4.	Recommender Systems, Collaborative recommendation, Content based recommendation, Other type & hybrid recommendation.	2
5.	Multimedia Information Retrieval, Basic Multimedia search technologies, Content based retrieval, Image and Audio data challenges, Multimedia IR Research, Web Search, Web Search Basics, Web Crawlers and Indexes, Link Analysis: The web as a graph, Google's page rank.	4

Text Books

1.	C. D. Manning, P. Raghavan and H. Schutze. Introduction to Information Retrieval, Cambridge University Press, 2008
2.	Modern Information Retrieval, Ricardo Baeza-Yates and Berthier Ribeiro-Neto, Addison-Wesley, 2000

References

1.	Search Engines: Information Retrieval in Practice by Bruce Croft, Donald Metzler, and Trevor Strohman, Addison-Wesley, 2009
2.	Cross-Language Information Retrieval by By Jian-Yun Nie Morgan & Claypool Publisher series 2010.
3.	Refer latest relevant research papers.

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Advanced Topics in Data Processing	**Semester**	M. Tech	
Department	Computer Science & Engineering	**Course Code**	CST853	
Credits	3	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. Provide insight into methods and tools for analysis and processing of the data.
2. To understand the basic concepts of Data science, Classification and clustering process.
3. Ability to analyse the data and carry out supervised, un-supervised Learning processes
4. Ability to do regression, correlation and knowledge discovery of the data.

Course Outcomes

By the end of this course, the student will be able to:

CO1. To understand the basic terms in the area of IS development and management.

CO2. Explain methods of data analysis in a company, define business.

CO3. Describes the data warehouse Process and Technology including the ETL and Metadata

CO4. CO-Extract knowledge using data mining techniques, its functionalities.

Course Outline / Content

Unit	Topics	Week
1.	Introduction: Data processing , methods of data processing, components. Introduction and Data Pre-processing. WhyData Mining?, Data Preprocessing: Why Preprocess the data – Data cleaning – Data Integration – Data Transformation – Data Reduction – Data Discretization. What is OLAP and OLTP system ϖ Advantages of OLAP and OLTP system ϖ What is Data ware house ϖ What are the key elements of data ware house ϖ What is fact table and dimension tables .	1
2.	Mining Frequent Patterns, Associations, and Correlations: Basic Concepts and Methods Basic Concepts, Frequent Itemset Mining Methods, Which Patterns Are Interesting?— Pattern Evaluation Methods , Advanced Pattern Mining: Pattern Mining: A Road Map, Pattern Mining in Multilevel, Multidimensional Space, Constraint-Based Frequent Pattern Mining, Mining High-Dimensional Data and Colossal Patterns, Mining Compressed or Approximate Patterns	2
3.	Basic Concepts, Decision Tree Induction, Bayes Classification Methods, Rule-Based Classification, Model Evaluation and Selection, Techniques to Improve Classification Accuracy, Support Vector Machines, Lazy Learners (or Learning from Your Neighbors)	3
4.	Cluster Analysis : Basic Concept and Methods Cluster Analysis, Partitioning Methods, Hierarchical Methods, Density-Based Methods, Grid-Based Methods, Evaluation of Clustering, Clustering High-Dimensional Data, Clustering Graph and Network Data	4
5.	Data Mining Trends and Research Frontiers Mining Complex Data Types, Other Methodologies of Data, Mining, Data Mining Applications, Data	5

	Mining and Society, Data Mining Trends.	
Textbooks		
1.	Jiawei Han and Micheline Kamber, "Data Mining Concepts and Techniques", Third Edition, Morgan Kaufmann, 2011.	
2.	K.P. Soman, Shyam Diwakar and V. Ajay ", Insight into Data mining Theory and Practice", Easter Economy Edition, Prentice Hall of India, 2016	
References		
1.	Vipin Kumar, Pang-Ning Tan, Michael Steinbach, Introduction to Data Mining,	
2.	Addison Wesley, 2006. 2. G Dong, J Pei, Sequence Data Mining, Springer, 2007	
3.	Refer latest relevant research papers.	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Software Project Management	**Semester**		M. Tech
Department	Computer Science & Engineering	**Course Code**		CST854
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. To understand the Software Project Planning and Evaluation techniques.
2. To plan and manage projects at each stage of the software development life cycle (SDLC).
3. To manage software projects and control software deliverables.
4. To develop skills to manage the various phases involved in project management.

Course Outcomes

By the end of this course, the student will be able to:

CO1. Understand Project Management principles while developing software.
CO2. Gain extensive knowledge about the basic project management concepts, framework.
CO3. Obtain adequate knowledge about software process models.
CO4. Estimate the risks involved in various project activities.

Course Outline / Content

Unit	Topics	Week
1.	**Project evaluation and project planning:** Importance of Software Project Management – Activities – Methodologies – Categorization of Software Projects – Setting objectives – Management Principles – Management Control – Project portfolio Management – Cost-benefit evaluation technology – Risk evaluation – Strategic program Management – Stepwise Project Planning.	3
2.	Project life cycle and effort estimation: Software process and Process Models – Choice of Process models – Rapid Application development – Agile methods – Dynamic System Development Method – Extreme Programming– Managing interactive processes – Basics of Software estimation – Effort and Cost estimation techniques – COSMIC Full function points – COCOMO II – a Parametric Productivity Model.	3
3	Activity planning and risk management: Objectives of Activity planning – Project schedules – Activities – Sequencing and scheduling – Network Planning models – Formulating Network Model – Forward Pass & Backward Pass techniques – Critical path (CRM) method – Risk identification – Assessment – Risk Planning –Risk Management – – PERT technique – Monte Carlo simulation – Resource Allocation – Creation of critical paths – Cost schedules.	3
4.	Project management and control: Framework for Management and control – Collection of data – Visualizing progress – Cost monitoring – Earned Value Analysis – Prioritizing Monitoring – Project tracking – Change control – Software Configuration Management – Managing contracts – Contract Management.	3
5.	Staffing in software projects: Managing people – Organizational behaviour –	3

	Best methods of staff selection – Motivation – The Oldham – Hack man job characteristic model – Stress – Health and Safety – Ethical and Professional concerns – Working in teams – Decision making – Organizational structures – Dispersed and Virtual teams – Communications genres – Communication plans – Leadership.	
Text Books		
1.	Bob Hughes, Mike Cotterell and Rajib Mall: Software Project Management – Fifth Edition, Tata McGraw Hill, New Delhi, 2012.	
References		
1.	Robert K. Wysocki ―Effective Software Project Management – Wiley Publication, 2011.	
2.	Walker Royce: ―Software Project Management- Addison-Wesley, 1998.	
3.	Refer latest relevant research papers.	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Advanced Java and Android Programming	**Semester**	M. Tech	
Department	Computer Science & Engineering	**Course Code**	CST855	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. Build Android apps from scratch using Android Studio and Java Programming.
2. To develop apps to Google Play and reach Millions of Android users.
3. To enhance the concept of Android.
4. To develops apps for android mobile .

Course Outcomes

By the end of this course, the student will be able to:

CO1. Use the Java programming language to build Android apps.
CO2. Use the development tools in the Android development environment.
CO3. Describe the life cycles of Activities, Applications and Fragments.
CO4. Package and prepare their apps for distribution on the Google Play Store.

Course Outline / Content

Unit	Topics	Week
1.	**Collections:** Collection Interfaces, Concrete Collections, The Collections Framework, Multithreading : Creating thread and running it, Multiple Thread acting on single object, Synchronization, Thread communication, Thread group, Thread priorities, Daemon Thread, Life Cycle of Thread.	3
2.	**Networking:** Internet Addressing, InetAddress, Factory Methods, Instance Methods, TCP/IP Client Sockets, URL, URL Connection, TCP/IP Server Sockets, Datagrams, Enterprise Java Bean: Preparing a Class to be a JavaBean, Creating a JavaBean, JavaBean Properties, Types of beans, Stateful Session bean, Stateless Session bean, Entity bean.	3
3.	**Java Database Connectivity (JDBC):** Merging Data from Multiple Tables: Joining, Manipulating Databases with JDBC, Prepared Statements, Transaction Processing, Stored Procedures C. **Servlets:** Servlet Overview and Architecture, Interface Servlet and the Servlet Life Cycle, Handling,HTTP get Requests, Handling HTTP post R equests, Redirecting Requests to Other Resources, Session Tracking, Cookies, Session Tracking with HttpSession.	3
4.	Introduction Smart Phone Application Development. Android Architecture, User Interface Architecture, Activities and Intents, Threads, Services, Receivers and Alerts, User Interface layouts, user interface events, UI Widgets, Notification and Toast, Menus, Dialogs, Lists, Locations and Maps.	3
5.	Hardware interface-Camera, Sensors, Telephony, Bluetooth, Near Field communication, Working with Data Storage, Using Google maps, Animation and Content Providers. Network Communication, Services, Publishing your App.	3

Text Books	
1.	Core and Advanced Java, Black Book, DreaMTech Press
2.	Java SE8 for Programmers (3rd Edition) (Deitel Developer Series) by Paul Deitel and Harvey Deitel
References	
1.	"Advanced Java 2 Platform HOW TO PROGRAM" by H. M.Deitel, P. J. Deitel, S. E. Santry – Prentice Hall
2.	"Beginning Java™ EE 6 Platform with GlassFish 3 From Novice to Professional" by Antonio Goncalves– Apress publication
3.	Refer latest relevant research papers.

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Unix and Shell Programming	**Semester**	M. Tech	
Department	Computer Science & Engineering	**Course Code**	CST856	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. Understand the history, origin, features and architecture of UNIX Operating System.
2. Learn basic commands to interact with UNIX System.
3. Understand UNIX file system.
4. Learn shell scripting.

Course Outcomes

By the end of this course, the student will be able to:

CO1. Understand the architecture, networking and basic commands of UNIX.
CO2. Apply various file processing commands used in UNIX.
CO3. Apply Regular expression to perform pattern matching using utilities.
CO4. Apply various shell scripts for simple applications.

Course Outline / Content

Unit	Topics	Week
1.	Introduction to Unix:- Architecture of Unix, Features of Unix , Basic Unix Commands – Unix Utilities:- Introduction to unix file system, vi editor, file handling utilities, security by file permissions, process utilities, disk utilities, networking commands – Text processing utilities and backup	2
2.	Introduction to Shells:-Unix Session, Standard Streams, Redirection, Pipes, tee Command, Command Execution, Command-Line Editing, Quotes, Command Substitution, Job Control, Aliases, Variables, Predefined Variables, Options, Shell/Environment Customization. Regular expressions, Filters and Pipes, Concatenating files, Display Beginning and End of files, Cut and Paste, Sorting, Translating Characters, Files with Duplicate Lines, Count characters, words or lines, Comparing Files.	4
3.	grep:-Operation, grep Family, Searching for File Content. sed:-Scripts, Operation, Addresses, commands, Applications, grep and sed. awk:-Execution, Fields and Records, Scripts, Operations, Patterns, Actions, Associative Arrays, String Functions, Mathematical Functions, User Defined Functions, Using System commands in awk, Applications of awk, grep and sed.	3
4.	Interactive Korn Shell : Korn Shell Features, Two Special Files, Variables, Output, Input, Exit Status of a Command, eval Command, Environmental Variables, Options, Startup Scripts, Command History, Command Execution Process	3
5.	Korn Shell Programming :	3

	Basic Script concepts, Expressions, Decisions: Making Selections, Repetition, special Parameters and Variables, changing Positional Parameters, Argument Validation,Debugging Scripts, Script Examples	
Text Books		
1.	Unix and shell Programming Behrouz A. Forouzan, Richard F. Gilberg.Thomson	
2.	Your Unix the ultimate guide, Sumitabha Das, TMH. 2nd Edition	
References		
1.	Unix for programmers and users, 3rd edition, Graham Glass, King Ables, Pearson Education.	
2.	Unix programming environment, Kernighan and Pike, PHI. / Pearson Education	
3.	Refer latest relevant research papers.	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Advanced Programming in Java	**Semester**	M. Tech	
Department	Computer Science & Engineering	**Course Code**	CST857	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. This module aims to introduce the students of advanced programming and practice.
2. It focuses on (GUI), multithreading, networking, and database manipulation.
3. To develop the real live projects in Java.
4. Enhance the concept of Applets in developing web page.

Course Outcomes

By the end of this course, the student will be able to:

CO1. Understand some advanced programming concepts.
CO2. To develop large programs using applets.
CO3. Be able to write sophisticated Java applications.
CO4. Compose more complex programs from simpler parts.

Course Outline / Content

Unit	Topics	Week
1.	Introduction to Java: Overview, Challenges, Applications,	3
2.	Java Applets; the Java Development Kit (JDK) Life Cycle, Applications, Pros and cons in web Development.	3
3.	Exception Handling, Multithreading, Graphical User Interface (GUI).	3
4.	Java Network Programming: Protocols, IP, TCP, URL; Java.net Package.	3
5.	URL class, URL Connection class; InetAddress class, Socket class, Client Server Programming, database manipulation in Java.	3

Text Books/

1. Core Java 2 Volume 1-Fundamental, Cay Horstmann and Gary Cornel,Sun Microsystems Press a Prentice Hall Title, 2001.

References

1. Java: The Complete Reference, Seventh Edition by Herbert Schildt.
2. Refer latest relevant research papers.

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Logic Programming	**Semester**	M. Tech	
Department	Computer Science & Engineering	**Course Code**	CST858	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. To introduce a number of logical systems of importance in computer science.
2. Deep insight familiar with a logic for reasoning about sequential programs.
3. Provide the concept to write programs in a logic programming language.
4. To understand the top-down and the bottom up operational semantics of logic programs.

Course Outcomes

By the end of this course, the student will be able to:

CO1. Able to conversant with the syntax and semantics of propositional and predicate logic.
CO2. May be familiar with applications of predicate logic in knowledge-based systems.
CO3. To write specifications in predicate logic expressing state constraints.
CO4. Understand the notion of formal proof, and be able to construct simple proofs

Course Outline / Content

Unit	Topics	Week
1.	**Propositional logic**: syntax and semantics, natural deduction proofs, decision procedures, Horn fragmen.	3
2.	**Predicate Calculus**: syntax and semantics, natural deduction proofs, undecidability and incompleteness.	3
3.	**Logic Programming**: Horn fragment of predicate logic, unification and top-down operational semantics, use of a logic programming language, Datalog and bottom up operational semantics.	3
4.	**Reasoning about sequential programs:** partial correctness assertions, computing weakest precondition, loop invariants, reasoning about termination.	3
5.	**Fundamental concepts:** relations, rules, unification, recursion. Relation between logic and logic programming: semantics, soundness and completeness. Programming in a logic programming language, such as Prolog. Encoding of algorithms and data structures; solving search problems and constraint problems.	3

Text Books/

1. Logic in Computer Science, Modelling and Reasoning about Systems, M.R. Huth and M.D. Ryan, Cambridge University Press 2000.

References

1. Programming Logic and Design: Comprehensive by Joyce Ferrall.
2. Refer latest relevant research papers.

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Special Topics in Programming	**Semester**	M. Tech	
Department	Computer Science & Engineering	**Course Code**	CST859	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. Object oriented programming concepts using C++ programming language.
2. Understanding Parallelism with GPUs. CUDA Architecture.
3. Developing applications for processors with parallel computing resources.
4. Atomic operations. Using single and multiple Streams. Performance measuring.

Course Outcomes

By the end of this course, the student will be able to:

CO1. To design and describe precise, unambiguous instructions to solve a problem.
CO2. Enable to develop programs that solve complex problems by decomposition.
CO3. Learn independently about new programming-language features and libraries
CO4. Solve basic problems in scientific computing using the concept of cloud.

Course Outline / Content

Unit	Topics	Week
1.	**General Information about the course**: Introduction to C++ Scope resolution operator Reference variables, const member functions Static members Constructor initializer, Default function arguments	2
2.	**Programming paradigms:**Dynamic memory, Destructor, Member-wise copy, Copy constructor, Friend functions, friend classes Operator overloading, non-member operator overloads Friend operator overloads, member operator overloads The this operator, Prefix and postfix notations, Inheritance, Single inheritance, Layered classes Derived class constructors, destructors, Visibilities Multiple Inheritance, Ambiguity resolution, Virtual base classes Inheritance hierarchy and pointers Runtime polymorphism, Abstract base classes.	4
3.	**Introduction to parallel and distributed computing:** Introduction to basic CUDA concepts and the tools needed to build and debug CUDA applications, Difference between host code and device code, Thread cooperation, execution of different threads.	3
4.	**Cloud Simulators:** CloudSim and GreenCloud Introduction to Simulator, understanding CloudSim simulator, CloudSim Architecture(User code, CloudSim, GridSim, SimJava) Understanding Working platform for CloudSim, Introduction to GreenCloud.	3
5.	**Introduction to VMW Simulator:** Basics of VMWare, advantages of VMware virtualization, using Vmware workstation, creating virtual machines-understanding virtual machines, create a new virtual machine on local host, cloning virtual machines, virtualize a physical machine, starting and stopping a virtual machine.	3

Text Books/

1.	CUDA By Example, Jason Sanders & Edward Kandrot, Addison-Wesley.
2.	C++ How to Program, Deitel & Deitel, Pearson Education.
	References
1.	Cloud Computing (Principles and Paradigms), Edited by Rajkumar Buyya, James Broberg, Andrzej Goscinski, John Wiley & Sons, Inc. 2011.
2.	Cloud computing a practical approach - Anthony T.Velte , Toby J. Velte Robert Elsenpeter, TATA McGraw- Hill , New Delhi – 2010.
3.	Refer latest relevant research papers.

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Special Topics in Software Engineering	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST860	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. Study the state of the art of research challenges of selected topics in software engineering.
2. Introduce various approaches and methodologies used in different phases of SDLC.
3. To enhance the concepts of software construction, software maintenance
4. Prepare students to independently solve the latest research problem.

Course Outcomes

By the end of this course, the student will be able to:

CO1. Enhanced their concept in Software development projects.
CO2. Discuss and argue about current topics in software engineering.
CO3. Demonstrate their ability to solve real life project.
CO4. Independently conduct research in implementation of software engineering.

Course Outline / Content

Unit	Topics	Week
1.	**Software Engineering:** Introduction to software life cycle models. Formal specification and validation. Techniques for software design and testing. Cost estimation models. Issues in software quality assurance and software maintenance.	4
2.	**Formal Methods in software engineering:** Integer functions: floors, ceiling, mod. Number Theory: Divisibility and Primes, Stirling numbers, Eulerian numbers, Harmonic numbers, Bernoulli numbers, Fibonacci numbers Generating Functions: Solving recurrences, Special generating functions, Convolutions, Exponential generating functions. Probability.	3
3.	**Stochastic processes:** Classification, Bernoulli processes, Markov Chains and Markov processes(birth and death process etc.), queuing models. Calculating programs from specifications; Review and Introduction of Z notation: Propositional and Predicate Logic, Equality, Sets, Relations, Functions, Groups, Sequences; Predicates and Programming: Specifications: pre-conditions, postconditions and the Hoare Triple, Weakest preconditions;	3
4.	**Proofs about Programs:** Proof of correctness of assignment statements, proof of conditional expressions, Proof of loop expressions - Invariant of a loop; Calculating Programs from Specifications: calculating expressions in assignments, calculating Conditionals, calculating Loops;	2
5.	**Schemas:** Structuring and Composing Descriptions, Schema Operators, Promotion, Preconditions on Schemas; Implementation: Refinement, Refinement with Schemas, Refinement Calculus; Objects, Classes, Inheritance: Object- Z and Object Oriented Specifications, Forward declaration, recursion, Contrast Z with Object-Z; Case Studies.	3

Text Books

1.	Rajib Mall, Fundamentals of Software Engineering, Prentice Hall India
2.	Pankaj Jalote, An integrated approach to Software Engineering, Springer/Narosa
	References
1.	Roger S. Pressman, Software Engineering: A practitioner's approach, McGraw Hill.
2.	Ian Sommerville, Software Engineering, Addison-Wesley.
3.	Refer latest relevant research papers.

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Advanced Internet Technologies	**Semester**		M. Tech
Department	Computer Science & Engineering	**Course Code**		CST861
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. This course focuses on building interactive web sites and web applications.
2. This course aims that student should learn creating interactive web applications using PHP.
3. Enable student to understand the concept of Ajax.
4. To analyze and develop static interactive web pages using HTML, CSS and XML.

Course Outcomes

By the end of this course, the student will be able to:

CO1. Apply the knowledge of the internet and PHP concepts in developing applications.
CO2. Use a server-side scripting language, PHP.
CO3. Use advanced topics in HTML5, JavaScript.
CO4. Understand the major areas and challenges of web programming.

Course Outline / Content

Unit	Topics	Week
1.	**HTML5** Basics of HTML5 – Introduction, features, form new elements & attributes in HTML5, Introduction to Scalable Vector Graphics (SVG) Angular JS: Introduction, MVC architecture (Model, Controller), Directives, Filters	2
2.	**XML** Concept of XML, features of XML , Writing XML elements, attributes etc, XML with CSS, programs on it, XML with DSO, programs on it, XML Namespace, XML DTD, programs on it, XML schemas, writing simple sheet using XSLT, SAX Parser, DOM Parser ,Introduction to SOAP, Examples on XML	3
3.	**JQuery** Introduction to jQuery, Syntax Overview , Anatomy of a jQuery Script, Creating first jQuery script ,Traversing the DOM, Selecting Elements with jQuery, Refining & Filtering Selections, Selecting Form Elements , Working with Selections - Chaining, Getters & Setters ,CSS, Styling, & Dimensions ,Manipulating Elements - Getting and Setting Information about Elements, Moving, Copying, and Removing Elements, Creating New Elements ,Manipulating Attributes, Utility Methods ,Events - Connecting Event to Elements, Namespacing Events, Event handling, Triggering Event handlers, Event Delegation ,JQuery Effects –hide/show, fade, slide, animate, callback, stop.	4
4.	**AJAX** Introduction to AJAX , Overview , Challenges, applications, jQuery's AJAX related methods, Ajax and Forms ,Ajax Events.	2
5.	**PHP** Obtaining, Installing and Configuring PHP , PHP and the Web Server Architecture, Model, Overview of PHP Capabilities, CGI vs. Shared Object Model, PHP and HTTP Environment Variables, PHP Language Core : Variables, Constants and Data Types, and Operators Decision Making ,	4

	Flow Control and Loops ,Working with Arrays, Working with Strings and functions, Include and Require Statements ,File and Directory Access Operations, Error Handling and Reporting Considerations, Processing HTML Form Input from the User, Introduction to Object-oriented PHP: Classes & Constructors ,PHP with AJAX .	
Text Books		
1.	Introducing HTML5 - Bruce Lawson, Remy Sharp	
2.	AngularJS - Brad Green, Shyam Seshadri	
References		
1.	Learning jQuery - Jonathan Chaffer, Karl Swedberg	
2.	Internet Technology at work Hofstetter fred, TMH.	
3.	Refer latest relevant research papers.	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Advanced Compilation Techniques.	**Semester**		M.Tech
Department	Computer Science & Engineering	**Course Code**		CST862
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. To provide understanding of the issues related to advanced compilation.
2. Able to design and implement translators, static analysis, type-checking and optimization.
3. Implement variety of software tools in a complete advanced compilation code optimization
4. Able to understand concepts and foundations of compiler design.

Course Outcomes

By the end of this course, the student will be able to:

CO1. Apply the knowledge of Lex tool & Yaac tool to develop a scanner & Parser.
CO2. Understand of the concepts and foundations of advanced compilation.
CO3. May be able to identify code optimization and lexical and syntactical errors.
CO4. The students can develop enhanced stand-alone applications.

Course Outline / Content

Unit	Topics	Week
1.	Compilers and translators; lexical and syntactic analysis, top-down and bottom up parsing techniques; internal form of source programs; semantic analysis, symbol tables, error detection and recovery, code generation and optimization. Type checking and static analysis. Static analysis formulated as fix point of simultaneous semantic equations. Data flow. Abstract interpretation. Correctness issues in code optimizations. Algorithms and implementation techniques for type-checking, code generation and optimization.	4
2.	Introduction to code optimization. Concept mapping as a knowledge representation tool. Different kinds of language processors. Static and dynamic issues. Features of adaptive software. Local and Global optimization: Control flow graph and Basic blocks, DAG-based local optimization. Loop optimization.	2
3.	Control flow analysis---Basic blocks and program points, depth-first numbering, reducible graphs, single entry regions and loops. Code movement optimization. Safety of code movement optimization. Strength reduction and loop test replacement.	3
4.	Introduction to data flow analysis. Available expressions. MOP solution of a data flow problem. Data flow equations---round-robin iterative data flow analysis. Lattice theoretic framework for data flow analysis---determining lattice top and bot values; initializations for iterative data flow analysis.	3
5.	Depth of a CFG and complexity of round-robin iterative data flow analysis. Worklist iterative data flow analysis. Revisit 2-boundedness, depth of a CFG,	3

	and worklist iterative data flow analysis. Introduction to partial redundancy elimination (PRE). Safety of code insertion. Computational optimality and Lifetime optimality. Eliminability path and E_path_PRE data flow equations.	
Text Books		
1.	Compilers---Principles, Techniques, and Tools (Second edition), A. V. Aho, M. Lam, R. Sethi, J. D. Ullman, Pearson Education.	
2.	Advanced Compiler Design & Implementation, Steven S Muchnick, Harcourt Asia/Morgan Kaufmann, 1997.	
References		
1.	An Introduction to FORMAL LANGUAGES and AUTOMATA Fifth Edition PETER LINZ by Davis JONES & BARTLETT LEARNING.	
2.	Refer latest relevant research papers.	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Special topics in Theoretical Computer Science	**Semester**	M.Tech	
Department	Computer Science & Engineering	**Course Code**	CST863	
Credits	3	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

1. To equip students with the deep concepts of Theoretical Computer Science.
2. To implement the foundations of computer science in solving real life problem.
3. To be aware of the N and NP Class Complexity.
4. To enhance their concept on Recursive functions.

Course Outcomes

By the end of this course, the student will be able to:

CO1. Determine roughly where a given problem lies in the complexity hierarchy.
CO2. Apply foundational and mathematical material to your own research
CO3. Design and conduct experiments for solving problem using probability.
CO4. Learn the new code optimization techniques to improve the performance of a program.

Course Outline / Content

Unit	Topics	Week
1.	**Mathematical Logic** Proof theory: Deductive systems, models, satisfiability, validity. Soundness, consistency, and completeness. Model theory: isomorphisms, homomorphisms, and substructures. Godels completeness and incompleteness theorems. Models of arithmetic. The Peano axioms.	3
2.	**Complexity theory** The complexity classes: P, NP, coNP, and polynomial-time reductions (review). Completeness and complete problems. Further complexity classes, including PSPACE, EXPTIME, and their complete problems. The polynomial hierarchy. Classes inside P: logspace, nondeterministic logspace, NC, RNC. P-complete problems. Logspace-reductions. Randomized computation and randomized complexity classes. Approximation algorithms and approximability.	4
3.	**Recursive function theory and computability theory** The Chomsky hierarchy (review). Primitive recursive and recursive functions. Recursive and recursively enumerable sets. The halting problem and other unsolvable problems. Reducibilities. The arithmetic and analytic hierarchies	3
4.	**Set theory** Naïve set theory: basic operations on sets (review). Axioms, rules of inference, and deductive systems. Axioms of ZF set theory. Countable and uncountable sets. Diagonalization. The axiom of choice. Ordinals and cardinals. The recursion principle. The Borel hierarchy. Non-wellfounded set theory. Co-induction.	3
5.	**Probability theory** Events, probabilities, random variables and sample spaces (review). Axioms of probability. Conditional probability. Distributions.	

	Markov chains.	2
Text Books		
1.	A Basis for Theoretical Computer Science by Arbib**,** M.A., Kfoury**,** A.J.**,** Moll**,** R.N	
2.	An Introduction to FORMAL LANGUAGES and AUTOMATA Fifth Edition PETER LINZ by Davis JONES & BARTLETT LEARNING.	
References		
1.	Rewriting, Computation and Proof by Comon-Lundh**,** Hubert**,** Kirchner**,** Claude**,** Kirchner**,** Helene.	
2.	Refer latest relevant research papers.	