DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Department: Computer Science and Engineering	
Course Title: Advanced Computer Architecture	*Course Code: SCE110*
Credits(L:T:P):4:1:0	*Core/Elective: Core*
Type of Course: Lecture, Tutorial	*Total Contact Hours:52:26:0*
CIE Marks : 50	*SEE Marks: 100*

Pre-requisite: Computer Organization, Microprocessors

Course Outcomes: After the completion of the course, the student should be able to

CO1: Comprehend the importance of quantitative design in parallelism and analyze pipelining mechanism.

CO2: Analyze the impact of ILP on speedup and evaluate various ILP mechanisms.

CO3: Appreciate the data parallelism concept using Vector, SIMD and GPU and synthesize thread level parallelism

CO4: Analyze the importance of memory hierarchy and apply various optimization schemes to achieve improved parallelism.

CO5: Get acquainted with the intrinsic details of Request and Data level parallelism in Warehouse scale computers.

Unit No.	Course Contents	No. of Hours
1.	**Fundamentals of Quantitative design and analysis:** Introduction, classes of computers, Defining computer architecture, Trends in technology, power and energy and cost. Dependability. Measuring, Reporting and summarizing performance, Quantitative principles of computer design. **Pipelining: Basics and Intermediate concepts:** Introduction, major hurdles of pipelining-pipeline hazards, How is pipelining implemented, what makes pipelining hard to implement, Extending the MIPS pipeline to handle multicycle operations	10
2.	**Instruction-Level Parallelism and Its Exploitation:** Instruction-Level Parallelism: Concepts and Challenges, Basic compiler Techniques for Exposing ILP, Reducing Branch Costs with Advanced Branch Prediction, Overcoming Data Hazards with Dynamic Scheduling, Dynamic Scheduling: Examples and the Algorithm, Hardware-Based Speculation, Exploiting ILP Using Multiple Issue and Static Scheduling, Exploiting ILP Using Dynamic Scheduling, Multiple Issue, and Speculation, Advanced Techniques for Instruction Delivery and Speculation, Studies of the Limitations of ILP	12

3.	**Data-Level Parallelism in Vector, SIMD, and GPU Architectures:** Introduction, Vector Architecture, SIMD Instruction Set Extensions for Multimedia, Graphics Processing, Detecting and Enhancing Loop-Level Parallelism **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	10
4.	**Review of memory Hierarch:** Introduction, Cache Performance, Six Basic Cache Optimizations, Virtual Memory, Protection and Examples of Virtual memory **Memory Hierarchy Design:** Introduction, Ten Advanced Optimizations of Cache performance, Memory Technology and Optimization, Protection: Virtual Memory and virtual machines,	10
5.	**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,	10

Text books:

1. Hennessey and Patterson, “Computer Architecture A Quantitative Approach”, 5th Edition, Elsevier, 2007.

Reference Books:

1. Kai Hwang: Advanced Computer Architecture - Parallelism, Scalability, Programmability, 2nd Edition, Tata McGraw Hill, 2010.
2. Richard Y. Kain, "Advanced Computer Architecture- A System Design approach", Printice Hall 1996.

Note: Students are informed to study the selected topics from the following NPTEL links

1. https://nptel.ac.in/courses/106105033/
2. https://nptel.ac.in/courses/106102062/
3. https://nptel.ac.in/courses/106104024/

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Department: Computer Science and Engineering	
Course title: Advanced Computer Networks	***Course Code: SCE120***
Credits(L:T:P):4:1:0	***Core/Elective: Core***
Type of Course: Lecture, Tutorial	***Total Contact Hours:52:26:0***
CIE Marks : 50	***SEE Marks: 100***

Pre-requisite: Data Communication, Computer Networks

Course Outcomes: After the completion of the course, the student should be able to

CO1: Understand network architecture, protocol implementation issues and performance metrics in network design.

CO2: Analyze and Implement various protocols in internetworking

CO3: Comprehend the working of upper layers and protocols in supporting different applications.

CO4: Analyze the issues of congestions to provide Quality of Service.

CO5: Comprehend the concepts of software defined networks and its architecture.

Unit No.	Course Content	No. of Hours
1.	**Foundation** Building a Network, Requirements, Perspectives, Scalable Connectivity, Cost Effective Resource sharing, Support for Common Services, Manageability, Protocol layering, Performance, Bandwidth and Latency, Delay X Bandwidth Product, Perspectives on Connecting, Classes of Links, Reliable Transmission, Stop and- Wait , Sliding Window, Concurrent Logical Channels.	10
2.	**Internetworking** Switching and Bridging, Datagram's, Virtual Circuit Switching, Source Routing, Bridges and LAN Switches, Basic Internetworking (IP), What is an Internetwork ?, Service Model, Global Addresses, Datagram Forwarding in IP, subnetting and classless addressing, Address Translation(ARP), Host Configuration(DHCP), Error Reporting(ICMP), Virtual Networks and Tunnels. 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	12

3	**End-to-End Protocols** Simple Demultiplexer (UDP), Reliable Byte Stream(TCP), End-to-End Issues, Segment Format, Connecting Establishment and Termination, Sliding Window Revisited, Triggering Transmission, Adaptive Retransmission, Record Boundaries, TCP Extensions, Queuing Disciplines, FIFO, Fair Queuing, TCP Congestion Control, Additive Increase/ Multiplicative Decrease, Slow Start, Fast Retransmit and Fast Recovery.	10
4.	**Congestion Control and Resource Allocation** Congestion-Avoidance Mechanisms, DEC bit, Random Early Detection (RED), Source-Based Congestion Avoidance. The Domain Name System(DNS), Electronic Mail(SMTP,POP, IMAP, MIME), World Wide Web(HTTP), Network Management(SNMP)	10
5.	**Software Defined Networking** (SDN, Open Flow): Introduction , Routes, Paths, And Connections ,Traffic Engineering And Control Of Path Selection , Connection-Oriented Networks And Routing Overlays , SDN: A New Hybrid Approach ,Separation Of Data And Control ,The SDN Architecture & External Controllers , SDN Across Multiple Devices , Implementing SDN With Conventional Switches , Open Flow Technology , Open Flow Basics , Specific Fields In An Open Flow Pattern , Actions That Open Flow Can Take , Open Flow Extensions And Additions , Open Flow Messages , Uses Of Open Flow , Open Flow: Excitement, Hype, And Limitations , Software Defined Radio (SDR) Applications: Bootstrap and Auto configuration (Boot P DHCP), Applications :Remote login (TELNET, Rlogin),File transfer and Access(FTP,TFTP and NFS)	10

Text books:

1. Larry Peterson and Bruce S Davis “Computer Networks: A System Approach” 5th Edition, Elsevier -2014.
2. Thomas D Nadeau & Ken Gray, “SDN: Software defined Networks”, First Edition, 2013.

Reference Books:

1. Douglas E Comer, “Internetworking with TCP/IP, Principles, Protocols and Architecture” 6th Edition, PHI – 2014
2. Uyless Black “Computer Networks, Protocols, Standards and Interfaces” 2nd Edition – PHI
3. Behrouz A Forouzan “TCP/IP Protocol Suite” 4th Edition – Tata McGraw-Hill

Note: Students are informed to visit NPTEL website (http://nptel.ac.in) for additional information on the course.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Department: Computer Science and Engineering	
Course title: Advanced Data Structures and Algorithms	***Course Code: SCE130***
Credits(L:T:P): 4:1:0	***Core/Elective: Core***
Type of Course: Lecture, Tutorial	***Total Lecture Hours:52:26:0***
CIE Marks : 50	***SEE Marks: 100***

Pre-requisite: Data Structures, Analysis and Design of Algorithms

Course Outcomes: After completing this course, students should be able to

CO1: Analyze the complexity of the algorithms.

CO2: Apply suitable searching technique for a given application.

CO3: Solve the problems by applying suitable algorithm design strategy.

CO4: Perform amortized analysis of various algorithms.

CO5: Design and develop randomized and online algorithms.

Unit No.	Course Contents	No. of Hours
1.	**The Complexity of Algorithms and the lower bounds of problems:** The time complexity of an algorithm, The best, average and worst case analysis of algorithm, The lower bound of a problem, the worst-case lower bound of sorting, Heap sort : The average-case lower bound of sorting, Improving a lower bound through oracles, Finding the lower bound by problem transformation	08
2.	**Advanced Searching Techniques:** The Two way merge problem, The minimum cycle basis problem solved by the greedy algorithm, The 2-terminal one to any problem solved by the greedy method, The minimum cooperative guards problem for 1-spiral polygons solved by the greedy methods, Hillclimbing, Best-first, Branch and Bound , A* searching strategies	10
3.	**Divide and Conquer and Dynamic Programming:** Introduction, The 2dimensional maxima finding problem, The closest pair problem, The convex hull problem, The Voronoi diagrams constructed by the divide and conquer strategy, Applications of the Voronoi diagrams. The Fast Fourier Transform, The resource allocation problem, The longest common subsequence problem, The RNA maximum base pair matching problem	12

4.	**Amortized Analysis:** An example of using the potential function, An amortized analysis of skew heaps, Amortized analysis of AVL-trees, Amortized analysis of self-organizing sequential search heuristics, Pairing heap and its amortized analysis, Amortized analysis of a disjoint set union algorithm, Amortized analysis of some disk scheduling algorithms	10
5.	**Randomized and On-line Algorithms:** Randomized algorithm to solve the closest pair problem, The average performance of the randomized closest pair problem, randomized algorithm to test whether a number is prime, randomized algorithm for pattern matching, randomized algorithm for interactive proofs, randomized linear time algorithm for minimum spanning trees. The on-line Euclidean spanning tree problem solved by the greedy method, The on-line k-server problem and greedy algorithm to solve this problem defined on planar trees, An on-line obstacle traversal algorithm based on the balance strategy.	12

Text Books:

1. R.C.T.Lee , S.S Tseng, R.C Cbang, Y.T Tsai : Introduction to the Design and Analysis of Algorithms, Mc Graw Hill Education(India) Edition 2012

Reference Books:

1. Ellis Horowitz, SartajSahni, S.Rajasekharan : Fundamentals of Computer Algorithms, 2nd Edition, Universities press,2007
2. T.H Cormen, C E Leiserson, R L Rivest and C Stein: Introduction to Algorithms, 3rd Edition,Prentice-Hall of India,2010
3. Mark Allen Weiss, Data Structures and Algorithm Analysis, 3rd Edition, Pearson, 2013.

Note: Students are informed to visit NPTEL website (http://nptel.ac.in) for additional information on the course.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Department: Computer Science and Engineering	
Course Title: Machine Learning	*Course Code: SCE141*
Credits(L:T:P):4:1:0	*Core/Elective: Elective*
Type of Course: Lecture, Tutorial	*Total Contact Hours:52:26:0*
CIE Marks : 50	*SEE Marks: 100*

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Pre-requisite: Linear Algebra, Elementary Probability and Statistics, Knowledge of Programming in some Language.

Course Outcomes: After completing this course, students should be able to

CO1: Translate a business problem into a closely related set of machine learning tasks.

CO2: Select the appropriate algorithms and apply for the machine learning tasks.

CO3: Execute the machine learning tasks using the Python language.

CO4: Retrieve and assess the algorithm outcomes.

CO5: Interpret and validate the outcomes

Unit No.	Course Contents	No. of Hours
1.	**Introduction & Bayesian Decision Theory:** What Is Machine Learning? Examples of Machine Learning Applications: Learning Associations, Classification, Regression, unsupervised Learning, Reinforcement Learning. Probability: Introduction, Probabilities of Events, Random Variables, Joint Distributions and Densities Introduction to Bayesian Decision Theory, Classification, Losses and Risks	10
2.	**Supervised Learning:** Learning a Class from Examples, Learning Multiple Classes, Regression, Model Selection and Generalization, Dimensions of Supervised Machine Learning Algorithm, Non-Parametric Methods: Histogram Estimator, Kernel Estimator, K-Nearest Neighbor Estimator	10
3.	**Dimensionality Reduction:** Introduction, Subset Selection, Principal Component Analysis PCA, Factor Analysis, Singular Value Decomposition and Matrix Factorization, Multidimensional Scaling, Linear Discriminant Analysis LDA	10
4.	**Unsupervised Learning:** Introduction, Hierarchical Clustering: Agglomerative Clustering Algorithm, The single Linkage Algorithm, The Complete Linkage Algorithm, The Average – Linkage Algorithm, Partitional Clustering: Forgy's Algorithm, The K-Means Algorithm,	10

5.	**Multilayer Perceptron**: The Perceptron, training a Perceptron, Learning Boolean Functions, Multilayer Perceptrons, Back Propagation Algorithm, Training Procedures, Tuning Network size.	12

Text books:

1. Ethem Alpaydin (2014). Introduction to Machin Learning, Third Edition, MIT Press. The textbook website is https://www. cmpe. boun. edu. tr/~ethem/i2ml3e/
2. Understanding Machine Learning, Shai Shalev-Shwartz and Shai Bendavid. Cambridge University press. 2017. [SS-2017]

Reference Books:

1. Machine Learning, *Tom M. Mitchell,* McGraw-Hill Publishers, 1997.
2. Pattern Recognition and Machine Learning, *Christopher M. Bishop,* Springer Publishers, 2011.
3. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
4. Hal Daume III, A course in Machine Learning, 2015 (Most chapters freely available online).

Note: Students are informed to visit NPTEL website (http://nptel.ac.in) for additional information on the course.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Department: Computer Science and Engineering	
Course title: Linear Algebra and its Applications	*Course Code:SCE142*
Credits(L:T:P): 4:1:0	*Core/Elective: Elective*
Type of Course: Lecture, Tutorial	*Total Contact Hours:52:26:0*
CIE Marks : 50	*SEE Marks: 100*

Pre-requisite: Basic Operations of Matrices, Basics of Vector Space.

Course Outcomes: After completing this course, students should be able to

CO1: Comprehend the core theories and concepts of system of linear equations.

CO2: Construct matrix algebra, invertibility, and the transpose and understand vector algebra

CO3: Apply the concept of vector spaces and subspaces for a given application.

CO4: Analysis of the given system using the Eigen values and eigenvectors

CO5: Apply various computational techniques with matrices for digital signal and image processing

Unit No.	Course Content	No. of Hours
1.	**Matrices and Gaussian Elimination :** Introduction , The Geometry of Linear Equations , An Example of Gaussian Elimination , Matrix Notation and Matrix Multiplication , Triangular Factors and Row Exchanges n Inverses and Transposes , Special Matrices and Application.	10
2.	**Vector Spaces** Vector Spaces and Subspaces, Solving AX=0, and AX=B, Linear Independence, Basis and Dimension, The Four Fundamental Subspaces, Graphs and Networks, Linear Transformations.	10
3	**Orthogonality:** Orthogonal Vectors and Subspaces, Cosines and Projections onto Lines, Projections and Least Squares, Orthogonal Bases and Gran-Schmidt, the Fast Fourier Transform.	10
4.	**Eigen values and Eigenvectors:** Introduction**,** Properties of determinants, Formulas for the Determinants, Diagonalisation of a matrix, Difference equations and Powers e^k, Difference equations and $e^{At.}$ Similarity Transformations.	12
5.	**Computations with Matrices:** Minima , maxima and Saddle Points , Tests for Positive Definiteness , SVD , Matrix Norm and Condition Number , Computation of Eigen values , Iterative Methods for AX=B.	10

Text Book:

Linear Algebra and its Applications – Gilbert Strang 2012, Fourth Edition 2012.

Reference Book:

Seymour Lipschutz – "Linear Algebra", Third Edition, Tata McGraw-Hill 2009.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Department: Computer Science and Engineering	
Course: Data warehousing and Data Mining	***Course Code: SCE143***
Credits(L:T:P):4:1:0	***Core/Elective: Elective***
Type of Course: Lecture, Tutorial	***Total Contact Hours:52:26:0***
CIE Marks : 50	***SEE Marks: 100***

Pre-requisite: Database Management System, Advanced Database Management System

Course Outcomes: After completing this course, students should be able to

CO1: Understand various tools of Data Mining and their techniques to solve the real time problems.

CO2: Apply the association rules for mining the data.

CO3: Design and deploy appropriate classification techniques

CO4: Apply clustering techniques to high dimensional data for better data organization.

CO5: Discover the knowledge imbibed in the high dimensional system.

Unit No.	Course Content	No. of Hours
1.	**Introduction:** What is a Data Warehouse?, A Multidimensional Data Model, Data Warehouse Architecture, Data Warehouse Implementation, Data cube Technology, From Data warehousing to Data Mining, Data Mining Functionalities, Data cleaning, Data Integration and Transformation, Data Reduction.	10
2.	**Data Mining** Primitives, Languages And System Architectures: Data Mining primitives, Presentation and Visualization of Discovered patterns, A Data Mining Query Language. MINING ASSOCIATION RULES IN LARGE DATA BASES: Association Rule Mining Single –Dimensional Boolean Association Rules From Transactional Databases, Mining Multilevel Association Rules from Transactional Databases.	12
3	**Classification And Prediction**: Issues regarding Classification and Prediction, classification by Decision tree induction, Bayesian classification, Classification by back propagation, Classification Based on the concepts from association rule mining. Other classification methods, prediction.	10

4.	**Cluster Analysis**: What is Cluster Analysis? Types of data in cluster Analysis: a Categorization of Major Clustering Methods, Partitioning Methods, And Hierarchical methods, Density-Based Methods, Model-Based Clustering Methods: Statistical Approach, Neural Network Approach Outliner Analysis.	10
5.	**Applications And Trends In Data Mining:** Data mining application, Data mining system Products research Prototypes, Additional Themes on Data Mining, Data Mining and Intelligent Query Answering, Tends in Data Mining.	10

Text Books:

1. Jiawei Han and Micheline Kamber: Data Mining - Concepts and Techniques, 3rd Edition, Morgan Kaufmann Publisher, 2014.
2. Pang Ning Tan, Michael Steinbach and Vipin kumar : Introduction to Data Mining, Pearson.

Reference Books:

1. Alex Berson and Stephen J. Smith, " Data Warehousing, Data Mining & OLAP", TataMcGraw – Hill Edition, Tenth Reprint 2007
2. G. K. Gupta: Introduction to Data Mining with Case Studies, 3rd Edition, PHI, New Delhi, 2009
3. The Data Warehouse Toolkit: The Complete Guide to Dimensional Modeling Ralph Kimball and Margy Ross, Wiley, 2002.
4. Leading With Knowledge: Knowledge Management Practices in Global Infotech Companies, Rao, Madan mohan, Tata Mc Graw Hill edition,2007.

Note: Students are informed to visit NPTEL website (http://nptel.ac.in) for additional information on the course.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Department: Computer Science and Engineering	
Course: Agile Software Engineering	***Course Code: SCE144***
Credits(L:T:P):4:1:0	***Core/Elective: Elective***
Type of Course: Lecture, Tutorial	***Total Contact Hours:52:26:0***
CIE Marks : 50	***SEE Marks: 100***

Pre-requisite: Software Engineering.

Course Outcomes: After completing this course, students should be able to

CO1: Comprehend and Analyze iterative, evolutionary and agile development process.

CO2: Realize agile foundations and its frameworks.

CO3: Apply extreme programming (XP) practices and principles to the given scenario.

CO4: Attain and apply the knowledge of SCRUM principles and practices to the real time problems.

CO5: Analyze and evaluate the agile software testing approaches and practices.

Unit No.	Course Content	No. of Hours
1.	**Agile and Iterative development:** Background: Iterative development, evolutionary and adaptive development, evolutionary and adaptive Planning, incremental delivery, evolutional delivery, most common mistakes, specific iterative and evolutionary methods. Motivation: The facts of change on software projects, key motivation for iterative development, meeting the requirement challenge iteratively. Problems with waterfall. Agile: What is agility and why? Is it worth? What changes with agile? How to be agile, Agile manifesto. Agile fear factors, agile criticism, Agile mindset.	10
2.	**Generic agile frameworks.:** Traditional v/s agile projects, Plan driven development v/s agile development, Agile methods and principles, agile method applicability, Problems with agile methods, agile principles, practices and values. Overview of agile methodologies. A generic agile process: Agile operating model; Common agile roles, common agile practices, common agile techniques: stories and backlog refinement, agile estimation, agile planning.	10
3	**Extreme Programming(XP):** Understanding XP: Essence of extreme programming, XP and Agile principles, XP Life cycle, XP team, XP concepts User stories, short cycles, acceptance tests, Extreme programming principles: incremental planning, simple release, simple design, sustainable pace, Test first development, refactoring, Pair programming, collective ownership, continuous integration, onsite customer, informative workspace, root cause analysis, Retrospectives. Case studies.	10

4	**Scrum:** Agile and Scrum, Scrum Principles, Scrum-an agile project Management, Scrum-an agile Process, Functionality of scrum: the Scrum process, Sprint, Sprint cycle, Sprint planning meeting, sprint review meeting, daily scrum, scrum board; Scrum roles: Product owner, Scrum Master, the team; scrum artifacts: Product backlog, Sprint Backlog, Burn-down charts; Scrum pros and cons. Case studies.	10
5	**Quality Assurance in Agile:** What is quality? , what is QA?, QA v/s Testing, What is agile testing?, traditional v/s agile Testing, agile testing mindset, agile testing challenges and success factors, agile testing principles and practices, agile testing approaches and techniques, Agile testing process: Test driven development(TDD), ATTD, continuous integration, Agile tester: Skills, roles and responsibilities, Agile testing quadrants, Agile test automation. Case study.	12

Text books:

1. "Agile and Iterative Development A Manger's Guide", Craig Larman Pearson Education, First Edition, India.
2. "Agile Testing – A practical guide for Testers" and agile Team, Lisa Crispin and Janet Gregory, Addison Wesley / Pearson Education.

Reference Books:

1. The Art of Agile Development (Pragmatic guide to agile software development), James shore, Chromatic, O'Reilly Media, Shroff Publishers & Distributors, 2007.
2. Agile Foundations: Principles, practices and frameworks, Peter Measey and Radtac, bcs the charted institute for IT.
3. Agile Software development: principles patterns and Practices, Robert Cecil Martin, Addison Wesley / Pearson Education.
4. Agile software engineering, Orit Hazzan and Yael Dubinsky, Springer Publications.

Note: Students are informed to visit NPTEL website (http://nptel.ac.in) for additional information on the course.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Department: Computer Science and Engineering	
Course Title: Image Processing and Analysis	***Course Code: SCE151***
Credits(L:T:P): 4:1:0	***Core/Elective: Elective***
Type of Course: Lecture, Tutorial	***Total Contact Hours:52:26:0***
CIE Marks : 50	***SEE Marks: 100***

Pre-requisite: Mathematics, Data Structures and Computer Graphics

Course Outcomes: After completing this course, students should be able to

CO1: Identify the principal areas in which digital image processing can be applied and understand the basics of digital image processing.

CO2: Determine the appropriate operations for image enhancement in spatial domain based on the application.

CO3: Apply color image processing techniques suitable for different applications.

CO4: Choose suitable method to segment the given image.

CO5: Appraise the use of descriptors to represent objects in an image.

Unit No.	Course Content	No. of Hours
1.	**Introduction:** Digital Image Processing, The Origins of Digital Image Processing, Examples of Fields that Use Digital Image Processing, Fundamental Steps in Digital Image Processing, Components of an Image Processing System. **The Image Representation:** Concepts, Image Sampling and Quantization, Some Basic Relationships Between Pixels, Digital Image Properties, Entropy, Visual Perception of the Image, Image Quality, Noise in Images.	08
2.	**Image Enhancement:** Basic Gray Level Transformations: Image negatives, Log transformations, Powerl-Law transformations, Piecewise linear transformations, Histogram Processing: Histogram Equalization, Histogram Specification/Matching, Local Histogram processing, Histogram statistics for image enhancement, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters, Combining Spatial Enhancement Methods.	10
3	**Color Image Processing:** Color fundamentals, Color models: RGB, CMY, CMYK, HIS, Pseudocolor Image Processing, Intensity Slicing, Gray Level to Color Transformations, Full color Image processing, Color Transformations, Formulation, Color Complements, Color Slicing, Tone and Color Corrections, Histogram Processing, noise in color images.	10

4.	**Morphological Image Processing**: Erosion and Dilation, opening and closing, Hit-or-Miss transformations, Basic morphological algorithms: Boundary extraction, Hole filling, Extraction of connected components, Convex Hull, Thinning, Thickenning, Skeletons, Pruning. **Image Segmentation:** Point, Line, and Edge Detection, Detection of Isolated Points, Line Detection, Edge Models, Basic Edge Detection, Thresholding, Foundation, Basic Global Thresholding, Optimum Global Thresholding Using Otsu's Method, Using Image Smoothing to Improve Global Thresholding, Using Edges to Improve Global Thresholding, Region-Based Segmentation, Region Growing, Region Splitting and Merging.	12
5.	**Representation and Descriptors:** Representation, Boundary (Border) Following, Chain Codes, Polygonal Approximations Using Minimum- Perimeter Polygons, Signatures, Boundary Segments, Skeletons, Boundary Descriptors, Some Simple Descriptors, Shape Numbers, Fourier Descriptors, Statistical Moments, Regional Descriptors, Some Simple Descriptors, Topological Descriptors, Texture, Use of Principal Components for Description.	12

Text Book:

1. Rafael C Gonzalez and Richard E Woods, Digital Image Processing, Pearson Education, 4th edition, 2018.
2. Milan Sonka, Vaclav Hlavac and Roger Boyle: Image Processing, analysis and Machine Vision, 4th Edition, 2016.

Reference Books:

1. Anil K Jain, Fundamental of Digital Image Processing, Prentice Hall of India, 2015.
2. Rafael C Gonzalez, Richard E Woods and Steven L. Eddins, Image Processing using MATLAB, Tata McGraw-Hill, 2015.
3. S.Jayaraman, S.Esakkirajan and T.Veerakumar: Digital Image Processing, 2nd Edition, TataMcGraw Hill, 2020.

Note: Students are informed to visit NPTEL website (http://nptel.ac.in) for additional information on the course.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Department: Computer Science and Engineering	
Course title: Multimedia Computing	*Course Code:SCE152*
Credits(L:T:P): 4:1:0	*Core/Elective: Elective*
Type of Course: Lecture, Tutorial	*Total Contact Hours:52:26:0*
CIE Marks : 50	*SEE Marks: 100*

Pre-requisite: Mathematics, Data Structures and Computer Graphics.

Course Outcomes: After completing this course, students should be able to

CO1: Define the fundamentals of multimedia characteristics and basic requirements.

CO2: Compare audio, graphics and image characteristics.

CO3: Analyze and synthesize the video and animation content processing techniques.

CO4: implement the compression algorithms and gain knowledge on optical storage media.

CO5: Conceptualize and apply content analysis for multimedia systems applications.

Unit No.	Course Content	No. of Hours
1.	**Introduction to Multimedia Systems Design, Media and Data Streams**: **Multimedia Systems Design: An Introduction:** Introduction; Multimedia Elements; Multimedia Applications; Multimedia Systems Architecture; Evolving Technologies for Multimedia Systems; Defining Objects for Multimedia Systems; Multimedia Data Interface Standards; The need for Data Compression; Multimedia Databases. **Media and Data Streams:** The Term Multimedia; The Term Media: Perception Media, Representation Media, Presentation Media, Storage Media, Transmission Media, Information Exchange Media, Presentation Spaces & Values, Presentation Dimensions; Key Properties of a Multimedia System: Discrete & Continuous Media, Independence Media, Computer Controlled Systems, Integration; Characterizing Data Streams: Asynchronous Transmission Mode, Synchronous Transmission Mode, Isochronous Transmission Mode; Characterizing Continuous Media Data Streams.	12
2.	**Audio Technology, Graphics and Images:** **Audio Technology:** Introduction; Sound; Frequency, Amplitude, Sound Perception and Psychoacoustics; Audio Representation on Computers: Sampling, Quantization; Three Dimensional Sound Projection: Spatial Sound, Reflection Systems; Music and MIDI Standards; Speech Signals: Human Speech, Speech Synthesis; Speech Output: Reproducible Speech Playout, Sound Concatenation in the Time and Frequency Range, Speech Synthesis; Speech Input: Speech Recognition. **Graphics and Images:** Introduction; Capturing Graphics and Images: Capturing Real-World Images, Image Formats, Creating Graphics, Storing Graphics, Computer Assisted Graphics and Image Processing; Image Analysis, Image Synthesis.	10

3	**Video Technology and Computer-Based Animation:** **Video Technology:** Introduction; Basics: Representation of Video Signals, Visual Representation; Signal Formats: Color Encoding, Composite Signal, Computer Video Format; Digitalization of Video Signals; Composite Coding, Component Coding. **Computer-Based Animation:** Introduction; Basic Concepts: Input Process, Composition Stage, Inbetween Process, Changing Colors; Specification of Animations; Methods of Controlling Animation: Explicitly Declared Control, Procedural Control, Constraint-based Systems, Control by Analyzing Live Action, Kinematic and Dynamic Control; Display of Animation; Transmission of Animation, Virtual Reality Modelling Language.	10
4.	**Data Compression and Optical Storage Media:** **Data Compression:** Storage Space; Coding Requirements; Source, Entropy, and Hybrid Coding: Entropy Coding, Source Coding, Major Steps of Data Compression; Basic Compression Techniques; Run-Length Coding, Zero Suppression, Vector Quantization, Pattern Substitution, Diatomic Encoding, Statistical Coding, Huffman Coding, Transformation Coding, Subband Coding; JPEG: Requirements, JPEG Overview, JPEG Modes, Image Preparation, Lossy Sequential DCT-based Mode. **Optical Storage Media:** Introduction to Magnetic and Optical Storage Devices; History of Optical Storage; Basic Technology: Optical Disc; Comparison of Magnetic and Optical Storage Devices.	10
5.	**Content Analysis and Multimedia Application Design:** **Content Analysis:** Introduction, Simple Vs. Complex Features; Analysis of Individual Images: Text Recognition, Similarity-Based Searches in Image Databases; Analysis of Image Sequences: Motion Vectors, Cut Detection, Analysis of Shots, Similarity-Based Search at the Shot Level, Similarity-Based Search at the Scene and Video Level; Audio Analysis: Syntactic Audio Indicators, Semantic Audio Indicators; Applications: Genre Recognition, Text Recognition in Videos. **Multimedia Application Design:** Introduction; Multimedia Application Classes; Types of Multimedia Systems; Virtual Reality Design; Components of Multimedia Systems; Organizing Multimedia Databases; Application Workflow Design Issues; Distributed Application Design Issues.	10

Text Books:

1. Ralf Steinmetz, Klara Narstedt: Multimedia Fundamentals: Vol 1-Media Coding and Content Processing, 2nd Edition, Pearson Education, 2017.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Reference Books:

1. Prabhat K. Andleigh, Kiran Thakrar: Multimedia Systems Design, 1st Edition, PHI, 2018.
2. K.R Rao, Zoran S. Bojkovic and Dragorad A. Milovanovic: Multimedia Communication Systems: Techniques, Standards, and Networks, 2nd Edition, PHI Learning, 2016.

Note: Students are informed to visit the following websites for additional information on the course.

1. https://onlinecourses.nptel.ac.in/multimediacommunication Course offered by IIT Khanapur
2. http://www.nptelvideos.in/2018/11/multimedia-and-its-applications.html
3. https://freevideolectures.com/course/multimediacomputing

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Department: Computer Science and Engineering	
Course title: Information Retrieval	***Course Code:SCE153***
Credits(L:T:P): 4:1:0	***Core/Elective: Elective***
Type of Course: Lecture, Tutorial	***Total Contact Hours:52:26:0***
CIE Marks : 50	***SEE Marks: 100***

CO-1	Define the retrieval strategies to languages in peer-to-peer, parallel, and distributed networks.
CO-2	Compare the different retrieval and indexing strategies and their application in different types of networks.
CO-3	Apply retrieval and indexing strategies for effectively ranking and searching of contents.

Unit No.	Course Content	No. of Hours
1.	**Introduction** **Retrieval Strategies-1:** Introduction, Retrieval Strategies: Vector Space Model. Self-study component: Probabilistic Retrieval strategies. **Retrieval Strategies-2:** Some More Retrieval Strategies: Language Models, Inference Networks, Extended Boolean Retrieval, Latent Semantic Indexing, Neural Networks, Genetic Algorithms. Fuzzy Set Retrieval.	10
2.	**Retrieval Utilities, Indexing and Searching** Relevance feedback, Clustering, Passage-Based Retrieval, N-Grams, Regression Analysis, Thesauri, Semantic Networks, Parsing. Searching Introduction, Inverted Files, Other indices for text, Boolean queries, Sequential searching, Structural queries, Compression. Pattern matching.	10
3.	**Cross-Language Information Retrieval and Efficiency, Integrating Structured Data and Text** Introduction, Crossing the language barrier, Cross-Language retrieval strategies, Cross language utilities. Duplicate Document Detection, Review of the relational model, A historical progression, Information retrieval as a relational application, Semi-structured search using a relational schema. multi-dimensional data model.	12

4.	Parallel Information Retrieval, Distributed Information Retrieval Parallel text scanning, Parallel indexing, Clustering and classification, Large parallel systems, A theoretic model of distributed information retrieval, Web search, Result fusion, other architectures. Peer-to-Peer information systems.	10
5.	**Multimedia IR** Introduction; data modelling, Query languages, Spatial access methods, A general multimedia indexing approach, One-dimensional time series, Two-dimensional colour images, Automatic picture extraction.	10

Text Books:

1. David A. Grossman, Ophir Frieder: Information Retrieval Algorithms and Heuristics, 2nd Edition, Springer, 2004.
2. Ricardo Baeza-Yates, Berthier Ribeiro-Neto: Modern Information Retrieval, Pearson Education, 1999

Reference Book:

1. William B. Frakes, Ricardo Baeza-Yates (Editors): Information Retrieval Data Structures & Algorithms, Prentice Hall PTR, 1992.

Note: Students are informed to visit NPTEL website (http://nptel.ac.in) for additional information on the course.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Department: Computer Science and Engineering	
Course Title: Web Scale Database	*Course Code: SCE154*
Credits(L:T:P):4:1:0	*Core/Elective: Elective*
Type of Course: Lecture, Tutorial	*Total Contact Hours:52:26:0*
CIE Marks : 50	*SEE Marks: 100*

Pre-requisite: NIL

Course Outcomes: After completing this course, students should be able to

CO1: Articulate the basic approaches and key development elements to building dynamic websites.

CO2: Describe the various storage architectures.

CO3: Design NoSQL queries for MongoDB

CO4: Apply indexing and ordering data sets using NoSQL.

CO5: Evaluate transactions management and data integrity in NoSQL

Unit No.	Course Contents	No. of Hours
1.	**Introduction to NOSQL:** Definition of NOSQL, Context and History of NOSQL, Big data, Scalibility Definition and Introduction, key/value stores, Document Databases: mongodb, couchdb, Graph Databases: Neo4j, flockdb	8
2.	**Understanding the storage architecture:** working with column-oriented databases, Hbase distributed storage architecture, document store internals, guidelines for using collections and indexes in Mongodb, Mongodb reliability and durability, Performing crud operations: creating records, accessing data, accessing data from hbase , updating and deleting data, updating and modifying data in Mongodb, HBase, and Redis, Limited Atomicity and Transactional Integrity.	12
3.	**Querying nosql stores :** Similarities between SQL and MongoDB query features, accessing data from column-oriented databases like Hbase, querying Redis data stores, **Modifying data stores and managing evolution:** changing document databases, schema-less flexibility, exporting and importing data from and into mongodb, hbase data import and export, data evolution in key/value stores	12
4.	**Indexing and ordering data sets:** essential concepts behind a database index, indexing and ordering in MongoDB, creating and using indexes in MongoDB, compound and embedded keys, indexing and ordering in couchDB	10

5.	**Managing Transactions and Data Integrity:** RDBMS and ACID, Isolation Levels and Isolation Strategies, distributed acid systems, consistency implementations in a few nosql products	10

Text Books

1. "Professional NOSQL" by Shashank Tiwari, 2011, WROX Press.
2. The Definitive guide to MongoDB, The NoSQL Database for Cloud and Desktop Computing, Apress 2010.

Reference Books:

1. Wolfgang Lehner, Kai-Uwe Sattler, "Web-Scale Data Management for the cloud", Springer Publications, 2013.
2. Jim Buyens, "Web Database Development-Step by Step", Microsoft Press, 2000.

Note: Students are informed to visit NPTEL website (http://nptel.ac.in) for additional information on the course.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Department: Computer Science and Engineering	
Course title: Advanced Programming Lab-I	*Course Code: SCE170L*
Credits(L:T:P): 0.0.1.5	*Core/Elective:*
Type of Course: Practical	*Total Contact Hours:*
CIE Marks : 50	*SEE Marks:*

Pre-requisite: Programming languages

Course Outcomes: After completing this course, students should be able to:

CO1: Comprehend and Implement the concepts

CO2: Evaluate the different implementation techniques

CO2: Design algorithms for different applications

A few topics that will be addressed in this laboratory are as follows:

1. Error Detecting code
2. Routing algorithms
3. Finding Loop Less Path
4. Client-Server interaction
5. Encryption/Decryption
6. Hamming code generation
7. Leaky Bucket for Congestion control
8. **Advanced searching techniques**: Two way merge problem, Minimum cycle basis problem, Two terminal one to any problem, Minimum cooperative guards problem, Hill-climbing, Best-first, Branch and Bound , A* searching strategies
9. **Divide and Conquer and Dynamic Programming:**

   The 2-dimensional maxima finding problem, The closest pair problem, The convex hull problem
10. **Randomized and On-line Algorithms:**

    Randomized algorithm to solve the closest pair problem to test whether a number is prime, for pattern matching, randomized linear time algorithm for minimum spanning trees.

    On-line Euclidean spanning tree problem solved by the greedy method, The on-line k-server problem and greedy algorithm to solve this problem defined on planar trees, An on-line obstacle traversal algorithm based on the balance strategy.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Department: Computer Science and Engineering	
Course title: Advanced Operating Systems and Distributed Computing	***Course Code:SCE210***
Credits(L:T:P): 4:1:0	***Core/Elective: Core***
Type of Course: Lecture, Tutorial	***Total Contact Hours:52:26:0***
CIE Marks : 50	***SEE Marks: 100***

Pre-requisite: Operating Systems

Course Outcomes:

After completing this course, students should be able to:

CO1: Comprehend the concept of Distributed operating system and lamp port logical clock

CO2: Analyze and design suitable Mutual Exclusion algorithm in designing distributed System.

CO3: Design and implement resource management in a Distributed Environment.

CO4: Understand and comprehend distributed system, design recovery, protection and Security model.

CO5: Design and apply operating system algorithms in multiprocessor and database Operating system environment.

Course Content:

Unit No.	Course Content	Hours
1.	**Introduction:** Review of core Operating systems, network Operating systems, Real-time Operating systems, Mobile Operating system. Distributed Operating System- Introduction, design issues, Communication primitives, Limitations of distributed system. lamp ports logical clocks - vector clocks - casual ordering of messages - global state - cuts of a distributed computation - termination detection.	10
2.	**Distributed Mutual Exclusion:** Token based Algorithms, non-taken based algorithms, comparative analysis, Deadlock handling Strategies, Classification of agreement Problems.	12

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3.	**Distributed File system, shared Memory and Distributed scheduling:** Distributed File system-Mechanisms, design issues, Distributed Shared Memory: Architecture, Algorithms for implementing DSM, Memory coherence, coherence protocols, Design issues. Distributed Scheduling- Issues, Components, Load distributing algorithms, Performance comparison.	10
4.	**Failure Recovery, Fault Tolerance, Protection and Security:** Failure Recovery and Fault Tolerance -Basic concepts, Classification of failures, Backward and forward recovery, Basic approaches, recovery in concurrent systems, Fault tolerance issues, Atomic actions & protocols, Commit, non-blocking, voting-static, dynamic protocols. Protection & Security: Preliminaries, Access matrix model, Implementation and safety, Data security- model, conventional, modern, private-public key Cryptography, multiple encryptions, Authentication	10
5.	**Multiprocessor Operating Systems and Database Operating system:** Multiprocessor Operating System: Introduction, Architecture, Interconnection networks for Multiprocessing, Caching, Structure of multiprocessing Operating System, Threads. Various types of Threads, processor synchronization. Database operating systems: Introduction, requirements of Database OS, database systems, Concurrency control-model, problem, distributed database systems Concurrency control algorithms – synchronization primitives, lock based, timestamp based and data replication algorithms .	10

Text books:

1. Mukesh Singhal, Niranjan G.Shivaratri, "Advanced concepts in operating systems: Distributed, Database and multiprocessor operating systems", Tata McGraw-Hill Publishing Company Limited.
2. Silberschatz-Galvin, “Operating System Concepts" 6th edition. Addison Willey Publications,

Reference Books:

1. Andrew S.Tanenbaum, "Modern operating system", PHI
2. Pradeep K.Sinha, "Distributed operating system-Concepts and design", PHI
3. Andrew S.Tanenbaum, "Distributed operating system", Pearson education
4. Relevant Research Papers from the Journals/Conferences.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Department: Computer Science and Engineering	
Course title: Multi-core Architecture and Programming	*Course Code: SCE220*
Credits(L:T:P): 4:1:0	*Core/Elective: Core*
Type of Course: Lecture, Tutorial	*Total Contact Hours:52:26:0*
CIE Marks : 50	*SEE Marks: 100*

Pre-requisite: Advanced Computer Architecture

Course Outcomes: After the completion of the course, the student should be able to

CO1: Understand the specialties of Parallel computing platforms

CO2: Analyze the essence of thread management and evaluate the parallelizing approaches

CO3: Design Parallel programs using Message Passing Interface (MPI)

CO4: Apply multithreading and Windows APIs for parallel programming

CO5: Synthesize Parallel applications using Open-MP threading libraries

Unit No.	Course Content	No. of Hours
1.	**Introduction to Multi-Core Architecture:** Motivation for Concurrency in software, Parallel Computing Platforms, Parallel Computing in Microprocessors, Differentiating Multi-Core Architectures from Hyper- Threading Technology, Multi-threading on Single Core versus Multi-Core Platforms Understanding Performance, Amdahl's Law, Growing Returns: Gustafson's Law.	10
2.	**System Overview of Threading:** Defining Threads, System View of Threads, threading above the Operating System, Threads inside the OS, Threads inside the Hardware, What Happens When a Thread Is Created, Application Programming Models and Threading, Virtual Environment: VMs and Platforms, Runtime Virtualization, System Virtualization. **Fundamental Concepts of Parallel Programming:** Designing for Threads, Task Decomposition, Data Decomposition, Data Flow Decomposition, Implications of Different Decompositions, Challenges You'll Face, Parallel Programming Patterns, A Motivating Problem: Error Diffusion, Analysis of the Error Diffusion Algorithm, An Alternate Approach: Parallel Error Diffusion, Other Alternatives.	10

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3	**Distributed Memory Programming with MPI:** Getting Started, the trapezoidal rule in MPI, dealing with I/O, Collective communication, MPI derived datatypes, Performance evaluation of MPI programs, A parallel sorting algorithm.	10
4.	**Threading and Parallel Programming Constructs:** Synchronization, Critical Sections, Deadlock, Synchronization Primitives, Semaphores, Locks, Condition Variables, Messages, Flow Control- based Concepts, Fence, Barrier, Implementation-dependent Threading Features. **Threading APIs:** Threading Apls for Microsoft Windows, Win32/MFC Thread Apls, Threading Apls for Microsoft. NET Framework, Creating Threads, Managing Threads, Thread Pools, Thread Synchronization, POSIX Threads, Creating Threads, Managing Threads, Thread Synchronization, Signaling, Compilation and Linking.	12
5.	**Open-MP: A Portable Solution for Threading:** Challenges in Threading a Loop, Loop-carried Dependence, Data-race Conditions, Managing Shared and Private Data, Loop Scheduling and Portioning, Effective Use of Reductions, Minimizing Threading Overhead, Work-sharing Sections, Performance-oriented Programming, Using Barrier and No wait, Interleaving Single-thread and Multi-thread Execution, Data Copy-in and Copy-out, Protecting Updates of Shared Variables, Intel Task queuing Extension to Open-MP, Open-MP Library Functions, Open-MP Environment Variables, Compilation, Debugging, performance.	10

Text Book:

1. Multicore Programming, Increased Performance through Software Multi-threading by Shameem Akhter and Jason Roberts, Intel Press, 2006
2. An Introduction to Parallel Programming – Peter Pacheco, Morgan Kaufmann, 2011.

Reference Books:

1. Introduction to Parallel Computing – Ananth Grama et. Al., Pearson Education, 2009.
2. Parallel Programming in C with MPI and Open-MP – Michael J. Quinn, Tata McGraw Hill, 2004.

Note: Students are informed to study the selected topics from the following NPTEL links

1. https://nptel.ac.in/courses/106104025/2
2. https://nptel.ac.in/courses/106104025/43
3. https://nptel.ac.in/courses/106104025/19

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Department: Computer Science and Engineering	
Course title: Big Data Analytics	***Course Code: SCE230***
Credits(L:T:P): 4:1:0	***Core/Elective: Core***
Type of Course: Lecture, Tutorial	***Total Contact Hours:52:26:0***
CIE Marks : 50	***SEE Marks: 100***

Pre-requisite: Database Management System.

Course Outcomes: After completing this course, students should be able to

CO1: Comprehend the significance, structure and standards of Big data.

CO2: Evaluate analytical scalability, methods & tools of data analytics.

CO3: Apply data stream computing techniques

CO4: Understand HDFS Frameworks and develop application to solve problems.

CO5: Use of Hortonworks data platform (HDP) on sandbox.

Unit No.	Course Content	No. of Hours
1.	**Introduction To Big Data:** What Is Big Data? Is The "Big" Part Or The "Data" Art More Important? How Is Big Data Different? How Is Big Data More of the Same? Risks of Big Data –Why you need to tame Big Data –The Structure of Big Data- Exploring Big Data, Most Big Data Doesn't Matter- Filtering Big Data Effectively –Mixing Big Data With Traditional Data- The need For StandardsToday's Big Data Is Not Tomorrow's Big Data. Web Data: The Original Big Data –Web Data Overview –What Web Data Reveals –Web Data In Action? A Cross-Section Of Big Data Sources And The Value They Hold.	12
2.	**Data Analysis:** Evolution Of Analytic Scalability, Convergence, Parallel Processing Systems, Cloud Computing, Grid Computing, Map Reduce, Enterprise Analytic Sand Box, Analytic Data Sets , Analytic Methods, Analytic Tools: Cognos – Microstrategy – Pentaho. Analysis Approaches, Statistical Significance, Business Approaches, Analytic Innovation, Traditional Approaches, Iterative	08
3	**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, Realtime Analytics Platform(RTAP) Applications, Case Studies, Real Time Sentiment Analysis, Stock Market Predictions.	10

4.	**The Hadoop Distributed File system Frameworks and Visualization** The Design of HDFS, HDFS Concepts – Blocks, Name nodes and Data nodes, Block Caching, HDFSFederation, HDFS High Availability, thecommand-Line Interface, Hadoop File system – InterfacesData Flow – Anatomy of a File Read, Anatomy of a File Write. Mapreduce,MapRSharding, Nosql Databases, S3- Hadoop Distributed File Systems, Visualizations: Visual Data Analysis Techniques, Interaction Techniques; Systems and Applications**.**	12
5.	**Introduction to Hortonworks Data Platform (HDP):** Hortonworks Data Platform (HDP),Data workflow,Sqoop, Flume, Kafka, Data access, Hive, Pig, HBase,Accumulo ,Phoenix ,Storm, Solr, Spark, Druid ,Data Lifecycle and Governance, Falcon, Atlas, Security, Ranger, Knox, Operations, Ambari, The Ambari web interface, Cloudbreak	10

Text Books:

1. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with advanced analytics, John Wiley & sons, 2012.
2. AnandRajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 2014.
3. Student Guide - Introduction to Big Data Ecosystem Skills Academy: Data Science Technologist, March 2018.
4. "Hadoop – The Definitive Guide; Storage and Analysis at Internet scale", Tom White, 4 thEdition,

Reference Books:

1. Paul Zikopoulos, Chris Eaton, Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data: Analytics for Enterprise Class Hadoop and Streaming Data, McGraw Hill Professional, 2011.
2. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
3. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, Pete Warden, Big Data Glossary, Oreilly.
4. Alex Holmes "Hadoop in Practice", Manning Press, Dreamtech Press.
5. Chuck Lam, "Hadoop in Action", Dreamtech Press.

Note: Students are informed to visit NPTEL website (http://nptel.ac.in) for additional information on the course.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Department: Computer Science and Engineering	
Course Title: Cryptography and Network Security	***Course Code: SCE241***
Credits(L:T:P):4:0:1	***Core/Elective: Elective***
Type of Course: Lecture, Practical	***Total Contact Hours:52:0:26***
CIE Marks : 50	***SEE Marks: 100***

Pre-requisite: Computer Networks

Course Outcomes: After completing this course, students should be able to CO1:

Attain the knowledge of different data encryption techniques and standards.

CO2: Comprehend and implement the Public Key Cryptosystems and hash functions.

CO3: Apply the concepts of authentication functions and key distribution techniques.

CO4: Analyze and implement protocols related to E-mail security and web security.

CO5: Analyze the security issues at network layer and evaluate system security mechanisms.

Unit No.	Course Content	No. of Hours
1.	**Encryption techniques and Data Encryption Standards:** *Classical Encryption Techniques*: Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Rotor Machines, Steganography. Traditional Block Cipher structure. Block cipher design Principles. *Data Encryption Standard*: DES, DES example, The Strength of DES, Multiple encryption and Triple DES, Electronic code book (ECB), cipher block chaining Mode, cipher feedback mode. Introduction to AES.	10
2.	**Public-Key cryptography and Hash Functions function:** *Public-Key cryptography:* Principles of Public-Key Cryptosystems, The RSA Algorithm, Diffie-Hellman Key Exchange, Elliptic curve cryptography. Cryptographic Hash Functions: Applications of Cryptographic Hash Functions, Two simple hash functions, Requirements and security, hash function based on cipher block chaining, secure hash algorithm (SHA).	10
3.	**Authentication and Key Management:** *Message Authentication*: Authentication Requirements, Authentication Functions, Requirements for Message Authentication Codes (MAC), Security of MACs, MAC based on Hash Function. Digital signature. *User authentication*: Remote user authentication principles, Remote user authentication using symmetric Encryption, Kerberos, Remote user authentication using Asymmetric Encryption. Symmetric key distribution using symmetric and asymmetric encryption. Distribution of public keys.	12

4.	**Security at Application layer and Transport Layer:** Application Layer Security: Pretty Good Privacy(PGP), Multipurpose internet Mail extensions(MIME) and secured Multipurpose internet Mail extensions (S/MIME). Transport Layer Security: Web security considerations, Secure socket layer (SSL), Transport Layer security, HTTP.	10
5.	**Network Security and System security.** IP Security: IP Security Overview, IP Security Policy, Encapsulation Security Payload, Wireless network security: wireless security, Mobile device security. System security: Buffer overflow and malicious software, Malicious programs, Intrusion detection systems, Firewalls.	10

Text Book:

1. William Stallings, "Cryptography and Network Security", Sixth Edition, 2016, Pearson Education Inc Publishing as Prentice hall (PHI).

Reference Books:

1. Behrouz A forouzan, debdeep Mukhopadhyay, "Cryptography and Network security", 3rd edition, Mc Graw Hill education, 2015.
2. Charles P. Pfleeger, Shari Lawrence Pfleeger – Security in computing Third Edition – Prentice Hall of India, 2006.

Note: Students are informed to visit NPTEL website (http://nptel.ac.in) for additional information on the course.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Department: Computer Science and Engineering	
Course Title: Wireless Sensor Networks	*Course Code: SCE242*
Credits(L:T:P):4:1:0	*Core/Elective: Elective*
Type of Course: Lecture, Tutorial	*Total Contact Hours:52:26:0*
CIE Marks : 50	*SEE Marks: 100*

Pre-requisite: Computer Networks, Wireless Networks

Course Outcomes: After completing this course, students should be able to

CO1: Summarize the concepts of Wireless Sensor Networks with their applications.

CO2: Assess and apply the medium access control protocols for different case studies.

CO3: Implement network and transport layer protocol for wireless sensor networks.

CO4: Comprehend the issues of Network Management in Wireless Sensor Networks.

CO5: Analyse and evaluate the performance of Wireless Sensor Networks.

Unit No.	Course Content	No. of Hours
1.	**Introduction and Overview of Wireless Sensor Networks:** Introduction, Background of Sensor Network Technology, Applications of Sensor Networks, Basic Overview of the Technology, Basic Sensor Network Architectural Elements, Brief Historical Survey of Sensor Networks, Challenges and Hurdles, Applications of Wireless Sensor Networks, Basic Wireless Sensor Technology- Introduction, Sensor Node TechnologyOverview, Hardware and Software, Sensor Taxonomy, WN Operating Environment, WN Trends	10
2.	**Wireless Transmission Technology and Systems:** Introduction, Radio Technology Primer, Propagation impairments, Modulation, Available Wireless Technologies, Campus Applications, MAN/WAN Applications, Medium Access Control Protocols for Wireless Sensor Networks – Introduction, Fundamentals of MAC Protocols, Performance Requirements, Common Protocols, MAC Protocols for WSNs, Schedule-Based Protocols, Random Access-Based Protocols, Sensor-MAC Case Study, IEEE 802.1, LR-WPANs Standard Case Study.	10

3.	**Routing Protocols for Wireless Sensor Networks:** Data Dissemination and Gathering, Routing Challenges and Design Issues in Wireless Sensor Networks, Routing Strategies in Wireless Sensor Networks, Transport **Control Protocols for Wireless Sensor Networks,** Traditional Transport Control Protocols, Transport Protocol Design Issues, Performance of Transport Control Protocols, Middleware for Wireless Sensor Networks, WSN Middleware Principles, Middleware Architecture, Existing Middleware.	12
4.	**Network Management for Wireless Sensor Networks:** Introduction, Network Management Requirements, Traditional Network Management Models, Simple Network Management Protocol, Telecom Operation Map, Network Management Design Issues, Example of Management Architecture: MANNA, Other Issues Related to Network Management.	10
5.	**Operating Systems for Wireless Sensor Networks:** Operating System Design Issues, Examples of Operating Systems, Performance and Traffic Management – Introduction, Background, WSN Design Issues, MAC Protocols, Routing Protocols, Transport Protocols, Performance Modeling of WSNs, Performance Metrics, Basic Models, Network Models, Case Study: Simple Computation of the System Life Span, Analysis.	10

Text Book:

1. KAZEM SOHRABY, DANIEL MINOLI, TAIEB ZNATI, “Wireless Sensor Networks: Technology, Protocols and Applications: WILEY, Second Edition (Indian) , 2014.

Reference Books:

1. Ian F. Akyildiz, Mehmet Can Vuran “Wireless Sensor Networks”, Wiley 2010
2. Feng Zhao & Leonidas J. Guibas, “Wireless Sensor Networks- An Information Processing Approach”, Elsevier, 2007.

Note:

1. https://nptel.ac.in/courses/106/105/106105160
2. https://www.youtube.com/watch?v=GUSrkWJ_Z2g
3. https://www.youtube.com/watch?v=uZjNNjyq25I

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Department: Computer Science and Engineering	
Course title: Mobile Computing	*Course Code: SCE243*
Credits(L:T:P):4:1:0	*Core/Elective: Elective*
Type of Course: Lecture, Tutorial	*Total Contact Hours:52:26:0*
CIE Marks : 50	*SEE Marks: 100*

Pre-requisite: Wireless Networks

Course outcomes: After completing this course, students should be able to

CO1: Illustrate different mobile computing Architectures.

CO2: Comprehend Short Message Service (SMS) and GPRS based services and applications.

CO3: Analyse and apply different frequency spectrum technologies for mobile applications.

CO4: Evaluate the requirements of mobile operating systems and applications for mobile client.

CO5: Design and develop Mobile applications using markup languages.

Unit No.	Course Content	No. of Hours
1.	**Mobile Computing Architecture:** Types of Networks, Architecture for Mobile Computing, 3-tier Architecture, Design Considerations for Mobile Computing. **Global Systems for Mobile Communication:** GSM Architecture, Entities, Call routing in GSM, GSM Addresses and Identities, Network Aspects in GSM, Mobility Management, GSM Frequency allocation.	10
2.	**Short Message Service (SMS):** Introduction to SMS, SMS Architecture, SM MT, SM MO, SMS as Information bearer, applications. **GPRS:** GPRS and Packet Data Network, GPRS Network Architecture, GPRS Network Operations, Data Services in GPRS, Applications for GPRS, Billing and Charging in GPRS	10
3	**CDMA, 3G and WiMAX:** Spread Spectrum technology, IS-95, CDMA versus GSM, Wireless Data, Third Generation Networks, Applications on 3G, Introduction to WiMAX.	10

4.	**Mobile Client:** Moving beyond desktop, Mobile handset overview, Mobile phones and their features, PDA, Design Constraints in applications for handheld devices. Mobile IP: Introduction, discovery, Registration, Tunneling, Cellular IP, Mobile IP with Ipv6 Mobile OS: Smart Client Architecture, The Client: User Interface, Data Storage, Performance, Data Synchronization, Messaging. The Server: Data Synchronization, Enterprise Data Source, Messaging.	10
5.	**Computing Environment:** Mobile Operating Systems: WinCE, Palm OS, Symbian OS, Linux, Proprietary OS Client Development: The development process, Need analysis phase, Design phase, Implementation and Testing phase, Deployment phase, Development Tools, Device Emulators. **Building, Mobile Internet Applications:** Thin client: Architecture, the client, Middleware, messaging Servers, Processing a Wireless request, Wireless Applications Protocol (WAP) Overview, Wireless Languages: Markup Languages, HDML, WML, HTML, cHTML, XHTML, VoiceXML.	12

Text Books:

1. Dr. Ashok Talukder, Ms.Roopa Yavagal,Mr.Hasan Ahmed:Mobile Computing,Technology, Applications and Service Creation, 2nd Edition, Tata McGraw Hill,2010.
2. Martyn Mallik:Mobile and Wireless Design Essentials, Wiely 2003.

Reference Books:

1. Rajkamal: Mobile computing, Oxford University Press, 2007.
2. Iti Saha Misra: Wireless Communications and Networks, 3G and Beyond, Tata McGraw Hill, 2009.
3. Reza B'Far: Mobile Computing Principles – Designing and Developing Mobile Applications with UML and XML, Cambridge University press, 5th Edition, 2006.

Note: Students are informed to visit NPTEL website (http://nptel.ac.in) for additional information on the course.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Department: Computer Science and Engineering	
Course Title: Internet of Things	***Course Code: SCE244***
Credits (L:T:P): 4:1:0	***Core/Elective: Elective***
Type of Course: Lecture, Tutorial	***Total Contact Hours: 52:26:0***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Cloud Computing and Embedded Systems.

Course Outcomes: After completing this course, students should be able to,

CO1: Develop schemes for the applications of IOT in real time scenarios.

CO2: Analyse and apply the various Key Technologies in IoT.

CO3: Choose suitable communication standards of the IoT.

CO4: Realize the practical knowledge through different case studies.

CO5: Understand the data sets received through IoT devices and tools used for analysis.

Unit No.	Course Contents	No. of Hours
1.	**Introduction to Internet of Things:** Introduction, Physical Design of IoT, Logical Design of IoT, IoT Enabling Technologies, IoT Levels & Deployment Templates.	10
2.	**Domain Specific IoTs:** Introduction, Home Automation (Lighting, Appliances, Intrusion Detection and Smoke/Gas Detectors), Cities (Parking, Lighting, Roads, Structural Health Monitoring, Surveillance and Emergency Response), Environment (Weather Monitoring, Air Pollution Monitoring, Noise Pollution Monitoring, Forest Fire Detection and River Floods Detection), Energy (Grids, Renewable Energy Systems and Prognostics), Retail (Inventory Management, Smart Payments and Smart Vending Machines), Logistics (Route Generation & Scheduling, Fleet Tracking, Shipment Monitoring and Remote Vehicle Diagnostics), Agriculture (Irrigation and Green House Control), Industry (Machine Diagnosis & Prognosis and Indoor Air Quality Monitoring), Health & Lifestyle (Health & Fitness Monitoring and Wearable Electronics)	10
3.	**IoT and M2M:** Introduction, M2M, Difference between IoT and M2M, SDN and NFV for IoT. **IoT System Management with NETCONF-YANG:** Need for IoT Systems Management, Simple Network Management Protocol (SNMP) with Limitations, Network Operator Requirements, NETCONF, YANG, IoT Systems Management with NETCONF-YANG.	12

4.	**IoT Platforms Design Methodology:** Introduction, IoT Design Methodology, Case Study on IoT System for Weather Monitoring, **Case Studies illustrating IoT:** Design-Introduction, Home Automation, Cities, Environment, Agriculture, Productivity Applications.	10
5.	**Data Analytics for IoT:** Introduction, Apache Hadoop, Using Hadoop, MapReduce for Batch Data Analysis; Apache Oozie, Apache Spark, Apache, Storm, Using Apache Storm for Real-time Data Analysis, Structural Health, Monitoring Case Study.	10

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

Reference Books:

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

Note: Students are informed to visit NPTEL website (http://nptel.ac.in) for additional information on the course.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Department: Computer Science and Engineering	
Course title: Advanced Database Management Systems	*Course Code: SCE251*
Credits(L:T:P): 4:1:0	*Core/Elective: Elective*
Type of Course: Lecture, Tutorial	*Total Contact Hours:52:26:0*
CIE Marks : 50	*SEE Marks: 100*

Pre-requisite: Database Management Systems.

Course Outcomes: After completing this course, students should be able to

CO1: Select the appropriate high performance database for the given application

CO2: Design and analyze the real world data using object oriented database

CO3: Appraise the architectures for parallel and distributed databases.

CO4: Design and implement data warehousing, perform data mining to present various views.

CO5: Choose and design database for recent applications database for better interoperability

Unit No.	Course Contents	No. of Hours
1.	**Review of Relational Data Model** and Relational Database Constraints: Relational model concepts; Relational model constraints and relational database schemas; Update operations, transactions and dealing with constraint violations. **The Enhanced Entity–Relationship (EER) Model:** Subclasses, Superclasses, and Inheritance, Specialization and Generalization, Constraints and Characteristics of Specialization and Generalization Hierarchies, Modeling of UNION Types Using Categories, Mapping EER to Relational Mapping	10
2.	**Object and Object-Relational Databases**: Overview of Object Database Concepts, Object Database Extensions to SQL , The ODMG Object Model and the Object Definition Language ODL, Object Database Conceptual Design, The Object Query Language OQL, Overview of the C++ Language Binding in the ODMG Standard. Comparing RDBMS, OODBMS and ORDBMS.	10

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3.	**Parallel and Distributed Databases:** Architectures for parallel databases; Parallel query evaluation; Parallelizing individual operations; Parallel query optimizations; **Distributed Database Concepts**: Data Fragmentation, Replication, and Allocation Techniques for Distributed Database Design, Overview of Concurrency Control and Recovery in Distributed Databases, Overview of Transaction Management in Distributed Databases, Query Processing and Optimization in Distributed Databases, Types of Distributed Database Systems, Distributed Database Architectures, Distributed Catalog Management. Introduction to NOSQL Systems, The CAP Theorem.	12
4.	**Data Warehousing and Data Mining**: Introduction, Definitions, and Terminology, Characteristics of Data Warehouses, Data Modeling for Data Warehouses, Building a Data Warehouse, Typical Functionality of a Data Warehouse, Data Warehouse versus Views, Difficulties of Implementing Data Warehouses. Overview of Data Mining Technology, Association Rules, Classification, Clustering, Approaches to Other Data Mining Problems, Applications of Data Mining	10
5.	**Enhanced Data Models** for Some Advanced Applications: Active database concepts and triggers; Temporal, Spatial, and Deductive Databases – Basic concepts. More Recent Applications: Mobile databases; Multimedia databases; Geographical Information Systems; Genome data management.	10

Text Books:

1. Elmasri and Navathe: Fundamentals of Database Systems, Pearson Education, seventh edition 2017.
2. Raghu Ramakrishnan and Johannes Gehrke: Database Management Systems, 3rd Edition, McGraw-Hill, 2016.

Reference Books:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan: Database System Concepts, 7th Edition, McGraw Hill, 2017.

Note:

Students are informed to visit NPTEL website (http://nptel.ac.in) for additional information on the course.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Department: Computer Science and Engineering	
Course Title: Cloud Computing	***Course Code: SCE252***
Credits(L:T:P): 4:1:0	***Core/Elective: Elective***
Type of Course: Lecture, Tutorial	***Total Contact Hours:52:26:0***
CIE Marks : 50	***SEE Marks: 100***

Pre-requisite: Nil

Course Outcomes: After completing this course, students should be able to CO1: Comprehend various cloud services and applications.

CO2: Design and develop mathematical models for parallel and distributed systems.

CO3: Analyse state machine model and map reduce concept for cloud applications.

CO4: Design virtual machines from available resources.

CO5: Access on mechanisms of resource management and security.

Unit No.	Course Contents	No. of Hours
1.	**Introduction, Cloud Infrastructure** Cloud computing, Cloud computing delivery models and services, Ethical issues, Cloud vulnerabilities, Cloud computing at Amazon, Cloud computing the Google perspective, Microsoft Windows Azure and online services, Open-source software platforms for private clouds, Cloud storage diversity and vendor lock-in, Exercises and problems.	10
2.	**Parallel and Distributed Systems** Parallel Computing, Parallel Computer Architecture, Distributed Systems**,** Communication Protocols and Process Coordination, Message Delivery Rules; Causal Delivery, Concurrency, Consensus Protocols, Enforced Modularity: The Client-Server Paradigm	12
3.	**Cloud Computing: Application Paradigms** Challenges of cloud computing, Architectural styles of cloud computing, Workflows: Coordination of multiple activities, Coordination based on a state machine model: The Zookeeper, The Map Reduce programming model, A case study: The GrepTheWeb application , Cloud for science and engineering, High-performance computing on a cloud, Cloud computing for Biology research, Social computing, digital content and cloud computing.	10

4.	**Cloud Resource Virtualization** Virtualization, Layering and virtualization, Virtual machine monitors, Virtual Machines, Performance and Security Isolation, Full virtualization and paravirtualization, Hardware support for virtualization, Case Study: Xen a VMM based paravirtualization, Optimization of network virtualization, vBlades, Performance comparison of virtualmachines, The dark side of virtualization, Exercises and problems.	10
5.	**Cloud Resource Management, Scheduling and Security** Policies and Mechanisms for Resource Management, Stability of a Two-Level Resource Allocation Architecture, Scheduling Algorithms for Computing Clouds, Fair Queuing, Cloud Security Risks, Security: The Top Concern for Cloud Users, rivacy and Privacy Impact Assessment, Trust, Operating System Security, Virtual Machine Security, Security of Virtualization.	10

Text Books:

1. Dan C Marinescu: Cloud Computing Theory and Practice. Elsevier (MK) 2013.

Reference Books:

1. Rajkumar Buyya, James Broberg, Andrzej Goscinski: Cloud Computing Principles and Paradigms, Willey 2014.
2. John W Rittinghouse, James F Ransome: Cloud Computing Implementation, Management and Security, CRC Press 2013.

Note: Students are informed to visit NPTEL website (http://nptel.ac.in) for additional information on the course.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Department: Computer Science and Engineering	
Course title: Embedded And Real Time Systems	*Course Code: SCE253*
Credits(L:T:P): 4:1:0	*Core/Elective: Elective*
Type of Course: Lecture, Tutorial	*Total Contact Hours:52:26:0*
CIE Marks : 50	*SEE Marks: 100*

Pre-requisite: Advanced Computer Architecture

Course Outcomes: After the completion of the course, the student should be able to

CO1: Understand the importance and characteristics of embedded systems necessary for Real time systems.

CO2: Analyze the models of embedded communication interfacing devices.

CO3: Analyze the working of interrupt service mechanism and device drivers for embedded systems.

CO4: Design the working of inter process communication mechanisms in embedded systems.

CO5: Evaluate Real time operating system and deploy it on an embedded system.

Unit No.	Course Content	No. of Hours
1.	**Introduction to real time systems and characterization:** Hard v/s Soft real time system, A Reference model of real time 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, Design process in embedded system, Formalization of system design, Design process and design examples, Classification of embedded systems, skills required for an embedded system designer.	12
2.	**Devices and communication buses for devices network:** I/O types and example, Serial communication devices, Parallel device ports, Sophisticated interfacing features in device ports, Wireless devices, Timer and counting devices, Watchdog timer, Real time clock, networked embedded systems, Serial bus communication protocols, Parallel bus device protocols-parallel communication Internet using ISA, PCI, PCI-X and advanced buses.	10

3	**Device drivers, Interrupts and Service mechanism:** Programming-I/O busy-wait approach without interrupt service mechanism, ISR concept, Interrupt sources, Interrupt servicing (Handling) Mechanism, Multiple interrupts, Context and the periods for context switching, interrupt latency and deadline, Classification of processors interrupt service mechanism from Context-saving angle, Direct memory access.	12
4.	**Inter processes communication and synchronization of processes, Threads and tasks:** Multiple process in an application, Multiple threads in an application, Tasks, Task states, Task and Data, Clear-cut distinction between functions. ISRS and tasks by their characteristics, concept and semaphores, Shared data, Inter-process communication, Signal function, Semaphore functions, Message Queue functions, Mailbox functions, Pipe functions, Socket functions, RPC functions.	10
5.	**Real-time operating systems:** OS Services, Process management, Timer functions, Event functions, Memory management, Device, file and IO subsystems management, Interrupt routines in RTOS environment and handling of interrupt source calls, Real-time operating systems, Basic design using an RTOS, RTOS task scheduling models, interrupt Latency and response of the tasks as performance metrics, OS security issues.	8

Text Books:

1. Jane W.S.Liu, " Real Time Systems " Pearson Education.
2. Raj Kamal, "Embedded Systems: Architecture, Programming, and Design" 2nd Edition, Tata McGraw hill-2013.

Reference Books:

1. Marilyn Wolf, "Computer as Components, Principles of Embedded Computing System Design" 3rd edition, Elsevier-2014.
2. Mohammed Ali Mazidi; Janice Gillispie Mazidi "The 8051 Micro controller and Embedded Systems"; Pearson Education Asia 2002.

Note: Students are informed to go through the following video tutorials of NPTEL

1. https://nptel.ac.in/courses/106105159/
2. https://www.coursera.org/lecture/embedded-operating-system/introduction-to-embedded-systems-vOlUy

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Course Title: Advanced Storage Area Networks	***Course Code: SCE254***
Credits(L:T:P): 4:0:1	***Core/Elective: Elective***
Type of Course: Lecture, Practical	***Total Contact Hours:52:0:26***
CIE Marks : 50	***SEE Marks: 100***

Prerequisites: Computer Networks. Network architecture, File Structures

Course Outcomes: After the completion of the course, the student should be able to

CO1: Comprehend and analyze performance evaluation metrics used in SAN.

CO2: Comprehend and design NAS architecture.

CO3: Design virtualization environment in SAN.

CO4: Design and develop the policies for SAN

CO5: Analyze the various resource management techniques for SAN.

Unit No.	Course Content	No. of Hours
1.	**Introduction:** Server Centric IT Architecture and its Limitations; Storage –Centric IT Architecture and its advantages. Case study: Replacing a server with Storage Networks The Data Storage and Data Access problem; The Battle for size and access. Intelligent Disk Subsystems: Architecture of Intelligent Disk Subsystems; Hard disks and Internal I/O Channels; JBOD, Storage virtualization using RAID and different RAID levels; Caching: Acceleration of Hard Disk Access; Intelligent disk subsystems, Availability of disk subsystems.	11
2.	**I/O Techniques:** The Physical I/O path from the CPU to the Storage System; SCSI; Fibre Channel Protocol Stack; Fiber Channel SAN; IP Storage. Network Attached Storage: The NAS Architecture, The NAS hardware Architecture, The NAS Software Architecture, Network connectivity, NAS as a storage system. File System and NAS : Local File Systems; Network file Systems and file servers; Shared Disk file systems; Comparison of fiber Channel and NAS.	11
3	**Storage Virtualization:** Definition of Storage virtualization; Implementation Considerations; Storage virtualization on Block or file level; Storage virtualization on various levels of the storage Network; Symmetric and Asymmetric storage virtualization in the Network.	10

4.	**SAN Architecture and Hardware devices:** Overview, creating a Network for storage; SAN Hardware devices; The fibre channel switch; Host Bus Adaptors; Putting the storage in SAN; Fabric operation from a Hardware perspective. Software Components of SAN: The switch's Operating system; Device Drivers; Supporting the switch's components; Configuration options for SANs.	10
5.	**Management of Storage Network:** System Management, Requirement of management System, Support by Management System, Management Interface, Standardized Mechanisms, Property Mechanisms, In-band Management, Use of SNMP, CIM and WBEM, Storage Management Initiative Specification (SMI-S), CMIP and DMI, Optional Aspects of the Management of Storage Networks, Summary	10

Text Books:

1. Ulf Troppens, Rainer Erkens and Wolfgang Muller: Storage Networks, Wiley India, 2013.
2. Richard Barker and Paul Massiglia: "Storage Area Network Essentials: A Complete Guide to understanding and Implementing SANs", Wiley India, 2006.

Reference Books:

1. Robert Spalding: "Storage Networks: The Complete Reference", Tata McGraw-Hill, 2011.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Department: Computer Science and Engineering	
Course title: Advanced Programming Lab-II	*Course Code: SCE270L*
Credits(L:T:P): 0.0.1.5	*Core/Elective: Core*
Type of Course: Practical	*Total Contact Hours:39*
CIE Marks : 50	*SEE Marks: NIL*

Pre-requisite: Programming languages

Course Outcomes: After completing this course, students should be able to:

CO1: Comprehend and Implement the concepts

CO2: Evaluate the different implementation techniques

CO3: Design algorithms for different applications

A few topics that will be addressed in this laboratory are as follows:

- CPU scheduling algorithms
- Application using IPC. (using shared memory, pipes or message queues)
- Producer Consumer Problem using Semaphores
- Memory management schemes.
- Distributed Mutual Exclusion
- Recovery algorithms
- Concurrency control algorithms
- Concept of : i) Threads ii) Child processes
- Stemming applications
- Parts of Speech tagging
- Sentiment analysis
- Map Reduce Hadoop
- Blooms filter etc.