### Syllabus for ME (Computer Engineering)
#### Course 2013 (w.e.f 2013)

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Teaching Scheme Hrs/Week</th>
<th>Examination Scheme</th>
<th>Credits</th>
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<tbody>
<tr>
<td>510101</td>
<td>Applied Algorithms</td>
<td>04</td>
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<tr>
<td>510102</td>
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<td>04</td>
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<td>510106</td>
<td>Laboratory Practice-I</td>
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<th>Subject Code</th>
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<th>Examination Scheme</th>
<th>Credits</th>
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<tbody>
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<td>Operating System Design</td>
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<td>Software Design and Architecture</td>
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SEM—IV

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#: Ref. Rule R-1.3 for Examination Rules of “Rules and Regulations for M.E. Programs under faculty of Engineering effective from June 2013”.

Electives:

<table>
<thead>
<tr>
<th>Elective I</th>
<th>Elective II</th>
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<tr>
<td>510105A</td>
<td>510110A</td>
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<tr>
<td>Intelligent Systems</td>
<td>Business Intelligence and Data Mining</td>
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<tr>
<td>510105B</td>
<td>510110B</td>
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<tr>
<td>IR and Web Mining</td>
<td>Usability Engineering</td>
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<td>510105C</td>
<td>510110C</td>
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<tr>
<td>Machine Learning and Translation</td>
<td>Advanced Compiler Design</td>
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<td>510105D</td>
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<tr>
<td>Open Elective /Real Time Systems</td>
<td>Open Elective/ Embedded System Design</td>
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Elective III

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<th>Non Credit Courses</th>
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<tr>
<td>610103A Network Security</td>
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<tr>
<td>610103B Cloud Computing</td>
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<tr>
<td>610103C Computer Vision and Pattern Recognition</td>
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<tr>
<td>610103D Open Elective/ Soft Computing</td>
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The dissertation must result into the publication of at least two research papers (at Stage–I and Stage-II respectively) preferably in the Journal having Citation Index 2.0 and ISSN number; or paper can be published in reputed International Journal recommended by the guide of the Dissertation and the BoS supported cPGCON event for paper presentation and participation. The guides certificate covering originality of the work and plagiarism-testing result shall be included in the report along with the Published Journal Papers and. cPGCON paper presentation and participation certificates. The comments received by the journal paper reviewers be attached in the Dissertation report and shall be made available during dissertation presentation/viva to the examiners.

**Note 1:** Refer R-2.7 for Examination Rules of “Rules and Regulations for M.E. Programs under faculty of Engineering effective from June 2013”. Non-credit courses are mandatory for the grant of the term and shall be completed by the students as a self study either by referring to the Handbooks, Journal/Conference papers (atleast 25 in number), open source software, tools and in addition may be by organizing educational visits to the technological/professional centers in the subject, if any. Each student is required to produce in own words, one 10 pages innovative, technical paper to be submitted as a part of the semester course work of non-credit courses.
510101- Applied Algorithms

Teaching Scheme
Lectures: 4Hrs/week

Examination Scheme
Theory In-semester Assessment: 50 Marks
Theory End-semester Assessment: 50 Marks
Total Credits : 04

Objectives

- This course covers selected topics in algorithms that have found applications in areas such as geometric modeling, graphics, robotics, vision, computer animation, etc.
- The course objective is to teach problem formulation and problem solving skills.
- The course aims at keeping a sound balance between programming and analytical problem solving.

Unit I. Analysis of Algorithms


Unit II. Fundamental Computing Algorithms

Numerical algorithms, Sequential and binary search algorithms. Quadratic sorting algorithms and O (n log n) sorting algorithms. Algorithms on graphs and their complexities using Greedy Approach for --- Prim’s and Krushkal’s Algorithm for minimum spanning tree, Single source shortest path Algorithm, all pair shortest paths in Graph

Unit III. Approximation Algorithms

Introduction, Absolute approximation, Epsilon approximation, Polynomial time Approximation schemes, probabilistically good algorithms.

Unit IV. Geometric Algorithms

Prerequisites – Basic properties of line, intersection of line, line segment, polygon, etc. Line segment properties, detaining segment intersection in time complexity (n log n), Convex full problem – formulation, solving by Graham scan algorithm, Jarvis march algorithm; closest pair of points – problem formulation, solving by divide & conquer method.

Unit V. Linear Programming


Unit VI. Probability Based Analysis

Expectations: Introduction, Moments, Expectations of functions of more than one random variable, transform methods, moments and transforms of distributions, computation of mean time to failure, inequalities and limit theorems

Reference Books:
1. Kishore S. Trivedi, “Probability & Statistics with Reliability, Queing, and Computer Science Applications” PHI
2. Cormen, Leiserson, Rivest, “Algorithms”, PHI
UNIT I. Physical database design & Tuning

Database workloads, physical design and tuning decisions, Need for Tuning

**Index selection:** Guideline for index selection, Clustering & Indexing Tools for index selection

**Database Tuning:** Tuning indexes, Tuning Conceptual schema Tuning Queries & views, Impact of Concurrency, Benchmarking

UNIT II. Distributed Databases


UNIT III. Advance Transaction Processing


UNIT IV. 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.

UNIT V. Emerging Trends in Databases

Introduction, Motivation, Temporal databases, Spatial & geographic databases, Multimedia Databases, Mobility & personal Databases

UNIT VI. Advanced Application Development


**References:**

- Database system Concept by Silberschatz And Korth 6th Edition
- Distributed Databases principles & systems by Stefano Ceri, Giuseppe Pelagatti
- Web Data Management, Abiteboul, Loana, Philippe Et. al Cambridge publication
- Database Management Systems by Raghu Ramakrishnan and Johannes Gehrke
Unit – I  Introduction to architectures and Computing Models  
Evolution in processor development, Generic computer architecture, Data representation, Instruction sets, data path and control, memory management, Buses and peripherals, Networking and communication, Multiprocessor and multicomputer, multivector and SIMD systems, PRAM and VLSI models, network properties, conditions for parallelisms, partitioning and scheduling, program flow mechanisms, system interconnect architectures

Unit –II Performance metrics  
Metrics and measures for parallel programs, Speedup performance laws, scalability analysis approaches, Amdahl’s law, limitation, Benchmark, SIMD, MIMD Performance.

Unit – III Hardware parallelism  
Processor and memory hierarchy- Advanced processor technology, superscalar and vector processors, memory hierarchy, virtual memory, shared memory organizations, bus systems, consistency on shared data, Pipelining- Linear and non linear pipelines, Instruction pipelines, instruction and arithmetic pipeline design

Unit – IV Parallel and Scalable architectures  
Multiprocessor and system interconnects, cache coherence and synchronization mechanisms, multicomputer generations, message passing paradigms, Multivector architecture-principles of vector processing, multivector multiprocessors, compound vector processing, SIMD organization, MIMD organization, multithread and dataflow architectures: Multithreading, fine grained multicomputers, dataflow and hybrid architectures, Single Program-Multiple Data(SPMD), Multiple Program, Multiple Data(MPMD), Case study of non-coherent multiprogramming in PRAM

Unit – V Parallel programming and program development environments  
Parallel programming models, parallel languages and compilers, dependence analysis and of data arrays, code optimization and scheduling, loop parallelism and pipelining, Parallel programming environments, synchronization and multiprocessing modes, shared variable programs, message passing programs, mapping programs on multi-computers. Operating system support for parallel program execution, processes and threads, parallel programming languages-C-Linda, Fortran-90, Programming with MPI. Introduction to map-reduce.

Unit – VI Advanced Computing Architectures  

Reference Books:
3. High Performance Computer Architectures by Harrold Stone
Objective: to introduce the student to research methodology, and to prepare them for conduct independent research

Unit I. Understand the research process
Evolution of research methodology; Meaning, nature, scope, and significance of research; Research paradigm; Objectives of research, Motivation for research; Postulates underlying scientific investigations; Types of research; Research process and workflow; Principles of ethics, ethical considerations in research; Intellectual Property Rights (IPR)

Unit II. Problem identification and hypothesis formulation
Selecting an area for research; Problem identification; Literature search; “Understanding” reported research; Fitting the pieces; Ascertaining current state of knowledge; Sources of information; Recording literature search findings; Defining the problem; Hypothesis formulation

Unit III. Research design
Type of research designs, pitfalls and advantages; Research approaches; Principles of experimental design; Design of experiments; Characteristics of good research design; Universe, population, and sample; Sampling concepts, principles, and techniques; Sample design (random, pseudo random, cluster, stratified, multi-stage); Sampling considerations (size, design, selection, measurements); Measures, Measurements, Metrics, and Indicators; Measurement scales and direct measurements

Unit IV. Methods, tools, and techniques
Data collection techniques (observation, interviewing, questionnaires, web-based, group techniques, experimentation, surveys); Sources of errors; Reliability and validity; Probability theory and theoretical distributions; Parametric statistics, Simple linear models (ANOVA, correlation and Regression, ANACOVA), Multivariate analysis, Step-wise regression; Non-parametric statistics, Sign test, Paired ranking test, Pearson Correlation, Man-Whitney U Test, Chi-square test,

Unit V. Data processing and Data analysis
Primary and secondary data; coding and summarization of data, quantification of qualitative data (content analysis); Computation of indirect metrics; Role of descriptive statistics; Measures of central tendency, dispersion, skewness, kurtosis; plots and correlations; Inferential statistics, hypothesis testing, Type I and Type II errors, Power of tests; Role of computers in research; Use of statistical packages (e.g. SPSS)

Unit VI. Reporting research
Dissemination of research findings; Reporting and interpretation of results; cautions in interpretations, Type of reports, Typical report outlines, use of diagrams, tables, and charts; Optimization and optimization methods, Introduction to game theory, Queuing theory

References:
2. Kumar, Ranjit, Research Methodology (3rd Ed); Sage Publications, 2011; IBSN: 978-1-8492-0301-2
510105A- Intelligent Systems

1. Introduction
   **Problem Formulation:** Problem-Solving Agents, Example Problems, Searching for Solutions, Uninformed Search Strategies, Avoiding Repeated States, Searching with Partial Information.

2. Search Methods
   **Informed Search and Exploration:** Informed (Heuristic) Search Strategies, Heuristic Functions, Local Search Algorithms and Optimization Problems, Local Search in Continuous Spaces, Online Search Agents and Unknown Environments, Generic Algorithms for TSP.
   **Constraint Satisfaction Problems:** Constraint Satisfaction Problems, Backtracking Search for CSPs, Local Search for Constraint Satisfaction Problems, Structure of Problems.

3. Planning

4. Planning and Acting in the Real World
   Time, Schedules and Resources, Hierarchical Task Network Planning, Planning and Acting in Nondeterministic Domains, Conditional Planning, Execution Monitoring and Replanning, Continuous Planning, Multi-Agent Planning.

5. Uncertain knowledge and reasoning
   Acting under Uncertainty, Basic Probability Notation, Representing Knowledge in an Uncertain Domain, The Semantics of Bayesian Networks, Efficient Representation of Conditional Distributions, Exact Inference in Bayesian Networks, Approximate Inference in Bayesian Networks, Extending Probability to First-Order Representations, Other Approaches to Uncertain Reasoning.


Reference Books:
Unit I. Information Retrieval Basics
- Goals and history of IR. The impact of the web on IR. Components of an IR system, Boolean and vector-space retrieval models; ranked retrieval; text-similarity metrics; TF-IDF (term frequency/inverse document frequency) weighting; cosine similarity. Simple tokenizing, stop-word removal, and stemming; inverted indices, Index Construction and compression.

Unit II. Information Retrieval Models
- Probabilistic Information Retrieval, Language Modeling for Information Retrieval, Adhoc Retrieval, Latent Semantic Indexing, Relevance feedback, Pseudo relevance feedback, Query expansion, Query languages, POS tagging,

Unit III. Web Mining
- Web Structure, content and usage mining, Web Crawling, Indexes, Search engines; spidering; metacrawlers; directed spidering; link analysis (e.g. hubs and authorities, Google PageRank), Information Extraction, spam filtering, XML retrieval.

Unit IV. Performance metrics
- Recall, precision, and F-measure; Evaluations on benchmark text collections, TREC Tracks.

Unit V. Semantic web
- Web 3.0, Ontology, OWL, RDF Schema, ontology learning, Knowledge representation, management and extraction, Multimedia Retrieval, Content based Image retrieval, Pattern Matching and classification for IR.

Unit VI. Specific topics in IR and Web Mining

References:
2. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, “Introduction to Information Retrieval” (available online at http://nlp.stanford.edu/IR-book/)

Additional References:
1. C.J. Rijsbergen, "Information Retrieval", (http://www.dcs.gla.ac.uk/Keith/Preface.html)
Unit I. Introduction to Machine Learning

Introduction to ML, Introduction to Statistical Learning Methods, History of Machine Learning, Machine-Learning Problem, Learning Paradigms, Machine-Learning Techniques and Paradigms, Need of Learning, Machine Intelligence

Unit II. Learning theory: Supervised learning and Unsupervised learning.


Unit III. Fundamentals of Whole-System, Systemic, and Multi-perspective Machine Learning


Unit IV. Reinforcement Learning

Learning Agents, Returns and Reward Calculations, Reinforcement Learning and Adaptive Control, Dynamic Systems, Reinforcement Learning and Control, Markov Property and Markov Decision Process, Value Functions, Action and Value, Learning an Optimal Policy (Model-Based and Model-Free Methods), Dynamic Programming, Adaptive Dynamic Programming, Example: Reinforcement Learning for Boxing Trainer

Unit V. Machine Learning Models and Inference

A Framework for Learning, Capturing the Systemic View for learning, Mathematical Representation of System Interactions, Impact Function, Decision-Impact Analysis. Inference Mechanisms and Need, Integration of Context and Inference, Statistical Inference and Induction, Pure Likelihood Approach, Applying Bayesian Paradigm and Inference, Time-Based Inference, Inference to Build a System View, Applying Bayesian Learning, Applying SVM, Applying Gaussian maximum likelihood

Unit VI. Adaptive and Incremental Machine Learning

Adaptive Learning and Adaptive Systems, Adaptive Machine Learning, Adaptation and Learning Method Selection Based on Scenario, Applications of Adaptive Learning, Competitive Learning and Adaptive Learning, Incremental Learning, Learning from What Is Already Learned, Supervised Incremental Learning, Incremental Unsupervised Learning and Incremental Clustering, Semi-supervised Incremental Learning, Incremental and Systemic Learning, Incremental Closeness Value and Learning Method, Learning and Decision-Making Model, Incremental Classification Techniques
Unit VII. Knowledge Representation and Augmentation: A Machine Learning Perspective

Knowledge Augmentation and Knowledge Elicitation, Life Cycle of Knowledge, Incremental Knowledge Representation, Case-Based Learning and Learning with Reference to Knowledge Loss, Knowledge Augmentation: Techniques and Methods

Heuristic Learning, Systemic Machine Learning and Knowledge Augmentation, Knowledge Augmentation in Complex Learning Scenarios

Unit VIII. Building a Learning System


References:
510105D- Real Time Systems

Teaching Scheme
Lectures: 5 Hrs/week

Examimation Scheme
Theory In-semester Assessment:  50 Marks
Theory End-semester Assessment: 50 Marks
Total Credits : 05

Unit I. Introduction

Unit II. Task Assignment and Scheduling
Classical Uni-processor Scheduling algorithm, Uni-processor Scheduling of IRIS Tasks, Task Assignment, Mode Changes, Fault Tolerant Scheduling

Unit III. Programming Languages and Tools

Unit IV. Real-Time Databases
Basic Definitions, Real-Time Vs General-Purpose Databases, Main Memory Databases, Transaction Priorities, Transaction Aborts, Concurrency Control Issues, Disk Scheduling algorithm, A Two Phase Approach To Improve Predictability, Maintain Serialization Consistency, Databases for Hard Real Time Systems.

Unit V. Real-Time Communication
Network Topologies ,Protocols ,Clocks , A Non Fault Tolerant Synchronization Algorithm, Impact of Faults , Fault Tolerant Synchronization in Hardware, Synchronization in Software

Unit VI. Fault Tolerant Techniques

References:
510106- Laboratory Practice- I

Teaching Scheme
Practical: 4 Hrs/week

Examination Scheme
OR: 50 Marks
TW: 50 Marks
Total Credits : 04

1. Develop algorithmic solution for solving the problem stated in assignment 2, 3 below using set theory, Probability theory and/or required theories, strategy to design Turing machine, multiplexer logic inducing concurrency and perform NP-Hard analysis for the solution feasibility.

2. Design and implement the distributed architecture for the Hadoop having Name node, Tracker node and data nodes (separated by ADSL routers) or such recent technology. Prepare architecture diagram and installation document to be used for the assignment number 3

3. Implement Digital Library Infrastructure using Hadoop or Similar recent technology for distributed database storage. To develop front end GUI and algorithm for searching the multimedia resource files, presentations in the selected domain, author, book title, ISBN.. Use different search exploration techniques.

Or Assignments equivalent to above assignments.

4. Elective teacher shall design four suitable assignments based on Elective I maintaining above quality of the assignments.

5. Design and implement class/classes using latest 64-bit C++/JAVA/ Python/QT 5.1 and above, Cuda C++ or such latest 64-bit programming tools for the implementation of Two journal (IEEE Transactions/ACM Elsevier/Springer) papers published in the current year related to the respective elective subjects. Development Tools such as MATLAB/OPENCV/OPENMP/NS3 or equivalent may be used if required to interface the developed classes to the simulators.

Tools for the Laboratories: The laboratories must be equipped with adequate, well maintained working resources as per the software/equipment/tools list published by the Board of Studies time to time. For maintaining the quality and effective performance the Board of Studies may publish the quality guidelines for effective conduct of the laboratories, seminars and dissertation.
Semester - II

510107- Operating System Design

Teaching Scheme
Lectures: 4 Hrs/week

Examination Scheme
Theory In-semester Assessment: 50 Marks
Theory End-semester Assessment: 50 Marks
Total Credits : 04

Unit I. Introduction

Design Techniques:

Unit II. Implementing Processes

Unit III. Inter process Communication Patterns
Patterns of Inter process communication, New message-passing system calls, IPC Patterns, Failure of Processes, Processes: Everyday Scheduling, Preemptive Scheduling Methods, Policy versus Mechanism in Scheduling, Scheduling in Real Operating Systems, Deadlock, Two Phase Locking, Starvation, Synchronization, Semaphores, Programming Language Based Synchronization Primitives, Message Passing Design Issues

Design Techniques:
Indirection, Using State Machines, Win Big Then Give Some Back, Separation of Concepts, Reducing a Problem to a Special Case, Reentrant Programs, Using Models for Inspiration, Adding a New Facility To a System.

Unit IV. Memory Management
Levels of Memory Management, Linking and Loading a Process, Variations in Program Loading, The Memory Management Design Problem, Dynamic Memory Allocation, Keeping Track of the Blocks, Multiprogramming Issues, Memory Protection, Memory Management System Calls, Virtual Memory, Virtual Memory Systems

Design Techniques:
Multiplexing, Late binding, Static Versus Dynamic, Space-Time Tradeoffs, Simple Analytic Models
Unit V. I/O Devices & File Systems


**Design Techniques:** Caching, Optimization and Hints, Hierarchical Names, Naming of Objects, Unification of Concepts.

Unit VI. Resource Management


References:

Unit I. Software Design Process
Role of Software Design: Software design process, nature of design process, design qualities; Transferring Design Knowledge: describe design solution, transferring design knowledge, design notations, design strategies.

Unit II. Object Oriented Design
Creational, Structural, behavioural design patterns, Component based design, Formal Approach to design

Unit III. Introduction to Software Architecture

Unit IV. Software Architecture Design

Unit V. Archetype Patterns
Archetypes and Archetype Patterns, Model Driven Architecture with Archetype Patterns. Literate Modeling, Archetype Pattern, Customer Relationship Management (CRM) Archetype Pattern, Product Archetype Pattern, Quantity Archetype Pattern, Rule Archetype pattern.

Unit VI. Software Architectures
Object-Oriented Paradigm, Data Flow Architectures, Data-Centered Software Architecture, Hierarchical Architecture, Interaction-Oriented Software Architectures, Distributed Architecture, Component-Based Software Architecture, Heterogeneous Architecture, Architecture of User Interfaces, Implicit asynchronous communication software architecture.

Reference Books:
510109- Advanced Computer Networks

Teaching Scheme
Lectures: 4 Hrs/week

Examination Scheme
Theory In-semester Assessment: 50 Marks
Theory End-semester Assessment: 50 Marks
Total Credits: 04

Unit I
Introduction: Types of Networks. Network design issues. Network design tools, advanced network architectures. Reliable data delivery, Routing and forwarding, resource allocation, Mobility, Networked applications, Data in support of network design, General Principles of Network Design, network characteristics.

Unit II
Delay Models in Data Networks: Modeling and Performance evaluation. Multiplexing of Traffic on a Communication Link, Queuing Models- Little’s Theorem, Probabilistic Form of Little’s Theorem, Application of Little’s Theorem, Queuing Systems: M/M/1, M/M/2, M/M/m, M/M/∞, M/M/m/m, M/M/m/q, M/M/1/N, D/D/1, M/G/1 System, M/G/1 Queues with Vacations, Reservations and Polling, Priority Queuing

Unit III

Unit IV
Quality of Service in Networks: Application and QoS, QoS mechanisms, Queue management Algorithms, Feedback, Resource reservations, traffic engineering, Ubiquitous Computing: Applications and Requirements, Smart Devices and Services, Smart Mobiles, Cards and Device Networks.

Unit V
IP packet format, IP routing method, routing using masks, fragmentation of IP packet, IPv6, advanced features of IP routers: filtering, IP QoS, NAT, routers

Unit VI

References:
2. Simulation Modeling and analysis, Averill M. Law, W. D. Kelton
3. Computer Networks, Principles, Technologies and Protocols for network design Natalia Olifer, Victor Olifer, Wiley India
4. Ubiquitous Computing, Stefan Poslad, WILEY INDIA EDITION
Elective – II

510110A - Business Intelligence and Data Mining

Teaching Scheme
Lectures: 5 Hrs/week

Examination Scheme
Theory In-semester Assessment: 50 Marks
Theory End-semester Assessment: 50 Marks
Total Credits: 05

Unit I. Introduction to Business Intelligence
Introduction to Data Information and knowledge, Data Decision Challenge, Operational vs Information Data, Introduction to Decision Support System, Introduction to Business Intelligence, Business Intelligent System Components, Business Models, Introduction to Data Warehouse, A Business analysis framework for DW.

Unit II. Data Warehouse
Introduction, Data warehouse modeling, Data warehouse design, Data warehouse technology, Distributed Data warehouse, index techniques, materialized view.

Unit III. Data Preprocessing and Cube Technology
Introduction to Data Preprocessing, Data Cleaning, Data integration, data reduction, transformation and Data Descritization.
Introduction to OLAP, Data Cube : A multidimensional model, data cube computation, data cube computation methods : multidimensional data analysis.

Unit IV. Mining Frequent Patterns and Association Rule
Introduction to association rule, market basket analysis, frequent item set, apriori algorithm, parameter, a pattern growth approach, mining closed and max patterns, pattern evaluation, pattern mining in multilevel, multidimensional data space, pattern exploration and application.

Unit V. Classification
Basic concepts, decision tree, rule based classification, Bayesian belief networks, classification by back propagation, support vector machines, lazy learners – k-NN classifier, case based reasoning , model evaluation and selection , techniques to improve classification accuracy, multiclass classification, semi-supervised classification, ensemble methods.

Unit VI. Clustering Analysis
Cluster analysis, Partitioning methods, hierarchical methods, density based methods, grid based methods, clustering graph and network data, clustering with constrains, evaluation of clustering outliers and analysis, outlier detection methods, scalable clustering algorithms.

References:
2. Introduction to Data Mining, Vipin Kumar, Pang-Ning Tan, Pearson
4. Introduction to Business Intelligence & Data Warehousing, IBM, PHI.
5. Business modeling and Data Mining Dorian Pyle, Elsevier Publication MK.
Unit I. Introduction to Human-Computer Interaction as an emerging field

Disciplines contributing to HCI, Human Information Processing Psychology of everyday things, Importance of human factors in design – cultural, emotional, technological, business, Need Satisfaction curve of technology, Levels of human computer interaction

Unit II. Foundations of User Interface Design (U.I.D)

Goals of UID, Goal directed Design, User Interface Models, Understanding and Conceptualizing Interface, Psychology of users designing for collaboration and communication, Process of Interaction Design, Standards & Guidelines, Usability Testing, GIU

Unit III. Human Factors

The importance of User Interface – UI and Software Designer – Goals of UI design – Motivations for human factors in Design – Understanding user needs and requirements.

Unit IV. Models

Theories – Different models - Object - Action Interface Model - Principles for Design – Data display and entry guidelines.

Unit V. Design Process


GUI design process - Design of icons – Use of metaphors – GUI style guides and toolkits – Portability – GUI design and object oriented approach – Case study.

Unit VI. Usability

The viewpoint of user, customer and designer – Usability specification – Description of stages in usability specification and evaluation.

References:

6. Elements of User Interface Design - Theo Mandel, John Wiley & Sons
7. Interaction Design – Preece, Roger, Sharp, John Wiley & Sons
8. Object Modeling & User Interface Design - Mark Hamelen
Unit I. Introduction

Notation and Concepts for Languages and Grammars, Traditional compilers, structure of compiler, architecture, properties, portability and re-targetability, optimization, grammars, Closure algorithms, abstract syntax tree: lexical structure, syntax.

Unit II. Attribute grammars

Dependency graphs, attribute evaluation, cycle handling, attribute allocation, multi-visit attribute grammars, types of attribute grammars, L-attribute grammar, S-attributed grammars, equivalence of L-attributed and S-attributed grammars, Extended grammar notations and attribute grammars, manual methods.

Unit III. Intermediate code processing

Interpretation, Code generation, Assembler design issues, linker design issues. Memory Management: data allocation with explicit de-allocation, data allocation with implicit de-allocation, Static, Dynamic and Heap Storage allocation.

Unit IV


Unit V. Functional & Logic Programs

Offside rules, Lists, List comprehensions, pattern matching, polymorphic typing, referential transparency, High-order functions, lazy evaluation, compiling functional languages, polymorphic type checking, Desugaring, Graph reduction, Code generation for functional, core programs, Optimizing the functional Core, Advanced graph manipulations

The logic programming models, implementation model interpretation, unification, implementation model compilation, compiled code for unification.

Unit VI. Parallel programming

Parallel programming models, processes and threads, shared variables, message passing, parallel object-oriented languages, Tuple space, automatic parallelization. Case study of simple object-oriented compiler/interpreter.

Reference Books

### 510110D - Embedded Systems Design

**Teaching Scheme**

- **Lectures:** 5 Hrs/week

**Examination Scheme**

- **Theory In-semester Assessment:** 50 Marks
- **Theory End-semester Assessment:** 50 Marks
- **Total Credits:** 04

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#### Unit I

Introduction to Embedded systems, building blocks, legacy Embedded processors, Integrated RISC processors, DSP Processors Architecture, Selection of Processor, LPC2148- Architecture, Register set, Programmers Model,

#### Unit II

Memory Systems, DRAM Technology, Video RAM, SRAM: Pseudo-Static RAM, Battery Backup SRAM, EPROM and OTP, Parity, Error Detection and Correcting Memory, Access times, Packages, DRAM Interfaces, DRAM Refresh Techniques, Optimizing line length and cache size, Logical versus physical caches, Unified versus Harvard caches, Cache coherency: Write through, write back, no caching of write cycles, write buffer, Bus snooping, MESI Protocol, MEI Protocol, BIG and Little Endian, Dual Port and Shared Memory, Bank Switching, Memory Overlays, Shadowing, Memory Interfacing, HY27UU0088G5M-Architecture, Register Set, Programmers Model

#### Unit III

Basic Peripherals: Parallel ports, Timer Counters, 8253, MC68230 modes, Timer Processors, Real-time clocks, Serial Ports, serial peripheral interface, I²C bus, M-Bus, RS232C, USB2.0, UART implementations, DMA Controllers, DMA Controller Models, Channels and Control Blocks, Sharing Bus Bandwidth, DMA Implementations, Intel82801 IO Controller HUB

Analogue to Digital Conversion, Sample Rate and Size, Codecs, Power Control

#### Unit IV

Interrupts and Exceptions, Interrupt Structure, Recognizing an Interrupt, Interrupt mechanism, MC68000 Interrupts, RISC Exceptions, Fast Interrupts, Interrupt Controllers, Instruction restart and continuation, Interrupt Latency, Interrupt Handling Do’s and Don’ts, Intel i7 interrupts and programmes model

#### Unit V


#### Unit VI

Buffering and other data Structures, buffers, Linear buffers, Directional Buffers, Double Buffering, Buffer Exchange, Linked list, FIFO, Circular buffers, buffer under run and over run, Allocating buffer memory, Memory leakage, effects of memory wait state scenarios, Making the right decisions, Software Benchmark Examples, Creating Software State mechanisms, Design of Burglar alarm system, Digital echo Unit, Choosing the software environment, Deriving realtime systems performance form non-real-time systems, Scheduling the data sampling, sampling the data, Controlling from an external Switch, Problems.

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**References**

2. Philips LPC2148 Datasheet (lpc2141_42_44_46_48_4.pdf)
3. HY27UU0088G5M.pdf
4. Intel82801 IO Controller HUB.pdf
5. (Intel i7 interrupt registers and programming) 322165.pdf
Use suitable 64-bit Linux environment and toolset to implement following assignments

1. Demonstrate the Reader-Writer Problem solution by creating multiple processes and share regions or blocks. Use 64-bit Linux derivative and tools for implementation.

2. Write a program to identify the least used icons/files/folders on the desktop and move them to temp folder created in Documents.

3. Create a computing facility grid using networks for Booth’s multiplication (64-bit) using sign-extension method. Where bit multiplication, additions and merging of the addition results for final processing. The computing grid is created using Advanced wireless network with few computing resources are separated by the router and identified by the NAT. The network controlling node will be submitted with files having total distributed storage of 1000 numbers as a SAN queued for the execution in sorted manner on the lesser cost due to length of the multiplier and display the results along with the network tracking report for the dynamic allocation of multiplier and addition nodes along with the sleeping/ inactive/ unutilized nodes in the network.

4. Design suitable software architecture for assignment number 1,2 and 3 above.

Or assignments equivalent to the above assignments

5. Design and implement class/classes using latest 64-bit C++/JAVA/ Python/QT 5.1 and above, Cuda C++ or such latest 64-bit programming tools for the implementation of Two journal (IEEE Transactions/ACM Elsevier/Springer) papers published in the current year related to the respective elective subjects. Development Tools such as MATLAB/OPENCV/OPENMP/NS3 or equivalent may be used if required to interface the developed classes to the simulators.

Tools for the Laboratories: The laboratories must be equipped with adequate, well maintained working resources as per the software/equipment/tools list published by the Board of Studies time to time. For maintaining the quality and effective performance the Board of Studies may publish the quality guidelines for effective conduct of the laboratories, seminars and dissertation.
Teaching Scheme
Practical: 4 Hrs/week

Examination Scheme
TW: 50 Marks
Presentation Oral: 50 Marks
Total Credits: 04

State-of-the-art topic approved by the guide useful for professional growth in the filed of expertise. The presentation should cover motivation, mathematical modeling, data-table discussion and conclusion. The reports to be prepared using LATEX derivative. To maintain the quality of the seminar work it is mandatory on the seminar guides to maintain a progressive record of the seminar contact Hrs of 1 Hrs per month per seminar which shall include the discussion agenda, weekly outcomes achieved during practical sessions, corrective actions and comments on the progress report as per the plan submitted by the students including dates and timing, along with the signature of the student as per the class and teacher time table (as additional teaching load); such record of progressive work shall be referred by the examiners during evaluation.
Semester III

610101- Advanced Storage Systems and Infrastructure Management

Teaching Scheme
Lectures: 4 Hrs/week

Examination Scheme
Theory In-semester Assessment: 50 Marks
Theory End-semester Assessment: 50 Marks
Total Credits : 04

Objectives:
- Understanding components of modern information storage infrastructure.

Upon successful completion of this course, participants should be able to:
- Evaluate storage architecture; understand logical and physical components of a storage infrastructure including storage subsystems;
- Describe storage networking technologies and data archival solution;
- Understand and articulate business continuity solutions including, backup and recovery technologies, and local and remote replication solutions;
- Identify parameters of infrastructure management and describe common infrastructure management activities and solutions;

Prerequisites
To understand the content and successfully complete this course, a participant must have a basic understanding of computer architecture, operating systems, networking, and databases.

Unit I: Introduction to Information Storage Technology / Systems

Review data creation and the amount of data being created and understand the value of data to a business, Challenges in Data Storage and Management, Data Storage Infrastructure.
Components of a Storage System Environment: Disk drive components, Disk Drive performance, Logical Components.
- Data protection: concept of RAID and different RAID levels (RAID 0, 1, 3, 5, 0+1/1+0, and 6);
- Intelligent Storage System (ISS) and its components, Implementation of ISS as high-end and midrange storage arrays.

Unit II: Different Storage Technologies and Virtualization

Content Addressed Storage (CAS): features and Benefits of a CAS. CAS Architecture, Storage and Retrieval, Examples.
- Storage Virtualization: Forms, Taxonomy, Configuration, Challenges, Types of Storage Virtualizations.
- Overview of emerging technologies such as Cloud storage, Virtual provisioning, Unified Storage, FCOE, FAST.
Unit III: Business Continuity

Concept of information availability and its measurement, causes and consequences of downtime, concept of RTO, and RPO, single points of failure in a storage infrastructure and solutions for its mitigation, backup/recovery purposes and considerations, architecture and different backup/recovery topologies;

Local replication technologies and their operation, remote replication technologies and their operation, emerging technologies like de duplication, offsite backup.

Unit IV: Infrastructure Management Overview


Unit V: Preparing for Infrastructure Management

Factors to consider in designing IT organizations and IT infrastructure, Determining customer's Requirements, Identifying System Components to manage, Exist Processes, Data, applications, Tools and their integration, Patterns for IT systems management, Introduction to the design process for information systems, Models, Information Technology Infrastructure Library (ITIL).

Unit VI: Service Management


Reference Books:
1. EMC Educational Services, Information Storage and Management, Wiley India.,
Unit I. Introduction to UNIX File system

Introduction to UNIX file system, file handling utilities, securities and file permissions, process utilities, Disk utilities, networking commands, Introduction to shell scripting, Working with Bourn shell: Shell responsibilities, PIPES and input and output redirection, Shell variables, Shell commands, Control structures, Shell script examples, ext4, IA-64 Architecture: Userlevel Instruction Set Architecture, Runtime and Software Conventions, System Instruction Set Architecture, The Register Stack Engine (RSE). Kernel Entry and Exit: Interruptions, System Calls, Signals, Kernel acces to user memory, Stack unwinding: IA-64 ELF unwind sections The Kernel Unwind Interface, Embedding unwind information in Assembly code, Implementation Aspects.

Unit II. Process Management

Process management and working of signals in Unix - process definition, its relation with its environment through environment variables, command-line arguments; process memory layout; process creation-fork(), process control - wait(), waitpid(); program loading-exec() family; process termination-exit(), _exit(); non-local goto-setjmp(), longjmp(); signals-signal disposition, reliable and unreliable ways of signals, creation, pending and delivery stages; signal sets-blocking, unblocking; useful signals-SIGINT, SIGKILL, SIGTERM, SIGALRM, alarm(), pause(), ELF64, Linux Tasks, Virtual Memory Management, Address space for Linux Process, Page Tables, Translation Lookahead Buffers, Page Faults, Memory Coherancy, Switching Address spaces.

Unit III. Advanced I/O in Unix

Introduction, Streams and file objects, Standard Input, Standard Output, and Standard Error, Buffering, opening reading & writing in streams, Nonblocking I/O, Record locking, streams, I/O multiplexing, asynchronous I/O, readv & writev functions, readn & writen functions, Memory mapped I/O.

Unit IV. Inter-process Communication

Inter Processes communication within the system and their applications in network programming: types of IPC-pipes, FIFOs, Message Queues, Semaphores, Shared memory; pipes-characteristics, creating a pipe, writing and reading from a pipe, popen(), synchronization, process pipe-lining, co-processes; FIFO-names pipe, characteristics, contrast with pipes, opening, reading and writing, non-blocking option; Message Queues-characteristics, contrast with pipes/fifos, concept of key space, identifier, fork(), msgget(), msgsnd(), msgrcv(),msgctl(); semaphores-characteristics, semget(),semop(),semctl(), semadj variable usage; shared memory-characteristics, fastest IPC, shmat(), shmdt(), semget(), shelter() shmdt() (0,shmctl).
Unit VI. Introduction to Socket

Understanding of sockets: what is a socket, Study of different types of sockets: Raw sockets, Unix Domain sockets, TCP & UDP sockets, Routing sockets, socket pair, socket descriptor, socket address structure for IPv4, end point addressing, Study of simple, protocol dependent socket program: Design of a simple client and server: daytime server, echo server with and without threading.

References:

1. Advanced Programming in the UNIX-W. Richard Stevens
2. Unix Network Programming: Vol-II Inter Process Communications

Additional References:

1. The Design of the Unix Operating System- Maurice J. Bach
Elective III

610103A - Network Security

Teaching Scheme
Lectures: 5 Hrs/week

Examination Scheme
Theory In-semester Assessment: 50 Marks
Theory End-semester Assessment: 50 Marks
Total Credits: 05

Unit I. Introduction

Unit II. Security at each layer:

Unit III. System Security:
Description of the system, Users, Trust and Trusted systems, Buffer overflow and Malicious software, malicious program, worm, viruses, IDS, Firewall.

Unit IV. Cryptographic Techniques
Secret versus “Public” key Cryptography, Types of attack, Types of cipher - Substitution, transposition, Other Cipher properties, Secret key cryptography, Public key cryptography and RSA key management, digital certificates, PKI, identity based encryption, Authentication

Unit V. Security Policies and Design Guidelines

Unit VI. Web Security
Computer Forensics: evidence, collecting Evidence Chain of Custody, free space vs Stack space. TCP/IP Vulnerabilities: Securing TCP/IP Spoofing: The process of an IP spoofing attack, Cost of Spoofing, Types of spoofing, spoofing tools, prevention and Mitigation

References:
4. Cheswick W. Bellovin S. “ Firewall and Internet security Repelling the Wily Hacker”, 2nd Addison Wesley
5. Security Architecture, design, deployment and operations – Christophr M King, Curtis, Dalton and T Ertem Osmanoglu
Unit I. Introduction
Cloud computing fundamentals, the role of networks in Cloud computing, Essential characteristics of Cloud computing, Cloud deployment model, Cloud service models, Multitenancy, Cloud cube model, Cloud economics and benefits, Cloud types and service scalability over the cloud, challenges in cloud NIST guidelines

Unit II. Virtualization, Server, Storage and Networking
Virtualization concepts, types, Server virtualization, Storage virtualization, Storage services, Network virtualization, Service virtualization, Virtualization management, Virtualization technologies and architectures, Internals of virtual machine, Measurement and profiling of virtualized applications. Hypervisors: KVM, Xen, HyperV Different hypervisors and features

Unit III. Data in cloud
Storage system architecture, Big data, Virtualized Data Centre (VDC) architecture, VDC environments, concepts, planning and design, Managing VDC and cloud infrastructures, hybrid storage networking technologies (iSCSI, FCIP, FCoE), host system design consideration

Unit IV. Cloud security
Cloud Security risks, Security, Privacy, Trust, Operating system security, Security of virtualization, Security risks posed by shared images, Security risk posed by a management OS, Xoar, Trusted virtual machine monitor

Unit V. QoS [Quality of Service] of Cloud
Taxonomy and survey of QoS management and service, Selection methodologies for cloud computing, Auto scaling, Load balancing and monitoring in open source cloud, Resource scheduling for Cloud Computing

Unit VI. Cloud patterns and application
Cloud Platforms: Amazon EC2 and S3, Cloudstack, Intercloud, Mobile Cloud Designing an image: Pre-packaged image, singleton instances prototype images Designing an architecture: Adapters, Facades, Proxies and balancers Clustering: The n-Tier Web pattern, Semaphores and Locking Map Reduce Peer-to-Peer framework

References:
1. Dr. Kumar Saurabh, “Cloud Computing”, Wiley Publication
7. Cloud computing: Data Intensive Computing and Scheduling by Chapman Hall/CRC
8. Christopher M. Moyer, Building Applications in the Cloud: Concepts, Patterns, and Projects

**Additional References:**

4. Rajkumar Buyya, "CLOUD COMPUTING Principles and Paradigms", Wiley and Sons, Inc
6. Tim Mather, "Cloud Security and Privacy”, O’REILLY
610103C - Computer Vision and Pattern Recognition

Teaching Scheme

<table>
<thead>
<tr>
<th>Lectures: 5 Hrs/week</th>
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Examination Scheme

| Theory In-semester Assessment: 50 Marks |
| Theory End-semester Assessment: 50 Marks |
| Total Credits : 05 |

Unit I. Basics of Digital Imaging

Image Acquisition, Sampling, Quantization, Difference in Monochrome and Multichrome imaging, concept of color spaces, point processing techniques, mask processing methods, image filtering, shape in images, edge detection, gradient operators- Roberts, Sobel, Prewitt, Canny, Slope magnitude method, morphological image processing, erosion, dilation, opening, closing, hit-n-miss transform, thinning, Top Hat transformation, Bottom hat transformation.

Unit II. Image Representation and Region Analysis

Shape Descriptors-contour based, region based, Boundary based; Thresholding based segmentation, Watershed based Segmentation, Gray level Co-occurrence Matrix-energy, entropy, maximum probability, contrast, correlation; wavelets, wavelet Pyramids, Image matching, similarity measures, feature extraction in spatial domain, block truncation coding, feature extraction in transform domain, image transforms, energy based feature extraction.

Unit III. Computer Vision Applications

Image Fusion and Clustering- K-means, Vector Quantization, Hierarchical Clustering, Partitioned Clustering, Image Inpainting, Multisensor image fusion, character recognition, face recognition, Trademark databases, Medical Imaging, Signature Verification, Vehicular license plate Recognition, image and Video retrieval, Surveillance, Robotic vision, Panoramic view Construction

Unit IV. Introduction to Pattern Recognition

Tree Classifiers-Decision Trees, Random Forests; Bayesian Decision Theory; Linear Discriminants Discriminative Classifiers- Separability, Perceptions, Support Vector Machines.

Unit V. Decision Theory


Unit VI. Clustering

K-Means, Expectation Maximization, Mean Shift, Vector Quantization- Codebook generation Methods; Classifier Ensembles- Bagging, Boosting / AdaBoost; Graphical Models The Modern Language of Pattern Recognition and Machine Learning- Bayesian Networks, Sequential Models; Neural Networks

Reference Books

2. David A. Forsyth, Jean Ponce, "Computer Vision: A Modern Approach” PHI
5. David G. Stork and Elad Yom-Tov, “Computer Manual in MATLAB to accompany Pattern Classification” Wiley Inter-science, 2004
Objectives:
- Design and develop intelligent systems in the framework of soft computing, and to acquire knowledge of scientific application-driven environments.

Outcomes:
Students who successfully complete this course will be able to
- Have a general understanding of soft computing methodologies, including artificial neural networks, fuzzy sets, fuzzy logic, fuzzy inference systems and genetic algorithms;
- Design and development of certain scientific and commercial application using computational neural network models, fuzzy models, fuzzy clustering applications and genetic algorithms in specified applications.

Unit I: Soft Computing Basics

Unit II: Neural Networks
Neuron, Nerve structure and synapse, Artificial Neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Various learning techniques; perception and convergence rule, Auto-associative and hetero-associative memory, perceptron model, single layer artificial neural network, multilayer perception model; back propagation learning methods, effect of learning rule co-efficient; back propagation algorithm, factors affecting back propagation training, applications.

Unit III: Fuzzy Logic

Unit IV: Genetic Algorithm
Unit V: Evolutionary computing
Role of biologically inspired software, Difficulties in search, optimization and machine learning, Overview of natural evolution and its abilities, Evolutionary Programming/Evolutionary Strategies
Issues in evolutionary search, applying an evolutionary algorithm, Artificial Life, Ant colony optimization, Swarm intelligence

Unit VI: Application areas of soft computing
Optimization, function regression, Scheduling, Fraud detection, Anomaly detection, Design Robot or agent control, Interactive tools such as music composition, art generation, decision making and others.

Text Books:
2. N.P.Padhy,”Artificial Intelligence and Intelligent Systems” Oxford University Press.

Reference Books:
1. Siman Haykin,”Neural Netowrks”Prentice Hall of India
2. Timothy J. Ross, “Fuzzy Logic with Engineering Applications” Wiley India.
### 610104 - Seminar- II

<table>
<thead>
<tr>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
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<tbody>
<tr>
<td>Practical: 4 Hrs/week</td>
<td>TW: 50 Marks</td>
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<tr>
<td>Presentation Oral: 50 Marks</td>
<td>Total Credits: 04</td>
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</table>

Seminar based on state-of-the-art in the selected electives. The presentation and the report should cover motivation, mathematical modeling, data-table discussion and conclusion. The reports to be prepared using LATEX derivative. To maintain the quality of the seminar work it is mandatory on the seminar guides to maintain a progressive record of the seminar contact Hrs of 1 Hrs per month per seminar which shall include the discussion agenda, weekly outcomes achieved during practical sessions, corrective actions and comments on the progress report as per the plan submitted by the students including dates and timing, along with the signature of the student as per the class and teacher time table (as additional teaching load); such record of progressive work shall be referred by the examiners during evaluation.

### 610105 – Dissertation Stage-I

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<td>Practical: 8 Hrs/week/student</td>
<td>TW: 50 Marks</td>
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<tr>
<td>OR: 50 Marks</td>
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Motivation, Problem statement, survey of journal papers related to the problem statement, problem modeling and design using set theory, NP-Hard analysis, SRS, UML, Classes, Signals, Test scenarios and other necessary, problem specific UML, software engineering documents. Student should publish one International Journal Paper (having ISSN Number and preferably with Citation Index II); or paper can be published in reputed International Journal recommended by the guide of the Dissertation and in addition to above the term work shall include the paper published, reviewers comments and certificate of presenting the paper in the conference organized/sponsored by the Board of Studies in Computer Engineering. To maintain the quality of the dissertation work it is mandatory on the dissertation guides to maintain a progressive record of the dissertation contact Hrs of 1 Hrs per week which shall include the dissertation discussion agenda, weekly outcomes achieved during practical sessions, corrective actions and comments on the progress report as per the plan submitted by the students including dates and timing, along with the signature of the student as per the class and teacher time table; such record of progressive work shall be referred by the dissertation examiners during evaluation. At the most 8 dissertations can be assigned to a guide.

**Important Note regarding all Open Electives**

Open Elective proposal shall be (current state-of the art in Computer Engineering or Inter-disciplinary or intra-disciplinary) focusing algorithms, technologies developed using computing or systems programming (Kernel level/ Embedded) or virtualization or useful for the professional growth, if any, to be forwarded to the BoS, Computer Engineering for necessary approvals on or before the month of December every year. The teaching shall be done through Industry-Institute Interaction/invited talks/webminars etc.
Semester - IV

610106 - Seminar- III

<table>
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<tr>
<td>Practical: 5 Hrs/week</td>
<td>TW: 50 Marks</td>
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<tr>
<td></td>
<td>Presentation Oral: 50 Marks</td>
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<td>Total Credits: 05</td>
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Seminar based on selected research methodology preferably algorithmic design advances as an extension to seminar-II. The presentation should cover motivation, mathematical modeling, data-table discussion and conclusion. The reports shall be prepared using LATEX derivative. To maintain the quality of the seminar work it is mandatory on the seminar guides to maintain a progressive record of the seminar contact Hrs of 1 Hrs per month per seminar which shall include the discussion agenda, weekly outcomes achieved during practical sessions, corrective actions and comments on the progress report as per the plan submitted by the students including dates and timing, along with the signature of the student as per the class and teacher time table (as additional teaching load); such record of progressive work shall be referred by the examiners during evaluation.

610106 – Dissertation Stage-II

<table>
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<tr>
<td>Practical: 20 Hrs/week/student</td>
<td>TW: 150 Marks</td>
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<td>OR: 50</td>
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<td></td>
<td>Total Credits: 20</td>
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</table>

Selection of Technology, Installations, UML implementations, testing, Results, performance discussions using data tables per parameter considered for the improvement with existing known algorithms and comparative graphs to support the conclusions drawn. Student should publish one International Journal Paper (having ISSN Number and preferably with Citation Index II); or paper can be published in reputed International Journal recommended by the guide of the Dissertation and in addition to above the term work shall include the paper published, reviewers comments and certificate of presenting the paper in the conference organized/sponsored by the Board of Studies in Computer Engineering. To maintain the quality of the dissertation work it is mandatory on the dissertation guides to maintain a progressive record of the dissertation contact Hrs of 1 Hrs per week which shall include the dissertation discussion agenda, weekly outcomes achieved during practical sessions, corrective actions and comments on the progress report as per the plan submitted by the students including dates and timing, along with the signature of the student as per the class and teacher time table; such record of progressive work shall be referred by the dissertation examiners during evaluation. At the most 8 dissertations can be assigned to a guide.

Important Note Regarding all Open Electives

Open Elective proposal shall be (current state-of the art in Computer Engineering or Inter-disciplinary or intra-disciplinary) focusing algorithms, technologies developed using computing or systems programming (Kernel level/ Embedded) or virtualization or useful for the professional growth, if any, to be forwarded to the BoS, Computer Engineering for necessary approvals on or before the month of December every year. The teaching shall be done through Industry-Institute Interaction/invited talks/webinars etc.

**Tools for the Laboratories**: The laboratories must be equipped with adequate, well maintained working resources as per the software/equipment/tools list published by the Board of Studies time to time. For maintaining the quality and effective performance the Board of Studies may publish the quality guidelines for effective conduct of the laboratories, seminars and dissertation.