Program Structure for B.E. Computer Engineering

Second Year (Computer) (Semester VIII)

(REV 201)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
CPC801	Data Warehouse and Mining	4	2	-	4	1	-	5
CPC802	Human Machine Interaction	4	2	-	4	1	-	5
CPC803	Parallel and distributed Systems	4	2	-	4	1	-	5
CPE803X	Elective-III	4	2	-	4	1	-	5
CPP802	Project II	-	-	-	-	6	-	6
CPL801	Cloud Computing Laboratory	-	2	-	-	1	-	1
	Total	**16**	**10**	**-**	**16**	**11**	-	**27**

Course Code	Course Name	Examination Scheme							
		Internal Assesment							
		Internal Assesment			End Sem Exam	Exam Duration (in Hrs)	TW	oral	Tot
		Test 1	Test 2	Avg					
CPC801	Data Warehouse and Mining	20	20	20	80	03	25	25	150
CPC802	Human Machine Interaction	20	20	20	80	03	25	25	150
CPC803	Parallel and distributed Systems	20	20	20	80	03	25	25	150
CPE803X	Elective-III	20	20	20	80	03	25	25	150
CPP802	Project II	-	-	-	-	-	50	50	100
CPL801	Cloud Computing Laboratory	-	-	-	-	-	25	-	-
	Total			80	320		175	150	725

Elective III - Sem 8

Electronics Group	**CPE8031**	Machine Learning
Digital Group	**CPE8032**	Embedded Systems
Network Group	**CPE8033**	Adhoc wireless networks
	CPE8034	Digital Forensic
DB Group	**CPE8035**	Big data Analytics

Course Code	Course/Subject Name	Credits
CPC801	**Data Warehousing and Mining**	5

Objectives:

1. To study the methodology of engineering legacy databases for data warehousing and data mining to derive business rules for decision support systems.
2. To analyze the data, identify the problems, and choose the relevant models and algorithms to apply.

Outcomes: Learner will be able to…

1. Enable students to understand and implement classical algorithms in data mining and data warehousing; students will be able to assess the strengths and weaknesses of the algorithms, identify the application area of algorithms, and apply them.
2. Students would learn data mining techniques as well as methods in integrating and interpreting the data sets and improving effectiveness, efficiency and quality for data analysis.

Module	Detailed Contents	Hrs.
01	**Introduction to Data Warehousing** 1.1 The Need for Data Warehousing; Increasing Demand for Strategic Information; Inability of Past Decision Support System; Operational V/s Decisional Support System; Data Warehouse Defined; Benefits of Data Warehousing ;Features of a Data Warehouse; The Information Flow Mechanism; Role of Metadata; Classification of Metadata; Data Warehouse Architecture; Different Types of Architecture; Data Warehouse and Data Marts; Data Warehousing Design Strategies.	04
02	**Dimensional Modeling** 2.1 Data Warehouse Modeling Vs Operational Database Modeling; Dimensional Model Vs ER Model; Features of a Good Dimensional Model; The Star Schema; How Does a Query Execute? The Snowflake Schema; Fact Tables and Dimension Tables; The Factless Fact Table; Updates To Dimension Tables: Slowly Changing Dimensions, Type 1 Changes, Type 2 Changes, Type 3 Changes, Large Dimension Tables, Rapidly Changing or Large Slowly Changing Dimensions, Junk Dimensions, Keys in the Data Warehouse Schema, Primary Keys, Surrogate Keys & Foreign Keys; Aggregate Tables; Fact Constellation Schema or Families of Star.	06
03	**ETL Process** 3.1 Challenges in ETL Functions; Data Extraction; Identification of Data Sources; Extracting Data: Immediate Data Extraction, Deferred Data Extraction; Data Transformation: Tasks Involved in Data Transformation, Data Loading: Techniques of Data Loading, Loading the Fact Tables and Dimension Tables Data Quality; Issues in Data Cleansing.	06
04	**Online Analytical Processing (OLAP)**	04

	4.1 Need for Online Analytical Processing; OLTP V/s OLAP; OLAP and Multidimensional Analysis; Hypercubes; OLAP Operations in Multidimensional Data Model; OLAP Models: MOLAP, ROLAP, HOLAP, DOLAP;	
05	**Introduction to data mining** 5.1 What is Data Mining; Knowledge Discovery in Database (KDD), What can be Data to be Mined, Related Concept to Data Mining, Data Mining Technique, Application and Issues in Data Mining	02
06	**Data Exploration** 6.1 Types of Attributes; Statistical Description of Data; Data Visualization; Measuring similarity and dissimilarity.	02
07	**Data Preprocessing** 7.1 Why Preprocessing? Data Cleaning; Data Integration; Data Reduction: Attribute subset selection, Histograms, Clustering and Sampling; Data Transformation & Data Discretization: Normalization, Binning, Histogram Analysis and Concept hierarchy generation.	04
08	**Classification** 8.1 Basic Concepts; **Classification methods:** 1. Decision Tree Induction: Attribute Selection Measures, Tree pruning. 2. Bayesian Classification: Naïve Bayes' Classifier. **8.2 Prediction**: Structure of regression models; Simple linear regression, Multiple linear regression. **8.3 Model Evaluation & Selection: A**ccuracy and Error measures, Holdout, Random Sampling, Cross Validation, Bootstrap; Comparing Classifier performance using ROC Curves. **8.4 Combining Classifiers**: Bagging, Boosting, Random Forests.	06
09	**Clustering** 9.1 What is clustering? Types of data, Partitioning Methods (K-Means, K-Medoids) Hierarchical Methods(Agglomerative , Divisive, BRICH), Density-Based Methods (DBSCAN, OPTICS)	06
10	**Mining Frequent Pattern and Association Rule** 10.1 Market Basket Analysis, Frequent Itemsets, Closed Itemsets, and Association Rules; Frequent Pattern Mining, Efficient and Scalable Frequent Itemset Mining Methods, The Apriori Algorithm for finding Frequent Itemsets Using Candidate Generation, Generating Association Rules from Frequent Itemsets, Improving the Efficiency of Apriori, A pattern growth approach for mining Frequent Itemsets; Mining Frequent itemsets using vertical data formats; Mining closed and maximal patterns; Introduction to Mining Multilevel Association Rules and Multidimensional Association Rules; From Association Mining to Correlation Analysis, Pattern Evaluation Measures; Introduction to Constraint-Based Association Mining.	08

Term Work:

Term work should consist of at least of the following:

1. One case study given to a group of 3 /4 students of a data mart/ data warehouse.
    a. Write Detail Statement Problem and creation of dimensional modeling (creation star and snowflake schema)
    b. Implementation of all dimension table and fact table
    c. Implementation of OLAP operations.

2. Implementation of classifier like Decision tree, Naïve Bayes, Random Forest using any languages like Java

3. Use WEKA to implement like Decision tree, Naïve Bayes, Random Forest

4. Implementation of clustering algorithm like K-means, K- Medoids, Agglomerative, Divisive using languages any like Java, C# , etc.

5. Use WEKA to implement the following Clustering Algorithms – K-means, Agglomerative, Divisive.

6. Implementation Association Mining like Apriori, FPM using languages like Java, C#, etc.

7. Use WEKA to implement Association Mining like Apriori, FPM.

8. Use R tool to implement Clustering/Association Rule/ Classification Algorithms.

9. Detailed study of any one BI tool like Oracle BI, SPSS, Clementine, and XLMiner etc. (paper Assignment)

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project

Practical/Oral examination:

An oral exam will be held based on the above syllabus

Text Books:

1) Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 3nd Edition

2) Paulraj Ponniah, “Data Warehousing: Fundamentals for IT Professionals”, Wiley India
3) Reema Theraja “Data warehousing”, Oxford University Press.
4) M.H. Dunham, "Data Mining Introductory and Advanced Topics", Pearson Education

Reference Books:

1) Randall Matignon, "Data Mining using SAS enterprise miner ", Wiley Student edition.
2) Alex Berson , S. J. Smith, “Data Warehousing, Data Mining & OLAP” , McGraw Hill.
3) Vikram Pudi & Radha Krishna, “Data Mining”, Oxford Higher Education.
4) Daniel Larose, “Data Mining Methods and Models”, Wiley India.

Course Code	Course/Subject Name	Credits
CPC802	**Human Machine Interaction**	5

Objectives:

1. To stress the importance of a good interface design.
2. To understand the importance of human psychology in designing good interfaces.
3. To motivate students to apply HMI in their day – to – day activities.
4. To bring out the creativity in each student – build innovative applications that are user friendly.
5. To encourage students to indulge into research in Machine Interface Design.

Outcomes: Learner will be able to…

1. To design user centric interfaces.
2. To design innovative and user friendly interfaces.
3. To apply HMI in their day-to-day activities.
4. To criticise existing interface designs, and improve them.
5. To Design application for social and technical task.

Module	Detailed Contents	Hrs.
01	**Introduction** 1.1 Introduction to Human Machine Interface, Hardware, software and operating environment to use HMI in various fields. 1.2 The psychopathology of everyday things – complexity of modern devices; human-centered design; fundamental principles of interaction; Psychology of everyday actions- how people do things; the seven stages of action and three levels of processing; human error;	10
02	**Understanding goal directed design** 2.1 Goal directed design; Implementation models and mental models; Beginners, experts and intermediates – designing for different experience levels; Understanding users; Modeling users – personas and goals.	08
03	**GUI** 3.1 benefits of a good UI; popularity of graphics; concept of direct manipulation; advantages and disadvantages; characteristics of GUI; characteristics of Web UI; General design principles.	08
04	**Design guidelines** 4.1 perception, Gesalt principles, visual structure, reading is unnatural, color, vision, memory, six behavioral patterns, recognition and recall, learning, factors affecting learning, time.	08
05	**Interaction styles** 5.1 menus; windows; device based controls, screen based controls;.	06
06	**Communication** 6.1 text messages; feedback and guidance; graphics, icons and images; colours.	08

Term Work:

The distribution of marks for term work shall be as follows:

- Laboratory work (experiments/case studies): …….. (15) Marks.
- Assignment:…..…… (05) Marks.
- Attendance ……. (05) Marks

TOTAL: ……. (25) Marks.

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project

Practical/Oral examination:

Oral examination will be based on the above syllabus.

Laboratory:

Students are free to choose any tool that they feel appropriate for a given experiment. Each experiment will involve research about a certain category of people, and then developing an appropriate interface.

Students are expected to perform at least eight experiments from the given list.

LIST OF HMI PRACTICAL / EXPERIMENTS

1. Know your client –

   a. Children (4-5 years of age): An application to teach math.

   b. Teenagers: Design a digital diary for young teens to help them overcome various social pressures they deal with during their teen years. The diary should also be like a self help tool which would help them deal with incidents like bullying, peer pressure, etc.. This is an open project and you can think in any direction to make the children sail through their teen years while trying to discover life around them.

   c. Older generation: Folks from the older generation has been very wary of using their credit card on the Internet. They have various concerns when it comes to paying their bills. Also because of their old age, it will be beneficial for them to use the internet and pay their phone, electricity, gas, etc. bills

   d. Rural people: ATVM for train ticketing in rural area

2. Understand the trouble of interacting with machines - Redesign interfaces of home appliances like microwave oven, land-line phone, fully automatic washing machine.

3. Learn HCI design principles – heuristic evaluation: Identify 5 different websites catering to one specific goal (eg. Goal – on-line shopping and 5 different websites – ebay, amazon, flipkart, zovi, myntra) and perform a competitive analysis on them to understand how each one caters to the goal, the interactions and flow of the payment system and prepare a report on the same..

4. Learn the importance of menus and navigation – website redesign: News websites like CNN are always cluttered with information. It takes the user a few minutes to find his way through and maybe more minutes to look for some specific information. Redesign the news websites to make it look less cluttered, provide relevant information (a person sitting in Russia should not get US news as top news), intelligently dig information that he might be interested in based on his searches on the web.

5. Learn the importance of connecting humans – service design : How often have you found yourself waiting at the airport for a flight that is delayed or you've missed it and the next one is 4 hours from now, or waiting for a connecting flight? Design an experience for passengers to deal with the long waiting hours.

6. Learn the use of statistical graphics – expense tracker: Matt is a young engineer who just finished his summer internship at a leading Software Company in the United States. He has never been independent in handling his own finances and after this internship his father has asked him to start managing his money on his own. He is looking for a tool/app/software that would help him budget his finances, create goals and track them, categorize and track his credit card spending and also get insights on the various types of categories he's spending on. Design a tool/app/software that would help Matt manage his personal finances given the above requirement.

7. Learn the importance of graphics – way finding: Design a map for someone who is new to the city/town/village and is trying to understand how to commute from one place to another (inspired by New York Subway Maps, London Subway Maps)

8. Icon designing: Choose a unique domain, design a few icons and show how it can be accommodated on an interface.

9. Understand the need of colors and animation – web site for an artist: A celebrity in some form of art like music, dance, painting, martial arts, etc (not actors). This site will be used to display his works and should portray his character.

10. Understand the various input methods available for interaction – concept generation: Study the various technologies for typing – standard keyboards QWERTY, T9 (predictive text), multi-touch (SYWPE, etc.), gestures and brainstorm on the various ways in which you could improve one of the existing technologies. You could choose any of the different input types.

11. Any other new relevant topics covering the above syllabus.

Text Books:

1. Alan Dix, J. E. Finlay, G. D. Abowd, R. Beale “Human Computer Interaction”, Prentice Hall.
2. Wilbert O. Galitz, “The Essential Guide to User Interface Design”, Wiley publication.
3. Alan Cooper, Robert Reimann, David Cronin, “About Face3: Essentials of Interaction design”, Wiley publication.
4. Jeff Johnson, “Designing with the mind in mind”, Morgan Kaufmann Publication.
5. Donald A. Normann, “Design of everyday things”, Basic Books; Reprint edition 2002.

Reference Books:

1. Donald A. Norman, “The design of everyday things”, Basic books.
2. Rogers Sharp Preece, “Interaction Design:Beyond Human Computer Interaction”, Wiley.
3. Guy A. Boy “The Handbook of Human Machine Interaction”, Ashgate publishing Ltd.

Course Code	Course/Subject Name	Credits
CPC803	**Parallel and Distributed Systems**	5

Objectives:

1. To provide students with contemporary knowledge in parallel and distributed systems
2. To equip students with skills to analyze and design parallel and distributed applications.
3. To provide master skills to measure the performance of parallel and distributed algorithms

Outcomes: Learner will be able to…

1. Apply the principles and concept in analyzing and designing the parallel and distributed system
2. Reason about ways to parallelize problems.
3. Gain an appreciation on the challenges and opportunities faced by parallel and distributed systems.
4. Understand the middleware technologies that support distributed applications such as RPC, RMI and object based middleware.
5. Improve the performance and reliability of distributed and parallel programs.

Module	Detailed Contents	Hrs.
01	**Introduction** 1.1 Parallel Computing, Parallel Architecture, Architectural Classification Scheme, Performance of Parallel Computers, Performance Metrics for Processors, Parallel Programming Models, Parallel Algorithms.	06
02	**Pipeline Processing** 2.1 Introduction, Pipeline Performance, Arithmetic Pipelines, Pipelined Instruction Processing, Pipeline Stage Design, Hazards, Dynamic Instruction Scheduling,	06
03	**Synchronous Parallel Processing** 3.1 Introduction, Example-SIMD Architecture and Programming Principles, SIMD Parallel Algorithms, Data Mapping and memory in array processors, Case studies of SIMD parallel Processors	06
04	**Introduction to Distributed Systems** 4.1 Definition, Issues, Goals, Types of distributed systems, Distributed System Models, Hardware concepts, Software Concept, Models of Middleware, Services offered by middleware, Client Server model.	06
05	**Communication** 5.1 Layered Protocols, Remote Procedure Call, Remote Object Invocation, Message Oriented Communication, Stream Oriented Communication	04
06	**Resource and Process Management** 6.1 Desirable Features of global Scheduling algorithm, Task assignment approach, Load balancing approach, load sharing approach, Introduction to process management, process migration, Threads, Virtualization, Clients, Servers, Code Migration	06
07	**Synchronization**	08

	7.1 Clock Synchronization, Logical Clocks, Election Algorithms, Mutual Exclusion, Distributed Mutual Exclusion-Classification of mutual Exclusion Algorithm, Requirements of Mutual Exclusion Algorithms, Performance measure, Non Token based Algorithms: Lamport Algorithm, Ricart–Agrawala's Algorithm, Maekawa's Algorithm 7.2 Token Based Algorithms: Suzuki-Kasami's Broardcast Algorithms, Singhal's Heurastic Algorithm, Raymond's Tree based Algorithm, Comparative Performance Analysis.	
08	**Consistency and Replication** 8.1 Introduction, Data-Centric and Client-Centric Consistency Models, Replica Management. **Distributed File Systems** 8.2 Introduction, good features of DFS, File models, File Accessing models, File-Caching Schemes, File Replication, Network File System(NFS), Andrew File System(AFS), Hadoop Distributed File System and Map Reduce.	06

Term Work:

Term work should consist of at least 10 experiments, 2 assignments based on above theory syllabus.

The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.

The distribution of marks for term work shall be as follows:

- Laboratory work (experiments): …….. (15) Marks.
- Assignments: …… (05) Marks.
- Attendance ……. (05) Marks

TOTAL: ……. (25) Marks.

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project

Practical/Oral examination:

Oral Examination will be based on above syllabus

Syllabus for Practical

Suggested topics for experiment but not limited to:

1. Load Balancing Algorithm.
2. Scalability in Distributed Environment
3. Client/server using RPC/RMI.
4. Inter-process communication
5. Election Algorithm.
6. Distributed Deadlock.
7. Name Resolution protocol.
8. Clock Synchronization algorithms.
9. Mutual Exclusion Algorithm.
10. Group Communication.
11. CORBA architecture.
12. Parallel Algorithms.
13. Message Passing Interface.

Text Books

1. M.R. Bhujade, “Parallel Computing”, 2nd edition, New Age International Publishers 2009.
2. Andrew S. Tanenbaum and Maarten Van Steen, “Distributed Systems: Principles and Paradigms, 2nd edition, Pearson Education, Inc., 2007, ISBN: 0-13-239227-5.

Reference Books

1. George Coulouris, Jean Dollimore, Tim Kindberg, “Distributed Systems: Concepts and Design” (4th Edition), Addison Wesley/Pearson Education.
2. Pradeep K Sinha, “Distributed Operating Systems : Concepts and design”, IEEE computer society press

Course Code	Course/Subject Name	Credits
CPE8031	**Elective-III Machine Learning**	5

Objectives:

1. To introduce students to the basic concepts and techniques of Machine Learning.
2. To become familiar with regression methods, classification methods, clustering methods.
3. To become familiar with support vector machine and Dimensionality reduction Techniques.

Outcomes: Learner will be able to…

1. Ability to analyze and appreciate the applications which can use Machine Learning Techniques.
2. Ability to understand regression, classification, clustering methods.
3. Ability to understand the difference between supervised and unsupervised learning methods.
4. Ability to appreciate Dimensionality reduction techniques.
5. Students would understand the working of Reinforcement learning.

Module	Detailed Contents	Hrs.
01	**Introduction to Machine Learning** 1.1 What is Machine Learning?, Key Terminology, Types of Machine Learning, Issues in Machine Learning, Application of Machine Learning, How to choose the right algorithm, Steps in developing a Machine Learning Application.	06
02	**Learning with Regression** 2.1 Linear Regression, Logistic Regression.	04
03	**Learning with trees** 3.1 Using Decision Trees, Constructing Decision Trees, Classification and Regression Trees (CART).	08
04	**Support Vector Machines(SVM)** 4.1 Maximum Margin Linear Separators, Quadratic Programming solution to finding maximum margin separators, Kernels for learning non-linear functions.	06
05	**Learning with Classification** 5.1 Rule based classification, classification by backpropoagation, Bayesian Belief networks, Hidden Markov Models.	06
06	**Dimensionality Reduction** 6.1 Dimensionality Reduction Techniques, Principal Component Analysis, Independent Component Analysis.	06
07	**Learning with Clustering** 7.1 K-means clustering, Hierarchical clustering, Expectation Maximization	06

	Algorithm, Supervised learning after clustering, Radial Basis functions.	
08	**Reinforcement Learning** 8.1 Introduction, Elements of Reinforcement Learning, Model based learning, Temporal Difference Learning, Generalization, Partially Observable States.	06

Term Work:

The distribution of marks for term work shall be as follows:

- Laboratory work (experiments): ……..…….. (15) Marks.
- Assignments:……..…… (05) Marks.
- Attendance ……. (05) Marks

TOTAL: ……. (25) Marks.

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project

Practical/Oral examination:

Oral examination will be based on the above syllabus.

LIST OF ML PRACTICAL / EXPERIMENTS

1. To implement Linear Regression

2. To implement Logistic Regression

3. To implement ID3.

4. To implement Support Vector Machine.

5. To implement Bayesian Classification.

6. To implement K-Nearest Neighbour.

7. To implement k-means Clustering.

8. To implement Agglomerative Clustering.

Any other practical covering the syllabus topics and subtopics can be conducted.

Text Books:

1. Peter Harrington “Machine Learning In Action”, DreamTech Press
2. Ethem Alpaydın, “Introduction to Machine Learning”, MIT Press
3. Tom M.Mitchell “Machine Learning” McGraw Hill
4. Stephen Marsland, “Machine Learning An Algorithmic Perspective” CRC Press

Reference Books:

1. William W.Hsieh, “Machine Learning Mehods in the Environmental Sciences”, Cambridge
2. Han Kamber, “Data Mining Concepts and Techniques”, Morgann Kaufmann Publishers
3. Margaret.H.Dunham, “Data Mining Introductory and Advanced Topics”, Pearson Education

Course Code	Course/Subject Name	Credits
CPE8032	**Elective-III Embedded Systems**	5

Objectives:

1. Develop, among students, an understanding of the technologies behind the embedded computing systems; and to differentiate between such technologies.
2. Make aware of the capabilities and limitations of the various hardware or software components.
3. Evaluate design tradeoffs between different technology choices.
4. Complete or partial design of such embedded systems

Outcomes: Learner will be able to…

1. Describe the special requirements that are imposed on embedded systems
2. Describe the key properties of microprocessor and digital signal processor
3. Sketch a design of an embedded system around a microprocessor or DSP
4. Explain how microprocessor, memory, peripheral components and buses interact in an embedded system
5. Evaluate how architectural and implementation decisions influence performance and power dissipation
6. Produce efficient code for embedded systems
7. Point out the role of the compiler in the embedded system design process
8. Define the properties of a real-time operating system
9. Estimate the requirement for additional hardware for optimized performance
10. Understand and distinguish between the RISC and the Advanced RISC architecture
11. Utilize embedded systems to perform operations such as signal processing in real time
12. Develop drivers for external peripheral devices as per requirement.

Module	Detailed Contents	Hrs.
01	**Introduction to computational technologies** 1.1 Review of computation technologies (ARM, RISC, CISC, PLD, SOC), architecture, event managers, hardware multipliers, pipelining. Hardware/Software co-design. Embedded systems architecture and design process.	08
02	**Program Design and Analysis** 2.1 Integrated Development Environment (IDE), assembler, linking and loading. Program-level performance analysis and optimization, energy and power analysis and program size optimization, program validation and testing. Embedded Linux, kernel architecture, GNU cross platform tool chain. Programming with Linux environment.	08
03	**Process Models and Product development life cycle management** 3.1 State machine models: finite-state machines (FSM), finite-state machines with data-path model (FSMD), hierarchical/concurrent state machine	08

	model (HCFSM), program-state machine model (PSM), concurrent process model. Unified Modeling Language (UML), applications of UML in embedded systems. IP-cores, design process model. Hardware software co-design, embedded product development life cycle management.	
04	**High Performance 32-bit RISC Architecture** 4.1 ARM processor family, ARM architecture, instruction set, addressing modes, operating modes, interrupt structure, and internal peripherals. ARM coprocessors, ARM Cortex-M3.	08
05	**Processes and Operating Systems** 5.1 Introduction to Embedded Operating System, multiple tasks and multiple processes. Multi rate systems, preemptive real-time operating systems, priority-based scheduling, inter-process communication mechanisms. Operating system performance and optimization strategies. Examples of real-time operating systems.	08
06	**Real-time Digital Signal Processing (DSP)** 6.1 Introduction to Real-time simulation, numerical solution of the mathematical model of physical system. DSP on ARM, SIMD techniques. Correlation, Convolution, DFT, FIR filter and IIR Filter implementation on ARM. Open Multimedia Applications Platform (OMAP)	08

Term Work:

Term work should consist of at least 10 practicals and one mini project. Objective type term work test shall be conducted with a weightage of 10 marks.

The distribution of marks for term work shall be as follows:

- Laboratory work (experiments/projects): …….…….. (10) Marks.
- Mini project: …… (10) Marks.
- Attendance ……. (05) Marks

TOTAL: ……. (25) Marks.

The final certification and acceptance of Term Work ensures the satisfactory performance of laboratory work and minimum passing in term work.

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project

Practical/Oral examination:

Oral examination will be based on the above syllabus.

List of Experiments:

Topic-1: Troubleshooting Tools [Any One]

In-Circuit Emulator (ICE) and In-Circuit Debugger (ICD), Logic Analyzer, Spectrum Analyzer, Pattern generator and Digital Storage Oscilloscope.

Topic -2: ARM Processors & Interfaces [Any Four]

LEDs and Keyboard Interface, LCD Interface, Counting external events with on chip counters, Real Time Clock (RTC), Pulse Width Modulation (PWM), Relay and Buzzer Control for alarm events, Stepper Motor Control , On chip ADC/DAC SPI / I2C / UART Interface, Bluetooth/Zig-bee interface.

Topic-3: Real-time Signal Processing ARM-DSP [Any Two]

Real-time physical model simulation, Correlation, convolution, DFT, FIR or IIR design, Real-time DAS and GUI using PC and ARM, Design with Programmable Logic Devices (CPLD/FPGA).

Topic-4: Device Driver Development [Any One]

Drivers for CAN, Drivers for USB, Drivers for Ethernet, SVGA, Drivers for Graphics TFT LCD.

Topic-5: Real Time Operating System (RTOS) [Any Two]

RTLinux , MicroC/OS_II, VxWorks, WIN CE, QNX, Palm OS, Symbian OS, Android OS or equivalent OS.

Text Books:

1. Embedded Systems an Integrated Approach – Lyla B Das, Pearson
2. Computers as Components – Marilyn Wolf, Third Edition Elsevier
3. Embedded Systems Design: A Unified Hardware/Software Introduction – Frank Vahid and Tony Givargis, John Wiley & Sons
4. An Embedded Software Primer – David E. Simon – Pearson Education Sough Asia
5. ARM System Developer's Guide Designing and Optimizing System Software – Andrew N. Sloss, Dominic Sysmes and Chris Wright – Elsevier Inc.

Reference Books:

1. Embedded Systems, Architecture, Programming and Design – Raj Kamal – Tata McGraw Hill
2. Embedded Linux – Hollabaugh, Pearson Education

3. Embedded Realtime Systems Programming – Sriram V Iyer, Pankaj Gupta – Tata McGRaw Hill.
4. Fundamentals of Microcontrollers and Applications in Embedded Systems – Ramesh Gaonkar – Penram International Publishing (India) Pvt. Ltd.
5. Embedded / Real-Time Systems: Concepts, Design & Programming – Dr. K. V. K. K. Prasad – Dreamtech Press, India.

Course Code	Course/Subject Name	Credits
CPE8033	**Elective-III Adhoc Wireless Networks**	5

Objectives:

1. To Identify the major issues associated with ad-hoc networks
2. To identify the requirements for protocols for wireless ad-hoc networks as compared to the protocols existing for wired network.
3. To explore current ad-hoc technologies by researching key areas such as algorithms, protocols, hardware, and applications.
4. To Provide hands-on experience through real-world programming projects
5. To provide advanced in –depth networking materials to graduate students in networking research.

Outcomes: Learner will be able to…

1. Define characteristics and features of Adhoc Networks
2. Appreciate the designing of MAC protocol for Adhoc networks
3. Implement few protocols
4. Apply security principles for routing

Module	Detailed Contents	Hrs.
01	**Introduction** 1.1 Introduction to wireless Networks. Characteristics of Wireless channel, Issues in Ad hoc wireless networks, Adhoc Mobility Models:- Indoor and outdoor models. 1.2 Adhoc Networks: Introduction to adhoc networks – definition, characteristics features, applications.	04
02	**MAC Layer** 2.1 MAC Protocols for Ad hoc wireless Networks: Introduction, Issues in designing a MAC protocol for Ad hoc wireless Networks, Design goals and Classification of a MAC protocol, Contention based protocols with reservation mechanisms. 2.2 Scheduling algorithms, protocols using directional antennas. IEEE standards: 802.11a, 802.11b, 802.11g, 802.15, 802.16, HIPERLAN.	10
03	**Network Layer** 3.1 Routing protocols for Ad hoc wireless Networks: Introduction, Issues in designing a routing protocol for Ad hoc wireless Networks, Classification of routing protocols, Table driven routing protocol, On-demand routing protocol. 3.2 Proactive Vs reactive routing, Unicast routing algorithms, Multicast routing algorithms, hybrid routing algorithm, Energy aware routing algorithm, Hierarchical Routing, QoS aware routing.	10
04	**Transport Layer** 4.1 Transport layer protocols for Ad hoc wireless Networks: Introduction, Issues in designing a transport layer protocol for Ad hoc wireless Networks, Design goals of a transport layer protocol for Ad hoc wireless	07

	Networks, Classification of transport layer solutions, TCP over Ad hoc wireless Networks, Other transport layer protocols for Ad hoc wireless Networks.	
05	**Security** 5.1 Security: Security in wireless Ad hoc wireless Networks, Network security requirements, Issues & challenges in security provisioning, Network security attacks, Key management, Secure routing in Ad hoc wireless Networks.	07
06	**QoS** 6.1 Quality of service in Ad hoc wireless Networks: Introduction, Issues and challenges in providing QoS in Ad hoc wireless Networks, Classification of QoS solutions, MAC layer solutions, network layer solutions.	07

Term Work:

- Term work should consist of at least 12 experiments.
- Journal must include at least 2 assignments.
- The final certification and acceptance of term work indicates that performance in laboratory work is satisfactory and minimum passing marks may be given in term work.

The distribution of marks for term work shall be as follows:

- Laboratory work (experiments): ……..…….. (15) Marks.
- Assignment:…….…… (05) Marks.
- Attendance ……. (05) Marks

TOTAL: ……. (25) Marks.

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project

Practical/Oral examination:

oral examination based on above syllabus will be conducted

Suggested Practicals for Adhoc Wireless

1. Installation of NS2 in Ubuntu 12.04 Linux.
2. Build and exchange data in simple infrastructure and Adhoc network by using personal computer and Android based mobile.
3. Develop sample wireless network in which

   a. implement AODV and AOMDV protocol

b. Calculate the time to receive reply from the receiver using NS2.
c. Generate graphs which show the transmission time for packet.

4. Implement wireless network. Capture data frame and identify fields using NS2.
5. Configure Wireless Access Point (WAP) and build different networks.
6. Implement Mobile device as a wireless access point.
7. Communicate between two different networks which has following specifications:
   a. One network has Class A network with "Tora protocol"
   b. Second has Class B network "AODV protocol"

Practical exam will be based on the above syllabus.

Text Books:

1. Siva Ram Murthy and B.S.Manoj, "Ad hoc Wireless Networks Architectures and protocols", 2nd edition, Pearson Education, 2007
2. Charles E. Perkins, "Adhoc Networking", Addison – Wesley, 2000
3. C. K. Toh,"Adhoc Mobile Wireless Networks", Pearson Education, 2002

Reference Books:

1. Matthew Gast, "802.11 Wireless Networks: The Definitive Guide", 2nd Edition, O'Reilly Media, April 2005.
2. Stefano Basagni, Marco Conti, Silvia Giordan and Ivan Stojmenovic, "Mobile Adhoc Networking", Wiley-IEEE Press, 2004.
3. Mohammad Ilyas, "The handbook of Adhoc Wireless Networks", CRC Press, 2002

Course Code	Course/Subject Name	Credits
CPE8034	**Elective-III Digital Forensics**	5

Objectives:

1. To focus on the procedures for identification, preservation, and extraction of electronic evidence, auditing and investigation of network and host system intrusions, analysis and documentation of information gathered, and preparation of expert testimonial evidence.
2. To provide hands on experience on various forensic tools and resources for system administrators and information system security officers.

Module	Detailed Contents	Hrs.
01	**Introduction:** 1.1 Introduction of Cybercrime: Types, The Internet spawns crime, Worms versus viruses, Computers' roles in crimes, Introduction to digital forensics, Introduction to Incident - Incident Response Methodology – Steps - Activities in Initial Response, Phase after detection of an incident.	09
02	**Initial Response and forensic duplication** 2.1 Initial Response & Volatile Data Collection from Windows system - Initial Response & Volatile Data Collection from Unix system - Forensic Duplication: Forensic duplication: Forensic Duplicates as Admissible Evidence, Forensic Duplication Tool Requirements, Creating a Forensic. 2.2 Duplicate/Qualified Forensic Duplicate of a Hard Drive.	08
03	**Preserving and Recovering Digital Evidence** 3.1 File Systems: FAT, NTFS - Forensic Analysis of File Systems - Storage Fundamentals: Storage Layer, Hard Drives Evidence Handling: Types of Evidence, Challenges in evidence handling, Overview of evidence handling procedure.	09
04	**Network Forensics** 4.1 Intrusion detection; Different Attacks in network, analysis Collecting Network Based Evidence - Investigating Routers - Network Protocols - Email Tracing- Internet Fraud.	07
05	**System investigation** 5.1 Data Analysis Techniques - Investigating Live Systems (Windows & Unix) Investigating 5.2 Hacker Tools - Ethical Issues – Cybercrime.	08
06	**Bodies of law** 6.1 Constitutional law, Criminal law, Civil law, Administrative regulations, Levels of law: Local laws, State laws, Federal laws, International laws , Levels of culpability: Intent, Knowledge, Recklessness, Negligence Level and burden of proof : Criminal versus civil cases ,Vicarious liability, Laws related to computers: CFAA, DMCA, CAN Spam, etc.	07

Term Work:

- Term work should consist of at least 12 experiments.
- Journal must include at least 2 assignments.
- The final certification and acceptance of term work indicates that performance in laboratory work is satisfactory and minimum passing marks may be given in term work.

The distribution of marks for term work shall be as follows:

- Laboratory work (experiments): …….. (15) Marks.
- Assignment: …… (05) Marks.
- Attendance ……. (05) Marks

TOTAL: ……. (25) Marks.

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project.

Practical/Oral examination:

Oral exam will be based on the above syllabus.

Text Books:

1. Kevin Mandia, Chris Prosise, “Incident Response and computer forensics”, Tata McGrawHill, 2006
2. Peter Stephenson, "Investigating Computer Crime: A Handbook for Corporate Investigations", Sept 1999
3. Eoghan Casey, "Handbook Computer Crime Investigation's Forensic Tools and Technology", Academic Press, 1st Edition, 2001

References:

1. Skoudis. E., Perlman. R. Counter Hack: A Step-by-Step Guide to Computer Attacks and Effective Defenses.Prentice Hall Professional Technical Reference. 2001
2. Norbert Zaenglein, "Disk Detective: Secret You Must Know to Recover Information From a Computer", Paladin Press, 2000
3. Bill Nelson, Amelia Philips and Christopher Steuart, “Guide to computer forensics investigation “Course technology, 4th edition

Course Code	Course/Subject Name	Credits
CPE8035	**Elective III - Big Data Analytics**	5

Objectives:

1. To provide an overview of an exciting growing field of big data analytics.
2. To introduce the tools required to manage and analyze big data like Hadoop, NoSql Map-Reduce.
3. To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
4. To enable students to have skills that will help them to solve complex real-world problems in for decision support.

Outcomes: Learner will be able to…

1. Understand the key issues in big data management and its associated applications in intelligent business and scientific computing.
2. Acquire fundamental enabling techniques and scalable algorithms like Hadoop, Map Reduce and NO SQL in big data analytics.
3. Interpret business models and scientific computing paradigms, and apply software tools for big data analytics.
4. Achieve adequate perspectives of big data analytics in various applications like recommender systems, social media applications etc.

Module	Detailed Contents	Hrs.
01	**Introduction to Big Data** 1.1 Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach, Case Study of Big Data Solutions.	03
02	**Introduction to Hadoop** 2.1 What is Hadoop? Core Hadoop Components; Hadoop Ecosystem; Physical Architecture; Hadoop limitations.	03
03	**NoSQL** 3.1 What is NoSQL? NoSQL business drivers; NoSQL case studies; 3.2 NoSQL data architecture patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, Variations of NoSQL architectural patterns; 3.3 Using NoSQL to manage big data: What is a big data NoSQL solution? Understanding the types of big data problems; Analyzing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer; Four ways that NoSQL systems handle big data problems	04
04	**MapReduce and the New Software Stack** **4.1 Distributed File Systems :** Physical Organization of Compute Nodes, Large-Scale File-System Organization. **4.2 MapReduce:** The Map Tasks, Grouping by Key, The Reduce Tasks,	06

	Combiners, Details of MapReduce Execution, Coping With Node Failures. **4.3 Algorithms Using MapReduce**: Matrix-Vector Multiplication by MapReduce , Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union, Intersection, and Difference by MapReduce, Computing Natural Join by MapReduce, Grouping and Aggregation by MapReduce, Matrix Multiplication, Matrix Multiplication with One MapReduce Step.	
05	**Finding Similar Items** 5.1 Applications of Near-Neighbor Search, Jaccard Similarity of Sets, Similarity of Documents, Collaborative Filtering as a Similar-Sets Problem . 5.2 **Distance Measures:** Definition of a Distance Measure, Euclidean Distances, Jaccard Distance, Cosine Distance, Edit Distance, Hamming Distance.	03
06	**Mining Data Streams** **6.1 The Stream Data Model**: A Data-Stream-Management System, Examples of Stream Sources, Stream Querie, Issues in Stream Processing. **6.2 Sampling Data in a Stream** : Obtaining a Representative Sample , The General Sampling Problem, Varying the Sample Size. **6.3 Filtering Streams**: The Bloom Filter, Analysis. **6.4 Counting Distinct Elements in a Stream** The Count-Distinct Problem, The Flajolet-Martin Algorithm, Combining Estimates, Space Requirements . **6.5 Counting Ones in a Window**: The Cost of Exact Counts, The Datar-Gionis-Indyk-Motwani Algorithm, Query Answering in the DGIM Algorithm, Decaying Windows.	06
07	**Link Analysis** 7.1 PageRank Definition, Structure of the web, dead ends, Using Page rank in a search engine, Efficient computation of Page Rank: PageRank Iteration Using MapReduce, Use of Combiners to Consolidate the Result Vector. 7.2 Topic sensitive Page Rank, link Spam, Hubs and Authorities.	05
08	**Frequent Itemsets** **8.1 Handling Larger Datasets in Main Memory** Algorithm of Park, Chen, and Yu, The Multistage Algorithm, The Multihash Algorithm. **8.2 The SON Algorithm and MapReduce** **8.3 Counting Frequent Items in a Stream** Sampling Methods for Streams, Frequent Itemsets in Decaying Windows	05
09	**Clustering** 9.1 CURE Algorithm, Stream-Computing , A Stream-Clustering Algorithm, Initializing & Merging Buckets, Answering Queries	05

10	**Recommendation Systems** 10.1 A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering.	04
11	**Mining Social-Network Graphs** 11.1 Social Networks as Graphs, Clustering of Social-Network Graphs, Direct Discovery of Communities, SimRank, Counting triangles using Map-Reduce	04

Term Work:

Assign a case study for group of 2/3 students and each group to perform the following experiments on their case-study; Each group should perform the exercises on a large dataset created by them.

The distribution of marks for term work shall be as follows:

- Programming Exercises: ……..….. (10) Marks.
- Mini project: …… (10) Marks.
- Attendance ……. (05) Marks

TOTAL: ……. (25) Marks.

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project.

Practical/Oral examination:

An oral exam will be held based on the above syllabus.

Suggested Practical List: Students will perform at least 8 programming exercises and implement one mini-project. The students can work in groups of 2/3.

1. Study of Hadoop ecosystem
2. programming exercises on Hadoop
3. programming exercises in No SQL
4. Implementing simple algorithms in Map- Reduce (3) - Matrix multiplication, Aggregates, joins, sorting, searching etc.
5. Implementing any one Frequent Itemset algorithm using Map-Reduce
6. Implementing any one Clustering algorithm using Map-Reduce
7. Implementing any one data streaming algorithm using Map-Reduce
8. Mini Project: One real life large data application to be implemented (Use standard Datasets available on the web)

a. Twitter data analysis
b. Fraud Detection
c. Text Mining etc.

Text Books:

1. Anand Rajaraman and Jeff Ullman "Mining of Massive Datasets", Cambridge University Press,
2. Alex Holmes "Hadoop in Practice", Manning Press, Dreamtech Press.
3. Dan McCreary and Ann Kelly "Making Sense of NoSQL" – A guide for managers and the rest of us, Manning Press.

References:

1. Bill Franks **, "**Taming The Big Data Tidal Wave: Finding Opportunities In Huge Data Streams With Advanced Analytics", Wiley
2. Chuck Lam, "Hadoop in Action", Dreamtech Press

Course Code	Course/Subject Name	Credits
CPL801	**Cloud Computing Laboratory**	1

Outcomes: Learner will be able to…

1. Appreciate cloud architecture
2. Create and run virtual machines on open source OS
3. implement Infrastructure , storage as a Service**.**
4. Install and appreciate security features for cloud

Module	Detailed Contents	Lab Session
01	**Title:** Study of Cloud Computing & Architecture. **Concept:** Cloud Computing & Architecture. **Objective:** Objective of this module is to provide students an overview of the Cloud Computing and Architecture and different types of Cloud Computing **Scope:** Cloud Computing & Architecture Types of Cloud Computing . **Technology:** ---	**01**
02	**Title:** Virtualization in Cloud. **Concept:** Virtualization **Objective:** In this module students will learn, Virtualization Basics, Objectives of Virtualization, and Benefits of Virtualization in cloud. **Scope:** Creating and running virtual machines on open source OS. **Technology:** KVM, VMware.	**02**
03	**Title:** Study and implementation of Infrastructure as a Service . **Concept:** Infrastructure as a Service**.** **Objective:** In this module student will learn Infrastructure as a Service and implement it by using OpenStack. **Scope:** Installing OpenStack and use it as Infrastructure as a Service . **Technology:** Quanta Plus /Aptana /Kompozer	**02**
04	**Title:** Study and installation of Storage as Service.	**02**

	Concept: Storage as Service (SaaS) **Objective:** is that, students must be able to understand the concept of SaaS , and how it is implemented using ownCloud which gives universal access to files through a web interface. **Scope:** is to installation and understanding features of ownCloud as SaaS**.** **Technology:** ownCloud	
05	**Title:** Implementation of identity management. **Concept:** Identity Management in cloud **Objective:** this lab gives an introduction about identity management in cloud and simulate it by using OpenStack **Scope:** installing and using identity management feature of OpenStack **Technology:** OpenStack	**02**
06	**Title:** Write a program for web feed. **Concept:** Web feed and RSS **Objective:** this lab is to understand the concept of form and control validation **Scope:** Write a program for web feed **Technology:** PHP, HTML	**02**
07	**Title:** Study and implementation of Single-Sing-On. **Concept:** Single Sing On (SSO),openID **Objective:** is to understand the concept of access control in cloud and single sing on (SSO), Use SSO and advantages of it, and also students should able to implementation of it. **Scope:** installing and using JOSSO **Technology:** JOSSO	**02**
08	**Title:** Securing Servers in Cloud. **Concept:** Cloud Security **Objective:** is to understand how to secure web server, how to secure data directory and introduction to encryption for own cloud.	**02**

	Scope: Installing and using security feature of ownCloud **Technology:** ownCloud	
09	**Title:** User Management in Cloud. **Concept:** Administrative features of Cloud Managenet ,User Management **Objective:** is to understand how to create, manage user and group of users accounts. **Scope:** Installing and using Administrative features of ownCloud **Technology:** ownCloud	**02**
10	**Title:** Case study on Amazon EC2. **Concept:** Amazon EC2 **Objective:** in this module students will learn about Amazon EC2. Amazon Elastic Compute Cloud is a central part of Amazon.com's cloud computing platform, Amazon Web Services. EC2 allows users to rent virtual computers on which to run their own computer applications	**01**
11	**Title:** Case study on Microsoft azure. **Concept:** Microsoft Azure **Objective:** students will learn about Microsoft Azure is a cloud computing platform and infrastructure, created by Microsoft, for building, deploying and managing applications and services through a global network of Microsoft-managed datacenters. How it work, different services provided by it. **Technology:** Microsoft azure	**01**
12	**Title:** Mini project. **Concept:** using different features of cloud computing creating own cloud for institute, organization etc. **Objective:** is student must be able to create own cloud using different features which are learned in previous practices. **Scope:** creating a cloud like social site for institute. **Technology:** any open system used for cloud	**05**

Term Work:

- Term work should consist of at least 6 experiments and a mini project.
- Journal must include at least 2 assignments.
- The final certification and acceptance of term work indicates that performance in laboratory work is satisfactory and minimum passing marks may be given in term work.

The distribution of marks for term work shall be as follows:

- Laboratory work (experiments): …….. (15) Marks.
- Mini project presentation: …… (05) Marks.
- Attendance ……. (05) Marks

TOTAL: …… (25) Marks.

Text Books:

1. Enterprise Cloud Computing by Gautam Shroff, Cambridge,2010
2. Cloud Security by Ronald Krutz and Russell Dean Vines, Wiley - India, 2010 , ISBN:978-0-470-58987-8
3. Getting Started with OwnCloud by Aditya Patawar , Packt Publishing Ltd, 2013
4. www.openstack.org

Course Code	Course/Subject Name	Credits
CP701 / CP802	**Project I/ II**	**3 / 6**

Guidelines for Project

- Students should do literature survey/visit industry/analyze current trends and identify the problem for Project and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem.
- Students should attempt solution to the problem by experimental/simulation methods.
- The solution to be validated with proper justification and report to be compiled in standard format.

Guidelines for Assessment of Project I

- Project I should be assessed based on following points
  - Quality of problem selected
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization
  - Clarity of objective and scope
  - Breadth and depth of literature survey
- Project I should be assessed through a presentation by the student project group to a panel of Internal examiners appointed by the Head of the Department/Institute of respective Programme.

Guidelines for Assessment of Project II

- Project II should be assessed based on following points
  - Quality of problem selected
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization / Industrial trends
  - Clarity of objective and scope
  - Quality of work attempted
  - Validation of results
  - Quality of Written and Oral Presentation
- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Project II should be assessed through a presentation by the student project group to a panel of Internal and External Examiners approved by the University of Mumbai
- Students should be motivated to publish a paper based on the work in Conferences/students competitions