Rashtreeya Sikshana Samithi Trust

R.V. College of Engineering, Bengaluru

(Autonomous Institution Affiliated to Visvesvaraya Technological University, Belagavi)

Master of Technology (M. Tech.)

Software Engineering

Scheme and Syllabus

Autonomous System w.e.f 2016

R.V. College of Engineering, Bengaluru – 59

(Autonomous Institution Affiliated to Visvesvaraya Technological University,, Belagavi)

Department of Information Science and Engineering

Vision:

To be the hub for innovation in Information Science & Engineering through Teaching, Research, Development and Consultancy; thus make the department a global resource center in advanced, sustainable and inclusive technology.

Mission:

1. To enable students to become responsible professionals, strong in fundamentals of information science and engineering through experiential learning
2. To bring research and entrepreneurship into class rooms by continuous design of innovative solutions through research publications and dynamic development oriented curriculum.
3. To facilitate continuous interaction with the outside world through student internship, faculty consultancy, workshops, faculty development programmes, industry collaboration and association with the professional societies.
4. To create a new generation of entrepreneurial problem solvers for a sustainable future through green technology with an emphasis on ethical practices, inclusive societal concerns and environment
5. To promote team work through inter-disciplinary projects, co-curricular and social activities.

Program Educational Objectives (PEO)

M. Tech. in Software Engineering Program, Students will be able to:

PEO1: Design, build and evaluate software systems of varying complexity based on client's requirements.

PEO2: Apply the knowledge of Software Engineering to configure, package and deliver solutions for different sectors like ERP, Web technology.

PEO3: Apply the skills in clear communication, responsible teamwork, and time management for working on multidisciplinary project.

Program Outcomes (PO)

M. Tech. in Software Engineering Students will be able to:

PO 1: Scholarship of Knowledge -Acquire in-depth knowledge of Software Engineering process, including wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.

PO 2: Critical Thinking - Analyse complex Software Engineering related problems, apply independent judgement for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.

PO 3 : Problem Solving - Think laterally and originally, conceptualise and solve issues related to Software Engineering, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.

PO 4: Research Skill - Extract information pertinent to unfamiliar problems in Software Engineering domain through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyse and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.

PO 5: Usage of modern tools - Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools of Software Engineering, including prediction and modelling, to complex engineering activities with an understanding of the limitations.

PO 6: Collaborative and Multidisciplinary work - Possess knowledge and understanding of group dynamics, recognise opportunities and contribute positively to collaborative-multidisciplinary scientific research in Software Engineering,

demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.

PO 7: Project Management and Finance - Demonstrate knowledge and understanding of Software Engineering principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economical and financial factors.

PO 8: Communication - Communicate with the Software Engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.

PO 9: Life-long Learning - Recognize the need for, and have the preparation and ability to engage in life-long learning independently in Software Engineering domain, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

PO 10: Ethical Practices and Social Responsibility - Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society using Software Engineering solutions.

PO 11: Independent and Reflective Learning - Observe and examine critically the outcomes of one's actions and make corrective measures subsequently, and learn from mistakes in project and professional practice without depending on external feedback.

Program Specific Outcomes (PSO)

M. Tech. in Software Engineering Students will be able to:

PSO 1. Design, develop and deliver complex, scalable and cost effective software systems by applying Software Engineering principles, tools and processes.

PSO 2. Comprehend the role and responsibilities of the professional software engineer with importance to quality and management issues involved in software construction

R. V. College of Engineering, Bengaluru – 59.

(An Autonomous Institution Affiliated to Visvesvaraya Technological University,, Belagavi)

Department of Information Science and Engineering

M.Tech. in Software Engineering

FIRST SEMESTER								
Sl. No	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Total Credits**
				Lecture **L**	**Tutorial** **T**	**Practical** **P**	**Experiential Learning/ Self Study** **S**	
1	16MEM11R	Research Methodology	IM	3	1	0	0	4
2	16MSE12 / 16MIT12	Data Engineering	IS	4	0	1	0	5
3	16MSE13	Advanced Data Structure and Algorithm	IS	4	0	0	1	5
4	16MSE14	Software Architecture and Design	IS	4	0	0	0	4
5	16MSE15X	Elective – 1	IS	4	0	0	0	4
6	16HSS16	Professional Skill Development		0	0	2	0	2
		Total		**19**	**1**	**3**	**1**	**24**
		Number of contact hours		19	2	2	4	27

Elective -1			
16MSE151	Advanced Web Programming	16MSE152/16MIT152	Human Computer Interaction

R. V. College of Engineering, Bengaluru – 59.

(An Autonomous Institution Affiliated to Visvesvaraya Technological University,, Belagavi)

Department of Information Science and Engineering

M.Tech. in Software Engineering

SECOND SEMESTER								
Sl. No	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Total Credits**
				Lecture **L**	**Tutorial** **T**	**Practical** **P**	**Experiential Learning / Self Study** **S**	
1	16MSE21P	Project Management	IM	3	1	0	0	4
2	16MSE22/16MIT22	Cyber security and Digital Forensics	IS	4	0	1	0	5
3	16MSE23X	Elective – 2	IS	4	0	0	0	4
4	16MSE24X	Elective – 3	IS	4	0	0	0	4
5	16MSE25X	Elective – 4	IS	4	0	0	0	4
6	16MSE26	Minor Project	IS	0	0	5	0	5
		Total		**19**	**1**	**6**	**0**	**26**
		Number of contact hours		19	2	2	0	**23**

Elective -2			
16MSE231	Simulation and Modelling	16MCE232/16MSE232	Computer Systems Performance Analysis
Elective – 3			
16MSE241	Software Reliability and Fault Tolerant Systems	16MSE242	Metrics and Models in Software Engineering
Elective – 4			
16MSE251/16MIT25	Advanced Computer Networks	16MSE252/16MIT252	Distributed Computing

1			

R. V. College of Engineering, Bengaluru – 59.

(An Autonomous Institution affiliated to VTU, Belagavi)

Department of Information Science and Engineering

M.Tech in Software Engineering

THIRD SEMESTER								
Sl. No	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Total Credits**
				Lecture L	**Tutorial T**	**Practical P**	**Experiential Learning/ Self Study S**	
1	16MSE31	Software Quality Assurance and Testing	ISE	4	0	1	0	5
2	16MSE32X	Elective – 5	ISE	4	0	0	0	4
3	16MSE33X	Elective – 6	ISE	4	0	0	0	4
4	16MSE34X	Elective – 7	ISE	4	0	0	0	4
5	16MSE35	Internship / Industrial Training	ISE	0	0	3	0	3
6	16MSE36	Technical Seminar	ISE	0	0	2	0	2
		Total		**16**	**0**	**6**	**0**	**22**
		Number of Contact Hours		16	0	6	0	22

Elective -5			
16MSE321/16MIT321	Soft Computing	16MSE322/16MIT322	Social Network Analysis
Elective – 6			
16MSE331/16MIT331	IoT and Cloud Computing	16MSE332/16MIT332	Big Data Analytics
Elective-7			
16MSE341	Enterprise Application Programming	16MSE342	Agile Methodology

R. V. College of Engineering, Bengaluru – 59.

(An Autonomous Institution Affiliated to Visvesvaraya Technological University,, Belagavi)

Department of Information Science and Engineering

M.Tech. in Software Engineering

FOURTH SEMESTER								
Sl. No	Course Code	Course Title	BoS	CREDIT ALLOCATION				Total Credits
				Lecture L	Tutorial T	Practical P	Experiential Learning/ Self Study S	
1	16MSE41	Major Project	IS	0	0	26	0	26
2	16MSE42	Seminar	IS	0	0	2	0	2
		Total		**0**	**0**	**28**	**0**	**28**

FIRST SEMESTER

Research Methodology						
Course Code	**:**	**16MEM11R**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L: T: P: S: 3:1:0:0**		**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives:

Students will be able to

1. Understand of the underlying principles of quantitative and qualitative research
2. Perform the gap analysis and identify the overall process of designing a research study .
3. Choose the most appropriate research methodology to address a particular research problem
4. Gain a overview of a range of quantitative and qualitative approaches leading to data analysis and suggesting solution..

Unit – I	**10 Hrs**

Overview of Research

Meaning of Research, Types of Research, Research and Scientific Method, Defining the Research Problem, Defining the Research Problem, Research Design, Different Research Designs.

Unit – II	**09 Hrs**

Methods of Data Collection

Collection of Primary Data, Observation Method, Interview Method, Collection of Data through Questionnaires, Collection of Data through Schedules, Collection of Secondary Data, Selection of Appropriate Method for Data Collection.

Unit – III	**10 Hrs**

Sampling Methods

Sampling process, Non-probability sampling, probability sampling: simple random sampling, stratified sampling, cluster sampling systematic random sampling, Determination of sample size, simple numerical problems.

Unit – IV	**10 Hrs**

Processing and analysis of Data

Processing Operations, Types of Analysis, Statistics in Research, Measures of: Central Tendency, Dispersion, Asymmetry and Relationship, correlation and regression, Testing of Hypotheses for single sampling: Parametric (t, z and F) Chi Square, ANOVA, and non-parametric tests, numerical problems.

Unit-V	**09 Hrs**

Essential of Report writing and Ethical issues:

Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Precautions for Writing Research Reports.

Syllabus includes 12 hours of tutorials in which:

- Faculty is expected to discuss research methodology for specializations under consideration.
- Numerical problems on statistical analysis as required for the domains in which students are studying must be discussed.
- Statistical analysis using MINITAB/ MatLab and such other softwares can be introduced.

Course Outcomes:

After going through this course the student will be able to

CO1: Adopt various principles and concepts of research methodology to their research problems.

CO2: Apply appropriate method of data collection and analyze using statistical methods.

CO3: Formulate research methodology for a given engineering and management problem situation.

CO4: Analyze research outputs in a structured manner and prepare report as per the technical and ethical standards.

Reference Books:

1. Kothari C.R., Research Methodology Methods and techniques by, New Age International, 2004, ISBN: 9788122415223 – Unit I, II, IV & V.
2. Krishnaswami, K.N., Sivakumar, A. I. and Mathirajan, M., Management Research Methodology, Pearson Education India, 2009, ISBN:9788177585636 – Unit III.
3. Levin, R.I. and Rubin, D.S., Statistics for Management, 7th Edition, Pearson Education: New Delhi, ISBN-13: 978-8177585841 – Unit III, IV.

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE will be 100 marks

Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	H	L	M	L	H	M	L	L	M	M	--
CO 2	H	M	M	M	H	L	M	L	M	M	--
CO 3	M	H	H	H	L	M	M	L	H	M	--
CO 4	M	H	M	M	L	M	H	L	H	M	--

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	L	L
CO2	L	M
CO3	M	H

CO4	M	H

Data Engineering						
Course Code	**:**	**16MSE12/16MIT12**		**CIE Marks**	**:**	**100+50**
Hrs/Week	**:**	**L:T:P:S 4:0:1:0**		**SEE Marks**	**:**	**100+50**
Credits	**:**	**5**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Explain and differentiate Parallel and Distributed databases and its applications
2. Apply the technology of OODBMS
3. Analyse the need for data warehousing systems and the technology for data warehousing
4. Adapt data mining techniques to real life applications to derive useful results

Unit – I	**10 Hrs**

Object DBMS: Object Oriented Databases – Introduction – Weakness of RDBMS – Object Oriented Concepts Storing Objects in Relational Databases – Next Generation Database Systems – Object Oriented Data models – OODBMS Perspectives – Persistence – Issues in OODBMS – Object Oriented Database Management System Manifesto – Advantages and Disadvantages of OODBMS – Object Oriented Database Design – OODBMS Standards and Systems – Object Management Group – Object Database Standard ODMG – Object Relational DBMS –Postgres - Comparison of ORDBMS and OODBMS

Unit – II	**09 Hrs**

Distributed Databases: Introduction, Functions and architectures of a DDBMS, Distributed Transaction Management, Distributed Concurrency Control, Distributed Deadlock Management, Distributed Database Recovery, Distributed query optimization

Replication and Mobile databases,: Introduction to database replication, Benefits of database replication, Applications of replication, Basic components of database replication, database replication environments, Replication Servers, Introduction to mobile databases

Unit – III	**10 Hrs**

Data Warehouse and OLAP Technology for Data Mining: Data Warehouse, Multidimensional Data Model, Data Warehouse Architecture, Data Warehouse Implementation, Further Development of Data Cube Technology, From Data Warehousing to Data Mining Data Cube Computation and Data Generalization: Efficient Methods for Data Cube Computation, Further Development of Data Cube and OLAP Technology, Attribute-Oriented Induction

Unit – IV	**10 Hrs**

Fundamentals of data mining, Data Mining Functionalities, Classification of Data Mining

systems, Data Mining Task Primitives, Integration of a Data Mining System with a Database or a Data Warehouse System, Major issues in Data Mining. Data Preprocessing: Need for Preprocessing the Data, Data Cleaning, Data Integration and Transformation, Data Reduction, Discretization and Concept Hierarchy Generation. Mining Frequent Patterns, Associations and Correlations: Basic Concepts, Efficient and Scalable Frequent Itemset Mining Methods, Mining various kinds of Association Rules, From Association Mining to Correlation Analysis, Constraint-Based Association Mining

Unit – V	**09 Hrs**

Classification and Prediction: Issues Regarding Classification and Prediction, Classification by Decision Tree Induction, Bayesian Classification, Rule-Based Classification, Classification by Backpropagation, Support Vector Machines, Associative Classification, Lazy Learners, Other Classification Methods, Prediction, Accuracy and Error measures, Evaluating the accuracy of a Classifier or a Predictor, Ensemble Methods

Cluster Analysis Introduction :Types of Data in Cluster Analysis, A Categorization of Major Clustering Methods, Partitioning Methods, Hierarchical Methods, Density-Based Methods, Grid-Based Methods, Model-Based Clustering Methods, Clustering High-Dimensional Data, Constraint-Based Cluster Analysis, Outlier Analysis.

Unit – VI (Guidelines for Minor Project)

For the Minor project students have a choice between a data mining project using and implementing a client/Server/web based database project based on Distributed databases or a project based on data mining method or a Project based on ODBMS. The topic of the minor project should be coordinated with the faculty

Project types

- Identify a suitable project under the following domains to implement the features specific to the type of DBMS. This should be an application-based project. Examples are given below but is not limited to the same.
- **Distributed Database Projects to exhibit the following**
    - Data partitioning experiments
    - Aggregation Operator
    - Implementing a special operator called shuffle to enable SimpleDB to run joins in parallel.
    - Implement a SkewedJoin
    - Implement a broadcast join
    - Implement a fuzzy join
    - Performance analysis

- **OODBMS Projects**
  - The project should demo the specific functionalities and applications that are salient to OODBMS, some examples are :
  - Encapsulation in OODBs, Object Versioning, Overloading in OODBs, Object Identity, Object Structure, Type Constructors etc.

- **Data mining Projects**
  - Decision support systems (DSS) Applications, on-line analytical processing (OLAP) Applications. Any application domain related to Banking, Retail, Insurance, Medical, Security etc to demo the following functionalities:

    - **pivoting** - rotating to display a different dimension (see cubes on right)
    - **rollup** - displaying a coarser level of data granularity, by combining or aggregating data
    - **drill-down** - showing more detail on some dimension, using finer granularity for the data; requires that the more detailed data be available
    - **slicing** - examining a portion of the data cube using a selection with equality conditions for one or more dimensions; appears as if the user has cut through the cube in the selected directions
    - **dicing**- specifying a range of values in a selection
    - **Cross-tabulation** – displaying totals (or other statistics)for the rows and columns in a two-dimensional spreadsheet-style display

  - Studying a data set that has not been thoroughly evaluated, or using a different approach. The analysis should not be trivial. Students are expected to study the dataset, determine the issues, address any preprocessing issues, try multiple modeling techniques, and perhaps take some creative steps to try to improve the predictive performance.

  - **Implementation:** Identify an algorithm to implement. Implement the algorithm (preferable with an interface to a data mining environment (R, WEKA, MOA, etc.). Test/compare the implementation with a data set.

Project Report guidelines

- The actual write-up of minor project should be double spaced. Everyone will be doing a presentation of their project. Students should be able to present their results during the last class/exam, the paper need not be organized exactly as described below, but this should be taken as a reasonable template.

- Abstract: summarizes the paper and the goals of the work (required)

- Introduction: Introduces the project and what is being done. May include some background.

- Background: Depending on the project, a separate background section, depending on how much background to include. For example, it may provide domain information for the domain that of study.

- Experiments: Describes the experiments and the experimental setup. May describe the data sets, the evaluation metrics, the data mining tools used, and any other details related to the experiments.

- Results: Includes the experiment results (which are typically not included in the experiments section). A discussion of the results may be included, or they could be included in a separate discussion section, which follows the results.

- Related Work: A brief description of related work, with citations to relevant papers. There should be a few references to data mining (e.g., a reference to the WEKA book or WEKA system) and there really should be a few references to similar work. If therelated work section is going to be very short, the same may be included in the background or introduction section

Course Outcomes:

After going through this course the student will be able to:

CO1: define & explain the key related concepts & models in OODBMS to data science including data cleaning & integration, data intensive distributed computing, data mining algo and data visualization.

CO2: Design-implement & evaluate the core algorithms underlying on end to end data science work flow, including the experimental design data collection, mining, analysis and visualization of information derived from large data set.

CO3: Apply best practices in data science including facility with modern tools.

CO4: Comprehend and write effective reports and design documentation by adhering to appropriate standards and make effective presentations.

Reference Books

1.	Database Systems – Thomas Connolly and Corolyn Begg, Pearson 4th Edition ISBN: 978-8131720257
2.	Data Mining – Concepts and Techniques - Jiawei Han & Micheline Kamber, Morgan Kaufmann Publishers, Elsevier, 3rd Ed ISBN : 0123814804, 9780123814807
3.	Elmasri and Navathe: Fundamentals of Database Systems, Pearson Education, 2013 6th Ed ISBN: 978-8131792476
4.	Abraham Silberschatz, Henry F. Korth, S. Sudarshan: Database System Concepts, 6th Edition, McGraw Hill, 2010. ISBN : 978-0073523323

Scheme of Continuous Internal Evaluation (CIE) for Theory

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Continuous Internal Evaluation (CIE) for Practical

CIE for the practical courses will be based on the performance of the student in the laboratory, every week. The laboratory records will be evaluated for 40 marks. One test will be conducted for 10 marks. The total marks for CIE (Practical) will be for 50 marks.

Scheme of Semester End Examination (SEE) for Theory
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE) for Practical
SEE for the practical courses will be based on conducting the experiments and proper results for 40 marks and 10 marks for viva-voce. The total marks for SEE (Practical) will be 50 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	H	H	H	M	-	-	-	-	L	-	-
CO 2	H	H	M	M	-	-	M	M	M	H	M
CO 3	H	-	M	-	H	-	-	L	M	H	M
CO 4	-	-	-	-	-	M	L	H	-	L	-

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	M	H
CO2	H	H
CO3	H	H
CO4	H	H

Advanced Data Structure and Algorithm						
Course Code	**:**	**16MSE13**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S 4:0:0:1**		**SEE Marks**	**:**	**100**
Credits	**:**	**5**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):
Students shall be able to
1. Apply data structure techniques for various programming aspects
2. Design and implement efficient solutions to various real world problems through algorithms.
3. Develop mathematical skills for algorithm design, analysis, and evaluation
4. Analyze various algorithms for efficiency.

Unit – I	**10 Hrs**

Analysis Techniques: Growth of Functions: Asymptotic notations, Recurrences relations and solutions Amortized Analysis: Aggregate, Accounting and Potential Methods. **Advanced Data structures**: Abstract data types (ADTs), Graph, Directed Acyclic Graph, Trees: Preliminaries, Binary tree, The search tree ADT: Binary search tree, 2-3-4 tree, B Tree, Red Black tree.	
Unit – II	**09 Hrs**
Heaps: Binary, Binomial, Fibonacci, leftist, Skew. **Graph Algorithms**: Bellman - Ford Algorithm, Single source shortest paths in a DAG, Dijkstra's algorithm, Johnson's Algorithm for sparse graphs, Flow networks and Ford- Fulkerson method, Maximum bipartite matching.	
Unit – III	**10 Hrs**
Tries: Ctrie, Radix, Suffix, Ternary search. **String-Matching Algorithms**: Naïve string Matching, Rabin - Karp algorithm, String matching with finite automata, Knuth-Morris-Pratt algorithm, Boyer – Moore algorithms	
Unit – IV	**10 Hrs**
Spatial data partitioning tree: K-d tree, segment tree, Range tree, Interval tree, Priority search tree. **Computational Geometry**: Line segment properties, determining whether any pair of segments intersects, Finding the convex hull, finding the closet pair of points.	
Unit – V	**09 Hrs**
Probabilistic and Randomized Algorithms: Probabilistic algorithms, Randomizing deterministic algorithms, Monte Carlo and Las Vegas algorithms, Probabilistic numeric algorithms.	
Note: The following programs can be executed on Java/C/C++/C# any equivalent tool/language by adapting exception handling technique wherever it is suitable. 1. Design, develop, and write a program to implement insertion, deletion and search operation in a 2-3-4 tree. Determine its performance. 2. Design, develop, and write a program to implement the Dijkstra's algorithm using binomial heap data structure to simulate a priority queue. Determine its performance. 3. Design, develop, and write a program to implement a spell checker using any Trie variant. Determine its performance. 4. Design, develop, and write a program to implement segment tree and determine its performance. 5. Design, develop, and write a program to implement a Monte Carlo algorithm to test the primality of a given integer and determine its performance.	
Course Outcomes: After going through this course the student will be able to: CO1: Understand the implementation, complexity analysis and applications of advanced data structures and algorithms CO2: Evaluate advanced data structures and algorithms with an emphasis on persistence. CO3: Analyze data structure impact on algorithms, program design and program performance. CO4: Design and implement efficient solutions to real world problems.	

Reference Books

	1.	Cormen, Thomas H., Leiserson, Charles E., Rivest, Ronald L. and Clifford Stein – Introduction to algorithms, 3rd Edition, MIT Press, 2009, ISBN-13: 978-0262033848
2.		Mark Allan Weiss, Data Structures and Algorithms Analysis in C++, 4th Edition, Pearson, 2014, ISBN-13: 9780132847377 (Java, 3rd Edition, 2012, ISBN:0-132-57627-9 / 9780132576277)
3.		Aho, Hopcroft and Ullman, Data structures and algorithms, 1st edition, Pearson Education

	India, 2002, ISBN: 8177588265, 9788177588262
4.	Steven S Skiena, The Algorithm Design Manual, Springer, 2008, ISBN: 9781848000704, 9781848000698

Scheme of Continuous Internal Evaluation (CIE)
CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	H	H	-	M	-	-	M	-	M	-	-
CO 2	H	H	L	-	L	L	-	-	-	-	M
CO 3	-	H	H	L	L	-	-	-	-	-	-
CO 4	H	H	H	H	H	M	-	M	H	-	-

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	-	H
CO2	H	M
CO3	H	-
CO4	H	-

Software Architecture and Design						
Course Code	**:**	**16MSE14**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S 4:0:0:0**		**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):
Students shall be able to
1. Comprehend the concepts of Software Architectures in development of Software Applications
2. Apply the process and techniques of Architectures in Software Systems.
3. Analyze the case studies related to Software Architectures.
4. Evaluate Software Architectural styles and patterns for specific Software Domains.

Unit – I	**10**

	Hrs
The Architecture Business Cycle: Where do architectures come from? Software processes and the architecture business cycle, What makes a "good" architecture? What software architecture is and what it is not, Other points of view, Architectural patterns, reference models and reference architectures, Importance of software architecture, Architectural structures and views. Architectural Styles: Architectural styles, Pipes and filters, Data abstraction and object-oriented organization, Event-based, implicit invocation, Layered systems, Repositories, Interpreters, Process control, Other familiar architectures, Heterogeneous architectures.	
Unit – II	**09 Hrs**
Quality: Functionality and architecture, Architecture and quality attributes, System quality attributes, Quality attribute scenarios in practice, Other system quality attributes, Business qualities, Architecture qualities.	
Unit – III	**10 Hrs**
Introducing tactics: Availability tactics, Modifiability tactics, Performance tactics, Security tactics, Testability tactics, Usability tactics, Relationship of tactics to architectural patterns, Architectural patterns and styles. Air Traffic Control- A Case Study in Designing for High Availability.	
Unit – IV	**10 Hrs**
Designing the Architecture: Architecture in the Life Cycle, Designing the Architecture, Forming the team structure, Creating a skeletal system. Flight Simulation – Case Study in Architecture for Integrability.	
Unit – V	**09 Hrs**
Documenting Software Architectures: Uses of architectural documentation, Views, Choosing the relevant views, documenting a view, Documentation across views. Reconstructing Software Architectures: Introduction, Information Extraction, Database Construction, View Fusion, Reconstruction, Example	
Course Outcomes: After going through this course the student will be able to: CO1: Comprehend the basic concepts of Software Architecture. CO2: Select and apply Software Architectures in design and development of Software Systems. CO3: Examine and analyze the case studies related to Software Architectures. CO4: Compare and Evaluate Software Architectural styles and patterns for specific Software Domains.	

Reference Books

	1.	Len Bass, Paul Clements, Rick Kazman: Software Architecture in Practice, Pearson Education Limited, 2015. ISBN-13: 9789332502307
2.		Mary Shaw and David Garlan: Software Architecture- Perspectives on an Emerging Discipline, Pearson Education Limited, 2015. ISBN-13: 9789332551954
3.		Frank Buschmann, Regine Meunier, Hans Rohnert, Peter Sommerlad, Michael Stal: Pattern-Oriented Software Architecture, A System of Patterns, Volume 1, 1st Edition, Wiley India

	Pvt.ltd, 2014. ISBN-13: 9788126516117
4.	E. Gamma, R. Helm, R. Johnson, J. Vlissides, "Design Patterns- Elements of Reusable Object-Oriented Software", 1st Edition, Pearson Education Limited, 2016. ISBN-13: 9789332555402

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	H	L	L	L	L	L	-	M	M	M	L
CO 2	H	M	L	L	L	L	-	M	M	M	L
CO 3	M	M	M	M	M	M	-	M	M	H	M
CO 4	M	M	M	L	M	M	-	M	M	M	M

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	L	L
CO2	L	M
CO3	M	H
CO4	M	M

Advanced Web Programming						
Course Code	**:**	**16MSE151**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S 4 :0 :0 :0**		**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Understand the Implementation of Web Development, using standard programming languages.
2. Demonstrate the knowledge of Accessing Database.
3. Analyze the importance and standard Frameworks.
4. Design the Backend Business Logic.

Unit – I	**10 Hrs**

Introduction to Python: Programming Basics, Operators, Variables, Decision Statements, Functions, Classes and Objects, File Handling.

Unit – II	**09 Hrs**

Database Connectivity Using Python: Working with DBM persistent Dictionaries, Working with Relational Databases: SQL statements, Defining Tables, Setting up a Database, Python database API's: Creating connections, Working with Cursors, Database Transactions, Error Handling.

Unit – III	**10 Hrs**

Python with XML: Introduction to XML, Document Type Definitions, Schemas, HTML with XML, XML Libraries for Python: SAX, DOM. Network Programming: Sending and retrieving E-mail, Socket Programming.

Unit – IV	**10 Hrs**

Introduction to Django: Introduction to Frameworks, MVC Design Pattern, Django Architecture, Basics of Dynamic Web Pages, Template System, Interacting with Databases.

Unit – V	**09 Hrs**

Extended Django Framework: Form Processing, Advanced and Generic Views, Extending Template Engine, Generating Non – HTML Content, Handling Sessions and User Authentications.

Course Outcomes:

After going through this course the student will be able to:

CO1: Illustrate handling of Client Requests from the Web Server.

CO2: Experiment with Database Connectivity and Backend Servers with the help of Frameworks.

CO3: Design Web entities involved in developing web applications.

CO4: Implement Frameworks using emerging technologies.

Reference Books

1. James Payne: Beginning Python, 1st Edition, Wiley India, 2010, ISBN-13: 978-0470414637 ISBN-10: 0470414634
2. Adrian Holobaty, Jacob Kaplan- Moss, The Definitive Guide to Django, 2nd Edition, Apress Publications, 2009, ISBN-13: 978-1430219361, ISBN-10: 143021936X

3.		John Zelle, Python Programming: An Introduction to Computer Science, 2nd Edition, Franklin, Beedle & Associates, 2010, ISBN-13: 860-1200643879, ISBN-10: 1590282418
4.		Wesley J Chun, Core Python Applications Programming , 3rd Edition, Publisher: Prentice Hall, 2012, ISBN-13: 007-6092048114, ISBN-10: 0132678209

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	H	H	H	M	H	-	-	-	H	M	M
CO 2	M	M	-	M	H	-	-	-	H	H	L
CO 3	M	H	M	M	H	L	L	-	H	M	-
CO 4	M	L	H	-	H	M	L	L	H	M	M

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	M	L
CO2	L	-
CO3	-	M
CO4	-	-

Human Computer Interaction						
Course Code	**:**	**16MSE152/16MIT152**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S 4:0:0:0**		**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Demonstrate knowledge of human computer interaction design concepts and related methodologies.
2. Recognize how a computer system may be modified to include human diversity and apply theories and concepts associated with effective work design to real-world application.
3. Improve quality and usability of their design, and will understand the theory behind what they do intuitively and design mock ups and carry out user and expert evaluation of interfaces
4. Conceptualise, design and evaluate interactive products systematically.

Unit – I	**10 Hrs**

Usability of Interactive Systems: Introduction, Usability Measures, Usability Motivations, Universal Usability, Goals for Our Profession.

Guidelines, Principles, and Theories: Introduction, Guidelines, Principles, Theories.

Development Processes: Managing Design Processes: Introduction, Organizational Design to Support Usability, The Four Pillars of Design, Development Methodologies, Ethnographic Observation, Participatory Design, Scenario Development, Social Impact Statement for Early Design Review, Legal Issues.

Unit – II	**09 Hrs**

Evaluating Interface Designs: Introduction, Expert Reviews, Usability Testing and Laboratories, Survey Instruments, Acceptance Tests, Evaluation During Active Use Controlled Psychologically Oriented Experiments.

Interaction Styles, Direct Manipulation and Virtual Environment : Introduction Examples of Direct Manipulation, Discussion of Direct Manipulation, 3D Interfaces Teleoperation, Virtual and Augmented Reality.

Menu Selection, Form Fill-in, and Dialog Boxes : Introduction, Task-Related Menu Organization, Single Menus, Combinations of Multiple Menus, Content Organization Fast Movement through Menus, Data Entry with Menus: Form Fill-in, Dialog Boxes and Alternatives, Audio Menus and Menus for Small Displays

Unit – III	**10 Hrs**

Command and Natural Languages: Introduction, Command-Organization, Functionality, Strategies, and Structure, Naming and Abbreviations, Natural Language in Computing. **Interaction Devices:** Introduction, Keyboards and Keypads, Pointing Devices Speech and Auditory Interfaces, Displays – Small and Large.

Collaboration and Social Media Participation: Introduction, Goals of Collaboration and Participation, Asynchronous Distributed Interfaces: Different Place, Different Time Synchronous Distributed Interfaces: Different Place, Same Time, Face-to-Face Interfaces: Same Place, Same Time.

Unit – IV	10 Hrs
Design Issues, Quality of Service: Introduction, Models of Response Time Impacts Expectations and Attitudes, User Productivity, Variability in Response Time, Frustrating Experiences. **Balancing Function and Fashion**: Introduction, Error Messages, Non anthropomorphic Design, Display Design, Web Page Design, Window Design, Color.	
Unit – V	**09 Hrs**
User Documentation and Online Help: Introduction, Online versus Paper, Documentation, Reading from Paper versus from Displays, Shaping the Content of the Documentation, Accessing the Documentation, Online Tutorials and Animated Demonstrations, Online Communities for User Assistance, The Development Process. **Information Search:** Introduction, Searching in Textual Documents and Database Querying, Multimedia Document Searches, Advanced Filtering and Search Interface. **Information Visualization:** Introduction, Data Type by Task Taxonomy, Challenges for Information Visualization.	
Course Outcomes: After going through this course the student will be able to: CO1: Explain fundamental design & evaluation methodologies of HCI. CO2: Analyse & adopt classic design standards & patterns. CO3: Apply Theories & concepts associated with effective work design for real world application. CO4: demonstrate knowledge of HCI design concepts & related methodologies	

Reference Books

1. Ben Shneiderman and Catherine Plaisant, "Designing the User Interface: Strategies for Effective Human-Computer Interaction", 5th Edition,2014, Pearson Publications, ISBN: 0321537351.
2. Wilbert O Galitz, "The essential guide to user interface design", Wiley, 3rd Ed,2007, ISBN: 978-0-471-27139-0.
3. Alan Dix, Janet Fincay, Gre Goryd, Abowd, Russell Bealg, "Human – Computer Interaction", Pearson 3rd Edition,2004, ISBN 0-13-046109-1.
4. Prece, Rogers, Sharps, "Interaction Design", 3rd Edition,2011, Wiley, ISBN: 978-1-119-02075-2.

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	M	L	-	-	-	-	-	L	-	-	-
CO 2	M	M	M	-	M	-	-	-	-	L	-
CO 3	M	L	L	-	-	-	-	L	H	-	-
CO 4	H	-	-	-	H	-	-	-	-	-	-

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	H
CO2	H	H
CO3	H	L
CO4	M	M

Professional Skill Development						
Course Code	**:**	**16HSS16**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L:T:P:S**	**0:0:4:0**	**Credits**	**:**	**02**

Course Learning Objectives (CLO):

Student will be able to

1. Understand the importance of verbal and written communication
2. Improve qualitative and quantitative problem solving skills
3. Apply critical and logical think process to specific problems
4. Learn to manage stress by applying stress management skills

UNIT 1	**5 hours**

Communication Skills: Basics of Communication, Personal Skills & Presentation Skills, Attitudinal Development, Self Confidence, SWOC analysis.

Resume Writing: Understanding the basic essentials for a resume, Resume writing tips Guidelines for better presentation of facts.

UNIT 2	**6 hours**

Quantitative Aptitude and Data Analysis: Number Systems, Math Vocabulary, fraction decimals, digit places etc. Reasoning and Logical Aptitude, - Introduction to puzzle and games organizing information, parts of an argument, common flaws, arguments and assumptions. Verbal Analogies – introduction to different question types – analogies, sentence completions, sentence corrections, antonyms/synonyms, vocabulary building etc. Reading Comprehension, Problem Solving

UNIT 3	**4 hours**

Interview Skills : Questions asked & how to handle them, Body language in interview, Etiquette, Dress code in interview, Behavioral and technical interviews, Mock interviews - Mock interviews with different Panels. Practice on Stress Interviews, Technical Interviews, General HR interviews

UNIT 4	**5 hours**

Interpersonal and Managerial Skills: Optimal co-existence, cultural sensitivity, gender sensitivity; capability and maturity model, decision making ability and analysis for brain storming; Group discussion and presentation skills;

UNIT 5	**4 hours**

Motivation and Stress Management: Self motivation, group motivation, leadership abilities Stress clauses and stress busters to handle stress and de-stress; professional ethics, values to be practiced, standards and codes to be adopted as professional engineers in the society for various projects**.**

Note: The respective departments should discuss case studies and standards pertaining to their domain

Course Outcome:

After going through this course the student will be able to

CO1: Develop professional skill to suit the industry and life long learning requirements.

CO2: Solve quantitative and reasoning problems with confidence.

CO3: Display leadership and interpersonal working skills in various situations.

CO4**:** Demonstrate verbal communication skills with appropriate body language.

References

1) Stephen R Covey, 'The 7 Habits of Highly Effective People', Free Press, 2004, ISBN: 0743272455

2) Dale Carnegie, 'How to win friends and influence people', General Press, 1st Edition, 2016, ISBN: 9789380914787
3) Kerry Patterson, Joseph Grenny, Ron Mcmillan, 'Crucial Conversation: Tools for Talking When Stakes are High", McGraw-Hill Publication, 2012, ISBN: 9780071772204
4) Ethnus, 'Aptimithra: Best Aptitude Book', Tata McGraw Hill, 2014, ISBN: 9781259058738

Scheme of Continuous Internal Examination (CIE)

Evaluation will be carried out in TWO Phases:

Phase	Activity	Weightage
I	After 5 weeks - Unit 1, 2 & Part of Unit 3	50%
II	After 12 weeks – Unit 3, 4, 5	50%

CIE Evaluation shall be done with weightage as follows:

Writing skills	10%
Logical Thinking	25%
Verbal Communication & Body Language	35%
Leadership and Interpersonal Skills	30%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	M	L	M	L	L	L	L	L	L	L	M
CO 2	L	M	H	L	M	L	L	L	L	M	M
CO 3	M	L	M	M	M	M	H	M	H	M	H
CO 4	H	M	L	H	L	M	L	H	H	L	M

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	L	L
CO2	L	M
CO3	M	H
CO4	M	H

SECOND SEMESTER

Project Management						
Course Code	**:**	**16MEM21P**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L: T: P: S: 3:1:0:0**		**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 hrs**

Course Learning Objectives:

Student are able to

1. Understand the basic principles and components of project management
2. Appreciate the integrated approach to managing projects.
3. Apply the appropriate project management tools and techniques.
4. Prepare project schedules with reports.

Unit – I	10 Hrs

Introduction: Project, Project management, relationships among portfolio management, program management, project management, and organizational project management, relationship between project management, operations management and organizational strategy, business value, role of the project manager, project management body of knowledge.

Unit – II	10Hrs

Generation and Screening of Project Ideas: Generation of ideas, monitoring the environment, corporate appraisal, scouting for project ideas, preliminary screening, project rating index, sources of positive net present value. Project costing,

Project Scope Management: Project scope management, collect requirements define scope, create WBS, validate scope, control scope.

Organizational influences & Project life cycle: Organizational influences on project management, project state holders & governance, project team, project life cycle.

Unit – III	10 Hrs

Project Integration Management: Develop project charter, develop project management plan, direct & manage project work, monitor & control project work, perform integrated change control, close project or phase.

Project Quality management: Plan quality management, perform quality assurance, control quality.

Unit – IV	08Hrs

Project Risk Management: Plan risk management, identify risks, perform qualitative risk analysis, perform quantitative risk analysis, plan risk resources, control risk.

Project Scheduling: Project implementation scheduling, Effective time management, Different scheduling techniques, Resources allocation method, PLM concepts. Project life cycle costing.

Unit-V	10 Hrs

Tools & Techniques of Project Management: Bar (GANTT) chart, bar chart for combined activities, logic diagrams and networks, Project evaluation and review Techniques (PERT) Planning, Computerized project management.

Syllabus includes tutorials for one hour per week:

- Case discussions on project management
- Numerical problems on PERT & CPM
- Computerized project management exercises using M S Project Software

Course Outcomes:

After going through this course the student will be able to:

CO1: Explain the concepts, tools and techniques for managing large projects.
CO2: Analyze various sub processes in the project management frameworks.
CO3: Evaluate risks in projects and economics analysis of project feasibility.
CO4: Develop project plans for various types of organizations.

Reference Books:

1. Project Management Institute, "A Guide to the Project Management Body of Knowledge (PMBOK Guide)", 5th Edition, 2013, ISBN: 978-1-935589-67-9
2. Prasanna Chandra, Project Planning Analysis Selection Financing Implementation & Review, Tata McGraw Hill Publication, 7th Edition, 2010, ISBN 0-07-007793-2.
3. Harold Kerzner, Project Management A System approach to Planning Scheduling & Controlling, John Wiley & Sons Inc., 11th Edition, 2013, ISBN 978-1-118-02227-6.
4. Rory Burke, "Project Management – Planning and Controlling Techniques", John Wiley & Sons, 4th Edition, 2004, ISBN: 9812-53-121-1

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	M	M	M	H	M	M	L	M	H	M	M
CO 2	M	H	M	H	H	M	M	M	H	H	M
CO 3	M	M	M	M	L	M	H	M	H	M	M
CO 4	H	H	H	M	M	M	H	M	M	M	M

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	M	L
CO2	M	M
CO3	L	H
CO4	H	H

Cyber Security and Digital Forensics						
Course Code	**:**	**16MSE22/16MIT22**		**CIE Marks**	**:**	**100+50**
Hrs/Week	**:**	**L:T:P:S 4:0:1:0**		**SEE Marks**	**:**	**100+50**
Credits	**:**	**5**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Comprehend the impact of cybercrime and forensics.
2. Describe the motive and remedial measures for cybercrime, detection and handling
3. Analyze areas affected by cybercrime and identify Legal Perspectives in cyber security
4. Demonstrate and investigate the use of Tools used in cyber forensic

Unit – I	**10 Hrs**

Introduction to Cybercrime: Cybercrime: Definition and Origins of the Word, Cybercrime and Information Security, Who are Cybercriminals?, Classifications of Cybercrimes, Cybercrime: The Legal Perspectives, Cybercrimes: An Indian Perspective, Cybercrime and the Indian ITA 2000, A Global Perspective on Cybercrimes, Cybercrime Era: Survival Mantra for the Netizens. **Cyberoffenses: How Criminals Plan Them**: How Criminals Plan the Attacks, Social Engineering, Cyberstalking, Cybercafe and Cybercrimes, Botnets: The Fuel for Cybercrime, Attack Vector, Cloud Computing.

Unit – II	**09 Hrs**

Cybercrime: Mobile and Wireless Devices: Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for organizations, Organizational Measures for Handling Mobile, Organizational Security Policies and Measures in Mobile Computing Era, Laptops.

Unit – III	**10 Hrs**

Tools and Methods Used in Cybercrime: Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Trojan Horses and Backdoors, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Overflow, Attacks on Wireless Networks. **Phishing and Identity Theft**: Introduction, Phishing, Identity Theft (ID Theft).

Unit – IV	**10 Hrs**

Understanding Computer Forensics: Introduction, Historical Background of Cyberforensics, Digital Forensics Science, The Need for Computer Forensics, Cyberforensics and Digital Evidence, Forensics Analysis of E-Mail, Digital Forensics Life Cycle, Chain of Custody Concept, Network Forensics, Approaching a Computer Forensics Investigation, Setting up a Computer Forensics Laboratory: Understanding the Requirements, Computer Forensics and Steganography,

Relevance of the OSI 7 Layer Model to Computer Forensics, Forensics and Social Networking Sites: The Security/Privacy Threats, Computer Forensics from Compliance Perspective, Challenges in Computer Forensics, Special Tools and Techniques, Forensics Auditing, Antiforensics.

Unit – V	09 Hrs
Introduction to Security Policies and Cyber Laws: Need for An Information Security Policy, Information Security Standards – ISO, Introducing Various Security Policies and Their Review Process, Introduction to Indian Cyber Law, Objective and Scope of the it Act, 2000, Intellectual Property Issues, Overview of Intellectual - Property - Related Legislation in India, Patent, Copyright, Law Related to Semiconductor Layout and Design, Software License.	
Unit – VI (Lab Component)	
Demonstrate the application of any two of the tools under each category to perform: **1. Systems Vulnerability Scanning** Netcat, Socat, Port and Services tools - Datapipe, Fpipe, WinRelay, Network Reconnaissance – Nmap, THC-Amap and System tools. Network Sniffers and Injection tools – Tcpdump and Windump, Wireshark, Ettercap, Hping Kismet **2. Network Defense tools** Firewalls and Packet Filters, Network Address Translation (NAT) and Port Forwarding, , Linux Firewall, Windows Firewall, Snort: Intrusion Detection System **3. Web Application Tools** Scanning for web vulnerabilities tools: Nikto, W3af, HTTP utilities - Curl, OpenSSL and Stunnel, Application Inspection tools – Zed Attack Proxy, Sqlmap. DVWA, Webgoat, Password Cracking and Brute-Force Tools – John the Ripper, L0htcrack, Pwdump, HTC-Hydra **4. Introduction to Cyber Crime Investigation** Password Cracking, Keyloggers and Spyware, Virus and Warms, Trojan and backdoors, Steganography, DOS and DDOS attack, SQL injection, Buffer Overflow, Attack on wireless Networks.	
Course Outcomes: After going through this course the student will be able to: CO1: Interpret the basic concepts of cyber security, cyber law and their roles. CO2: Articulate evidence collection and legal challenges CO3: Discuss tools support for detection of various attacks . CO4: Demonstrate through use of proper tools knowledge on the cyber security, Cybercrime and forensics.	
Reference Books	
1.	SunitBelapure and Nina Godbole, "Cyber Security: Understanding Cyber Crimes, Computer Forensics And Legal Perspectives", Wiley India Pvt Ltd, ISBN: 978-81-265-21791, 2013.
2.	Dr. Surya PrakashTripathi, RitendraGoyal, Praveen Kumar Shukla, KLSI. "Introduction to information security and cyber laws". Dreamtech Press. ISBN: 9789351194736, 2015.
3.	Thomas J. Mowbray, "Cybersecurity: Managing Systems, Conducting Testing, and Investigating Intrusions", Copyright © 2014 by John Wiley & Sons, Inc, ISBN: 978 -1-118 84965 -1
4.	I. A. Dhotre , "Cyber Forensics , Technical Publications; 1st Edition edition (2016), ISBN-13: 978-9333211475

Scheme of Continuous Internal Evaluation (CIE) for Theory
CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Continuous Internal Evaluation (CIE) for Practical
CIE for the practical courses will be based on the performance of the student in the laboratory, every week. The laboratory records will be evaluated for 40 marks. One test will be conducted for 10 marks. The total marks for CIE (Practical) will be for 50 marks.

Scheme of Semester End Examination (SEE) for Theory
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE) for Practical
SEE for the practical courses will be based on conducting the experiments and proper results for 40 marks and 10 marks for viva-voce. The total marks for SEE (Practical) will be 50 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	M	M	-	-	-	-	-	-	H	L	-
CO 2	L	M	-	M	M	-	-	M	M	H	L
CO 3	M	H	-	M	M	M	-	M	H	M	-
CO 4	H	M	H	M	H	L	-	M	H	M	L

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	L	-
CO2	-	M
CO3	L	M
CO4	H	H

Simulation and Modeling						
Course Code	**:**	**16MSE231**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S 4 :0 :0 :0**		**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Classify the types, role and value of formal Modeling and Simulations, and their various characterizations for application to systems.
2. Demonstrate the principles of experimental simulation design and inferential procedure.
3. Distinguish between modeling methods that are suitable for continuous-time, discrete-time, discrete-event, and hybrid systems, and apply these methods to simple systems
4. Develop techniques to model and to simulate various systems

Unit – I	10 Hrs

Introduction :

The notion of system, model, simulation. Types of simulations. Illustrative examples. Conceptual and computer models. Verification and validation of models. Simulation experiment. Simulation project life cycle. Description of simulation models. Structure vs. behaviour models. Classification of tasks solvedwithin the modeling and simulation process. Detailed example introduction: database server as a typical queuing system. Description of discrete-event systems behaviour. Modeling of time. The notion of status, event, activity, process and their interdependencies. Object-oriented model design. Simulation time, control of timeadvancement, event list. Event driven simulation algorithm.Detailed example: implementation of the database server as a queuing system. Random numbers in simulation. Random variables with discrete and continuous probability distribution. Pseudo-random generators. Multiplicative and additive congruential method. Nonuniform random numbers.

Unit – II	09 Hrs

Testing of pseudo-random generators: Monte Carlo method. Precision. Queueing systems. Entities: queues, service facilities, storages. Properties of input and output stream. Kendall classification of queueing systems. Entity behaviour and statistical data sampling during the simulation run. Discrete and continuous Markov model. Birth -Death processes.Steady-state queueing systems of types M/M/1, M/M/? , M/M/m, M/Er/1, Er/M/1 and their variants

Unit – III	10 Hrs

Models: M/G/1, G/M/1, G/M/m, G/G/1, G/D/1, M+D/D/1. Closed systems and queueing networks. Simulation languages for discrete-event systems. Case study and comparison: Simscript, GPSS.

Unit – IV	10 Hrs

Case study and comparison: Object oriented design and implementation of simulation models. Persistence of objects in C++, case studies. Application in a simulation system. Simulation experiments. Preparation and pre-processing of input data. Statistical data collected during the simulation run. Time dependency of statistics. Histograms. Evaluation and interpretation of results. Model validation and verification. Simulation of digital systems. Abstractions levels of digital

system description. Models of signals and functions. Structure vs. behavior. Models of components. Models of delays.

Unit – V	09 Hrs
Digital systems simulators - methods of implementation. Flow of simulation time. Synchronous and asynchronous algorithm of digital systems simulation. Acceleration of simulation run. Register-transfer level simulation. Simulation languages of HDL type. VHDL language and tools. Implementation of concurrent statements and processes in VHDL. Modeling of time and event list.	

Course Outcomes:

After going through this course the student will be able to:

CO1: Demonstrate basic concepts in modeling and simulation

CO2: Construct a model for a given set of data and motivate its validity

CO3: Generate and test random number variates and apply them to develop simulation models

CO4: Analyze output data produced by a model and test validity of the model

Reference Books

	Law, A.M., Kelton, W.D.: Simulation Modeling and Analysis. McGraw-Hill, New York, 5th edition, 2014. ISBN : 978-0073401324
	Jerry Banks , John S. Carson , Barry L. Nelson, David M. Nicol : Discrete-Event System Simulation: Pearson 2010, ISBN : 9780136062127
	John A. Sokolowski, Catherine M. Banks: Modeling and Simulation Fundamentals: Theoretical Underpinnings and Practical Domains, Wiley 2010, ISBN: 978-0-470-48674-0
	Bernard P. Zeigler,Herbert Praehofer,Tag Gon Kim :Theory of Modeling and Simulation, Academic Press, 2000, ISBN : 978-0127784557

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	M	M	M	L	-	-	-	-	-	M	L
CO 2	M	M	M	L	L	-	-	-	M	M	M
CO 3	M	L	L	M	-	-	-	-	-	M	L
CO 4	L	L	L	L	L	-	-	-	-	L	L

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2

CO1	M	M
CO2	L	L
CO3	L	-
CO4	L	-

Computer Systems Performance Analysis						
Course Code	**:**	**16MCE232/16MSE232**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S 4 :0 :0 :0**		**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Identify the need and importance of performance evaluation and its systematic approach.
2. Illustrate different types of workloads, their selection and characterization techniques.
3. Explore various types of monitoring and capacity planning techniques.
4. Formulate experiments with various levels and factors.
5. Demonstrate working of various queues, their representations and rules.

Unit – I	**10 Hrs**

Introduction and Workloads and Workload Selection

The art of Performance Evaluation, Common mistakes in Performance Evaluation, A systematic approach to Performance Evaluation, Selecting an evaluation technique, Selecting performance metrics, Commonly used performance metrics, Utility classification of performance metrics, Setting performance requirements.

Types of workloads, addition instructions, Instruction mixes, Kernels, Synthetic programs, Application benchmarks, Popular benchmarks. Work load selection, Services exercised, Level of detail, Representativeness, Timeliness, other considerations in workload selection.

Unit – II	**10 Hrs**

Workload Characterization, Monitors, Capacity Planning and Benchmarking

Work load characterization techniques, Terminology, Averaging, Specifying dispersion, Single-parameter histograms, Multi-parameter histograms, Principle-component analysis, Markov models, Clustering. Monitors, Terminology and classification, Software and hardware monitors, Software versus hardware monitors, Firmware and hybrid monitors, Distributed system monitors. Program execution monitors and accounting logs, Program execution monitors, Techniques for improving program performance, Accounting logs, Analysis and interpretation of accounting log data, Using accounting logs to answer commonly asked questions.

Steps in capacity planning and management, Problems in capacity planning, Common mistakes in benchmarking, Benchmarking games, Load drivers, Remote-terminal emulation, Components of an RTE, Limitations of RTEs.

Unit – III	**10 Hrs**

Experimental Design and Analysis

Introduction, Terminology, Common mistakes in experiments, types of experimental designs, 2^k Factorial Designs, concepts, Computation of effects, Sign table method for computing effects, Allocation of variance, General 2^k Factorial Designs. General full factorial designs with k factors, Model, Analysis of a general design, Informal methods.

Unit – IV	**10 Hrs**

Queuing Models

Introduction, Queuing notation, Rules for all Queues, Little's law, Types of stochastic processes. Analysis of Single Queue: Birth-Death processes, M / M / 1 Queue, M / M / m Queue, M / M / m / B Queue with finite buffers, Results for other M / M / 1 Queuing Systems.

Unit – V	**10 Hrs**

Queuing Networks: Queuing Networks, Open and closed Queuing Networks, Product form networks, Queuing Network models of Computer Systems. Operational Laws, Utilization law, Forced flow law, Little's law, General response time law, and Interactive response time law, Bottleneck analysis.

Course Outcomes:

After going through this course the student will be able to:

CO1: Explore systematic approach to performance evaluation using suitable metrics and workloads.
CO2: Analyze queuing models and networks.
CO3: Design experiments with various levels and factors.
CO4: Evaluate performance of systems using appropriate techniques and benchmarks

Reference Books

1.	Raj Jain: The Art of Computer Systems Performance Analysis, John Wiley and Sons, 2013. ISBN: 0471503363
2.	Paul J Fortier, Howard E Michel , "Computer Systems Performance Evaluation and prediction, Elsevier, 2003. ISBN: 978-1-55558-260-9
3.	Trivedi K S, Kishor S. Trivedi; Probability and Statistics with Reliability, Queuing and Computer Science Applications; John Wiley; 2nd Edition; 2008. ISBN: 978-0-471-33341-8.
4.	R. Panneerselvam; Research Methodology; Prentice Hall; 2004, ISBN - 9788120324527.

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11

CO1	H	H	L	H	-	L	-	L	-	-	H
CO2	M	M	-	H	-	-	-	L	L	-	M
CO3	M	H	-	H	L	-	-	M	-	-	M
CO4	H	L	-	H	-	-	-	-	-	-	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	L	L
CO2	M	H
CO3	M	-
CO4	L	L

Software Reliability and Fault Tolerant System						
Course Code	**:**	**16MSE241**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S 4:0:0:0**		**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1 Understand the differences between fault, error and failure. Discuss the process by which a fault eventually causes a system failure. Understand the link between fault model and the corresponding dependability mechanisms. Introduction of terms such as fail-safe, fail-operational, fail-stop, etc. Concepts such as fault tree, FMECA, FMEA, etc.

2 HW/System: Calculate reliability of a system. Use of tools for reliability modelling. Design of dependable HW.

3 Middleware: Understand critical functions such as clock synchronisation, consensus, FDIR protocols, etc. Understand Byzantine failures and its impact on system complexity. Introduction to asynchronous message-passing distributed systems.

4 SW: Understand the various methods for SW fault tolerance. NVP, recovery blocks, run-time checks, problem of predicate detection.

Unit – I	**10 Hrs**

Fault Classification, Types of Redundancy, Basic Measures of Fault Tolerance: Traditional and Network ; Failure Rate, Reliability, and Mean Time to Failure, Canonical and Resilient Structures, Reliability Evaluation Techniques, Fault-Tolerance Processor-Level Techniques, Byzantine Failures

Unit – II	**09 Hrs**

Fault Tolerant Design: Basic concepts ,static,(NMR,use of error correcting codes), dynamic, hybrid and self purging redundancy, Sift-out Modular Redundancy (SMR), triple modular redundancy, SMR reconfiguration

Unit – III	**10 Hrs**

Information Redundancy Coding, Resilient Disk Systems, Data Replication, Algorithm-Based Fault Tolerance. Fault-Tolerant Networks Measures of Resilience, Common Network Topologies and their Resilience, Fault-Tolerant Routing

Unit – IV	**10 Hrs**

Software Fault Tolerance Acceptance Tests, Single-Version Fault Tolerance, N-Version Programming, Recovery Block Approach, Preconditions, Postconditions, and Assertions, Exception-Handling, Software Reliability Models, Fault-Tolerance Remote Procedure Call	
Unit – V	**09 Hrs**
Checkpointing What is Checkpointing?, Checkpoint Level, Optimal Checkpointing – An Analytical Model, Cache-Aided Rollback Error Recovery (CARER), Checkpointing in Distributed Systems, Checkpointing in Shared-Memory Systems, Check pointing in Real-Time Systems, Other.Uses of Checkpointing . Fault Detection in Cryptographic Systems Overview of Ciphers, Security Attacks Through Fault Injection, Countermeasures	
Course Outcomes: After going through this course the student will be able to: CO1: Discuss the main concepts and the relationship between defect, fault and error and the main issues of fault modeling and simulation. CO2: Analyze and design fault tolerant system and fault tolerant schemes/ architectures in hardware and software. CO3: Demonstrate the operation of the most popular fault tolerant approaches used in digital systems and computer networks. CO4: Apply the concepts of availability, dependability and reliability in the design of software.	
Reference Books	
	Israel Koren, C. Mani Krishna, "Fault Tolerant Systems", Elsevier/Morgan Kaufmann, 2007, ISBN: 9780120885251
	Hoang Pham, "System Software Reliability", Spirnger 2006, ISBN : 978-1-85233-950-0
	Hassan Noura, Didier Theilliol, Jean-Christophe Ponsart, Abbas Chamseddine "Faulttolerant Control Systems: Design and Practical Applications", Spirnger 2009, ISBN : 978-184882-653-
	Magdi S. Mahmoud, Yuanqing Xia, "Analysis and Synthesis of Fault-Tolerant Control Systems", john wiley & sons, 2014 ,ISBN : 978-1-118-54133-3

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	L	-	-	H	-	-	-	M	M	-	-
CO 2	M	M	-	H	-	-	-	-	-	-	-

CO 3	M	M	-	H	-	-	M	-	-	-	-
CO 4	-	-	M	H	H	-	-	-	-	-	-

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	**PSO2**	**PSO3**
CO1	H	M	-
CO2	M	M	-
CO3	M	M	L
CO4	H	H	L

Metrics and Models in Software Engineering						
Course Code	**:**	**16MSE242**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S 4:0:0:0**		**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Gain basic knowledge about metrics, measurement theory and related terminologies
2. Learn measure the quality level of internal and external attributes of the software product
3. Explore various metrics and models of software reliability
4. Compare various models of software reliability based on its application

Unit – I	**10 Hrs**

The history and evolution of software metrics: Evolution of the software industry and evolution of software measurements – The cost of counting function point metrics – The paradox of reversed productivity for high-Level languages- The Varieties of functional metrics – Variations in application size and productivity rates – Future Technical Developments in Functional Metrics- Software measures and metrics not based on function points

Unit – II	**09 Hrs**

Measuring software quality: Quality control and international competition – Defining quality for measurement and estimation – Five steps to software quality control- Measuring software defect removal- Measuring Defect removal efficiency – Measuring the costs of defect removal – Evaluating defect prevention methods – Measuring customer reported defects- Measuring invalid defects, Duplicate defects and special cases-Reliability Models - The Rayleigh Model- Reliability Growth Models.

Unit – III	**10 Hrs**

Process metrics: In-Process Metrics for Software Testing - Test Progress S Curve - Testing Defect Arrivals Over Time - Product Size Over Time - CPU Utilization - Effort/Outcome Model. Complexity Metrics and Models - Lines of Code - Halstead's Software Science - Cyclomatic Complexity. - Syntactic Constructs - Structure Metrics. Metrics for Object-Oriented Projects - Concepts and Constructs - Design and Complexity Metrics - Lorenz Metrics and Rules of Thumb - CK OO Metrics Suite - Productivity Metrics

Unit – IV	**10 Hrs**

Mechanics of measurement: Software Assessments – Software Baselines – Software Benchmarks- What a Baseline analysis covers – Developing or Acquiring a baseline data collection Instrument – Administering the data collection questionnaire – Analysis and aggregation of the Baseline data. Measuring and Analyzing Customer Satisfaction - Surveys - Data Collection - Sampling Methods - Analyzing Satisfaction Data. Conducting In-Process Quality Assessments - Preparation - Evaluation - Quantitative Data - Qualitative Data - Evaluation Criteria - Overall Assessment

Unit – V	**09 Hrs**

Measurements, metrics and industry leadership: Measures and metrics of industry leaders – Measures, metrics and innovation – Measurements, metrics and outsource litigation – Measurements, metrics and behavioral changes – Commercial software measurement tools. Measuring Process Maturity - Process Capability - Value of Process Improvement - Process Adoption – Process Compliance. Function Point Metrics to Measure Software Process Improvement - Software Process Improvement Sequences.

Course Outcomes:
After going through this course the student will be able to:
CO1: Identify and apply various software metrics, which determines the quality level of software
CO2: Compare and Pick out the right reliability model for evaluating the software
CO3: Evaluate the reliability of any given software product
CO4: Design new metrics and reliability models for evaluating the quality level of the software based on the requirement

Reference Books

1.	Caper Jones, "Applied Software Measurement: Global Analysis of Productivity and Quality" , Third Edition, McGraw Hill Companies, 2008 ISBN : 978-0071502443
2.	Stephen H. Kan, "Metrics and Models in Software Quality Engineering", Addison Wesley, 2011. ISBN : 978-0133988086
3.	Mark Lorenz, Jeff Kidd, "Object-Oriented Software Metrics", Prentice Hall, 2000. ISBN : 9780131792920
4.	Ravindranath Pandian C., "Software Metrics A Guide to planning, Analysis, and Application", Auerbach, First , Indian Reprint, 2011. ISBN : 978-0849316616

Scheme of Continuous Internal Evaluation (CIE)
CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	H	M	L	M	M	-	-	-	M	M	M
CO 2	M	M	M	M	M	-	-	-	M	L	M
CO 3	M	L	-	L	L	-	-	-	M	L	L
CO 4	L	L	-	L	L	-	-	-	L	L	L

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	M	M
CO2	L	L
CO3	M	L

CO4	L	L

Advanced Computer Networks

Course Code	**:**	**16MSE251/16MIT251**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S 4 :0 :0 :0**		**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Understand the basic concepts of Computer Networks.
2. Apply the knowledge of advanced internetworking concepts to problem solving.
3. Evaluate the distributed networks and its security.
4. Design and implement the real world network problems.

Unit – I	**10 Hrs**

Foundation to Networks: Building a Network, Requirements, Perspectives, Scalable Connectivity, Cost-Effective Resource sharing, Support for Common Services, Manageability, Protocol layering, Performance, Bandwidth and Latency, Delay X Bandwidth Product, Perspectives on Connecting, Classes of Links, Reliable Transmission, Stop-and-Wait , Sliding Window, Concurrent Logical Channels.

Unit – II	**09 Hrs**

Advanced Internetworking- I: Switching and Bridging, Datagrams, Virtual Circuit Switching, Source Routing, Bridges and LAN Switches, Basic Internetworking (IP), What is an Internetwork?, Service Model, Global Addresses, Datagram Forwarding in IP, subnetting and classless addressing, Address Translation(ARP), Host Configuration(DHCP), Error Reporting(ICMP), Virtual Networks and Tunnels.

Unit – III	**10 Hrs**

Advanced Internetworking- II: Network as a Graph, Distance Vector(RIP), Link State(OSPF), Metrics, The Global Internet, Routing Areas, Routing among Autonomous systems(BGP), IP Version 6(IPv6), Mobility and Mobile IP.

Unit – IV	**10 Hrs**

Distributed Network Intelligence and Systems: Cooperative Regression-Based Forecasting in Distributed Traffic Networks, A Sensor Data Aggregation System Using Mobile Agents, Underlay-Aware Distributed Service Discovery Architecture with Intelligent Message Routing, Self-Organizing Maps: The Hybrid SOM–NG Algorithm, A Semi-Supervised and Active Learning Method for Alternatives Ranking Functions.

Unit – V	**09 Hrs**

Distributed Network Security: Tackling Intruders in Wireless Mesh Networks, Semi-Supervised Learning BitTorrent Traffic Detection, Applications and Trends in Distributed Enterprises: User Activity Recognition through Software Sensors, Multi-Agent Framework for Distributed Leasing-Based Injection Mould Remanufacturing, The Smart Operating Room: smartOR, State of the Art of Service-Level Agreements in Cloud Computing, Used Products Return Service Based on Ambient Recommender Systems to Promote Sustainable Choices

Course Outcomes: After going through this course the student will be able to: CO1: Classify network services, protocols and architectures, explain why they are layered. CO2: Illustrate the advanced internetworking protocols and their operations. CO3: Apply the concepts of distributed networks and tackle security issues. CO4: Implement & design applications using advanced network concepts.	
Reference Books	
1.	Larry Peterson and Bruce S Davis "Computer Networks: A System Approach", 5th Edition, Elsevier -2014, ISBN-13: 978-0-12-370548-8.
2.	Qurban A. Memon, "Distributed Networks: Intelligence, Security, and Applications", CRC Press, 2013, ISBN: 9781466559578.
3.	Douglas E Comer, "Internetworking with TCP/IP, Principles, Protocols and Architecture" 6th Edition, PHI – 2014, ISBN-10: 0130183806.
4.	Uyless Black "Computer Networks, Protocols, Standards and Interfaces" 2nd Edition - PHI , ISBN-10: 8120310411.

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	H	H	H	H	H	M	-	-	H	-	-
CO 2	H	H	H	H	H	-	-	-	H	-	M
CO 3	H	H	H	H	H	M	-	-	H	H	M
CO 4	H	H	H	H	H	M	M	L	H	M	L

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	-
CO2	M	-
CO3	H	L
CO4	H	M

Distributed Computing						
Course Code	**:**	**16MSE252/16MIT252**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S 4 :0 :0 :0**		**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Understand and remember the basic concepts of distributed system management (DSM).
2. Apply the concepts of load balancing, process management, fault tolerance in DSM.
3. Evaluate and analyze the concepts of distributed file systems through case studies.
4. Implement and design the security concepts in distributed computing systems.

Unit – I	**10 Hrs**

Distributed System management: Introduction, Resource management, Task Assignment Approach, Load-Balancing Approach, Load-Sharing Approach, Process management in a Distributed Environment, Process Migration, Threads, Fault Tolerance.

Unit – II	**09 Hrs**

Distributed Shared Memory: Introduction, Basic Concepts of DSM, Hardware DSM, Design Issue in DSM Systems, Issue in Implementing DSM Systems, Heterogeneous and Other DSM Systems, Case Studies.

Unit – III	**10 Hrs**

Distributed File System: Introduction to DFS, File Models, Distributed File System Design, Semantics of File Sharing, DFS Implementation, File Caching in DFS, Replication in DFS, Case studies.

Naming: Introduction, Desirable features of a good naming system, Basic concepts, System-oriented names, Object-locating mechanisms, Issues in designing human-oriented names, Name caches, Naming and security, Case study: Domain name service.

Unit – IV	**10 Hrs**

Security in distributed systems: Introduction, Cryptography, Secure channels, Accesscontrol, Security Management, Case studies, Developing a Content Distribution System over a Secure Peer-to-Peer Middleware.

Unit – V	**09 Hrs**

Real-Time Distributed Operating Systems: Introduction, Design issues in real-time distributed systems, Real-time communication, Real-time scheduling, Case study: Real-time communication in MARS, Distributed Online Safety Monitor Based on Multi-Agent System and AADL Safety Assessment Model. Emerging Trends in distributed Computing: Introduction to emerging trends, Grid Computing, SOA, Cloud computing, the future of emerging Trends.

Course Outcomes:

After going through this course the student will be able to:

CO1: Understand distributed system and process management.

CO2: Comprehend load balancing, resource management, shared memory and hardware concepts.

CO3: Analyze advantages of DFS and its security issues.

CO4: Apply mechanisms to manage security in Distributed Systems through understanding of real time DoS.	
Reference Books	
1.	Sunitha Mahajan, Seema Shah: Distributing Computing, Published by Oxford University press 2010 ,*ISBN*: 13: 9780198093480.
2.	Qurban A. Memon, "Distributed Networks: Intelligence, Security, and Applications", CRC Press, 2013, ISBN:9781466559578.
3.	George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair, Distributed Systems: Concepts and Design, 5th Edition, 2013, ISBN:13: 978-0132143011.
4.	Carlos A. Varela, Programming Distributed Computing Systems, A Foundational Approach, MIT Press, 2013, ISBN: 9780262018982.

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	H	H	H	M	H	-	-	-	H	-	-
CO 2	H	H	H	H	H	M	-	-	H	-	L
CO 3	H	H	M	H	H	-	-	-	H	M	L
CO 4	H	H	H	H	H	-	-	-	H	M	M

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	L
CO2	H	M
CO3	M	H
CO4	H	L

MINOR PROJECT						
Course Code	**:**	**16MPE26**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**0:0:10:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**05**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students are able to

1) Understand the method of applying engineering knowledge to solve specific problems.
2) Apply engineering and management principles while executing the project
3) Demonstrate the skills for good presentation and technical report writing skills.
4) Identify and solve complex engineering problems using professionally prescribed standards.

GUIDELINES

1. Each project group will consist of maximum of two students.
2. Each student / group has to select a contemporary topic that will use the technical knowledge of their program of study after intensive literature survey.
3. Allocation of the guides preferably in accordance with the expertise of the faculty.
4. The number of projects that a faculty can guide would be limited to four.
5. The minor project would be performed in-house.
6. The implementation of the project must be preferably carried out using the resources available in the department/college.

Course Outcomes: After completion of the course the student will be able to:
CO1: Conceptualize, design and implement solutions for specific problems.
CO2: Communicate the solutions through presentations and technical reports.
CO3: Apply resource managements skills for projects
CO4: Synthesize self-learning, team work and ethics.

Scheme of Continuous Internal Examination (CIE)
Evaluation will be carried out in THREE Phases. The evaluation committee will comprise of FOUR members : guide, two senior faculty members and Head of the Department.

Phase	Activity	Weightage
I	Synopsis submission, Preliminary seminar for the approval of selected topic and Objectives formulation	20%
II	Mid-term seminar to review the progress of the work and documentation	40%
III	Oral presentation, demonstration and submission of project report	40%

****Phase wise rubrics to be prepared by the respective departments**

CIE Evaluation shall be done with weightage / distribution as follows:

- Selection of the topic & formulation of objectives: 10%
- Design and simulation/ algorithm development/experimental setup: 25%
- Conducting experiments / implementation / testing: 25%
- Demonstration & Presentation: 15%
- Report writing: 25%

Scheme for Semester End Evaluation (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightage would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

1. Brief writeup about the project: 5%
2. Presentation / Demonstration of the project: 20%
3. Methodology and Experimental Results & Discussion 25%
4. Report: 20%
5. Viva Voce: 30%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1											
CO 2											
CO 3											
CO 4											

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1		
CO2		
CO3		
CO4		

THIRD SEMISTER

Software Quality Assurance and Testing						
Course Code	**:**	**16MSE31**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S 4-0-1-0**		**SEE Marks**	**:**	**100+50**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Interpret the goals of software testing.
2. Analyze and design various tools which can be used for automating the testing process
3. Apply various concept of software quality standards for establishing quality environment
4. Demonstrate and evaluate the procedures for improving the quality Models

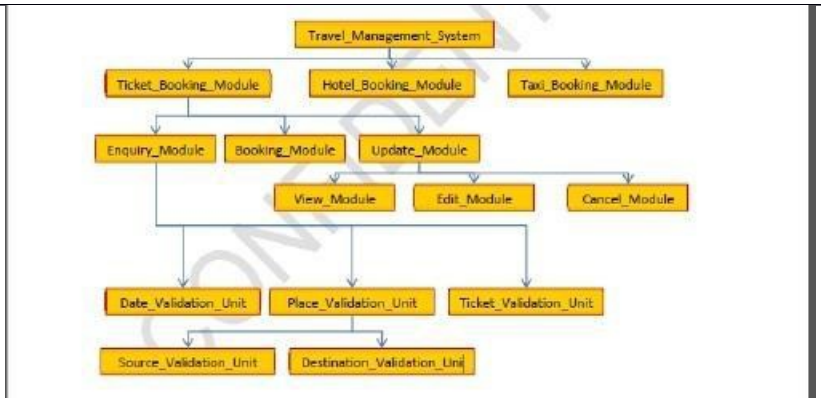
Unit – I	10 Hrs

What Is Software Quality: Quality: Popular Views, Quality Professional Views, Software Quality, Total Quality Management and Summary. Fundamentals Of Measurement Theory: Definition, Operational Definition, And Measurement, Level Of Measurement, Some Basic Measures, Reliability And Validity, Measurement Errors, Be Careful With Correlation, Criteria For Causality, Summary. Software Quality Metrics Overview: Product Quality Metrics, In Process Quality Metrics, Metrics for Software Maintenance, Examples For Metrics Programs, Collecting Software Engineering Data.

Unit – II	09 Hrs

Applying The Seven Basic Quality Tools In Software Development : Ishikawa's Seven Basic Tools, Checklist, Pareo Diagram, Histogram, Run Charts , Scatter Diagram, Control Chart, Cause And Effect Diagram. The Rayleigh Model: Reliability Models, The Rayleigh Model Basic Assumptions, Implementation, Reliability And Predictive Validity.

Unit – III	10 Hrs
Basics of Software Testing and Examples: Basic definitions, Test cases, Insights from a Venn diagram, Identifying test cases, Error and fault taxonomies, Levels of testing. Examples: Generalized pseudocode, The triangle problem, The NextDate function, The commission problem, The SATM (Simple Automatic Teller Machine) problem	
Unit – IV	**10 Hrs**
Decision Table-Based Testing: Decision tables, Test cases for the triangle problem, Test cases for the NextDate function, Test cases for the commission problem, Guidelines and observations. Data Flow Testing: Definition-Use testing, Slice-based testing, Guidelines and observations. Levels of Testing: Traditional view of testing levels, Alternative life-cycle models, The SATM system, Separating integration and system testing. Integration Testing: A closer look at the SATM system, Decomposition-based, call graph-based, Path-based integrations, Case study.	
Unit – V	**09 Hrs**
System Testing: Threads, Basic concepts for requirements specification, Finding threads, Structural strategies and functional strategies for thread testing, SATM test threads, System testing guidelines, ASF (Atomic System Functions) testing example. Interaction Testing: Context of interaction, A taxonomy of interactions, Interaction, composition, and determinism, Client/Server Testing,. Issues in Object-Oriented Testing: Units for object-oriented testing, Implications of composition and encapsulation, inheritance, and polymorphism, Levels of object-oriented testing, GUI testing, Dataflow testing for object-oriented software, Examples. Class Testing: Methods as units, Classes as units.	
Unit – VI (Lab Component)	
Objective To identify the usage of stubs or drivers in the context of an integration testing scenario. **Background** Integration testing is carried out after the completion of unit testing and before the software is delivered for system testing. In top down integration testing, dummy stubs are required for bottom level modules. Similarly in bottom up testing, dummy drivers are required for top level modules. **Problem Description :** Consider the scenario of development of software for Travel, Management System (TMS) is in progress. The TMS software has 3 major modules namely Ticket_Booking_Module, Hotel_Booking_Module and Taxi_Booking_Module. The Ticket_Booking_Module has 3 sub modules namely Enquiry_Module, Booking_Module and Update_Module. The enquiry module uses Date_Validation_Unit, Ticket_Validation_Unit and Place_Validation_Unit.	



In the context of the given scenario, identify the usage of stub or driver for the following situations.
1. Except the Ticket_validation_Unit, the coding and unit testing of all other modules, sub modules and units of TMS are completed. The top-down integration is in progress for the TMS software. To carry out the integration testing, which among the following is necessary?

- A Stub for Ticket_Validation_Unit
- A Driver For Ticket_Validation_Unit
- A Stub for Enquiry_Module
- A Driver for Enquiry_Module
- A Stub For Ticket_Booking_Module
- A Driver For Ticket_Booking_Module

to be started for the TMS software. Mention any stub or driver needed to carry out the integration testing?
3. Except the Taxi_Booking_Module, the coding and unit testing of all other modules, sub modules and units of TMS are completed. The top-down integration is to be started for the TMS software. Mention any stub or driver needed to carry out the integration testing

Program 2

Objective Identify the different types of performance testing

Background Performance testing tests the non-functional requirements of the system.The different types of performance testing are load testing, stress testing, endurance testing and spike testing.

Problem

Identify the type of performance testing for the following:
1. A space craft is expected to function for nearly 8 years in space. The orbit control system of the spacecraft is a real-time embedded system. Before the launch, the embedded software is to be tested to ensure that it is capable of working for 8 years in the space. Identify the suitable performance testing category to be carried out to ensure that the space craft will be functioning for 8 years in the space as required.

2. Global Education Centre (GEC) at Infosys Mysore provides the training for fresh entrants. GEC uses an automated tool for conducting objective type test for the trainees. At a time, a maximum of 2000 trainees are expected to take the test. Before the tool is deployed, testing of the tool was carried out to ensure that it is capable of supporting 2000 simultaneous users. Indicate the performance testing category?

3. A university uses its web based portal for publishing the results of the students. When the results of an examination were announced on the website recently on a pre-planned date, the web site crashed. Which type of performance testing should have been done during web-site development to avoid this

unpleasant situation?

4. During unexpected terrorist attack, one of the popular websites crashed as many people logged into the web-site in a short span of time to know the consequences of terrorist attack and for immediate guidelines from the security personnel. After analyzing the situation, the maintenance team of that website came to know that it was the consequences of unexpected load on the system which had never happened previously testing should be done on the system to ensure that the existing features have not been disturbed.

Performance Testing Type

Problem

Consider the scenario of development of software for Travel

Description

Management System (TMS) discussed in previous assignment. TMS has been developed by Infosys and released to its customer Advance Travel Solutions Ltd. (ATSL). Integration testing, system testing and acceptance testing were carried out before releasing the final build to the customer. However, as per the customer feedback during the first month of usage of the software, some minor changes are required in the Enquiry Module of the TMS. The customer has approached Infosys with the minor changes for upgrading the software. The development team of Infosys has incorporated. Those changes, and delivered the software to testing team to test the upgraded software.

Which among the following statement is true?

1. Since minor changes are there, integration of the Enquiry Module and quick system testing on Enquiry module should be done.
2. The incorporation of minor changes would have introduced new bugs into other modules, so regression testing should be carried out.
3. Since the acceptance testing is already carried out, it is enough if the team performs sanity testing on the Enquire module.
4. No need of testing any module.

Program 4

Objective To classify the given defects into different defect types.

Background Defect detection activities like reviews and testing help in identifying the defects in the artifacts (deliverables). These defects must be classified into various buckets before carrying out the root cause analysis. Following are some the defect Categories.

1. Logical
2. User interface
3. Maintainability
4. Standards

Problem

In the context of the above defect categories, classify the following statements

Description

Under the defect categories and mention in the table given below:

1. Divide by Zero Error is not guarded
2. Usage of 3.14 in the statement Circle_Area = 3.14 * Radius * Radius;

3. 3500 lines of code in a single function
4. A pointer is declared but not initialized. It is used in the program for storing a value.
5. A program designed to handle 1000 simultaneous users, crashed when 1001 the user logged in.
6. A "while" loop never exits
7. User interface displays "MALFUNCTION 54" when something goes wrong in the back-end
8. No documentation (comments) for the source code
9. Hungarian Notation not followed while coding, even though the coding guidelines mandate to use Hungarian Notation
10. Pressing of "Tab" key moves the cursor in different fields of a web form randomly.

Statement	Defect Category	Defect Name
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Program 5
Objective To understand usage of software metrics.
Background There are some metrics which are fundamental and the rest can be derived from these. Examples of basic (fundamental) measures are Size, Effort, Defect, Schedule. If the fundamental measures are known, then we can derive others. For example if size and effort are known, we can get Productivity (=size/effort). If the total numbers of defects are known we can get the Quality (=defect/size) and so on.
Problem Online loan system has two modules for the two basic services, namely Car loan service and House loan service.

Course Outcomes:
After going through this course the student will be able to:
CO1: Explain the basic principles of software quality & apply these concepts to frame test cases.
CO2: design the test cases using the entities of software Quality and assurance.
CO3: Implement the various testing models to develop decision table based test case.
CO4: Evaluate the test cases designed for testing quality software development tools.

Reference Books

1.	Stephen H Khan: Metrics and Models in Software Quality Engineering, Pearson 2nd edition 2013.ISBN: 978-81-203-1136-7
2.	Paul C. Jorgensen: Software Testing, A Craftsman's Approach, 3rd Edition, Auerbach Publications, 2013.ISBN: 9670201785602
3.	Aditya P Mathur: Foundations of Software Testing, Pearson, 2008. ISBN 9780201515602
4.	Mauro Pezze, Michal Young: Software Testing and Analysis – Process, Principles and Techniques, John Wiley & Sons, 2008 ISBN: 978-81-203-1351-4

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)
CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	M	M	L	M	-	-	L	-	M	-	L
CO 2	L	L	-	M	M	L	-	M	L	-	L
CO 3	L	L	M	M	L	L	L	M	M	M	L
CO 4	M	M	L	M	M	M	L	-	-	M	-

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	M	M
CO2	-	L
CO3	L	M
CO4	-	L

Soft Computing						
Course Code	**:**	**16MSE321/16MIT321**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S 4:0:0:0**		**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):
Students shall be able to
1. Design learning algorithms using neural networks.
2. Apply fuzzy logic to solve real world problems.
3. Analyze fuzzy neuro systems
4. Apply genetic algorithm to solve optimization problems

Unit – I	**10 Hrs**

Neural Networks: History, overview of biological Neuro-system, Mathematical Models of Neurons, ANN architecture	
Unit – II	**09 Hrs**
Learning Processes: Learning rules, Learning Paradigms-Supervised, Unsupervised and reinforcement Learning, ANN training Algorithms-perceptions, Training rules, Delta, Back Propagation Algorithm, Multilayer Perceptron Model, Hopfield Networks, Associative Memories, Applications of Artificial Neural Networks.	
Unit – III	**10 Hrs**
Fuzzy Logic: Introduction to Fuzzy Logic, Classical and Fuzzy Sets: Overview of Classical Sets, Membership Function, Fuzzy rule generation.	
Unit – IV	**10 Hrs**
Operations on Fuzzy Sets: Fuzzy Arithmetic, Fuzzy Logic, Uncertainty based Information Complement, Intersections, Unions, Combinations of Operations, Aggregation Operations. Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals & Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations. Classical Logic, Multivalued Logics, Fuzzy Propositions, Fuzzy Qualifiers, Linguistic Hedges. Information & Uncertainty, Non specificity of Fuzzy & Crisp Sets, Fuzziness of Fuzzy Sets.	
Unit – V	**09 Hrs**
Introduction of Neuro-Fuzzy Systems: Architecture of Neuro Fuzzy Networks, Applications of Fuzzy Logic: Medicine, Economics etc. **Genetic Algorithms:** An Overview, Genetic Algorithms in problem solving, Implementation of Genetic Algorithms	
Course Outcomes: After going through this course the student will be able to: CO1: Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems CO2: Analyze genetic algorithms to combinatorial optimization problems CO3: Effectively use existing software tools to solve real problems using a soft computing approach CO4: Evaluate and compare solutions by various soft computing approaches for a given problem.	

	Reference Books	
	1.	Anderson, James a., An Introduction to Neural Networks, ISBN: 978-81-203-1351-4,PHI, 2008
2.		Hertz J. Krogh, R.G. Palmer - Introduction to the Theory of Neural Computation, Addison-Wesley, 1991, ISBN: 9780201515602
3.		G.J. Klir& B. Yuan - Fuzzy Sets & Fuzzy Logic, PHI, 2006, ISBN: 978-81-203-1136-7
4.		Melanie Mitchell - An Introduction to Genetic Algorithm, PHI, 2006 ISBN: 9670201785602

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	L	-	-	H	-	-	-	M	M	-	-
CO 2	M	M	-	H	-	-	-	-	-	-	-
CO 3	M	M	-	H	-	-	M	-	-	-	-
CO 4	-	-	M	H	H	-	-	-	-	-	-

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	M
CO2	M	M
CO3	H	M
CO4	H	H

Social Network Analysis						
Course Code	**:**	**16MSE322/16MIT322**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S 4 :0 :0 :0**		**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. List basic principles behind network analysis algorithms
2. Acquire essential knowledge of network analysis
3. Apply real world data with examples from today's most popular social networks.
4. Plan and execute network analytical computations

Unit – I	**10 Hrs**

Introduction to Social Network Analysis: Introduction to new science of networks. Networks examples. Graph theory basics. **Descriptive Network Analysis**: Statistical network properties. Degree distribution, clustering coefficient. Frequent patterns. Network motifs. Cliques and k-cores.

Unit – II	**09 Hrs**

Network structure: Nodes and edges, network diameter and average path length. **Node centralities and ranking on network:** Node centrality metrics: degree, closeness and betweenness centrality. Eigenvector centrality and PageRank. Algorithm HITS.

Unit – III	**10 Hrs**

Network communities: Networks communities. Graph partitioning and cut metrics. Edge betweenness. Modularity clustering. **Affiliation networks:** Affiliation network and bipartite graphs. 1-mode projections. Recommendation systems.

Unit – IV	**10 Hrs**

Information and influence propagation on networks: Social Diffusion. Basic cascade model. Influence maximization. Most influential nodes in network. **Network visualization**: Network visualization and graph layouts. Graph sampling. Low -dimensional projections

Unit – V	**09 Hrs**

Social media mining: FB/VK and Twitter analysis: Natural language processing and sentiment mining. **SNA in real world: FK/VK and Twitter Analysis:** Properties of large social networks: friends, connections, likes, re-tweets

Course Outcomes:
After going through this course the student will be able to:
CO1: Comprehend basic notation and terminology used in network science
CO2: Visualize, summarize and compare different network elements
CO3: Analyze real world network
CO4: Evaluate the performance of network communities and social media mining

Reference Books

1. Albert-Laszlo Barabasi. "Linked. The New Science of Networks", Edition- 2014, ISBN-13: 978-0738206677
2. Robert Knell, Introductory R: A Beginner's Guide to Data Visualization, Statistical Analysis and Programming in R ,Kindle Edition, ISBN: 0957597118
3. Robert Kabacoff. "R in action. Data Analysis and graphics with R", Manning Publications, 2011, ISBN-13: 978-1935182399
4. Eric Kolaczyk, Gabor Csardi. "Statistical Analysis of Network Data with R (Use R!)". Springer, 2014, ISBN-13: 978-1493909827

Scheme of Continuous Internal Evaluation (CIE)
CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	H	M	H	-	M	M	-	M	M	M	M
CO 2	H	H	H	H	H	M	M	M	H	-	M
CO 3	M	H	H	H	H	H	M	H	M	H	M
CO 4	H	H	H	H	H	M	-	H	H	M	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	M	L
CO2	H	M
CO3	H	L

CO4	H	H

IOT and Cloud Computing						
Course Code	**:**	**16MSE331/16MIT331**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S 4 :0 :0 :0**		**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Interpret the fundamentals of Internet of Things.
2. Analyze and design a small low cost embedded system using Arduino / Raspberry Pi or equivalent boards.
3. Apply the concept of Internet of Things in the real world scenario
4. Demonstrate the application of cloud technologies to the world of IoT

Unit – I	**10 Hrs**

Fundamentals of IoT: Introduction-Characteristics-Physical design - Protocols – Logical design – Enabling technologies – IoT Levels – Domain Specific IoTs – IoTvs M2M

Unit – II	**09 Hrs**

IoT Design Methodology: IoT systems management – IoT Design Methodology – Specifications Integration and Application Development.

Unit – III	**10 Hrs**

IoT Physical Devices & Endpoints: What is an IoT Device , Basic building blocks of an IoT Device Exemplary Device: Raspberry Pi- About the Board Linux on Raspberry Pi Raspberry Pi Interfaces -Serial SPI , I2C, Programming Raspberry Pi with Python , Controlling LED with Raspberry Pi, Interfacing an LED and Switch with Raspberry Pi , Interfacing a Light Sensor (LDR) with Raspberry Pi Other IoT Devices -BeagleBone Black.

Unit – IV	**10 Hrs**

IoT Physical Servers & Cloud Offerings: Designing a RESTful Web API , Amazon Web Services for IoT-Amazon EC2 , Amazon AutoScaling, Amazon S3 , Amazon RDS , Amazon DynamoDB , Amazon Kinesis, Amazon SQS , Amazon EMR, SkyNetIoT Messaging Platform **.**

Unit – V	**09 Hrs**

Case Studies- IoT Design and Cloud incorporation: Introduction to IOT Design, Home Automation, Smart Lighting , Home Intrusion Detection, Cities , Smart Parking , Environment , Weather Monitoring System , Weather Reporting Bot , Air Pollution Monitoring , Forest Fire Detection, Agriculture, Smart Irrigation, Productivity Applications , IoT Printer.

Course Outcomes:

After going through this course the student will be able to:

CO1: Interpret the essentials of IOT

CO2: Design a portable IoT using Arduino/ equivalent boards using relevant protocols

CO3: Describe the concept of web services to access/control IoT devices

CO4: Identify physical devices required to deploy an IoT application and connect to the cloud for real time scenarios.

Reference Books	
1.	Arshdeep Bahga, Vijay Madisetti, "Internet of Things – A hands-on approach", Universities Press, 2015, ISBN: 978-81-7371-954-7.
2.	Rajkumar Buyya , James Broberg, Andrzej Goscinski: Cloud Computing Principles and Paradigms, Willey 2014.
3.	Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective" ,CRC Press 2013, ISBN : 978-1-4398-9299-2.
4.	Soyata, Tolga, "Enabling Real-Time Mobile Cloud Computing through Emerging Technologies", IGI Global, 2015, ISBN: 978-1-4666-8662-5.

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	M	-	M	-	-	-	-	-	H	-	-
CO 2	H	M	L	H	H	M	-	M	H	L	M
CO 3	L	M	-	M	M	L	-	-	H	M	M
CO 4	H	L	M	M	H	H	-	M	H	H	M

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	-	L
CO2	H	L
CO3	L	M
CO4	H	M

Big Data Analytics						
Course Code	**:**	**16MSE332/16MIT332**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S 4 :0 :0 :0**		**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Understand big data for business intelligence.
2. Identify business case studies for big data analytics.
3. Defend big data Without SQL.
4. Discuss the process of data analytics using Hadoop and related tools.

Unit – I	10 Hrs

Understanding Big Data: Characteristics of Data, Introduction to Big Data and its importance, Evolution of Big Data, Challenges posed by Big Data, Big data analytics and its classification, Big data applications: big data and healthcare – big data in medicine – advertising and big data, big data technologies.

Unit – II	09 Hrs

Hadoop Distributed File System: Hadoop Ecosystem, Hadoop Architecture, Analyzing data with Hadoop, HDFS Concepts, Blocks, Namenodes and Datanodes, Hadoop FileSystems, The Java Interface, Reading Data from a Hadoop URL, Reading Data Using the FileSystem API, Writing Data, Directories, Querying the FileSystem, Deleting Data, Anatomy of File Read and Write

Unit – III	10 Hrs

Hadoop Distributed File System: Hadoop Ecosystem, Hadoop Architecture, Analyzing data with Hadoop, HDFS Concepts, Blocks, Namenodes and Datanodes, Hadoop FileSystems, The Java Interface, Reading Data from a Hadoop URL, Reading Data Using the FileSystem API, Writing Data, Directories, Querying the FileSystem, Deleting Data, Anatomy of File Read and Write.

Unit – IV	10 Hrs

NOSQL Data Management: Introduction to NOSQL – aggregate data models , aggregates key-value and document data models, relationships – graph databases, schema less databases , materialized views , distribution models , sharding - version – map reduce – partitioning and combining – composing map-reduce calculations.

Unit – V	09 Hrs

MapReduce and Yarn: Hadoop MapReduce paradigm, Map and Reduce tasks, Job and Task trackers, Writing a Unit Test with MRUnit, Mapper, Reducer, MapReduce workflows – unit tests with MRUnit – test data and local tests – anatomy of MapReduce job run – classic Map-reduce – YARN – failures in classic Map-reduce and YARN – job scheduling – shuffle and sort – task execution – MapReduce types – input formats – output formats

Course Outcomes:

After going through this course the student will be able to:

CO1: Demonstrate big data and use cases from selected business domains.

CO2: Apply the knowledge of NoSQL big data management and experiment with Install, configure, and run Hadoop and HDFS.

CO3: Analyze map-reduce analytics using Hadoop.

CO4: Adapt Hadoop related tools such as HBase, Cassandra, Pig, and Hive for big data Analytics.	
Reference Books	
1.	Tom White, "Hadoop: The Definitive Guide", Third Edition, O'Reilly, 2012, ISBN -13: 978-1449311520, ISBN-10: 1449311520
2.	Eric Sammer, "Hadoop Operations", O'Reilly, 2012, ISBN -13 978-1449327057, ISBN-10: 1449327052
3.	Vignesh Prajapati, Big data analytics with R and Hadoop, 2013, ISBN -13: 978-1782163282
4.	E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilly, 2012, ISBN -13: 978-1449319335

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	H	H	H	H	H	M	M	-	H	L	L
CO 2	-	M	H	M	H	M	M	-	H	H	L
CO 3	M	H	M	M	H	M	L	L	H	M	M
CO 4	M	M	H	M	H	M	-	-	H	-	M

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	L	L
CO2	M	-
CO3	-	M
CO4	M	L

Enterprise Application Programming						
Course Code	**:**	**16MSE341**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S 4:0:0:0**		**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):
Students shall be able to

1. Comprehend the metrics in Web Application Development and related terminologies
2. Apply the knowledge of frameworks and Enterprise Application Development Tools
3. Analyze the Web frameworks.
4. Develop EA solutions using Design Patterns

Unit – I	**10 Hrs**

Web application and java EE 6: Exploring the HTTP Protocol, Introducing web applications, describing web containers, exploring web architecture models, exploring the MVC architecture. Working with servlets 3.0Exploring the features of java servlet, Exploring new features in servlet 3.0, Exploring the servlet API, explaining the servlet life cycle, creating a sample servlet, creating a servlet by using annotation, working with servlet config and servlet context objects, working with the Http servlet request and Http Httpservlet response interfaces, Exploring request delegation and request scope, implementing servlet collaboration.

Unit – II	**09 Hrs**

Handling sessions in servlet 3.0: Describing a session, introducing session tracking, Exploring the session tracking, mechanisms, using the java servlet API for session tracking, creating login application using session tracking. Implementing event handling Introducing events, Introducing event handling, working with the servlet events, developing the online shop web application. Working with java server pages: Introducing JSP technology, Exploring new features of JSP2.1, listing advantages of JSP over java servlet, Exploring the architecture of a JSP page, Describing the life cycle of a JSP page, working with JSP basic tags and implicit objects, working with the action tags in JSP, exploring the JSP unified EL, using functions with EL.

Unit – III	**10 Hrs**

Implementing JSP tag extensions: Exploring the elements of tag extensions, Working with classic tag handlers, Exploring the tag extensions, Working with simple tag handlers. Implementing java server pages standard tag library 1.2: Introducing JSTL, Exploring the tag libraries JSTL, working with the core tag library. Implementing filters: Exploring the need of filters, exploring the working of filters, exploring filters API, configuring a filter, creating a web application using filters, using initializing parameter in filters.

Unit – IV	**10 Hrs**

Persistence Management and Design Patterns: Implementing java persistence using hibernate Introducing hibernate, exploring the architecture of hibernate, downloading hibernate, exploring HQL, understanding hibernate O/R mapping, working with hibernate, Implementing O/R mapping

with hibernate. Java EE design patterns: Describing the java EE application architecture, Introducing a design patterns, discussing the role of design patterns, exploring types of patterns.	
Unit – V	**09 Hrs**
Web Frameworks: Working with struts 2 Introducing struts 2, understanding actions in struts 2.Working with java server faces 2.0: Introducing JSF, Explaining the features of JSF, Exploring the JSF architecture, describing JSF elements, Exploring the JSF request processing life cycle. Working with spring 3.0: Introducing features of the spring framework, exploring the spring framework architecture, exploring dependency injection & inversion of control, exploring AOP with spring, managing transactions. Securing java EE 6 applications: Introducing security in java EE 6, exploring security mechanisms, implementing security on an application server.	
Course Outcomes: After going through this course the student will be able to: CO1: Comprehend WEB basics and their functionalities. CO2: Apply JAVA support and API skills for Enterprise Application Development. CO3: Analyze WEB application frameworks. CO4: Manage deployment configurations and implement Security mechanisms	
Reference Books	
1.	Kogent learning solution, Java Server Programming Java Ee7 J2ee 1.7, Dreamtech press, 2015. ISBN-13: 9789351194170
2.	Cary E. Umrysh, Khawar Zaman Ahmed, Developing Enterprise Java Applications With J2EE(TM) And UML - Best Practices And Design Strategies, Addison-Wesley Professional, ISBN-13: 9780201738292
3.	John Brock Arun Gupta, Greertan Wielenga, Java Ee & Html5 Enterprise Application Development, Tata Mcgraw Hill Publishing Co Ltd, 2015-06. ISBN-13: 9789339222321
4.	Gerald Gierer ," Enterprise Application Development with Ext JS and Spring ", Packt Publishing 2013 ISBN-13: 97823401738292

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	M	L	L	L	M	M	L	M	H	L	L
CO 2	H	M	M	L	H	H	L	H	H	M	M
CO	M	H	M	M	H	H	L	H	H	H	M

3											
CO 4	H	H	H	H	H	H	M	H	H	H	M

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	L	L
CO2	M	M
CO3	H	M
CO4	H	H

Agile Methodologies						
Course Code	**:**	**16MSE342**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S 4 :0 :0 :0**		**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Comprehend an iterative, incremental development process leads to faster delivery of more useful software.
2. Apply the principles and practices of extreme programming.
3. Analyze the essence of agile development methods.
4. Develop prototyping in the software process.

Unit – I	**10 Hrs**

The Agile Movement - A Five Minute Primer, What is Agile Development? The Agile Methodologies Agile Values, Agile Practices, Agile Principles

Agile Characteristics-The Characteristics of an Agile Project, The Development Team Project Management, The Customer, Processes and Tools The Contract, What Projects Can Benefit from Agile Development?

Unit – II	**09 Hrs**

The Agile Methodologies: Common Themes, Methodology Descriptions, Extreme Programming, Scrum, Feature Driven Development, The Crystal Methodologies, Adaptive Software Development, Dynamic Systems Development Method, Lean Software Development, Starting Monday: Investigate Further

Selecting an Approach that Fits: Choosing between an Agile or Traditional Approach, Selecting the Right Agile Approach

Unit – III	**10 Hrs**

Going Agile: Is the Team Ready? Announcing the Team's Intention to Go Agile, Encountering, Addressing and Overcoming Resistance, Start with the Bare Minimum, Altering the Project Environment, Iteration Zero, Discontinue a Process Once its Served its Purpose, False Agile, Practitioners and Projects, Starting Monday: Measuring The Team's Progress.

Unit – IV	**10**

	Hrs
Agile Practices: Getting Started, Agile Practices Explained, Selecting the Next Practice, Rejecting a Practice, Adopt Practices before Tools Learn Programming Practices in Pairs, Agile Practices in this Book Agile Practices Explained, Why these Practices were Chosen	
Unit – V	**09 Hrs**
Testing : An Agile Approach to Testing, The Good Enough Approach Testing as the Best Defense, Sharing a Code Base with another Project Team, Sharing Common Components with another Project Team, Depending upon Code or Components Produced by Another Project Team	
Course Outcomes: After going through this course the student will be able to: CO1: Comprehend the common characteristics of an agile development process. CO2: Identify and contrast state of the practice agile methodologies. CO3: Analyze and contrast agile software development process models and plan driven process models. CO4: Determine software project characteristics that would be suitable for an agile process	
Reference Books	
1	Ken Schwaber And Mike Beedle, Agile Software Development With Scrum, Pearson Education, 2015. ISBN-13: 9780132074896
2	Peter Schuh, Integrating Agile Development In The Real World (Charles River Media Programming), 2004 Cengage Learning, ISBN-13: 9781584503644
3	Alistair Cockburn, Agile Software Development: The Cooperative Game, Pearson Education, 2015. ISBN-13: 9780321482754
4	Mike Cohn, Succeeding With Agile : Software Development Using Scrum, Pearson Education Limited, 2016, ISBN-13: 9789332547964

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	H	L	-	L	-	H	H	M	H	-	M
CO 2	H	H	M	M	L	-	-	-	H	L	M
CO 3	M	H	H	M	L	M	-	H	H	-	-

CO 4	H	H	H	L	M	M	L	M	M	L	M

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	M	H
CO2	M	H
CO3	H	L
CO4	M	M