R.V.COLLEGE OF ENGINEERING

(Autonomous Institution Affiliated to VTU, Belagavi)

R.V. Vidyaniketan Post, Mysore Road

Bengaluru – 560 059

Bachelor of Engineering (B.E)

Scheme and Syllabus for V & VI Semesters

2016 SCHEME

INDUSTRIAL ENGINEERING AND MANAGEMENT

VISION

Imparting innovation and value based education in Industrial Engineering and Management for steering organizations to global standards with an emphasis on sustainable and inclusive development.

MISSION

- To impart scientific knowledge, engineering and managerial skills for driving organizations to global excellence.
- To promote a culture of training, consultancy, research and entrepreneurship interventions among the students.
- To institute collaborative academic and research exchange programs with national and globally renowned academia, industries and other organizations.
- To establish and nurture centers of excellence in the niche areas of Industrial and Systems Engineering.

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

PEO1. Conceive, design, implement and operate integrated systems, focus on appropriate measures of performance at strategic, tactical and operational levels.
PEO2. Develop competency to adapt to changing roles for achieving organizational excellence.
PEO3. Design and develop sustainable technologies and solutions for betterment of society.
PEO4. Pursue entrepreneurial venture with a focus on creativity and innovation for developing newer products, processes and systems.

PROGRAM SPECIFIC OUTCOMES (PSO)

PSO	Description
PSO1	Design, develop, implement and improve integrated systems that include people, materials, information, equipment and energy.
PSO2	Apply statistical and simulation tools, optimization and meta heuristics techniques for analysis of various systems leading to better decision making.
PSO3	Demonstrate the engineering relationships between the management tasks of planning, organization, leadership, control, and the human element in various sectors of economy.

Lead Society: Institute of Industrial Engineers (IIE)

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2016 SCHEME

INDUSTRIAL ENGINEERING AND MANAGEMENT

Abbreviations

SL. NO.	ABBREVIATION	MEANING
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	CS	Computer Science and Engineering
5.	CV	Civil Engineering
6.	CHY	Chemistry
7.	EC	Electronics and Communication Engineering
8.	EE	Electrical and Electronics Engineering
9.	ES	Engineering Science
10.	HSS	Humanities and Social Sciences
11.	ME	Mechanical Engineering
12.	PHY	Engineering Physics
13.	SEE	Semester End Examination
14.	MAT	Engineering Mathematics
15.	PCE	Professional Core Elective
16.	GE	Global Elective

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R V College of Engineering, Bengaluru-560 059
(Autonomous Institution Affiliated to VTU, Belagavi)
Department of Industrial Engineering and Management

FIFTH SEMESTER CREDIT SCHEME								
Sl. No.	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				
				L	**T**	**P**	**S**	**Total Credits**
1.	16HEM51	Foundations of Management & Economics	HSS	2	0	0	0	2
2.	16IM52	Industrial Ergonomics	IEM	3	0	1	0	4
3.	16IM53	Quality and Reliability Engineering	IEM	3	1	0	0	4
4.	16IM54	Simulation Modelling and Analysis	IEM	3	0	0	1	4
5.	16IM55	Operations Management	IEM	3	0	1	0	4
6.	16IM5AX	Elective A (PCE)	IEM	3	0	0	1	4
7.	16G5BXX	Elective B (OE)	Respective BoS	4	0	0	0	4
Total number of Credits								**26**
Total Number of Hours / Week				**21**	**2**	**4**	**8****	

SIXTH SEMESTER CREDIT SCHEME								
Sl. No.	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				
				L	**T**	**P**	**S**	**Total Credits**
1.	16HSI61	Intellectual Property Rights & Entrepreneurship	HSS	3	0	0	0	3
2.	16IM62	Enterprise Information Systems	IEM	3	0	0	1	4
3.	16IM63	Facilities Planning and Design	IEM	3	0	1	0	4
4.	16IM64	Supply Chain & Logistics Management	IEM	3	0	1	0	4
5.	16IM6CX	Elective C (PCE)	IEM	3	0	0	1	4
6.	16IM6DX	Elective D (PCE)	IEM	4	0	0	0	4
7.	16G6EXX	Elective E (OE)	Respective BOS	3	0	0	0	3
8.	16HS68	Professional Practice-III (Employability Skills and Professional Development of Engineers)	HSS	0	0	0	0	1
Total number of Credits								**27**
Total Number of Hours / Week				**22**	**0**	**4**	**8****	

**Non contact hours

V SEMESTER FOUNDATIONS OF MANAGEMENT AND ECONOMICS (Theory) (Common to BT, CHE, CV, E&I, IEM, ME)		
Course Code: 16HEM51		**CIE Marks: 50**
Credits: L:T:P:S: 2:0:0:0		**SEE Marks: 50**
Hours: 23L		**SEE Duration: 02Hrs**

Course Learning Objectives: The students will be able to	
1	Understand the evolution of management thought.
2	Acquire knowledge of the functions of Management.
3	Gain basic knowledge of essentials of Micro economics and Macroeconomics.
4	Understand the concepts of macroeconomics relevant to different organizational contexts.

UNIT-I	
Introduction to Management: Management Functions, Roles & Skills, Management History – Classical Approach: Scientific Management & Administrative Theory, Quantitative Approach: Operations Research, Behavioural Approach: Hawthorne Studies, Contemporary Approach: Systems & Contingency Theory.	**04 Hrs**
UNIT-II	
Foundations of Planning: Types of Goals & Plans, Approaches to Setting Goals & Plans, Strategic Management Process, Corporate & Competitive Strategies.	**02 Hrs**
Organizational Structure & Design: Overview of Designing Organizational Structure: Work Specialization, Departmentalization, Chain of Command, Span of Control, Centralization & Decentralization, Formalization, Mechanistic & Organic Structures.	**03 Hrs**
UNIT-III	
Motivating Employees: Early Theories of Motivation: Maslow's Hierarchy of Needs Theory, McGregor's Theory X & Theory Y, Herzberg's Two Factor Theory, Contemporary Theories of Motivation: Adam's Equity & Vroom's Expectancy Theory.	**03 Hrs**
Managers as Leaders: Behavioural Theories: Ohio State & University of Michigan Studies, Blake & Mouton's Managerial Grid, Contingency Theories of Leadership: Hersey & Blanchard's Situational Leadership, Contemporary Views of Leadership: Transactional & Transformational Leadership.	**03 Hrs**
UNIT-IV	
Introduction to Economics: Concept of Economy and its working, basic problems of an Economy, Market mechanism to solve economic problems, Government and the economy, **Essentials of Micro Economics:** Concept and scope, tools of Microeconomics, themes of microeconomics, Decisions: some central themes, Markets: Some central themes, Uses of Microeconomics.	**04 Hrs**
UNIT-V	
Essentials of Macroeconomics: Prices and inflation, Exchange rate, Gross domestic product(GDP) , components of GDP, the Labour Market, Money and banks, Interest rate, Macroeconomic models- an overview, Growth theory, The classical model, Keynesian cross model, IS-LM-model, The AS-AD-model, The complete Keynesian model, The neo-classical synthesis, Exchange rate determination and the Mundell-Fleming model	**04 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1:	Explain the principles of management theory & recognize the characteristics of an organization.
CO2:	Demonstrate the importance of key performance areas in strategic management and design appropriate organizational structures and possess an ability to conceive various organizational dynamics.
CO3:	Select & Implement the right leadership practices in organizations that would enable systems orientation.
CO4:	Understand the basic concepts and principles of Micro economics and Macroeconomics

Reference Books	
1.	Management, Stephen Robbins, Mary Coulter & Neharika Vohra, 10th Edition, 2001, Pearson Education Publications, ISBN: 978-81-317-2720-1.
2.	Management, James Stoner, Edward Freeman & Daniel Gilbert Jr, 6th Edition, 1999, PHI, ISBN: 81-203-0981-2.
3.	Microeconomics, Douglas Bernheim B & Michael D Whinston, 5th Edition, 2009, TMH Pub. Co. Ltd, ISBN: 13:978-0-07-008056-0.
4.	Macroeconomics: Theory and Policy, Dwivedi.D.N, 3rd Edition, 2010, McGraw Hill Education; ISBN-13: 978-0070091450.
5.	Essentials of Macroeconomics, (www.bookboon.com), Peter Jochumzen, 1st Edition. 2010, e-book, ISBN:978-87-7681-558-5.

Continuous Internal Evaluation (CIE); Theory (50 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 05 marks adding up to 15 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 25 marks each and the sum of the marks scored from three tests is reduced to 30. The marks component for Assignment is 05. The total marks of CIE are 50.

Semester End Evaluation (SEE); Theory (50 Marks)

SEE for 50 marks are executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 10 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 08 marks adding up to 40 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1											
CO2	1		2	2			1			2	2	
CO3	1							2	2	2	1	
CO4	1	2				2						2

Low-1 Medium-2 High-3

V Semester		
INDUSTRIAL ERGONOMICS (Theory & Practice)		
Course Code: 16IM52		**CIE Marks: 100+50**
Credits: L:T:P:S: 3:0:1:0		**SEE Marks: 100+50**
Hours: 33L		**SEE Duration: 03 + 03 Hrs**

Course Learning Objectives: The students will be able to	
1	Define the scope of ergonomics in work system design for productivity improvement.
2	Express the role of cognitive ergonomics in problem solving and decision making.
3	Compile basic anthropometric data for designing the man-machine systems for various applications.

UNIT-I	
Introduction: Description of human-machine systems, ergonomics and its area of application in the work system, history of ergonomics, modern ergonomics. **Anatomy, Posture, and Mechanics:** Basic body mechanics, aspects of muscle functions, anatomy of the spine and pelvis related to posture, musculoskeletal problems in sitting and standing postures, behavioral aspects of posture.	**07 Hrs**
UNIT-II	
Anthropometric Principles in Workspace and Equipment Design: Anthropometry and its use, types of anthropometric data, principles of applied anthropometry in ergonomics, application of anthropometry in product design, case studies.	**07 Hrs**
UNIT-III	
Workspace Design: Contribution of ergonomics to work station design, ergonomic approach to work station design, work surface design, visual display terminals, case studies.	**07 Hrs**
UNIT-IV	
Cognitive Ergonomics: Problem solving and decision-making, cognitive control of systems, Modelling of human operator control strategy, user models of interactive systems, the human operator as a decision maker, improving human decision making and problem solving.	**06 Hrs**
UNIT-V	
Environment: Measurement and Design. Hearing, Sound, Noise, and Vibration. **Work Organization and Work System Design:** Design of human-machine system, the systems approach, work organization, motivation and job satisfaction, sociotechnical systems theory, trends in work system design, legislative trends: standards, guidelines, intervention programs and NPC guidelines on work organization and work system design.	**06 Hrs**

Assignment:
Case study, Design and Emerging Technologies to be discussed pertaining to the course.

INDUSTRIAL ERGONOMICS LABORATORY
• Experiments on fatigue measurement using bio-medical parameter. • Experiments on Measurement of anthropometric data. • Experiments on evaluation workstation. • Experiments on Measurement of local muscle activity using EMG. • Experiments on virtual evaluation workstation.

Course Outcomes: After completing the course, the students will be able to	
CO1.	Explain and apply the ergonomic concepts in the evaluation of existing systems and design of new systems.
CO2.	Demonstrate an understanding of concepts of ergonomics and human body mechanics.

CO3.	Analyze the relationship between work attributes and ergonomic risk factors.
CO4.	Evaluate the effect of ergonomic risk factors on the physiological and bio-mechanical mechanisms of human worker.

Reference Books	
1.	Introduction to Ergonomics, R S Bridger, 3rd Edition, 2008, CRC Press, ISBN: 9780849373060.
2.	Human Factors in Engineering and Design; Mark S. Sanders and Ernest J McCormick; 7th Edition, McGraw-Hill and Co. Singapore 1992. ISBN 0-07-112826-3.
3.	Handbook of Human Factors and Ergonomics, Gavriel. Salvendy, 3rd Edition, 2006, Wiley, Hoboken, New Jersey, USA, ISBN: 0471116904.
4.	Introduction to Human Factors Engineering, Christopher D. Wickens, John D. Lee, Yili Liu, Sallie Gordon-Becker, 2nd Edition, 2003, Pearson Publication, ISBN: 978-0131837362

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Laboratory- 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 40 marks. At the end of the semester a test is conducted for 10 marks. Total marks for the laboratory is 50.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

CO-PO Mapping												
CO / PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1				1						
CO2	2	1				1						
CO3	1	2	1									
CO4		2		1								

Low-1 Medium-2 High-3

V Semester		
QUALITY AND RELIABILITY ENGINEERING (Theory)		
Course Code: 16IM53		**CIE Marks: 100**
Credits: L:T:P:S: 3: 1: 0: 0		**SEE Marks: 100**
Hours: 33L + 24T		**SEE Duration: 03 Hrs**
Course Learning Objectives: The students will be able to		
1	Explain basics of quality control and quality improvement.	
2	Construct control charts for variables and attributes to monitor processes, and interpret the charts.	
3	Perform process homogenization & process harmonization, & to estimate capability of various processes.	
4	Develop strategies for conducting design of experiments in process improvements	
5	Perform Reliability evaluation of Mechanical, Electrical, Electronics and Software Technology Systems.	

UNIT-I	
Introduction: Dimensions of Quality, Statistical Methods for Quality, Quality costs. Quality assurance, ISO 9000, 14000 standards. **Statistical Process Control:** Chance and assignable causes of variation. Statistical basis of control charts, Basic principles of control charts, choice of control limits, sample size and sampling frequency, rational sub groups, statistical basis of control charts. Analysis of patterns of control charts.	**06 Hrs**
UNIT-II	
Control Charts for Variable and Attribute Data: Controls charts for mean and Range, Control charts for mean and standard deviation. Brief discussion on – Pre control, Control charts for individual measurements, Moving-range charts, Sloping control charts, Group control charts. Controls chart for fraction non- conforming (p, np, 100p charts), Control chart for non-conformities (c and u charts). **Process capability** – methods of estimating process capability, Process capability indices- c_p and c_{pk},	**06 Hrs**
UNIT-III	
Acceptance Sampling: Concept of acceptance sampling, economics of inspection, Acceptance sampling plans – Single, Double and Multiple Sampling. Operating Characteristic curves – construction and use. Determination of Average Outgoing Quality (AOQ), Average Outgoing Quality Level, Average Total Inspection, Production Risk and Consumer Risk, Published Sampling Plans.	**07 Hrs**
UNIT-IV	
Experimental Design for Process Improvement: General model of a process, Examples of designed experiments in process improvement, Principles of experimentation, Guidelines for designing experiments, Completely randomized designs (CRD), Randomized block designs (RBD), Factorial experiments – 2^2 design.	**07 Hrs**
UNIT-V	
Reliability And Life Testing: Failure models of components, definition of reliability, MTBF, Failure rate, common failure rate curve, types of failure, reliability evaluation in simple cases of exponential failures in series, parallel and series-parallel device configurations.	**07 Hrs**

Assignments: Case study, Design and Emerging Technologies to be discussed pertaining to the course, along with usage of softwares for Experimental design and Statistical Quality Control.

Course Outcomes: After completing the course, the students will be able to	
CO1.	Explain the DMAIC process and fundamentals of quality control and improvement.
CO2.	Apply modern statistical methods for process quality control and improvement.
CO3.	Examine the data and draw inference about the process.
CO4.	Evaluate processes and select statistical tools and techniques for quality control and improvement.

Reference Books	
1.	"Statistical Quality Control : A Modern Introduction", D C Montgomery, 6th Edition, 2009, John Wiley and Sons, ISBN 978-81-265-2506-5.
2.	"Statistical Quality Control", Grant and Leavenworth, 7th Edition, 2008, McGraw Hill, ISBN – 0-07-043555-3.
3.	An Introduction to Reliability and Maintainability Engineering, Charles E. Ebeling, 1st Edition, 1997, McGraw-Hill International Editions, ISBN0070188521
4.	Quality Planning & Analysis, Joseph M. Juran; Gryna, Frank M., Jr., 3rd Edition, 2009, Tata McGraw Hill, ISBN – 9780070331839.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3				2	2	1				1	
CO2		2	1	1								
CO3												
CO4		2	2	3								

Low-1 Medium-2 High-3

V Semester		
SIMULATION MODELLING & ANALYSIS (Theory)		
Course Code: 16IM54		**CIE Marks: 100**
Credits:L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 34L		**SEE Duration:03 + 03 Hrs**

Course Learning Objectives: The students will be able to	
1	Define the basics of simulation modelling and replicating the practical situations in organizations
2	Generate random numbers and random variates using different techniques.
3	Develop simulation model using heuristic methods.
4	Analysis of Simulation models using input analyzer, and output analyzer
5	Explain Verification and Validation of simulation model.

UNIT-I	
Introduction to Simulation: Simulation, Advantages, Disadvantages, Areas of application, System environment, components of a system, Model of a system, types of models, steps in a simulation study. **Simulation Examples:** Simulation of Queuing systems, Simulation of Inventory System, Other simulation examples.	**07 Hrs**
UNIT-II	
Analysis of Simulation Data **Input Modelling**: Data collection, Identification and distribution with data, parameter estimation, Goodness of fit tests, Selection of input models without data, Multivariate and time series analysis. **Random Numbers:** Properties, Generations methods, Tests for Random number-Frequency test, Runs test, Autocorrelation test.	**08 Hrs**
UNIT-III	
Random Variate Generation: Inversion transforms technique-exponential distribution. Uniform distribution, weibull distribution, continuous distribution, generating approximate normal variates – Erlang distribution. **Empirical Discrete Distribution:** Discrete uniform –distribution, poisson distribution – -acceptance –rejection technique for Poisson distribution, gamma distribution.	**07 Hrs**
UNIT-IV	
Optimisation Via Simulation: Meaning, difficulty, Robust Heuristics, Random Search. **Verification and Validation of Model –** Model Building, Verification, Calibration and Validation of Models.	**06 Hrs**
UNIT-V	
Output Analysis – Types of Simulations with Respect to Output Analysis, Stochastic Nature of output data, Measures of Performance and their estimation, Output analysis of terminating simulation, Output analysis of steady state simulations. **Simulation Software:** Selection of Simulation Software, Simulation packages, Trend in Simulation Software.	**06 Hrs**

Experiential Learning:
Case study, Design and Emerging Technologies to be discussed pertaining to the course. Students will use simulation software such as Arena, Promodel, Excel, Palisade, Matlab
1 Credit: 4 Hrs / Week

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe the role of important elements of discrete event simulation and modeling paradigm
CO2	Conceptualize real world situations related to systems development decisions, originating

	from source requirements and goals
CO3	Develop skills to apply simulation to construct and execute goal-driven system models
CO4	Interpret the model and apply the results to resolve critical issues in a real world environment

Reference Books	
1.	Discrete Event System Simulation, Jerry Banks, John S Carson, II, Berry L Nelson, David M Nicol, 4th Edition, 2007, Pearson Education, Asia, ISBN: 81-203-2832-9.
2.	Simulation Modelling & Analysis, Averill M Law, W David Kelton, 5th Edition, 2014, McGraw Hill International Editions – Industrial Engineering series, ISBN: 978-0073401324.
3.	Systems Simulation with Digital Computer, Narsingh Deo, 3rd Edition, 2004, PHI Publication (EEE), ISBN : 0-87692-028-8.
4.	Discrete-Event Simulation: Modeling, Programming, and Analysis, George S. Fishman, 1st Edition, 2013, Springer Science & Business Media, ISBN :1475735529, 9781475735529

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Self-Study(S). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Self-study is 20. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2		3	2	2				1			1
CO2		2								1		1
CO3	2			2	2			1				
CO4		2		1	2				1			

Low-1 Medium-2 High-3

V Semester		
OPERATIONS MANAGEMENT (Theory & Practice)		
Course Code: 16IM55		**CIE Marks: 100 + 50**
Credits: L:T:P:S: 3:0:1:0		**SEE Marks: 100 + 50**
Hours: 33L		**SEE Duration: 03 + 03 Hrs**
Course Learning Objectives: The students will be able to		
1	Apply the various methods of forecasting.	
2	Define capacity and utilization and their relationship to financial performance measures.	
3	Define the key performance measures to consider the need for the schedule.	
4	Design of Conversion process systems in manufacturing and service organizations.	
5	Illustrate the role of operations, and their interaction with the other activities of a firm: finance, marketing, organization, corporate governance, etc.	

UNIT-I	
Using operations to create value: Role of operations in an organization, a process view, a supply chain view, operations strategy, competitive priorities and capabilities, addressing the trends and challenges in operations management, decision making models	**07 Hrs**
UNIT-II	
Process strategy and analysis: process structure in services, process structure in manufacturing, process strategy decisions, strategic fit, strategies for change, documenting and evaluating the process, redesigning and managing process improvements	**07 Hrs**
UNIT-III	
Planning capacity: Planning long term capacity, planning timing and sizing strategies, a systematic approach to long term capacity decisions, tools for capacity planning, waiting line models. **Managing process constraints:** the theory of constraints, managing bottlenecks in service and manufacturing processes, applying the theory of constraints to product mix decisions, managing constraints in line processes	**07 Hrs**
UNIT-IV	
Forecasting Demand: managing demand, key decisions on making forecasts, forecast error, judgment methods, causal methods: linear regression, time series, forecasting as a process **Managing Inventories:** inventory tradeoffs, types of inventory, inventory reduction tactics, ABC Analysis, economic order quantity, continuous review system, modeling review system, special inventory models	**06 Hrs**
UNIT-V	
Planning and Scheduling Operations: levels in operations planning and scheduling, S&OP supply options, S&OP strategies, scheduling. **Efficient resource planning:** Material requirements planning, master production scheduling, MRP explosion, enterprise resource planning, resource planning for service providers.	**06 Hrs**

Assignment:
Case study, Design and Emerging Technologies to be discussed pertaining to the course.

OPERATIONS MANAGEMENT LABORATORY Part – I
Features of Ofbiz, Creation of sales order from E-commerce website
Preparation of Bill of Materials
MRP Run- Generating of Various reports for confirmed orders
Carrying out business process cycles – Purchase

Creating Production Run for the items
Simulation of Production/Service Operations using Simulation software

Part – II
Features of Sixth Sense ERP Package.
Sales Order Processing using Sales and Marketing Management Modules
Creating Item Master for various Engineering Designs
Preparation of Bill of Materials
Generating Purchase Order and carrying out Purchase Flows.
Development of an integrated ERP module for a product

Course Outcomes: After completing the course, the students will be able to	
CO1.	Explain the concept and scope of operations management in a business context
CO2.	Recognize the role of Operations management among various business functions and its role in the organizations' strategic planning and gaining competitive advantage.
CO3.	Analyze the appropriateness and applicability of a range of operations management systems/models in decision making.
CO4.	Assess a range of strategies for improving the efficiency and effectiveness of organizational operations.
CO5.	Evaluate a selection of frameworks used in the design and delivery of operations

Reference Books	
1.	Operations Management – Processes and Supply Chain,Lee J Karjewski and Larry P Ritzman, Manoj Malhotra, 11th Edition, 2010, Pearson Education Asia, ISBN: 0133872467, 9780133872460
2.	Production and Operations Management, R. Paneerselvam, 2nd Edition, 2006, PHI, ISBN:81-203-2767-5
3.	Operations Management – Theory and Practice, B. Mahadevan, 2nd Edition, 2010, PHI, ISBN: 978 8131730706
4.	Productions & Operations Management, Adam & Ebert, 5th Edition, 2002, Prentice Hall, ISBN – 013718008-X.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Laboratory- 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 40 marks. At the end of the semester a test is conducted for 10 marks. Total marks for the laboratory is 50.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

CO-PO Mapping												
CO/ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2											
CO2		3										
CO3			3	2	2							1
CO4		1	2			1						
CO5		3	3		2							

Low-1 Medium-2 High-3

V Semester		
ADVANCED MANUFACTURING PROCESSES (Group A : Professional Core Elective)		
Course Code: 16IM5A1		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 35L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	Explain range of current industrial processes and practices used to manufacture products in high and low volumes.
2	Apply the factors that control the rate of production and influence the quality, cost and flexibility of processes.
3	Demonstrate the working principle of various manufacturing methods

UNIT-I	
Mechanical Machining Processes : Abrasive Jet Machining (AJM), Ultrasonic Machining (USM), Abrasive Finishing Processes – Abrasive Flow Finishing (AFF), Magnetic Abrasive Finishing (MAF), Water Jet Machining (WJM), Abrasive Water Jet Machining (AWJM).	**06 Hrs**
UNIT-II	
Thermoelectric Machining Processes : Electric Discharge Machining (EDM), Electric Discharge Grinding and Electric Discharge Diamond Grinding, Wire Electric Discharge Machining, Laser Beam Machining (LBM), Plasma Arc Machining (PAM), Electron Beam Machining (EBM).	**08 Hrs**
UNIT-III	
Electrochemical and Chemical Manufacturing Processes :Electrochemical Machining (ECM), Electromechanical Grinding (ECG), Electrochemical Drilling (ECD), Electrochemical Deburring (ECDe), Chemical Machining (ChM)	**08 Hrs**
UNIT-IV	
High Velocity Forming Processes: Explosive forming processes, Propellant forming, Electro-Hydraulic forming, Electromagnetic forming, Pneumatic / Mechanical forming. Micro-Machining: Classification of Micromachining, Various Micromachining Processes- Abrasive micro machining, Ultrasonic micro machining, Micro EDM, Micro ECM, Laser Micromachining.	**07 Hrs**
UNIT-V	
MEMS (Micro Electro Mechanical Systems)- Development and need of MEMS, overview of MEMS technology with relevant non conventional processes. Nano materials, Nano tubes and Nano wires, Nanofabrication.	**06 Hrs**

Self Study:
Case study, Design and Emerging Technologies to be discussed pertaining to the course. 1 Credit: 4 Hrs / Week

Course Outcomes: After completing the course, the students will be able to	
CO1.	Explain the trends in development of both traditional and nontraditional manufacturing methods.
CO2.	Make relevant process selections in the areas of Metal forming, metal cutting and non-traditional manufacturing methods in a product life cycle development.
CO3.	Describe the specific process characteristics of various advanced manufacturing technologies and identify their possible applications.
CO4.	Analyse and evaluate the benefits of advanced manufacturing processes and discuss their limitations.

Reference Books	
1.	Advanced Machining Processes, V.K.Jain, 1st Edition, 2007, Allied Publishers Pvt. Limited, ISBN: 8177642944
2.	Modern Machining Process, Pandey P C and Shah H S, 1st Edition, 2007, TMH Publication, ISBN – 9780070965539
3.	Micromachining of Engineering Materials, Joseph McGeough, Marcel Dekker, 1st Edition, 2001, ISBN-10: 0849327857.
4.	Fundamental of Modern Manufacturing: Materials, Processes and Systems, Mikell P.Groover, 2nd Edition, 2002, Willey India, ISBN-10 81-265-1266-0

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Self-Study(S). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Self-study is 20. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2											
CO2	2	2		1	1							
CO3							1	1				
CO4	2		3		L							

Low-1 Medium-2 High-3

V Semester		
Elective - A **METHODOLOGIES FOR QUALITY IMPROVEMENT** **(Group A : Professional Core Elective)**		
Course Code: 16IM5A2		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 33L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	Develop an understanding on the necessary information and skills needed to manage, control and improve quality practices in the organizations through TQM philosophy.
2	Explain the four revolutions in management thought processes.
3	Apply the reactive and proactive improvement methodologies for problem solving in organizations.
4	Demonstrate the importance of team work in problem solving processes.
5	Evaluate the business excellence models implemented in various organizations.

UNIT-I	
Quality Pioneers: Deming's approach, Juran's quality trilogy, Crosby and quality treatment, Imai's Kaizen, Ishikawa's company-wide quality control, and Feigenbaum's theory of TQC. **Evolution of Quality Concepts and Methods:** Quality concepts, Development of four fitness's, evolution of methodology, evolution of company integration.	**07 Hrs**
UNIT-II	
Four Revolutions in Management thinking, Focus on customers: Change in work concept, market-in, and customers. **Continuous Improvement:** Improvement as problem solving process: Management by process, WV model of continuous improvement. **Reactive Improvement**: Identifying the problem, standard steps, seven steps case study, General guidelines for managers diagnosing a QI story. **Proactive Improvement:** Introduction to proactive improvement, standard steps for proactive improvement, semantics, Seven Management and Planning Tools.	**06 Hrs**
UNIT-III	
Total Participation; Teamwork skill, Dual function of work, teams and teamwork, principles for activating teamwork, creativity in team processes, Initiation strategies **Hoshin Management**: Definition, Concepts, Phases in Hoshin Management – overview. **Societal Networking:** Networking and societal diffusion, infrastructure for networking. TQM as learning system, a TQM model for skill development.	**07 Hrs**
UNIT-IV	
Introduction to Six Sigma: Benefits, fundamentals, myths, essentials and costs of Six Sigma. Assessing readiness for Six Sigma, five key players, Planning for the Six Sigma initiative. Case discussions. **Statistical Foundation:** Variation & causes, normal distribution, process capability, rolled throughput yield, Cost of poor quality. **Metrics for Six Sigma:** The critical-to-quality concept, criteria to metrics, universal standard, baselines, benchmarking, guidelines for metrics.	**07 Hrs**
UNIT-V	
Project Selection: Project selection process, evaluating projects. Project selection matrix, project review. DMAIC phases. **Design for Six Sigma:** Overview of DFSS, DMADV Method. **Beyond Six sigma:** Supply chain management using Lean and Six Sigma, Knowledge management and Six Sigma, Growth Management System – building blocks and architecture.	**06 Hrs**

Self Study: Case study, Design and Emerging Technologies to be discussed pertaining to the course.
1 Credit: 4 Hrs / Week

Course Outcomes: After completing the course, the students will be able to	
CO1.	Explain the TQM & Six Sigma principles and concepts for organizations
CO2.	Compare TQM and Six Sigma methodologies.
CO3.	Evaluate and select the appropriate framework for continuous improvement.
CO4.	Design & implement TQM & Six Sigma projects in organizational situations.

Reference Books	
1.	A New American TQM – Four Practical Revolutions in Management, Shoji Shiba, Alan Graham and David Walden, 2nd Edition, 1993, Productivity Press, Portland (USA), ISBN: 9781563270321
2.	Six Sigma, Greg Brue and Rod Howes, 1st Edition, 2006, TATA McGraw- Hill Edition, ISBN: 0-07-063468-8
3.	Managing for Total Quality: from Deming to Taguchi and SPC, N Logothetis , 1st Edition, 1993, Prentice Hall of India, ISBN: 0135535123
4.	Total Quality Management, Dale H. Besterfield, Carol Besterfield-Michna, Glen Besterfield, Mary Besterfield – Sacre, 3rd Edition, 2002, Pearson Education, ISBN-81-297-0260-6.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2				2		3	2	1	
CO2	2	3	2				2		2	2	1	
CO3		3	2				2		2	2	1	
CO4	2	3	2				2		2	2	1	

Low-1 Medium-2 High-3

V Semester		
ADVANCED OPERATIONS RESEARCH (Group A : Professional Core Elective)		
Course Code: 16IM5A3		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 34L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	Develop the skills in the application of advanced constructs of operations research models for complex decision making situations.
2	Implement the advanced methodology and tools of operations research to assist decision-making.

UNIT-I	
Linear Programming: Two phase simplex techniques, revised simplex techniques, Sensitivity analysis, Integer Programming, Gomory's techniques, branch & Bound technique – two variables only, solutions of Assignment and Travelling salesman problems using Branch and Bound Approach.	**07 Hrs**
UNIT-II	
Goal Programming: Introduction and simple formulation. **Non-Linear Programming:** Kuhn – Tucker conditions, Quadratic Programming-Wolfe's Method, Convex Programming.	**07 Hrs**
UNIT-III	
Dynamic Programming: Characteristics and Dynamic Programming model, Computational procedure (no problem solving, only formulation). **Network Optimization Models:** The Shortest-Path Problem, The Minimum Spanning Tree Problem, The Maximum Flow Problem, The Minimum Cost Flow Problem.	**07 Hrs**
UNIT-IV	
Queuing Theory: Prototype, Basic Structure, Real Queuing systems, Role of Exponential distribution, Birth-Death Process, Models, Non exponential distributions, Priority discipline queuing model, queuing networks.	**06 Hrs**
UNIT-V	
Markov Chains: Discrete Stochastic Process, Markovian process, Stationary Markov chains, Markov diagrams, Ergodic and Absorbing Markov chains, Steady State probabilities, stochastic matrix, transition, matrix and their applications.	**07 Hrs**

Self Study:
Case study, Design and Emerging Technologies to be discussed pertaining to the course, along with usage of optimization softwares such as GAMS, Matlab, Excel. 1 Credit: 4 Hrs / Week

Course Outcomes: After completing the course, the students will be able to	
CO1.	Incorporate a range of ideas concerning Statistics and Operational Research including methods appropriate in specialized applications.
CO2.	Analyze and interpret information in a manner that can be communicated effectively to non-specialists.
CO3.	Carry out analyses of complex data sets, design experiments & analyze practical OR problems using computer programmes and/or packages

Reference Books	
1.	Operation Research, Taha H A, 9th Edition, 2014, Macmillan, ISBN – 978-93-325-1822-3.
2.	Operations Research: Principles and Practice, Ravindran, Phillips and Solberg, 2nd Edition, 2007, Wiley International, ISBN – 8126512563.
3.	Introduction to Operation Research, Hiller, Leiberman, 8th Edition, 2004, Mc Graw Hill Publication, ISBN – 0073017795.
4.	Operation Research Methods and Problems, M N Sasieni, A. Yaspan and L. Friedman, 1st Edition, 2013, Literary Licensing, LLC, ISBN: 978-1258819453.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Self-Study(S). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Self-study is 20. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1				1						
CO2	2	1				1						
CO3	1	2	1									

Low-1 Medium-2 High-3

V Semester		
MARKETING MANAGEMENT & RESEARCH (Group A : Professional Core Elective)		
Course Code: 16IM5A4		**CIE Marks: 100**
Credits:L:T:P:S: 3: 0: 0:1		**SEE Marks: 100**
Hours: 33L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	To understand and analyze the opportunities and challenges of marketing in a global market.
2	To develop an effective marketing strategy, and marketing plan, using holistic marketing orientation.
3	To understand the need and importance of marketing research to maintain the competitive edge.
4	To analyze the effectiveness of modern modes of delivering value to customers.

UNIT-I	
Understanding Marketing Management-Challenges in Defining Marketing Management for 21st Century: The Importance of Marketing, the Scope of Marketing, Core Marketing Concepts, The New Marketing Realities, Company Orientation Toward the Market Place, Updating the Four Ps, Marketing Management Tasks, Importance of Digital Marketing.	**06 Hrs**
UNIT-II	
Developing Marketing Strategies and Plans: Marketing and Customer Value, The Holistic Marketing Orientation, Corporate and Division Strategic Planning, Business Unit Strategic Planning, Product Planning-The Nature and Contents of a Marketing Plan, The Role of Research in marketing, The Role of Relationships from Marketing Plan to Marketing.	**07 Hrs**
UNIT-III	
Assessing the Marketing Opportunities and Conducting Marketing Research: Components of Modern Marketing Information System, Marketing Intelligence, Analyzing the Microenvironment, The Market Research System, Marketing Research Process, Researching Rural Markets-Overcoming Barriers to Use of Marketing Research.	**07 Hrs**
UNIT-IV	
Measurement Techniques in Marketing Research: Concept of measurement in Marketing Research, Questionnaire Design, Direct Response Attitude Scales and Measure of Emotions, Derived Attitude Scales-Conjoint Analysis, Perceptual Mapping, Qualitative Research, Observation and Physiological Measures, Case studies.	**07 Hrs**
UNIT-V	
Managing Retailing, Wholesaling, And Market Logistics: Retailing- Types of Retailers, Private Labels-Role of Private Labels, Private-Label Success Factor, Wholesaling- Trends in Wholesaling, Marketing Logistics- Integrated Logistics Systems, Marketing-Logistics Objectives and Decisions, Organizational Lessons.	**06 Hrs**

Self Study:
Case study, Design and Emerging Technologies to be discussed pertaining to the course. 1 Credit: 4 Hrs / Week

Course Outcomes: After completing the course, the students will be able to	
CO1.	Differentiate the benefits drawn by updated marketing mix from traditional marketing mix for effective marketing management there by to stay competitive in today's global market-place.
CO2.	Develop an effective holistic marketing atmosphere to efficiently face the challenges in dynamically changing market.
CO3.	Formulate a potential marketing plan to effectively reach the targeted market segments, by delivering the value to targeted customers through practicing sound marketing research.

CO4.	Create new channels to improvise marketing to achieve and maintain competitive position in globalized market-place.

Reference Books	
1.	Marketing Management- A South Asian Perspective, Philip Kotler,Kevin Lane Keller, Abrahan Koshy, Mithileshwar Jha, 14th Edition, 2013, Pearson, ISBN –978-81-317-6716-0
2.	Marketing Research, Donald S Tull, Del I Hawkins, 6th Edition, 1995, Prentice Hall India, ISBN: 8120309618
3.	Marketing Management, Philip Kotler, Kevin Lane Keller, 15 Edition, e-book – 2015 (Kindle Edition), ASIN: B07C9BDWSM.
4.	Marketing Research, Aaker, Kumar, Day, 9th Edition, 2007, Wiley India, ISBN: 978-265-1791-6

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	3	2	3	2				2	2		
CO2	2	3		3		1	1	2		2		
CO3		2	2	3	3	1		1			1	
CO4			1			1	2					

Low-1 Medium-2 High-3

V Semester		
SOFTWARE ENGINEERING & TESTING (Group A : Professional Core Elective)		
Course Code: 16IM5A5		**CIE Marks: 100**
Credits:L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 33L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	Understand the software development tasks and different approaches to software development
2	Define and analyze information-gathering techniques to document the requirements for an information system solution.
3	Solve the software testing issues through test case designs and test bed design.
4	Design and develop project plans, and understand how to organize, direct, and control a project for software development or implementation.

UNIT-I	
Introduction: Software development, software process models, Agile software development, Requirements engineering.	**06 Hrs**
UNIT-II	
System Modelling-Context models, Interaction models, Structural models, Architectural design decisions, Application architectures.	**08 Hrs**
UNIT-III	
Software testing-Development test cases, Test-driven development, Release testing, User testing, Availability and reliability	**08 Hrs**
UNIT-IV	
Advanced Software Engineering-Software reuse, The reuse landscape, Client–server computing, Architectural patterns for distributed systems.	**06 Hrs**
UNIT-V	
Software Management- Project management, Project planning, Quality management Configuration management	**05 Hrs**

Self Study:
Case study, Design and Emerging Technologies to be discussed pertaining to the course. 1 Credit: 4 Hrs / Week

Course Outcomes: After completing the course, the students will be able to	
CO1.	Understand the body of knowledge relating to Software Engineering and maintenance, the principles of large scale software systems, and the processes that are used to build them.
CO2.	Demonstrate the ability to manage a project including planning, scheduling and risk assessment/management
CO3.	Execute specific software tests with well-defined objectives and targets
CO4.	Apply various testing techniques, including domain, code, fault, usage and model-based.
CO5.	Create an integrated facilities plan for various applications.

Reference Books	
1.	Software Engineering, Ian Sommerville 9th Edition, 2009, Pearson Includes index.ISBN-13: 978-0-13-703515-1,ISBN-10: 0-13-703515-2,QA76.758.S657
2.	Software Engineering Handbook, Jessica Keyes, 1st Edition, 2003, Auerbach Publications, (CRC Press), ISBN: 0-8493-1749-8
3.	Software Engineering: A Practioner's Approach, Roger S. Pressman, 6th Edition, 2005, International Edition). McGraw-Hill, ISBN 0–07–337597–7
4.	Hans van Vliet. Software Engineering: Principles and Practice (Second Edition). Wiley, 1999 ISBN-10: 047003146

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2					1						
CO2			2				2			1	2	
CO3		3	2		2		1			2	2	
CO4			3	2	2			1		1	2	
CO5				2	2							

Low-1 Medium-2 High-3

V Semester		
BIOINFORMATICS (Group B: Global Elective)		
Course Code: 16G5B01		**CIE Marks: 100**
Credits :L:T:P:S: 4:0:0:0		**SEE Marks: 100**
Hours: 45L		**SEE Duration: 3Hrs**

Course Learning Objectives:	
1	Understand the underlying technologies of Bioinformatics and Programming
2	Explore the various algorithms behind the computational genomics and proteomic structural bioinformatics, modeling and simulation of molecular systems.
3	Apply the tools and techniques that are exclusively designed as data analytics to investigate the significant meaning hidden behind the high throughput biological data.
4	Analyze and evaluate the outcome of tools and techniques employed in the processes of biological data preprocessing and data mining.

Unit-I	
Biomolecules: Introduction to Biomolecules. Structure, Types and Functions of Carbohydrates, Lipids, Nucleic Acids and Proteins. Genetic code, Codon degeneracy, Genes and Genomes. **Bioinformatics & Biological Databases:** Introduction to Bioinformatics, Goals, Scope, Applications in biological science and medicine. Biological databases – Sequence, structure, Special Databases and applications - Genome, Microarray, Metabolic pathway, motif, and domain databases. Mapping databases – genome wide maps. Chromosome specific human maps.	**09 Hrs**
Unit – II	
Sequence Alignment: Introduction, Types of sequence alignments - Pairwise and Multiple sequence alignment, Alignment algorithms (Needleman & Wunch, Smith & Waterman and Progressive global alignment). Database Similarity Searching- Scoring matrices – BLOSSUM and PAM, Basic Local Alignment Search Tool (BLAST), and FASTA. Next Generation Sequencing – Alignment and Assembly. **Molecular Phylogenetics:** Introduction, Terminology, Forms of Tree Representation. Phylogenetic Tree Construction Methods - Distance-Based & Character-Based Methods and Phylogenetic Tree evaluation.	**09 Hrs**
Unit -III	
Predictive methods: Predicting secondary structure of RNA, Protein and Genes – algorithms to predict secondary structure of RNA, Protein and Gene. Prediction of Tertiary structure of Protein, Protein identity and Physical properties of protein. **Molecular Modeling and Drug Designing:** Introduction to Molecular Modeling. Methods of Molecular Modeling and Force Fields used in Molecular Modeling. Drug designing process - deriving Pharmacophore, Receptor Mapping, Estimating Receptor-Ligand interactions and Molecular Docking.	**09 Hrs**
Unit –IV	
Perl: Introduction to Perl, writing and executing a Perl program. Operators, Variables and Special variables. Data Types – Scalar, Array and Associative array. Regular Expressions (REGEX), Components of REGEX - Operators, Metacharacters and Modifiers. Subroutines – types of functions, defining and calling functions in Perl, calling function - call by value and call by reference. Object Oriented Programming in Perl–Class and object, Polymorphism, inheritance and encapsulation. Perl Package – writing and calling package. Perl Module – writing and calling module.	**09 Hrs**
Unit –V	
BioPerl: Introduction to BioPerl, BioPerl Modules, Applications of BioPerl – Sequence retrieval from Database and submission of sequence to online Database, Indexing and accessing local databases, Transforming formats of database record, Sequence alignments BioPerl and Sequence Analysis - Pair wise and Multiple sequence alignment, Restriction mapping. Identifying restriction enzyme sites, acid cleavage sites, searching for genes and	**09 Hrs**

other structures on genomic DNA, Parsing BLAST and FASTA results. BioPerl and phylogenetic analysis, BioPerl and Phylogenetic tree manipulation, creating graphics for Sequence display and Annotation.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the Architecture and Schema of online databases including structure of records in these databases.
CO2:	Explore the Mind crunching Algorithms, which are used to make predictions in Biology, Chemical Engineering, and Medicine.
CO3:	Apply the principles of Bioinformatics and Programming to the problems related to process simulation and process engineering in Biological system.
CO4:	Use Bioinformatics tools and Next Generation Technologies to model and simulate biological phenomenon.

Reference Books	
1	T. Christiansen, B. D. Foy, L. Wall, J. Orwant, Programming Perl: Unmatched power for text processing and scripting, O'Reilly Media, Inc., 4th edition, 2012, ISBN-13: 978-0596004927
2	B. Haubold, T. Weihe, Introduction to Computational Biology: An Evolutionary Approach, new age publishers, Paperback Edition, 2009, ISBN-13: 978-8184890624
3	C. Bessant, I. Shadforth, D. Oakley, Building Bioinformatics Solutions: with Perl, R and MySQL, Oxford University Press, 1st edition, 2009, ISBN
4	D. C. Young. Computational Drug Design: A Guide for Computational and Medicinal Chemists,Wiley-Interscience, 1st edition, 2009, ISBN-13: 978-0470126851.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	3	2	3	2	3	3	-	-	1	2	-
CO2	3	3	3	2	3	3	2	-	2	-	-	-
CO3	3	2	2	2	2	1	1	-	-	-	1	-
CO4	1	2	3	3	3	2	1	-	-	2	-	-

High-3 : Medium-2 : Low-1

V Semester		
FUEL CELL TECHNOLOGY (Group B: Global Elective)		
Course Code: 16G5B02		**CIE Marks: 100**
Credits: L:T:P:S:: 4:0:0:0		**SEE Marks: 100**
Hours: 45L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	Recall the concept of fuel cells
2	Distinguish various types of fuel cells and their functionalities
3	Know the applications of fuel cells in various domains
4	Understand the characterization of fuel cells

UNIT-I	
Introduction: Fuel cell definition, historical developments, working principle of fuel cell, components of fuel cell, EMF of the cell, Fuel Cell Reactions, fuels for cells and their properties.	**09 Hrs**
UNIT-II	
Fuel Cell Types: Classification of fuel cells, alkaline fuel cell, polymer electrolyte fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, advantages and disadvantages of each .	**09 Hrs**
UNIT-III	
Fuel Cell Reaction Kinetics: activation kinetics, open circuit voltage, intrinsic maximum efficiency, voltage efficiency, Faradaic efficiency, overall efficiency, over-voltages and Tafel equation.	**09 Hrs**
UNIT-IV	
Fuel Cell Characterization: current – voltage curve, in-situ characterization, current – voltage measurement, current interrupt measurement, cyclic voltammetry, electrochemical impedance spectroscopy and ex-situ characterization techniques.	**09 Hrs**
UNIT-V	
Applications of Fuel Cells: applications of fuel cells in various sectors, hydrogen production, storage, handling and safety issues.	**09 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Understand the fundamentals and characteristics of fuel cells
2	Apply chemical engineering principles to distinguish fuel cells from conventional energy systems
3	Analyze the performance of fuel cells using different characterization techniques
4	Evaluate the possibility of integrating fuel cell systems with conventional energy systems

Reference Books	
1.	Fuel Cells – Principles and Applications, Viswanathan and M Aulice Scibioh, 1st Edition, 2009, Universities Press, ISBN – 13: 978 1420 060287
2.	Fuel Cell Systems Explained, James Larminie and Andrew Dicks, 2nd Edition, 2003, John Wiley & Sons, ISBN – 978 0470 848579
3.	Fuel Cell Fundamentals, O 'Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, 1st Edition, 2006, Wiley, New York, ISBN – 978 0470 258439
4.	Recent Trends in Fuel Cell Science and Technology, Basu. S, 1st Edition, 2007, Springer, ISBN – 978 0387 688152

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**1**	**-**	**-**	**-**
CO 2	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO 3	**-**	**3**	**-**	**-**	**-**	**-**	**3**	**-**	**2**	**-**	**-**	**-**
CO 4	**-**	**2**	**2**	**-**	**-**	**-**	**2**	**-**	**3**	**-**	**-**	**2**

High-3 : Medium-2 : Low-1

V Semester		
GEOINFORMATICS (Group B: Global Elective)		
Course Code:16G5B03		**CIE Marks: 100**
Hrs/Week: L:T:P:S: 4:0:0:0		**SEE Marks: 100**
Credits: 48L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	To understand concept of using photographic data to determine relative positions of points
2	To study the use of electromagnetic energy for acquiring qualitative and quantitative land information
3	To analyze the data gathered from various sensors and interpret for various applications
4	To understand the various applications of RS, GIS and GPS

UNIT-I	
Remote Sensing- Definition, types of remote sensing, components of remote sensing, Electromagnetic Spectrum, Black body, Atmospheric windows, energy interaction with earth surface features. spectral reflectance curve- physical basis for spectra reflectance curve, false color composite. Platforms and sensors. Sensor resolutions. Types of satellites- Indian and other remote sensing satellites (IRS, IKONS and Landsat). Concept of image interpretation and analysis - Principle of visual interpretation, recognition elements. Fundamentals of image rectification. Digital Image classification - supervised and unsupervised	**10 Hrs**
UNIT-II	
Photogrammetry: Introduction types of Photogrammetry, Advantages of Photogrammetry, Introduction to digital Photogrammetry. Locating points from two phases determination of focal length. **Aerial Photogrammetry:** Advantages over ground survey methods - geometry of vertical phographs, scales of vertical photograph. Ground coordination- relief displacement, scale ground coordinates – flight planning	**10 Hrs**
UNIT-III	
Geographic Information System- Introduction, Functions and advantages, sources of data for GIS. Database – Types, advantages and disadvantages. Data Management – Transformation, Projection and Coordinate systems. Data input methods, Data Analysis.- overlay operations, network analysis, spatial analysis. Outputs and map generation. . Introduction to GPS- components and working principles	**10 Hrs**
UNIT-IV	
Applications of GIS, Remote Sensing and GPS: Case studies on Water Resources engineering and management (prioritization of river basins, water perspective zones and its mapping), **Case studies on applications of GIS and RS in** highway alignment, Optimization of routes, accident analysis, Environmental related studies. **Case studies on applications of GIS and RS in** Disaster Management (Case studies on post disaster management - Earthquake and tsunami and pre disaster management - Landslides and floods) Urban Planning & Management - mapping of zones, layouts and infrastructures.	**09 Hrs**
UNIT-V	
Applications of GIS, Remote Sensing and GPS: Land use land cover (LULC) mapping. Case studies on infrastructure planning and management- Case studies on urban sprawl. Change detection studies – case studies on forests and urban area. Case studies on agriculture. **Applications of geo-informatics in natural resources management: Geo Technical case Studies**, site suitability analysis for various applications.	**09 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Understand the principle of Remote Sensing (RS) and Geographical Information Systems (GIS) data acquisition and its applications.
2	Apply RS and GIS technologies in various fields of engineering and social needs.

3	Analyze and evaluate the information obtained by applying RS and GIS technologies.
4	Create a feasible solution in the different fields of application of RS and GIS.

Reference Books	
1.	Geographic Information System-An Introduction, Tor Bernharadsen, 3rd Edition, Wiley India Pvt. Ltd. New Delhi , 2009.
2.	Principles of Remote sensing and Image Interpretation, Lillesand and Kiefer, 5th Edition, John Wiley Publishers, New Delhi, 2007.
3.	Remote Sensing and GIS, Bhatta B, Oxford University Press, New Delhi, 2008
4.	Remote Sensing, Robert A. Schowengerdt, 3rd Edition, Elsevier India Pvt Ltd, New Delhi, 2009

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	-	-	-	-	1	-	-	-	-	-	-
CO2	2	1	-	-	1	1	-	-	-	-	-	-
CO3	2	2	1	-	2	1	1	-	-	-	-	1
CO4	2	2	1	-	3	2	2	-	-	-	1	1

Low-1 Medium-2 High-3

V Semester		
GRAPH THEORY **(Group B: Global Elective)**		
Course Code:16G5B04		**CIE Marks: 100**
Credits: L:T:P:S: 4:0:0:0		**SEE Marks: 100**
Hours: 45L		**SEE Duration: 3 Hrs**

Course Learning Objectives: The students will be able to	
1	Understand the basics of graph theory and their various properties.
2	Model problems using graphs and to solve these problems algorithmically.
3	Apply graph theory concepts to solve real world applications like routing, TSP/traffic control, etc.
4	Optimize the solutions to real problems like transport problems etc.,

UNIT-I	
Introduction to graph theory Introduction, Mathematical preliminaries, definitions and examples of graphs, degrees and regular graphs, sub graphs, directed graphs, in degrees and out degrees in digraphs. **Basic concepts in graph theory** Paths and cycles, connectivity, homomorphism and isomorphism of graphs, connectivity in digraphs.	**09 Hrs**
UNIT-II	
Graph representations, Trees, Forests Adjacency matrix of a graph, Incidence matrix of a graph, Adjacency lists, Trees and properties of trees, Characterization of trees, Centers of trees, Rooted trees, Binary threes, Spanning trees and forests, Spanning trees of complete graphs, An application to electrical networks, Minimum cost spanning trees.	**09 Hrs**
UNIT-III	
Fundamental properties of graphs and digraphs Bipartite graphs, Eulerian graphs, Hamiltonian graphs, Hamiltonian cycles in weighted graphs, Eulerian digraphs. **Planar graphs, Connectivity and Flows** Embedding in surfaces, Euler's formula, Characterization of planar graphs, Kuratowski's theorem, Dual of a planar graphs.	**09 Hrs**
UNIT-IV	
Matchings and Factors Min-Max theorem, Independent sets and covers, Dominating sets, maximum bipartite matching. **Coloring of graphs** The chromatic number of a graph, Results for general graphs, The chromatic polynomial of a graph, Basic properties of chromatic polynomial, chordal graphs, powers of graphs, Edge coloring of graphs	**09 Hrs**
UNIT-V	
Graph algorithms Graph connectivity algorithms, Breadth first search and Depth first search, Shortest path algorithms, Dijikstra's shortest path algorithm, Minimum cost spanning tree algorithms, Algorithm of Kruskal's and Prim's.	**09 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1.	Understand and explore the basics of graph theory.
CO2.	Analyse the significance of graph theory in different engineering disciplines
CO3.	Demonstrate algorithms used in interdisciplinary engineering domains.
CO4.	Evaluate or synthesize any real world applications using graph theory.

Reference Books	
1.	Introduction to graph theory, Douglas B. West, 2nd Edition, 2001, PHI, ISBN- 9780130144003, ISBN-0130144002.
2.	Graph Theory, modeling, Applications and Algorithms, Geir Agnarsson, Raymond Greenlaw, Pearson Education, 1st Edition,2008, ISBN- 978-81-317-1728-8.
3.	Introduction to Algorithms ,Cormen T.H., Leiserson C. E, Rivest R.L., Stein C. , 3rd Edition, 2010,PHI, ISBN:9780262033848

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**-**	**-**
CO2	**2**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**2**	**2**	**-**	**1**
CO3	**2**	**2**	**3**	**2**	**-**	**-**	**-**	**-**	**2**	**2**	**-**	**1**
CO4	**2**	**2**	**3**	**2**	**-**	**1**	**-**	**-**	**2**	**2**	**-**	**1**

Low-1 Medium-2 High-3

V Semester		
ARTIFICIAL NEURAL NETWORKS &DEEP LEARNING (Group B: Global Elective)		
Course Code: 16G5B05		**CIE Marks: 100**
Credits: L:T:P:S: 4:0:0:0		**SEE Marks: 100**
Hours: 46L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	Define what is Neural Network and model a Neuron and Express both Artificial Intelligence and Neural Network
2	Analyze ANN learning, Error correction learning, Memory-based learning, Hebbian learning, Competitive learning and Boltzmann learning
3	Implement Simple perception, Perception learning algorithm, Modified Perception learning algorithm, and Adaptive linear combiner, Continuous perception, learning in continuous perception.
4	Analyze the limitation of Single layer Perceptron and Develop MLP with 2 hidden layers, Develop Delta learning rule of the output layer and Multilayer feed forward neural network with continuous perceptions,

UNIT-I	
Introduction to Neural Networks: Neural Network, Human Brain, Models of Neuron, Neural networks viewed as directed graphs, Biological Neural Network, Artificial neuron, Artificial Neural Network architecture, ANN learning, analysis and applications, Historical notes.	**08 Hrs**
UNIT-II	
Learning Processes: Introduction, Error correction learning, Memory-based learning, Hebbian learning, Competitive learning, Boltzmann learning, credit assignment problem, learning with and without teacher, learning tasks, Memory and Adaptation.	**10 Hrs**
UNIT-III	
Single layer Perception: Introduction, Pattern Recognition, Linear classifier, Simple perception, Perception learning algorithm, Modified Perception learning algorithm, Adaptive linear combiner, Continuous perception, Learning in continuous perception. Limitation of Perception.	**10 Hrs**
UNIT-IV	
Multi-Layer Perceptron Networks: Introduction, MLP with 2 hidden layers, Simple layer of a MLP, Delta learning rule of the output layer, Multilayer feed forward neural network with continuous perceptions, Generalized delta learning rule, Back propagation algorithm	**10 Hrs**
UNIT-V	
Introduction to Deep learning: Neuro architectures as necessary building blocks for the DL techniques, Deep Learning & Neocognitron, Deep Convolutional Neural Networks, Recurrent Neural Networks (RNN), feature extraction, Deep Belief Networks, Restricted Boltzman Machines, Autoencoders, Training of Deep neural Networks, Applications and examples (Google, image/speech recognition)	**08 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1:	Model Neuron and Neural Network, and to analyze ANN learning, and its applications.
CO2:	Perform Pattern Recognition, Linear classification.
CO3:	Develop different single layer/multiple layer Perception learning algorithms
CO4:	Design of another class of layered networks using deep learning principles.

Reference Books	
1.	Neural Network- A Comprehensive Foundation , Simon Haykins, 2nd Edition, 1999, Pearson Prentice Hall, ISBN-13: 978-0-13-147139-9
2.	Introduction to Artificial Neural Systems, Zurada and Jacek M, 1992, West Publishing Company, ISBN: 9780534954604
3.	Learning & Soft Computing, Vojislav Kecman, 1st Edition, 2004, Pearson Education, ISBN:0-262-11255-8
4.	Neural Networks Design, M T Hagan, H B Demoth, M Beale, 2002, Thomson Learning, ISBN-10: 0-9717321-1-6/ ISBN-13: 978-0-9717321-1-7

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**1**
CO2	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**1**
CO3	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**1**	**-**	**1**
CO4	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**1**	**-**	**1**

Low-1 Medium-2 High-3

V Semester		
HYBRID ELECTRIC VEHICLES (Group B: Global Elective)		
Course Code : 16G5B06		**CIE Marks : 100**
Credits : L:T:P:S 4:0:0:0		**SEE Marks : 100**
Hours : 45L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to,	
1	Explain the basics of electric and hybrid electric vehicles, their architecture, technologies and fundamentals.
2	Explain plug – in hybrid electric vehicle architecture, design and component sizing and the power electronics devices used in hybrid electric vehicles.
3	Analyze various electric drives suitable for hybrid electric vehicles and Different energy storage technologies used for hybrid electric vehicles and their control.
4	Demonstrate different configurations of electric vehicles and its components, hybrid vehicle configuration by different techniques, sizing of components and design optimization and energy management.

Unit-I	
Introduction: Sustainable Transportation, A Brief History of HEVs, Why EVs Emerged and Failed, Architectures of HEVs, Interdisciplinary Nature of HEVs, State of the Art of HEVs, Challenges and Key Technology of HEVs. **Hybridization of the Automobile:** Vehicle Basics, Basics of the EV, Basics of the HEV, Basics of Plug-In Hybrid Electric Vehicle (PHEV), Basics of Fuel Cell Vehicles (FCVs).	**07 Hrs**
Unit-II	
HEV Fundamentals: Introduction, Vehicle Model, Vehicle Performance, EV Powertrain Component Sizing, Series Hybrid Vehicle, Parallel Hybrid Vehicle, Wheel Slip Dynamics. **Plug-in Hybrid Electric Vehicles:** Introduction to PHEVs, PHEV Architectures, Equivalent Electric Range of Blended PHEVs, Fuel Economy of PHEVs, Power Management of PHEVs, Component Sizing of EREVs, Component Sizing of Blended PHEVs, Vehicle-to-Grid Technology.	**10 Hrs**
Unit-III	
Power Electronics in HEVs: Power electronics including switching, AC-DC, DC-AC conversion, electronic devices and circuits used for control and distribution of electric power, Thermal Management of HEV Power Electronics. **Batteries, Ultracapacitors, Fuel Cells, and Controls:** Introduction, Different batteries for EV, Battery Characterization, Comparison of Different Energy Storage Technologies for HEVs, Battery Charging Control, Charge Management of Storage Devices, Flywheel Energy Storage System, Hydraulic Energy Storage System, Fuel Cells and Hybrid Fuel Cell Energy Storage System and Battery Management System.	**10 Hrs**
Unit-IV	
Electric Machines and Drives in HEVs: Introduction, BLDC motors, Induction Motor Drives, Permanent Magnet Motor Drives, Switched Reluctance Motors, Doubly Salient Permanent Magnet Machines, Design and Sizing of Traction Motors, Thermal Analysis and Modelling of Traction Motors. **(only functional treatment to be given**)	**10 Hrs**
Unit-V	
Integration of Subsystems: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems. **Energy Management Strategies:** Introduction to energy management strategies used in hybrid and electric vehicle, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy strategies.	**08 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Explain the basics of electric and hybrid electric vehicles, their architecture, technologies and fundamentals.
2	Evaluate the performance of electrical machines and power electronics converters in HEVs.
3	Analyse the different energy storage devices used for hybrid electric vehicles, their technologies and control and select appropriate technology
4	Design and evaluate the sizing of subsystem components and Energy Management strategies in HEVs.

Reference Books:	
1.	Hybrid Electric Vehicle: Principles and Applications with Practical Perspectives, Mi Chris, Masrur A.and Gao D.W. Wiley Publisher, 1st Edition, 2011,*ISBN*:0-824-77653-5
2.	Ali, Modern Electric, Hybrid electric and Fuel Cell Vehicles, Ehsani Mehrdad, Gao Yimin, E. Gay Sebastien, Emadi CRC Press, 1st Edition, 2005, ISBN: *0-8493-3154-4.*
3.	Modern Electric Vehicle Technology, Chan, C.C.,Chau, K.T. Oxford University Press, 2001, ISBN 0 19 850416 0.
4.	Hybrid Electric Vehicles: Energy Management Strategies, Simona Onori, Lorenzo Serrao, Giorgio Rizzoni, *ISBN*: 978-1-4471-6779-2.

Continuous Internal Evaluation (CIE); Theory (100 Marks):
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Semester End Evaluation (SEE); Theory (100 Marks):
SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**2**	**3**	**2**	**2**	**1**	**1**	**3**	**1**	**-**	**1**	**-**	**2**
CO2	**3**	**3**	**2**	**2**	**3**	**-**	**3**	**-**	**2**	**1**	**2**	**1**
CO3	**2**	**3**	**2**	**2**	**2**	**2**	**3**	**1**	**1**	**1**	**-**	**1**
CO4	**3**	**3**	**3**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**1**	**3**

High-3 : Medium-2 : Low-1

V Semester		
OPTIMIZATION TECHNIQUES (Group B: Global Elective)		
Course Code : 16G5B07		**CIE Marks : 100**
Credits : L: T: P: S:4:0:0:0		**SEE Marks : 100**
Hours : 44L		**SEE Duration : 03 Hrs**
Course Learning Objectives: The students will be able to		
1.	To understand the concepts behind optimization techniques.	
2.	To explain the modeling frameworks for solving problems using optimization techniques.	
3.	To design and develop optimization models for real life situations.	
4.	To analyze solutions obtained using optimization methods.	
5.	To compare models developed using various techniques for optimization.	

UNIT – I	
Introduction: OR Methodology, Definition of OR, Application of OR to Engineering and Managerial problems, Features of OR models, Limitations of OR.	**09 Hrs**
Linear Programming: Definition, Mathematical Formulation, Standard Form, Solution Space, Types of solution – Feasible, Basic Feasible, Degenerate, Solution through Graphical Method. Problems on Product Mix, Blending, Marketing, Finance, Agriculture and Personnel. **Simplex methods:** Variants of Simplex Algorithm – Use of Artificial Variables.	
UNIT – II	
Duality and Sensitivity Analysis: Graphical sensitivity analysis, Algebraic sensitivity analysis - changes in RHS, Changes in objectives, Primal-Dual relationships, Economic interpretation of duality, Post optimal analysis - changes affecting feasibility and optimality, Revised simplex method	**09 Hrs**
UNIT – III	
Transportation Problem: Formulation of Transportation Model, Basic Feasible Solution using North-West corner, Least Cost, Vogel's Approximation Method, Optimality Methods, Unbalanced Transportation Problem, Degeneracy in Transportation Problems, Variants in Transportation Problems **Assignment Problem:** Formulation of the Assignment problem, solution method of assignment problem-Hungarian Method, Variants in assignment problem, Travelling Salesman Problem (TSP).	**08 Hrs**
UNIT – IV	
Queuing Theory: Queuing system and their characteristics, The M/M/I Queuing system, Steady state performance analyzing of M/M/1 queuing models. Introduction to M/M/C and M/Ek/1 queuing models **Game Theory**: Introduction, Two person Zero Sum game, Pure strategies, Games without saddle point - Arithmetic method, Graphical Method, The rules of dominance	**09Hrs**
UNIT – V	**09 Hrs**
Markov chains: Definition, Absolute and n-step transition probabilities, Classification of the states, Steady state probabilities and mean return times of ergodic chains, First passage times, Absorbing states. Applications in weather prediction and inventory management. Over view of OR software's used in practice.	

Course Outcomes: After going through this course the student will be able to	
CO1	Understand the various optimization models and their areas of application.
CO2	Explain the process of formulating and solving problems using optimization methods.
CO3	Develop models for real life problems using optimization techniques.
CO4	Analyze solutions obtained through optimization techniques.
CO5	Create designs for engineering systems using optimization approaches.

Reference Books:	
1.	Operation Research An Introduction, Taha H A, 8th Edition, 2009, PHI, ISBN: 0130488089.
2.	Principles of Operations Research – Theory and Practice, Philips, Ravindran and Solberg, 2nd Edition, 2000, John Wiley & Sons (Asia) Pte Ltd, ISBN 13: 978-81-265-1256-0
3.	Introduction to Operation Research, Hiller, Liberman, Nag, Basu, 9th Edition, 2012,Tata McGraw Hill, ISBN 13: 978-0-07-133346-7
4.	Operations Research Theory and Application, J K Sharma, 4th Edition, 2009, Pearson Education Pvt Ltd, ISBN 13: 978-0-23-063885-3.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2											
CO2	2	2		1	1							
CO3							1	1				
CO4	2		3		1							
CO5			2			1						1

Low-1 Medium-2 High-3

V Semester		
SENSORS & APPLICATIONS (Group B: Global Elective)		
Course Code:16G5B08		**CIE Marks: 100**
Credits/Week: L:T:P:S:4:0:0:0		**SEE Marks: 100**
Hours:44L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	Impart the principles and working modes of various types of Resistive, Inductive, Capacitive, Piezoelectric and Special transducers.
2	Give an idea about the applications of various transducers and selection criteria of a transducer for a particular application.
3	Give an insight into the static and dynamic characteristics of different orders of instruments.
4	Describe different data conversion techniques and their applications.

UNIT-I	
Introduction: Definition of a transducer, Block Diagram, Active and Passive Transducers, Advantages of Electrical transducers. **Resistive Transducers:** Potentiometers: Characteristics, Loading effect, and problems. **Strain gauge:** Theory, Types, applications and problems. **Thermistor, RTD:** Theory, Applications and Problems.	**09 Hrs**
UNIT-II	
Thermocouple: Measurement of thermocouple output, compensating circuits, lead compensation, advantages and disadvantages of thermocouple. **LVDT:** Characteristics, Practical applications and problems. **Capacitive Transducers:** Capacitive transducers using change in area of plates, distance between plates and change of dielectric constants, Applications of Capacitive Transducers and problems.	**10 Hrs**
UNIT-III	
Piezo-electric Transducers: Principles of operation, expression for output voltage, Piezo-electric materials, equivalent circuit, loading effect, and Problems. **Special Transducers:** Hall effect transducers, Thin film sensors, and smart transducers: Principles and applications, Introduction to MEMS Sensors and Nano Sensors, Schematic of the design of sensor, applications.	**10 Hrs**
UNIT-IV	
Chemical sensors: pH value sensor, dissolved oxygen sensor, oxidation-reduction potential sensor. **Light sensors**: Photo resistor, Photodiode, Phototransistor, Photo-FET, Charge coupled device. **Tactile sensors:** Construction and operation, types.	**08 Hrs**
UNIT-V	
Data Converters: Introduction to Data Acquisition System, types of DAC, Binary Weighted DAC, R-2R ladder DAC, DAC-0800, Types of ADC, Single Slope ADC and Dual-slope integrated type ADC, Flash ADC, 8-bit ADC-0808, Programmable Gain Amplifier.	**07 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1:	Remember and understand the basic principles of transducers and smart sensors.
CO2:	Apply the knowledge of transducers and sensors to comprehend digital instrumentation systems.
CO3:	Analyze and evaluate the performance of different sensors for various applications.
CO4:	Design and create a system using appropriate sensors for a particular application

Reference Books	
1	Electrical and Electronic Measurements and Instrumentation, A.K. Sawhney, 18th Edition, 2008, Dhanpat Rai and Sons, ISBN: 81-7700-016-0.
2	Sensor systems: Fundamentals and applications, Clarence W.de Silva, 2016 Edition, CRC Press, ISBN: 9781498716246.
3	Transducers and Instrumentation, D.V.S. Murthy, 2nd Edition 2008, PHI Publication, ISBN: 978-81-203-3569-1.
4	Introduction to Measurement and Instrumentation, Arun K. Ghosh, 3rd Edition, 2009, PHI, ISBN: 978-81-203-3858-6.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marksis executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO MAPPING												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**2**	**3**	**-**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**1**	**2**	**2**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**-**	**-**	**-**	**-**	**1**	**1**	**-**	**-**	**-**	**3**	**-**	**1**

Low-1 Medium-2 High-3

V Semester		
INTRODUCTION TO MANAGEMENT INFORMATION SYSTEMS (Group B: Global Elective)		
Course Code: 16G5B09		**CIE Marks: 100**
Credits: L:T:P:S: 4:0:0:0		**SEE Marks: 100**
Hours : 45L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	To understand the basic principles and working of information technology.
2	Describe the role of information technology and information systems in business.
3	To contrast and compare how internet and other information technologies support business processes.
4	To give an overall perspective of the importance of application of internet technologies in business administration.

UNIT I	
Information Systems in Global Business Today: The role of information systems in business today, Perspectives on information systems, Contemporary approaches to information systems, Hands-on MIS projects. **Global E-Business and Collaboration** : Business process and information systems, Types of business information systems, Systems for collaboration and team work, The information systems function in business. A Case study on E business.	**09 Hrs**
UNIT II	
Information Systems, Organizations and Strategy: Organizations and information systems, How information systems impact organization and business firms, Using information systems to gain competitive advantage, management issues, **Ethical and Social issues in Information Systems**: Understanding ethical and Social issues related to Information Systems, Ethics in an information society, The moral dimensions of information society. A Case study on business planning.	**09 Hrs**
UNIT III	
IT Infrastructure and Emerging Technologies : IT infrastructure, Infrastructure components, Contemporary hardware platform trends, Contemporary software platform trends, Management issues**. Securing Information Systems**: System vulnerability and abuse, Business value of security and control, Establishing framework for security and control, Technology and tools for protecting information resources. A case study on cybercrime.	**09 Hrs**
UNIT IV	
Achieving Operational Excellence and Customer Intimacy: Enterprise systems, Supply Chain Management (SCM) systems, Customer relationship management (CRM) systems, Enterprise application. **E-commerce: Digital Markets Digital Goods**: E-commerce and the internet, E-commerce-business and technology, The mobile digital platform and mobile E-commerce, Building and E-commerce web site. A Case study on ERP.	**09 Hrs**
UNIT V	
Managing Knowledge: The knowledge management landscape, Enterprise-wide knowledge management system, Knowledge work systems, Intelligent techniques. **Enhancing Decision Making**: Decision making and information systems, Business intelligence in the enterprise. Business intelligence constituencies. **Building Information Systems**: Systems as planned organizational change, Overview of systems development.	**09 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand and apply the fundamental concepts of information systems.
CO2:	Develop the knowledge about management of information systems.
CO3:	Interpret and recommend the use information technology to solve business problems.
CO4:	Apply a framework and process for aligning organization's IT objectives with business strategy.

Reference Books	
1	Management Information System, Managing the Digital Firm, Kenneth C. Laudon and Jane P. Laudon, 14th Global Edition, 2016, Pearson Education, ISBN:9781292094007
2	Management Information Systems, James A. O' Brien, George M. Marakas, 10th Edition, 2011, Global McGraw Hill, ISBN: 978-0072823110
3	Information Systems The Foundation of E-Business, Steven Alter, 4th Edition, 2002, Pearson Education, ISBN:978-0130617736
4	W.S. Jawadekar, Management Information Systems, Tata McGraw Hill, 2006, ISBN: 9780070616349

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	3	-	1	-	-	-	1	-	-	1	-
CO2	1	2	-	1	-	-	-	1	-	-	1	-
CO3	-	-	3	2	2	-	-	1	-	1	1	-
CO4	-	-	2	1	-	-	-	1	-	1	1	-

Low-1 Medium-2 High-3

V Semester		
INDUSTRIAL AUTOMATION (Group B: Global Elective)		
Course Code: 16G5B10		**CIE Marks: 100**
Credits: L:T:P:S : 4:0:0:0		**SEE Marks: 100**
Hours: 44L		**SEE Duration: 3 Hrs**

Course Learning Objectives: The students should be able to:	
1	Identify types of actuators, sensors and switching devices for industrial automation
2	Explain operation and controls of Hydraulic and Pneumatic systems
3	Understand fundamentals of CNC, PLC and Industrial robots
4	Define switching elements and sensors which are interfaced in an automation system
5	Describe functions of Industrial switching elements and Inspection technologies for automation
6	Select sensors to automatically detect motion of actuators
7	Develop manual part programs for CNC and Ladder logic for PLC
8	Develop suitable industrial automation systems using all the above concepts

UNIT-I	
Automation in Production Systems: Manufacturing support systems, Automation principles and strategies, Levels of Automation, Production Concepts and Mathematical models, Numericals **Automated Production Lines:** Fundamentals, Applications, Analysis with no storage, Analysis with storage buffer, Numericals	**08 Hrs**
UNIT-II	
Switching theory and Industrial switching elements Binary elements, binary variables, Basic logic gates, Theorems of switching algebra, Algebraic simplification of binary function, Karnough maps, Logic circuit design, problems. Electromechanical relays, Moving part logic elements, Fluidic elements, Timers, Comparisons between switching elements, Numericals **Industrial Detection Sensors and Actuators:** Introduction, Limit switches, Reed switches, Photoelectric sensors- methods of detection, Hall effect sensors, Inductive proximity sensors, Capacitive proximity sensors, Pneumatic back pressure sensors, Absolute encoder, Incremental encoder, Pressure switches and temperature switches; their working principles and applications, Brushless DC motors, Stepper motors and Servo motors	**08 Hrs**
UNIT-III	
Hydraulic Control circuits Components, Symbolic representations, Control of Single and Double Acting Cylinder, Regenerative Circuit application, Pump unloading circuit, Double Pump Hydraulic System, speed control circuits, accumulator circuits **Pneumatic Control circuits** Components, Symbolic representations as per ISO 5599, Indirect control of double acting cylinders, memory control circuit, cascading design, automatic return motion, quick exhaust valve circuit, and cyclic operation of a cylinder, pressure sequence valve and time delay valve circuits.	**10 Hrs**
UNIT-IV	
Introduction to CNC Numerical control, components of CNC, classification, coordinate systems, motion control strategies, interpolation, programming concepts **Industrial Robotics** Components of Robots, base types, classification of robots, end of arm tooling, robot precision of movement, programming, justifying the use of a robot, simple numericals	**08 Hrs**
UNIT-V	
Programmable logic control systems Difference between relay and PLC circuits, PLC construction, principles of operation, latching, ladder diagrams, programming instructions, types of timers, forms of counters, writing simple	**10 Hrs**

ladder diagrams from narrative description and Boolean logic. **Programming exercises on PLC with Allen Bradley controller** Programming exercises on motor control in two directions, traffic control, annunciator flasher, cyclic movement of cylinder, can counting, conveyor belt control, alarm system, sequential process, and continuous filling operation on a conveyor.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Illustrate applications of sensors actuators, switching elements and inspection technologies in industrial automation
CO2	Build circuit diagrams for fluid power automation, Ladder diagrams for PLC and identify its application areas
CO3	Evaluate CNC programs for 2D complex profiles performed on machining and turning centres interfaced with Robots
CO4	Develop suitable industrial automated system integrating all of the above advanced automation concepts

Reference Books	
1.	Industrial automation - Circuit design and components , David W. Pessen, 1st Edition, 2011, Wiley India, ISBN –13–978–8126529889
2.	Pneumatic Controls , Joji P, 1st Edition, Wiley India, ISBN – 978–81–265–1542–4
3.	Fluid Power with Applications , Anthony Esposito, 7th Edition , 2013, ISBN – 13; 978– 9332518544
4.	Automation, Production systems and Computer Integrated Manufacturing , Mikell P. Groover, 3rd Edition , 2014 , ISBN – 978–81–203–3418–2

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**				**2**	**1**	**2**	**1**			**1**	**2**
CO2	**1**		**2**	**3**	**2**	**2**	**2**			**2**		
CO3		**1**		**2**	**1**					**2**		
CO4			**3**	**2**	**2**	**1**		**2**	**2**	**3**	**2**	**2**

Low-1 Medium-2 High-3

V Semester		
TELECOMMUNICATION SYSTEMS (Group B: Global Elective)		
Course Code: 16G5B11		**CIE Marks: 100**
Credits: L:T:P:S: 4:0:0:0		**SEE Marks: 100**
Hours: 46L		**SEE Duration: 03Hrs**

Course Learning Objectives: The students will be able to	
1	Represent schematic of communication system and identify its components.
2	Classify satellite orbits and sub-systems for communication.
3	Analyze different telecommunication services, systems and principles.
4	Explain the role of optical communication system and its components.
5	Describe the features of wireless technologies and standards.

UNIT-I	
Introduction to Electronic Communication: The Significance of Human Communication, Communication Systems, Types of Electronic Communication, Modulation and Multiplexing, Electromagnetic Spectrum, Bandwidth, A Survey of Communication Applications. **The Fundamentals of Electronics**: Gain, Attenuation, and Decibels.	**09 Hrs**
UNIT-II	
Modulation Schemes: Analog Modulation: AM, FM and PM- brief review. **Digital Modulation:** PCM, Line Codes, ASK, FSK, PSK, and QAM. **Wideband Modulation:** Spread spectrum, FHSS, DSSS. **Multiplexing and Multiple Access Techniques:** Frequency division multiplexing, Time division multiplexing **Multiple Access**: FDMA, TDMA, CDMA, Duplexing.	**10 Hrs**
UNIT-III	
Satellite Communication: Satellite Orbits, Satellite Communication Systems, Satellite Subsystems, Ground Stations, Satellite Applications, Global Positioning System.	**09 Hrs**
UNIT-IV	
Optical Communication: Optical Principles, Optical Communication Systems, Fiber-Optic Cables, Optical Transmitters and Receivers, Wavelength-Division Multiplexing, Passive Optical Networks.	**09 Hrs**
UNIT-V	
Cell Phone Technologies: Cellular concepts, Frequency allocation, Frequency reuse. Advanced Mobile Phone System (AMPS) **Digital Cell Phone Systems:** 2G, 2.5G, 3G and 4G cell phone systems, Advanced Cell Phones. **Wireless Technologies:** Wireless LAN, PANs and Bluetooth, ZigBee and Mesh Wireless Networks, WiMAX and Wireless Metropolitan-Area Networks.	**09 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe the basics of communication systems.
CO2	Analyze the importance of modulation and multiple access schemes for communication systems.
CO3	Compare different telecommunication generations, wired and wireless communication.
CO4	Justify the use of different components and sub-system in advanced communication systems.

Reference Books	
1.	Principles of Electronic Communication Systems, Louis E. Frenzel, 3rd Edition, 2008, Tata McGraw Hill, ISBN: 978-0-07-310704-2.
2.	Electronic Communication Systems, Roy Blake, 2nd Edition, 2002, Thomson/Delamar, ISBN: 978-81-315-0307-2.
3.	Electronic Communication Systems, George Kennedy, 3rd Edition, 2008, Tata McGraw Hill ISBN: 0-02-800592-9.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1		1	1				1			
CO2	2	1		1	1				1			
CO3	2	1		1	1				2			
CO4	1	1		1	1	1			1			

Low-1 Medium-2 High-3

V Semester		
COMPUTATIONAL ADVANCED NUMERICAL METHODS (Group B: Global Elective)		
Course Code:16G5B12		**CIE Marks: 100**
Credits: L:T:P:S: 4:0:0:0		**SEE Marks: 100**
Hours: 44L		**SEE Duration: 3Hrs**

Course Learning Objectives:

1	Adequate exposure to learn alternative methods and analyze mathematical problems to determine the suitable numerical techniques.
2	Use the concepts of interpolation, eigen value problem techniques for mathematical problems arising in various fields.
3	Solve initial value and boundary value problems which have great significance in engineering practice using ordinary differential equations.
4	Demonstrate elementary programming language, implementation of algorithms and computer programs to solve mathematical problems.

Unit-I	
Algebraic and Transcendental equations: Roots of equations in engineering practice, Polynomials and roots of equations, Fixed point iterative method, Aitken's process, Muller's method, Chebychev method.	**08 Hrs**
Unit – II	
Interpolation: Introduction to finite differences, Finite differences of a polynomial, Divided differences and Newton's divided difference interpolation formula, Hermite interpolation, Spline interpolation–linear, quadratic and cubic spline interpolation.	**08 Hrs**
Unit -III	
Ordinary Differential Equations: Solution of second order initial value problems–Runge-Kutta method, Milne's method, Boundary value problems (BVP's)–Shooting method, Finite difference method for linear and nonlinear problems, Rayleigh-Ritz method.	**09 Hrs**
Unit –IV	
Eigen value problems: Eigen values and Eigen vectors, Power method, Inverse Power method, Bounds on Eigen values, Greschgorin circle theorem, Jacobi method for symmetric matrices, Givens method.	**09 Hrs**
Unit –V	
Computational Techniques: Algorithms and Matlab programs for Fixed point iterative method, Aitken's–process, Muller's method, Chebychev method, Newton's divided difference method, Hermite interpolation, Spline interpolation, Power method, Inverse Power method, Runge-Kutta method, Milne's method, Shooting method, Rayleigh-Ritz method, Jacobi method and Givens method.	**10 Hrs**

Course Outcomes: After completing the course, the students will be able to

CO1:	Identify and interpret the fundamental concepts of polynomial equations, Interpolation, Eigen value problems, Differential equations and corresponding computational techniques.
CO2:	Apply the knowledge and skills of computational techniques to solve algebraic and transcendental equations, Ordinary differential equations and eigen value problems.
CO3:	Analyze the physical problem and use appropriate method to solve roots of equations, Interpolating the polynomial, Initial and boundary value problems, Eigen value problems numerically using computational techniques.
CO4:	Distinguish the overall mathematical knowledge gained to demonstrate and analyze the problems of finding the roots of equations, Interpolation, Differential equations, Eigen value problems arising in engineering practice.

Reference Books	
1	Numerical methods for scientific and engineering computation, M. K. Jain, S. R. K. Iyengar and R. K. Jain, New Age International Publishers, 6th Edition, 2012, ISBN-13: 978-81-224-2001-2.
2	Numerical Analysis, Richard L. Burden and J. Douglas Faires, Cengage Learning, 9th Edition, 2012, ISBN-13: 978-81-315-1654-6.
3	Introductory Methods of Numerical Analysis, S. S. Sastry, PHI Learning Private Ltd., 4th Edition, 2011, ISBN: 978-81-203-2761-0.
4	Numerical Methods for Engineers, Steven C Chapra, Raymond P Canale, Tata Mcgraw Hill, 5th Edition, 2011, ISBN-10: 0-07-063416-5.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO2	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**2**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO4	**3**	**3**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**

High-3: Medium-2: Low-1

V Semester		
BASICS OF AEROSPACE ENGINEERING (Group B: Global Elective)		
Course Code: 16GE5B13		**CIE Marks: 100**
Credits: L:T:P:S: 4:0:0:0		**SEE Marks: 100**
Hours: 44L		**SEE Duration: 3Hours**

Course Learning Objectives: To enable the students to:	
1	Understand the history and basic principles of aviation
2	Demonstrate and explain foundation of flight, aircraft structures, material, aircraft propulsion
3	Comprehend the importance of all the systems and subsystems incorporated on a air vehicle
4	Appraise the significance of all the subsystems in achieving a successful flight

Unit-I	
Introduction to Aircraft : History of aviation, International Standard atmosphere, Atmosphere and its properties, Temperature, pressure and altitude relationships, Classification of aircrafts, Anatomy of an aircraft & Helicopters, Basic components and their functions, Introduction to Unconventional and Autonomous Air vehicles.	**08 Hrs**
Unit – II	
Basics of Aerodynamics : Bernoulli's theorem, Aerodynamic forces and moments on an Airfoil, Lift and drag, Types of drag, Centre of pressure and its significance, Aerodynamic centre, Aerodynamic Coefficients, Wing Planform Geometry, Airfoil nomenclature, Basic characteristics of airfoils, NACA nomenclature, Simple problems on lift and drag.	**08 Hrs**
Unit -III	
Aircraft Propulsion : Introduction, Classification of powerplants, Piston Engine: Types of reciprocating engines, Principle of operation of turbojet, turboprop and turbofan engines, Introduction to ramjets and scramjets, Comparative merits and demerits of different types Engines.	**07 Hrs**
Unit -IV	
Introduction to Space Flight : History of space flight, Evolution of Indian Space Technology, The upper atmosphere, Introduction to basic orbital mechanics, some basic concepts, Kepler's Laws of planetary motion, Orbit equation, Space vehicle trajectories**.** **Rocket Propulsion :** Principles of operation of rocket engines, Classification of Rockets, Types of rockets.	**08 Hrs**
Unit -V	
Aerospace Structures and Materials : Introduction, General types of construction, Monocoque, Semi-Monocoque and Geodesic structures, Typical wing and fuselage structure; Metallic and non-metallic materials for aircraft application. Use of aluminum alloy, titanium, stainless steel and composite materials, Low temperature and high temperature materials.	**07 Hrs**

Course Outcomes: At the end of this course the student will be able to :	
CO1	Appreciate and apply the basic principles of aviation
CO2	Apply the concepts of fundaments of flight, basics of aircraft structures, aircraft propulsion and aircraft materials during the development of an aircraft
CO3	Comprehend the complexities involved during development of flight vehicles.
CO4	Evaluate and criticize the design strategy involved in the development of airplanes

Reference Books	
1	John D. Anderson, Introduction to Flight, 7th Edition, 2011, McGraw-Hill Education, ISBN 9780071086059.
2	Sutton G.P., Rocket Propulsion Elements, 8th Edition, 2011, John Wiley, New York, ISBN:1118174208, 9781118174203.
3	Yahya, S.M, Fundamentals of Compressible Flow, 5th Edition, 2016, New Age International, ISBN: 8122440223
4	T.H.G Megson, Aircraft structural Analysis, 2010, Butterworth-Heinemann Publications, ISBN: 978-1-85617-932-4

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**1**	**1**	**3**	**2**	**2**				**1**
CO2	**2**	**2**	**2**	**3**	**2**	**1**	**1**	**1**				**1**
CO3	**1**		**3**	**3**								**1**
CO4	**2**	**2**	**3**	**3**		**2**	**2**	**2**				**1**

High-3 : Medium-2 : Low-1

VI Semester		
INTELLECTUAL PROPERTY RIGHTS AND ENTREPRENEURSHIP (Theory) (Common to BT, CHE, CV, E&I, IEM, ME)		
Course Code: 16HSI51/61		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:0		**SEE Marks: 100**
Hours: 36L		**SEE Duration: 03Hrs**

Course Learning Objectives: The students will be able to	
1	To build awareness on the various forms of IPR and to build the perspectives on the concepts and to develop the linkages in technology innovation and IPR.
2	To equip students on the need to protect their own intellectual works and develop ethical standards governing ethical works.
3	To motivate towards entrepreneurial careers and build strong foundations skills to enable starting, building and growing a viable as well as sustainable venture.
4	Develop an entrepreneurial outlook and mind set along with critical skills and knowledge to manage risks associated with entrepreneurs.

UNIT-I	
Introduction: Types of Intellectual Property, WIPO, WTO, TRIPS. **Patents:** Introduction, Scope and salient features of patent; patentable and non-patentable inventions, Patent Procedure - Overview, Transfer of Patent Rights; Biotechnology patents, protection of traditional knowledge, Infringement of patents and remedy, Case studies **Trade Secrets:** Definition, Significance, Tools to protect Trade secrets in India.	**07 Hrs**
UNIT-II	
Trade Marks: Concept, function and different kinds and forms of Trade marks, Registrable and non- registrable marks. Registration of trade mark; Deceptive similarity; Assignment and transmission; ECO Label, Passing off; Offences and penalties. Infringement of trade mark with Case studies	**04 Hrs**
UNIT-III	
Industrial Design: Introduction, Protection of Industrial Designs, Protection and Requirements for Industrial |Design. Procedure for obtaining Design Protection, Revocation, Infringement and Remedies, Case studies **Copy Right:** Introduction, Nature and scope, Rights conferred by copy right, Copy right protection, transfer of copy rights, right of broad casting organizations and performer's rights, Case Studies. **Intellectual property and cyberspace:** Emergence of cyber-crime; Grant in software patent and Copyright in software; Software piracy; Data protection in cyberspace	**09 Hrs**
UNIT-IV	
Introduction to Entrepreneurship – Learn how entrepreneurship has changed the world. Identify six entrepreneurial myths and uncover the true facts. Explore E-cells on Campus **Listen to Some Success Stories: -** Global legends Understand how ordinary people become successful global entrepreneurs, their journeys, their challenges, and their success stories. Understand how ordinary people from their own countries have become successful entrepreneurs. **Characteristics of a Successful Entrepreneur** Understand the entrepreneurial journey and learn the concept of different entrepreneurial styles. Identify your own entrepreneurship style based on your personality traits, strengths, and weaknesses. Learn about the 5M Model, each of the five entrepreneurial styles in the model, and how they differ from each other. **Communicate Effectively:** Learn how incorrect assumptions and limiting our opinions about people can negatively impact our communication. Identify the barriers which cause communication breakdown, such as miscommunication and poor listening, and learn how to overcome them. **Communication Best Practices.** Understand the importance of listening in communication and learn to listen actively. Learn a few body language cues such as eye contact and handshakes to strengthen communication. (Practical Application)	**08 Hrs**

UNIT-V	
Design Thinking for Customer Delight: - Understand Design Thinking as a problem-solving process. Describe the principles of Design Thinking. Describe the Design Thinking process. **Sales Skills to Become an Effective Entrepreneur: -** Understand what is customer focus and how all selling effort should be customer-centric. Use the skills/techniques of personal selling, Show and Tell, and Elevator Pitch to sell effectively. **Managing Risks and Learning from Failures: -** Identify risk-taking and resilience traits. Understand that risk-taking is a positive trait. Learn to cultivate risk-taking traits. (Practical Application) Appreciate the role of failure on the road to success, and understand when to give up. Learn about some entrepreneurs/risk-takers. (Practical Application). **Are You Ready to be an Entrepreneur: -** Let's ask "WHY" Give participants a real picture of the benefits and challenges of being an entrepreneur. Identify the reasons why people want to become entrepreneurs. Help participants identify why they would want to become entrepreneurs.	**08 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1:	Comprehend the applicable source, scope and limitations of Intellectual Property within the purview of engineering domain.
CO2:	Knowledge and competence related exposure to the various Legal issues pertaining to Intellectual Property Rights with the utility in engineering perspectives.
CO3:	Enable the students to have a direct experience of venture creation through a facilitated learning environment.
CO4:	It allows students to learn and apply the latest methodology, frameworks and tools that entrepreneurs use to succeed in real life.

Reference Books	
1.	Law Relating to Intellectual Property, Wadehra B L,5th Edition, 2012, Universal Law Pub Co. Ltd.-Delhi, ISBN: 9789350350300
2.	Intellectual Property Rights: Unleashing Knowledge Economy, Prabuddha Ganguly, 1st Edition, 2001, Tata McGraw Hill Publishing Company Ltd., New Delhi, ISBN: 0074638602.
3.	Intellectual Property and the Internet, Rodney Ryder, 2002, Lexis Nexis U.K., ISBN: 8180380025, 9788180380020.
4.	Entrepreneurship, Rajeev Roy, 1st Edition, 2012, Oxford University Press, New Delhi, ISBN: 9780198072638.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**1**	**-**	**-**	**-**	**3**	**3**	**-**	**3**	**1**	**2**	**-**	**3**
CO2	**1**				**3**	**3**	**3**	**3**	**1**	**2**	**-**	**3**
CO3	**-**	**3**	**2**	**-**	**-**	**2**	**2**	**3**	**3**	**3**	**3**	**3**
CO4	**-**	**3**	**2**	**-**	**-**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

Low-1 Medium-2 High-3

VI Semester		
ENTERPRISE INFORMATION SYSTEMS (Theory)		
Course Code: 16IM62		**CIE Marks: 100**
Credits:L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 33L		**SEE Duration: 03 Hrs**

Course Learning Objectives: The students will be able to	
1	Understand the importance of information systems for business and management;.
2	Define various workflow, information architecture and information systems. To enterprise business.
3	Analyze the techniques and approaches of enterprise information system planning, design, implementation and management.
4	Design and develop Business information systems for various Industrial Applications

UNIT-I	
Enterprise Information System: Historical background, The manufacturing Roots of ERP, comparative coverage between MRP, ERP, EIS. Concepts of EIS, EIS Characteristics, EIS As per Garter View.	**06 Hrs**
UNIT-II	
Business Process Reengineering and Best Practices- Business process, Typical Business process. Reengineering, Business Process Reengineering, Business Process management, BPR with respect to EIS.	**08 Hrs**
UNIT-III	
Enterprise Information Systems Development – Data storage systems, Data warehousing, Data marts, Online analytical processing, Data mining, Customer relationship Management, Business intelligent system.	**08 Hrs**
UNIT-IV	
Enterprise Information Systems and Supply chain: Magnitude of EIS in SCM, Web enable EIS/ERP and its impact on SCM,Eis Vs SCM, product Life cycle management.	**06 Hrs**
UNIT-V	
Trends in Enterprise Systems-MRPIII (Money Resource Planning), Next Generation Of Enterprise software, Expenditure trends, Reduction In implementation time.	**05 Hrs**

Self Study:
Case study, Design and Emerging Technologies to be discussed pertaining to the course. 1 Credit: 4 Hrs / Week

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the role of enterprise information system analytics in decision making.
CO2	Understand the technologies for data warehousing data mining and data visualization. And its use in organizations.
CO3	Apply information-gathering techniques to document the requirements for an information system solution
CO4	Develop an understanding of investigative methods for building and designing computer based information systems.
CO5	Realize the trends in enterprise system and the supportive technologies.

Reference Books	
1.	Enterprise Information Systems: Contemporary Trends and Issues, David L. Olson and Subodh Kesharwani, 2009 Retrieved 20 August 20, New York: World Scientific, ISBN 9814273163.
2.	Enterprise Information Systems: Concepts, Methodologies, Tools and Applications, Information Resources Management Association (USA), 1st Edition, 2011, Idea Group Inc. ISBN 978-1-61692852-0.

3.	Enterprise Information Systems: A Pattern - Based Approach, Cheryl L. Dunn, 3rd Edition, 2005, McGraw-Hill, ISBN: 9780071111201
4.	Software Project Management, Hughes, B. and Mike Cotterell, M. 5th Edition, 2009, McGraw-Hill, ISBN:1070-1389

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Self-study (S). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Self-study is 20. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1		1									
CO2	1	1	2	1								
CO3			2	1	2				2	1		
CO4			1	2	2				2	1	2	
CO5				2		1	2	2	2		2	

Low-1 Medium-2 High-3

VI Semester		
FACILITIES PLANNING AND DESIGN (Theory & Practice)		
Course Code: 16IM63		**CIE Marks: 100 + 50**
Credits:L:T:P:S: 3: 0: 1: 0		**SEE Marks: 100 + 50**
Hours: 35L		**SEE Duration: 03 + 03 Hrs**
Course Learning Objectives: The students will be able to		
1	Understand the importance of Facilities Planning Process & Material handling Systems.	
2	Define various types of layouts and their linkages to design of product, process and layout.	
3	Solve various facility design problems through computer aided layout design and flow processes.	

UNIT-I	
Introduction: Facilities planning defined, significance of facilities planning, objectives of facilities planning, facilities planning process, strategic planning process, developing facilities planning strategies, examples of inadequate planning. **Plant Location And Layout:** Factors influencing plant location, Theories of plant location. Objectives of plant layout, Principles of plant layout, types of plant layout, their merits and demerits, numerical on plant location.	**08 Hrs**
UNIT-II	
Materials Handling: Introduction, scope and definition of material handling, material handling principle, designing material handling systems, unit load design, material handling equipment, estimating material handling costs, safety considerations.	**06 Hrs**
UNIT-III	
Computer Aided Layout: Introduction, CRAFT, COFAD, PLANET, CORELAP, ALDEP. Numerical on CRAFT / ALDEP. **Warehouse Operations:** Introduction, Mission of a warehouse, functions in the warehouse, receiving & shipping operations, dock locations, storage operations, order picking operations.	**08 Hrs**
UNIT-IV	
Designing of Material flow: Factors for consideration in planning material flow. Designing of Layout corresponding to typical types of Flow: Straight Line Flow / U Flow / S flow, Numerical on material flow. Examples on hospitals, super & hyper markets, airports, petrol stations, hotels, IT & Ites sector.	**06 Hrs**
UNIT-V	
Facilities Design for Manufacturing Systems: Introduction, fixed automation systems, flexible manufacturing systems, single-stage multi-machine systems, reduction of work-in-process, Just-In-Time Manufacturing, facilities planning trends.	**07 Hrs**

Assignment:
Case study, Design and Emerging Technologies to be discussed pertaining to the course.

FACILITIES PLANNING AND DESIGN LAB	
1.	Redesigning of Material Flow using Charts, Diagrams and Models.
2.	Designing of Product Layout using Line Balancing techniques.
3.	Development of Layout plans using Systematic Layout Planning technique.
4.	Evaluating alternative layout proposals using simulation.
5.	Designing Cellular Layouts using Rank Order Clustering algorithm.
6.	Designing of Layout corresponding to typical types of Flow – Straight Line Flow / U Flow / S flow.
7.	Assessing Layout performance using efficiency indices.
8.	Preparation and Presentation of Actual Layout for an organization.

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the factors influencing decisions related to plant locations, layout and material handling.
CO2	Recognize the influence of planning process and strategies and their effect on facility location planning.
CO3	Develop different layout plans and their operations on warehouse.
CO4	Evaluate different flow systems of a facility.

Reference Books	
1.	Facilities Planning, James A Tompkins, John A White, Yavuz A Bozer, J M A Tanchoco, 4th Edition, 2010, John Wiley & Sons INC, ISBN- 978-0-470-44404-7.
2.	Plant Layout and Material Handling, James M Apple, 3rd Edition, January 1991, Krieger Pub Co., ISBN-13: 978-0894645457.
3.	Facility layout and Location, Francies, R.L. and White, J.A, 2nd Edition, 1998, Prentice Hall of India, ISBN: 8120314603.
4.	Facilities Design, Sunderesh Heragu, 4th edition, 2016, CRC Press, ISBN: 978-1-4987-3290-1

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Laboratory- 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 40 marks. At the end of the semester a test is conducted for 10 marks. Total marks for the laboratory is 50.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2											
CO2		3					1					
CO3			2		1							
CO4				2						1		

Low-1 Medium-2 High-3

VI Semester		
SUPPLY CHAIN AND LOGISTICS MANAGEMENT (Theory & Practice)		
Course Code: 16IM64		**CIE Marks: 100 + 50**
Credits:L:T:P:S: 3: 0: 1: 0		**SEE Marks: 100 + 50**
Hours: 33L		**SEE Duration: 03 + 03Hrs**
Course Learning Objectives: The students will be able to		
1	To Understand the Building Blocks, Major Functions, Business Processes, and their relevance to Decisions in a Supply Chain Management.	
2	To design and analyze the linkages between Supply Chain Structures and Logistical Capabilities of a firm or supply chain.	
3	To develop Quantitative models to ensure effective Decision Making by analyzing the supply chain issues.	

UNIT-I	
Building a Strategic Frame Work to Analyse Supply Chains: Definition and Objective of Supply Chain, The importance of Supply Chain Decisions, Decision Phases in a Supply Chain, Process View of Supply Chains. Competitive and Supply Chain Strategies, Achieving Strategic fit, Expanding Strategic Scope. Drivers of Supply Chain Performance, Frame work for Structuring Drivers, Facilities, Inventory, Transportation, Information, Sourcing, Pricing, Obstacles to Achieving Fit.	**06 Hrs**
UNIT-II	
Designing The Supply Chain Network: The Role of Distribution in the Supply Chains, Factors influencing Distribution Network design, Design Options for a Distribution Network, e-Business and the Distribution network, Distribution Networks in practice. Factors influencing network design decisions, Framework for Network design decisions, Models for Facility location and Capacity allocation, The role of IT in Network design. The impact of uncertainty on network design, Discounted cash flow analysis, Representations of Uncertainty, Evaluating Network Design Decisions Using Decisions Trees, Risk Management and Network Design, Mumbai Dabbawalla Case Study, **Problems**.	**07 Hrs**
UNIT-III	
Planning and Managing Inventories in a Supply Chain: The Role of Cycle inventory in a Supply Chain, Economies of Scale to Exploit Fixed costs, Economies of Scale to Exploit Quantity Discounts, Short-Term Discounting, Trade Promotions, Managing Multi-echelon Cycle Inventory. The Role of Safety Inventory in a Supply Chain, Determining appropriate level of Safety inventory, Impact of supply Uncertainty on Safety inventory, Impact of aggregation on safety inventory, impact of replenishment policies on safety inventory, Managing Safety Inventory in a Multi-echelon Supply Chain, The Role of IT in inventory management. The importance of the level of product Availability, Factors affecting optimal level of Product Availability, Managerial levers to improve supply chain Profitability, **Problems**.	**07 Hrs**
UNIT-IV	
Designing And Planning Transportation Networks: The role of transportation in a Supply chain, Modes of transportation and their performance characteristics, Transportation infrastructure and policies, Design options for a transportation network, Trade-offs in transportation design, Tailored transportation, The role of IT in transportation, **Problems.** **Managing Cross-Functional Drivers In A Supply Chain:** The role of sourcing in a supply chain, in-house or outsource, Third-and Fourth-party logistics providers, Supplier scoring and assessment, Supplier selection-Auctions and Negotiations, Contracts and supply chain performance, Design Collaboration, The procurement process, sourcing planning and analysis, the role of IT in sourcing.	**07 Hrs**

UNIT-V	
Managing Cross-Functional Drivers In A Supply Chain: The role of IT in a supply chain, The supply chain in IT framework, The supply chain macro processes, Lack of Supply Chain co-ordination and the Bullwhip effect, managerial levers to achieve coordination, continuous replenishment and vendor-managed inventories, collaborative planning, forecasting and replenishment (CPFR), **Problems**	**06 Hrs**

Assignment:
Case study, Design and Emerging Technologies to be discussed pertaining to the course.

SUPPLY CHAIN AND LOGISTICS MANAGEMENT LABORATORY	
Part – I	
1.	Exercises on designing supply chain networks: Facility location models, Network optimization models.
2.	Planning supply chain inventory and sensitivity analysis: Cycle inventory, Safety inventory and Product availability, Inventory aggregation.
Part – II	
3.	Exercises on transportation design: Transportation cost and inventory cost trade off, Customer response and transportation cost trade off, Routing and scheduling.
4.	Exercises on Designing Marketing Campaign, Customer Service and Customer Order Processing.
5.	Demonstration Exercises on the beer game, illustrating bullwhip effect; Risk Pool Game; Auctions
6.	Demonstration Exercises using SCM Simulator.

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand supply chain concepts, systemic and strategic role of SCM in global competitive environment.
CO2	Evaluate alternative supply and distribution network structures using optimization models.
CO3	Develop optimal sourcing and inventory policies in the supply chain context.
CO4	Select appropriate information technology frameworks for managing supply chain processes.

Reference Books	
1.	Supply Chain Management – Strategy, Planning & Operation, Sunil Chopra, Peter Meindl & D V Kalra, 6th Edition, 2016, Pearson Education Asia; ISBN: 978-0-13-274395-2.
2.	Supply Chain Management – Creating Linkages for Faster Business Turnaround, Sarika Kulkarni & Ashok Sharma, 1st Edition, 2004, TATA Mc Graw Hill, ISBN: 0-07-058135–5
3.	Designing & Managing the Supply Chain – Concepts Strategies and Case Studies, David Simchi Levi, Philip Kaminsky, Edith Simchi Levi & Ravi Shankar, 3rd Edition, 2008, Mc Graw Hill, ISBN: 978- 0-07-066698-6
4.	Modelling the Supply Chain, Jeremy F Shapiro, 2nd Edition, 2009, Cengage Learning, ISBN 0-495-12609-8.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Laboratory- 50 Marks
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 40 marks. At the end of the semester a test is conducted for 10 marks. Total marks for the laboratory is 50.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3											1
CO2		3	2	2	2		3					
CO3		3	2		2							1
CO4			2		2					1		

Low-1 Medium-2 High-3

VI Semester		
DIGITAL MANUFACTURING **(Group C : Professional Core Elective)**		
Course Code: 16IM6C1		**CIE Marks: 100**
Credits:L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 34L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	Understand the concepts of digital manufacturing systems
2	Explain the manufacturing informatics, intelligent manufacturing, managing key technology of digital manufacturing.
3	Recognize digital technology with integration in product.

UNIT-I	
Introduction: Concept and research and development status of Digital Manufacturing (DM). **Theory system of DM**, modelling theory and method of Digital manufacturing science, basic architecture model of DM system.	**07 Hrs**
UNIT-II	
Computing manufacturing; manufacturing computational model, theoretical units in manufacturing computing, **Manufacturing Informatics;** Principal properties of manufacturing information-characteristics, activities, principles; Measurement, synthesis and materialization; Integration, Sharing and security of manufacturing information.	**07 Hrs**
UNIT-III	
Intelligent manufacturing; Intelligent multi information sensing, knowledge engineering in the 'Whole Life Cycle', Anatomy, Self-Learning, Adapting of manufacturing system; Intelligent manufacturing system, **Management of Technology in DM;** R&D system framework and management mode, technological strategies management & technological venture, Human-machine engineering on DM processes and production patterns, MOT mode based on cultural differences.	**08 Hrs**
UNIT-IV	
Key technology of DM; Digital technologies in product lifecycle, Resource and Environment technology, Management technology, Control technology, Digital recognition and Integration technology in product.	**06 Hrs**
UNIT-V	
Future development; Precision of digital manufacturing- Micro Nano Electro Mechanical System, Micro Nano Equipment, Externalization and Environment protection of digital manufacturing.	**06 Hrs**

Self Study:
Case study, Design and Emerging Technologies to be discussed pertaining to the course. 1 Credit: 4 Hrs / Week

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the System of modelling theory and method of digital manufacturing science.
CO2	Explain the basic principles and methodology of digital manufacturing system
CO3	Apply concepts of manufacturing informatics in measuring, synthesizing and integration of manufacturing information system.

Reference Books	
1.	Fundamentals of Digital Manufacturing Science, Zude Zhou, Shane Shengquan Xie, Dejun Chen, 2012, Springer publishers, ISBN: 978-0-85729-563-7, e-ISBN 978-0-85729-564-4.

2.	Cloud Manufacturing –Distributed Computing Technologies for Global and Sustainable Manufacturing, Weidong Li, Jörn Mehnen, 1st Edition, 2013, Springer series in Advanced Manufacturing, ISBN 978-1-4471-4934-7
3.	Collaborative Design and Planning for Digital Manufacturing , Lihui Wang, Andrew Yeh Ching Nee, 2009, Springer publications, ISBN: 978-1-84882-286-3
4.	Digital Manufacturing: Prospects and Challenges, Christoph Haag, Torsten Niechoj, 1st Edition, 2016, Metropolis Verlag, ISBN: 3731611562, 9783731611561

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Self-Study(S). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Self-study is 20. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2											
CO2		2								**1**		
CO3		2	1		1						**2**	

Low-1 Medium-2 High-3

VI Semester		
SERVICE OPERATIONS MANAGEMENT (Group C : Professional Core Elective)		
Course Code: 16IM6C2		**CIE Marks: 100**
Credits:L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 36L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	To obtain an overview of the successful Service Operations Management (SOM) function through the introduction of the topics traditionally associated with the study of Service Operations Management.
2	To develop an understanding of the terminology and responsibilities that relate to Service Operations Management.
3	To formulate and describe the function of the Service Operations Management discipline in various sectors of the economy through case study.
4	To obtain a set of basic tools and skills used in solving problems traditionally associated with operating the service operations system.

UNIT-I	
Introduction to service operations management: Introduction, what is service operations management?, The challenges facing service operations managers, different types of services, different types of service processes, judging the success of a service operation	**07 Hrs**
UNIT-II	
The service concept: the service concept, the service concept defined, the service concept as a strategic tool, focused and unfocussed service operations **Customers and relationships:** customers and customer segmentation, customer retention, managing customer relationships, managing customer relationships.	**07 Hrs**
UNIT-III	
Customer expectations and satisfaction: customer satisfaction, service quality and confidence, customer expectations, defining expectations-service quality factors, finding expectations and assessing satisfaction, managing perceptions **Managing supply relationships:** types of supply relationships, managing service supply chains, managing through intermediaries, supply partnerships, service level agreements	**08 Hrs**
UNIT-IV	
Service processes: service processes and their importance, understanding the nature of service processes, engineering service processes, controlling service processes, repositioning service processes **Service people:** understanding the pressures on service providers, managing and motivating service providers, managing customers	**07 Hrs**
UNIT-V	
Resource utilization: capacity management, operations planning and control, managing bottlenecks and queues, managing the coping zone, improving resource utilization **Performance measurement:** the purpose of Performance measurement, a balance of measures, Interlinking, targets and rewards, benchmarking	**07 Hrs**

Self Study:
Case study, Design and Emerging Technologies to be discussed pertaining to the course. 1 Credit: 4 Hrs / Week

Course Outcomes: After completing the course, the students will be able to	
CO1	Develop an understanding of the terminology and responsibilities that relate to Service Operations Management.
CO2	Formulate and describe the function of the Service Operations Management discipline in various sectors of the economy through case study.
CO3	Obtain a set of basic tools and skills used in solving problems traditionally associated with operating the service operations system.

CO4	Explore the interface of Service Operations Management with the other management functions, such as marketing, procurement & sourcing, outsourced good & services and customers.
CO5	Deploy technology in the improvement of service, customer relationships and globalization.

Reference Books	
1.	Service Operations Management, Improving Service Delivery, Robert Johnston, Graham Clark, 2nd Edition, 2008, Pearson, ISBN:8131715205
2.	Service Operations Management, Richard Metters, King-Metters, Steve Walton, 13th Edition, 2002, South-Western, ISBN: 978-0324135565
3.	Service Operations Management: The Total Experience, David W. Parker, 13th Edition, 2012, Edward Elgar Pub, ISBN-978-1781007860
4.	

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Self-Study(S). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Self-study is 20. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2					1						
CO2		2								2		
CO3			2	2	2				1	1		
CO4				2			2				2	
CO5					2		2	1				2

Low-1 Medium-2 High-3

VI Semester		
RELIABILITY ENGINEERING **(Group C : Professional Core Elective)**		
Course Code: 16IM6C3		**CIE Marks: 100**
Credits:L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 33L		**SEE Duration: 03Hrs**

Course Learning Objectives: The students will be able to	
1	Provide an insight into various tools and techniques of Reliability Engineering.
2	Review the various mathematical, physical and logical modeling tools for estimation and evaluation of component and system level reliability.
3	Appraise failure phenomena and there by provide valuable inputs for product design to achieve higher levels of reliability standards.
4	Assessment and evaluation of reliability goals and their improvements.

UNIT-I	
Introduction: Introduction to reliability engineering, Scope of reliability engineering, Reasons for engineering items to fail, Probabilistic reliability, Repairable and non repairable items, Reliability Program activities, Reliability Economics and Management, The development of reliability engineering, Organizations involved in reliability work, The study of reliability and maintainability, Concepts, terms and definitions, Applications.	**07 Hrs**
UNIT-II	
Basic Reliability Models **Failure distribution:** The reliability function, Mean time to failure, Hazard rate function, Hazard rate function, Bathtub curve, Conditional reliability **Time dependent failure models:** The Weibull distribution, Normal distribution, The Log Normal distribution	**07 Hrs**
UNIT-III	
Basic Reliability Models **Constant failure rate model:** The exponential reliability function, Failure modes, Applications, The Two Parameter Exponential distribution, Poisson process, Redundancy and CFR model exercises	**06 Hrs**
UNIT-IV	
Reliability of Systems: Serial Configuration, Parallel Configuration, Combined Series-Parallel system, System structure function, Minimal cuts and Minimal paths. Common mode failure, Three state devices, State space analysis (Markov analysis), Load sharing systems, Standby systems, Graded systems. Fault Tree Analysis, Failure Modes and Effects Analysis.	**07 Hrs**
UNIT-V	
Failure Data Analysis: Data Collection, Empirical Methods, Static Life Estimation, Product Testing, Reliability Life Testing, Test Time Calculations, Burn-In Testing, Acceptance Testing, Accelerated Life Testing, Experimental Design, Competing Failure Modes	**06 Hrs**

Self Study:
Case study, Design and Emerging Technologies to be discussed pertaining to the course. 1 Credit: 4 Hrs / Week

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain basic terminologies as applied to reliability engineering.
CO2	Develop the capability to design systems and process for reliability improvement.
CO3	Analyze failure phenomenon of components and systems so as to develop strategies for eliminating/ minimizing product failures.
CO4	Generate estimates for reliability through different modelling approaches for component and system level reliability in real life contexts.

Reference Books	
1.	An Introduction to Reliability and Maintainability Engineering, Charles E. Ebling, 1st Edition, 2000, Tata McGraw Hill, ISBN: 0-07-042138-2.
2.	Practical Reliability Engineering, Patrick D.T. Oconnor, et al, 4th Edition, 2002, John Wiley and Sons, ISBN: 9812-53-045-2.
3.	Reliability Engineering, Dr. E. Balaguruswamy, 1st Edition, 2003, McGraw Hill, ISBN: 978-0070483392
4.	Reliability Engineering, L.S. Srinath, 3rd Edition, 1991, Affiliated East West Press Pvt Ltd, ISBN: 81 85336393

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Self-Study(S). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Self-study is 20. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**											
CO2			**2**		**1**							
CO3		**2**		**2**			**1**					
CO4		**2**		**2**		**1**						**1**

Low-1 Medium-2 High-3

VI Semester		
FINANCIAL MANAGEMENT **(Group C : Professional Core Elective)**		
Course Code: 16IM6C4		**CIE Marks: 100**
Credits:L:T:P:S : 3:0:0:1		**SEE Marks: 100**
Hours: 33L		**SEE : 3 Hrs**

Course Learning Objectives: The students will be able to	
1	Explain the nature of finance and its interaction with other management functions.
2	Highlight the use of present value technique in financial decisions.
3	Discuss the pros and cons of various source of long term finance.
4	Recognize the diagnostic role of financial ratios and elaborate the concept of working capital.

UNIT-I	
Introduction: scope of finance, finance function, financial manager's role, financial goal: profit maximization v/s wealth maximization. **Value and return:** time preference for money, future value, future value of a single cash flow, future value of annuity, present value, present value of a single cash flow, present value of annuity	**07 Hrs**
UNIT-II	
Valuation of bonds and share: concept of value, features of bond, present value of bond, bond value and interest rate, valuation of preference shares, valuation of ordinary shares, **Risk and return:** return on a single assets, risk of rate of return: variance and standard deviation, problems only on single assets. **Capital budget decisions:** nature of investment decision, types of investment decision, investment evaluation criteria, net present value, internal rate of return(simple problems on NPV and IRR)	**07 Hrs**
UNIT-III	
Financial statement analysis: users of financial analysis, nature of ratio analysis, liquidity ratios, leverage ratios, activity ratios, profitability ratios, trend analysis, inter-firm analysis, utility and limitations of ratio analysis	**07 Hrs**
UNIT-IV	
Long term finance: ordinary shares, rights issue of equity shares, preference share, debentures, lease financing, hire purchase financing. **Venture capital financing:** notion of venture capital, the process of venture capital financing, methods of venture capital financing, disinvestment mechanisms, development of venture capital in India.	**06 Hrs**
UNIT-V	
Working capital management: concept of working capital, operating and cash conversion cycle, permanent and variable working capital, determinants of working capital, issues in working capital management, estimating working capital needs, policies for financing current assets.	**06 Hrs**

Self Study:
Case study, Design and Emerging Technologies to be discussed pertaining to the course. 1 Credit: 4 Hrs / Week

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the basic concepts in financial management.
CO2	Discuss the financial requirement of individual corporations.
CO3	Demonstrate the understanding of the nature of finance management.
CO4	Apply the concepts of financial management to contemporary financial events.

Reference Books	
1.	Financial Management, I M Pandey, 11th Edition, 2015, Vikas Publishing House, ISBN: 9789325982291
2.	Basic Financial Management, Khan & Jain, 2nd Edition, 2005, Tata McGraw-Hill Education, ISBN, 0070599432
3.	Financial Management: Theory and Practice, Prasanna Chandra, 9th Edition, 2015, Mcgraw Higher Education, ISBN: 9789339222574, 9339222571
4.	Fundamentals of Financial Management, James C. Van Horne, 13th Edition, 2008, Prentice Hall, ISBN: 978-0273713630

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Self-Study(S). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Self-study is 20. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1										1	2	
CO2										2	2	
CO3											2	
CO4				1				1			2	

Low-1 Medium-2 High-3

VI Semester		
DATA MINING TECHNIQUES **(Group C : Professional Core Elective)**		
Course Code: 16IM6C5		**CIE Marks: 100**
Credits:L:T:P:S: 3: 0: 0:1		**SEE Marks: 100**
Hours: 35L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	Recognize the importance of data, their managerial issues, and their life cycle.
2	Describe the sources of data, their collection, and quality issues.
3	Apply data mining solutions to real time data using common data mining techniques.
4	Identify research opportunities in the area of data mining and related applications

UNIT-I	
Introduction: Data mining, Type of data used for mining, Type of pattern used for mining, Related technologies, Major issues in data mining, Applications of data mining. **Getting to know your data:** Data objects and attribute types, Basic statistical description of data, Data visualization, Measuring data similarity and dissimilarity.	**07 Hrs**
UNIT-II	
Data Preprocessing: Data Preprocessing, Data cleaning, Data Integration, Data reduction, Data Transformation and data discretization. Mining Frequent Patterns, Associations, and Correlation: Basic concepts and Methods.	**07 Hrs**
UNIT-III	
Classification: Basic concepts, Decision tree induction, Bayes classification methods, Rule based classification	**07 Hrs**
UNIT-IV	
Classification (Advanced methods): Bayesian belief Networks, Classification by back propagation, Classification using frequent patterns, Lazy learners, Other classification methods.	**07 Hrs**
UNIT-V	
Cluster analysis: Cluster analysis, Partitioning methods, Hierarchical methods, Density based methods. **Data Mining Trends and Research Frontiers:** Mining complex data types, Data mining application, Data mining and society.	**07 Hrs**

Self Study:
Case study, Design and Emerging Technologies to be discussed pertaining to the course. 1 Credit: 4 Hrs / Week

Course Outcomes: After completing the course, the students will be able to	
CO1	Examine the types of the data to be mined and present a general classification of tasks and primitives to integrate a data mining system.
CO2	Apply preprocessing statistical methods for any given raw data.
CO3	Discover interestingness patterns from large amounts of data to analyze and extract patterns to solve problems, make prediction of outcomes.
CO4	Select and apply proper data mining algorithms to build analytical applications.

Reference Books	
1.	Data Mining – Concepts and Techniques, Jiawei Han and Micheline Kamber, 3rd Edition, 2011, Morgan Kaufmann Publishers Inc, ISBN - 9789380931913.
2.	Introduction to Data Mining, Pang-Ning Tan,Vipin Kumar, Michael Steinbach, 2nd Edition, 2013, Pearson Education Inc., ISBN: 9780133128901
3.	Data Mining and Analysis, Mohammed J Zaki, Wagner Meira JR, 1st edition, 2014, Cambridge University Press, ISBN 978-0-521-76633-3.

4.	Data Mining, Sushmita Mitra, Tinku Acharya, 1st Edition, 2003, John Wiley and Sons, ISBN 0-471-46054-0.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Self-Study(S). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Self-study is 20. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2		1		1							
CO2		3		2								
CO3		3		3								
CO4		3						1				

Low-1 Medium-2 High-3

VI Semester		
3-D METROLOGY **(Group C : Professional Core Elective)**		
Course Code: 16IM6C6		**CIE Marks: 100**
Credits:L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 34L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	Explain the concepts of GD&T.
2	Define the relevance of metrology concepts in Advanced measuring machines.
3	Apply the principles of metrology and measurements in manufacturing industries.

UNIT-I	
Geometrical Dimensioning and Tolerancing: Dimensioning and tolerancing rules and practices: MMC & LMC. Feature control frame. Geometric characteristic symbols, 1982 ANSI Symbols Versus 1994 ASME including 2009 upgrades. Datums, datum reference frame, datum targets, establishing setups for datums. Form and Profile tolerances: straightness, flatness, circularity and cylindricity. Profile of a line and profile of a surface. Orientation. Parallelism, perpendicularity, run out. Location tolerances: position, concentricity.	**07 Hrs**
UNIT-II	
Advanced Metrology : Advanced measuring machines, CNC systems, Laser vision, In-process gauging, 3D metrology, metrology softwares, Nano technology instrumentation, stage position metrology, testing and certification services, optical system design, lens design, coating design, precision lens assembly techniques, complex opto mechanical assemblies, contact bonding and other joining technologies.	**07 Hrs**
UNIT-III	
Co-ordinate Measuring Machines: Introduction: Structure of CMM:, a) Cantilever, b) Bridge, c) Column, d)Horizontal arm, and e) Gantry types. Advantages and Limitations, Probes (Contact/Non-contact)-Touch trigger & Scanning (Active & Passive), Styli, Calibration, Geometry & its interpretation, Construction of features, Interpretation of results.	**07 Hrs**
UNIT-IV	
Automated Inspection: Automated inspection and sensors, Probes and probing systems, Construction and operating principles of typical probes for dimensional and geometrical me asurements, Softwares. Processing data from probing. **Nano-Measurements:** Introduction to nanometric measurement systems, requirements and equipment, Clean rooms. Applications of nanometric technology in mechanical engineering.	**07 Hrs**
UNIT-V	
CAD Interfaces: Working with CAD models for coordinate measuring, Programming with CAD, Simulation, measurement and interpretation of results like detailed printout, custom printout and form & position plots. Applications of CMMs.	**06 Hrs**

Self Study:
Case study, Design and Emerging Technologies to be discussed pertaining to the course. 1 Credit: 4 Hrs / Week. *Plant visits will be a part of this course.

Course Outcomes: After completing the course, the students will be able to	
CO1	Select the appropriate CMM and accessories for a given application.
CO2	Use a standard CMM and software interface to simulate inspection of gears, splines, 2D and 3D surfaces.
CO3	Compare the production process, the product function and the product design, and to select appropriate Techniques and tools for these purposes.

Reference Books	
1.	Engineering Metrology and Measurements N.V. Raghavendra and L. Krishnamurthy, 1st Edition, 2013 Oxford University Press, ISBN 13: 9780198085492
2.	Optical Imaging and Metrology: Advanced Technologies Wolfgang Osten, Nadya Reingand, 1st Edition, 2012, John Wiley and Sons, ISBN: 978-3-527-41064-4
3.	Applied Metrology for Manufacturing, Ammar Grous, 1st Edition, 2013, Print ISBN: 9781848211889
4.	Engineering Metrology, IC Gupta, 7th Edition, 2012, Dhanpat Rai Publications, ISBN-108189928457

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Self-Study(S). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Self-study is 20. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	3	1	2		1					
CO2	2	3	2	2	3		1					
CO3	3	2	2	3	2		1					

Low-1 Medium-2 High-3

VI Semester		
SYSTEMS ENGINEERING **(Group D : Professional Core Elective)**		
Course Code : 16IM6D1		**CIE Marks : 100**
Credits : L: T: P: S: 4:0:0:0		**SEE Marks : 100**
Hours : 44L		**SEE Duration : 03 Hrs**

Course Learning Objectives:

1. Develop an appreciation and understanding of the role of systems engineering processes and systems management in producing products and services.
2. Document systematic measurement approaches for generally cross disciplinary development effort.
3. Discuss capability assessment models to evaluate and improve organizational systems engineering capabilities.

UNIT – I	
System Engineering and the World of Modem System: What is System Engineering?, Origins of System Engineering, Examples of Systems Requiring Systems Engineering, System Engineering viewpoint, Systems Engineering as a Profession, The power of Systems Engineering, problems. **Structure of Complex Systems:** System building blocks and interfaces, Hierarchy of Complex systems, System building blocks, The system environment, Interfaces and Interactions. **The System Development Process:** Systems Engineering through the system Life Cycle, Evolutionary Characteristics of the development process, The system engineering method, Testing throughout system development, problems.	**09 Hrs**
UNIT – II	
Systems Engineering Management: Managing systems development and risks, Work breakdown structure (WBS), System Engineering Management Plan (SEMP), Risk Management, Organization of Systems Engineering, Systems Engineering Capability Maturity Assessment, Systems Engineering standards, Problem. **Needs Analysis:** Originating a new system, Operations analysis, Functional analysis, Feasibility analysis, Feasibility definition, Needs validation, System operational requirements, problems. **Concept Exploration:** Developing the system requirements, Operational requirements analysis, Performance requirements formulation, Implementation concept exploration, Performance requirements validation, problems.	**09 Hrs**
UNIT – III	
Concept Definition: Selecting the system concept, Performance requirements analysis, Functional analysis and formulation, Concept selection, Concept validation, System Development planning, System Functional Specifications, problems **Advanced Development:** Reducing program risks, Requirements analysis, Functional Analysis and Design, Prototype development, Development testing, Risk reduction, problems.	**09 Hrs**
Unit – IV	
Engineering Design: Implementing the System Building blocks, requirements analysis, Functional analysis and design, Component design, Design validation, Configuration Management, problems. **Integration and Evaluation:** Integrating, Testing and evaluating the total system, Test planning and preparation, System integration, Developmental system testing, Operational test and evaluation, problems.	**09 Hrs**
UNIT – V	
Production: Systems Engineering in the factory, Engineering for production, Transition from development to production, Production operations, Acquiring a production knowledge base, problems.	**08 Hrs**

Operations and support: Installing, maintenance and upgrading the system, Installation and test, In-service support, Major system upgrades: Modernization, Operational factors in system development, problems.	

Assignment:
Case study, Design and Emerging Technologies to be discussed pertaining to the course.

Course Outcomes: After completion of course student will be able to	
CO1	Understand the Life Cycle of Systems.
CO2	Explain the role of Stake holders and their needs in organizational systems.
CO3	Develop and Document the knowledge base for effective systems engineering processes.
CO4	Apply available tools, methods and technologies to support complex high technology systems.
CO5	Create the frameworks for quality processes to ensure high reliability of systems.

Reference Books	
1	Systems Engineering – Principles and Practice, Alexander Kossiakoff, William N Sweet, 2nd Edition, 2011, John Wiley & Sons, Inc, ISBN: 978-0470405482
2	Handbook of Systems Engineering And Management, Andrew P. Sage, William B. Rouse, 2nd Edition, 2014, John Wiley & Sons, Inc., ISBN 978-0-470-08353-6
3	General System Theory: Foundations, Development, Applications, Ludwig Von Bertalanffy, Revised edition 2015, George Braziller Inc. ISBN-13: 9780807600153
4	Systems Engineering and Analysis, Blanchard, B and Fabrycky, W. 5th Edition, 2010, Saddle River, NJ, USA: Prentice Hall.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2					1						
CO2			2									
CO3					2							
CO4			2									
CO5	2					2				2		

Low-1 Medium-2 High-3

VI Semester		
COGNITIVE ERGONOMICS **(Group D : Professional Core Elective)**		
Course Code: 16IM6D2		**CIE Marks: 100**
Credits:L:T:P:S: 4:0:0:0		**SEE Marks: 100**
Hours: 44L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	Define the scope of cognitive ergonomics in work system design for productivity improvement.
2	Express the role of cognitive ergonomics in problem solving and decision making.

UNIT-I	
Cognition: information processing models, perception, working memory, long-term memory, situation awareness, problem solving and troubleshooting, met cognition and effort.	**09 Hrs**
UNIT-II	
Decision making: definition, decision making models, heuristics and biases, dependency of decision making on the decision context, factors affecting decision making, improving human decision making.	**09 Hrs**
UNIT-III	
Stress and work load: environmental stressors, psychological stressors, life stress, workload overload, fatigue and sleep disruption.	**09 Hrs**
UNIT-IV	
Human- computer interaction: the troubles with computer and software design, software design cycle, understand system and user characteristics, design using theories and models, design to support mental models with conceptual models, design using principles and guidelines, design of user support, evaluate with usability test and metrics, information technology.	**09 Hrs**
UNIT-V	
Selection and training: personnel selection, performance support and job aids, supporting people with disabilities, training program design.	**08 Hrs**

Assignment:
Case study, Design and Emerging Technologies to be discussed pertaining to the course.

Course Outcomes: After completing the course, the students will be able to	
CO1	Recognize the role of cognitive ergonomics and its areas of application in the work system.
CO2	Explain and apply the cognitive ergonomic concepts in the evaluation of existing systems and design of new systems.
CO3	Demonstrate an understanding of concepts of cognitive ergonomics.

Reference Books	
1.	An Introduction To Human Factors Engineering, Christopher. D. Wickens, John D Lee, Yili Liu, Sallie E Gordon Becker, 2nd Edition, 2011, Pearson, ISBN 978-81-203-4371-9
2.	Introduction to Ergonomics, R S Bridger, 2nd Edition, 2003, Taylor & Francis, ISBN: 0415273781.
3.	Human Factors in Engineering and Design, Mark S. Sanders and Ernest J McCormick, 7th Edition, 1992, McGraw-Hill and Co., Singapore, ISBN 0-07-112826-3.
4.	Handbook of Human Factors and Ergonomics, Gavriel, Salvendy, 3rd Edition, 2006, Wiley, Hoboken, New Jersey, USA, ISBN: 0471116904.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1				1						
CO2	2	1				1						
CO3	1	2	1									

Low-1 Medium-2 High-3

VI Semester		
DESIGN OF EXPERIMENTS **(Group D : Professional Core Elective)**		
Course Code: 16IM6D3		**CIE Marks: 100**
Credits:L:T:P:S: 4: 0: 0:0		**SEE Marks: 100**
Hours: 44L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	Explain the terminology and basic principles of design of experiments.
2	Use ANOVA and effect plots to compute significance of factors and reach conclusions about effect of factors involved.
3	Develop factorial and fractional factorial designs for product and process optimization
4	Use signal to noise ratios to illustrate robust design concepts in process optimization.
5	Select suitable experimental design for engineering applications using orthogonal arrays.

UNIT-I	
Introduction: Strategy of experimentation, applications, Basic principles, Terminology, Guidelines, History of statistical design. **Principles of quality engineering** – Tools used in robust design, Applications and benefits, Quality loss function, Quadratic loss function, Noise factors, P diagram, Optimization of product & process design, Role of various quality control activities.	**08 Hrs**
UNIT-II	
Factorial Experimentation- The 2^2 design, The 2^3 design, The general 2^k design, A single replicate of the 2^k design, The 3^2 design. Problems.	**09 Hrs**
UNIT-III	
Blocking and Confounding in the 2^k Factorial Design: Blocking a replicated 2^k factorial design, Confounding in the 2^k factorial design, Confounding the 2^k factorial design in 2 & 4 blocks. Problems. **Fractiona**l **Factorial Designs:** The one – half fraction & one – quarter fraction of the 2^k design, Resolution III, IV & V designs. Problems.	**09 Hrs**
UNIT-IV	
Constructing Orthogonal Arrays: Counting degrees or freedom, selecting a standard orthogonal array, dummy level technique, and compound factor method. Linear graphs and interaction assignment, modification of linear graphs, column merging method, branching design. Strategy for constructing an orthogonal array. Problems.	**09 Hrs**
UNIT-V	
Steps In Robust Design Case study discussion illustrating steps in Robust Design. **Signal-To-Noise Ratio**: Evaluation of sensitivity to noise. S/N ratios for static problems, S/N ratios for dynamic problems. Analysis of ordered categorical data. Minimizing variability and optimizing averages. **Advanced Techniques:** Taguchi Inner and Outer Arrays. Grey Taguchi Methods, Shainin Techniques, Softwa**re** packages for design of Experiments.	**09 Hrs**

Assignment:
Case study, Design and Emerging Technologies to be discussed pertaining to the course.

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain principles and concepts of design of experiments and quality engineering.
CO2	Illustrate quality engineering and robust design concepts.
CO3	Develop factorial, fractional factorial and orthogonal array designs for product and process optimization
CO4	Conduct experiments and analyse data for product and process improvements.

Reference Books	
1.	Design and Analysis of Experiments, D.C. Montgomery, 5th Edition, 2006, Wiley India, ISBN – 812651048-X.
2.	Quality Engineering Using Robust Design, Madhav S. Phadke, 1989,Prentice Hall PTR, Englewood Cliffs, New Jersey 07632, ISBN: 0137451679.
3.	Designing for Quality – an Introduction Best of Taghuchi and Western Methods or Statistical Experimental Design, Robert H. Lochner, Joseph E. Matar, 1st Edition, 1990, Chapman and Hall, ISBN – 0412400200
4.	Taguchi Techniques for Quality Engineering: Loss Function, Orthogonal Experiments, Parameter and Tolerance Design, Philip J. Ross, 2nd Edition, 1996, McGraw-Hill, ISBN: 0070539588

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2		2	2		1					
CO2	3	2	3	2								
CO3	2	3	2	2								
CO4		2	2	3								

Low-1 Medium-2 High-3

VI Semester		
HUMAN RESOURCE MANAGEMENT & DEVELOPMENT (Group D : Professional Core Elective)		
Course Code: 16IM6D4		**CIE Marks: 100**
Credits:L:T:P:S: 4:0:0:0		**SEE Marks: 100**
Hours: 44L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	Understand the importance of human resource management in present day organizations.
2	Demonstrate the various techniques of recruiting, selecting, developing & appraising employees.
3	Analyze the emerging trends in managing human resources in various organizational contexts.

UNIT-I	
Introduction to Human Resource Management: Objectives of HRM, Importance of HRM, Line & Staff aspects of HRM, Duties & Responsibilities of HRM and Competencies of HRM. **Human Resource Management Strategy:** Strategic Planning & Management Process, Overview of Corporate, Competitive & Functional Strategy and Introduction to Strategic HRM.	**09 Hrs**
UNIT-II	
Job Analysis & Talent Management: Talent Management Process, Basics of Job Analysis, Methods for collecting Job Analysis Information and Writing Job Descriptions & Specifications. **Personnel Planning & Recruiting:** Workforce Planning & Forecasting, Recruitment Process and Internal & External Sources of Candidates.	**09 Hrs**
UNIT-III	
Employee Testing, Selection & Interviewing: Basics of Testing & Selecting Employees, Types of Tests, Work Samples & Simulations, Background Investigation & Other Selection Methods, Basic Types of Interviews and Design & Conduction of An Effective Interview.	**09 Hrs**
UNIT-IV	
Training & Development: Orienting & Onboarding New Employees, Training Process, Implementing Training Program, Implementing Management Development Programs and Evaluating Training Process.	**09 Hrs**
UNIT-V	
Performance Management & Appraisal: Basics of Performance Management & Appraisal, Techniques for Appraising Performance, Managing Appraisal Interview, Talent Management & Employee Appraisal and Overview of Managing Employee Turnover, Retention & Engagement.	**08 Hrs**

Assignment:
Topics such as Employee Relations & Welfare, Labor Relations & Unions, Employee Safety & Health, HR Audit & Accounting, International HRM, Emerging Trends & Challenges in Human Resource Management & Development and other such related areas.

Course Outcomes: After completing the course, the students will be able to	
CO1	Recognize the basic functions, strategy & practices of human resource management.
CO2	Understand the processes of planning & recruitment of employees in organizations.
CO3	Demonstrate the employee selection & interviewing techniques in organizations.
CO4	Analyze the techniques of training & developing human resources in organizations.
CO5	Evaluate the performance appraisal measures prevailing in present day organizations

Reference Books	
1.	Human Resource Management, Gary Dessler & Biju Varkkey, 14th Edition, 2015, Pearson, ISBN: 978-93-325-4219-8.
2.	Human Resources Management, Dr. K Ashwathappa, 5th Edition, 2007, Tata McGraw Hill, ISBN: 0070660204.
3.	Fundamentals of Human Resources Management, David A. Decenzo & Stephen P. Robbins, 8th Edition, 2004, John Wiley India Pvt. Ltd, ISBN: 0471656801.
4.	A Handbook of Human Resource Management Practice, Michael Armstrong, 10th Edition, 2006, Kogan Page, ISBN: 0-7494-4851-2.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1					3	2	1	1			2
CO2		1	1		3	3						
CO3		1	1		3				1	3	2	1
CO4	1	2	2		2							
CO5		2	2		2			1	1	1	2	

Low-1 Medium-2 High-3

VI Semester		
E-COMMERCE **(Group D : Professional Core Elective)**		
Course Code: 16IM6D5		**CIE Marks: 100**
Credits:L:T:P:S: 4: 0: 0:0		**SEE Marks: 100**
Hours: 44L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	Discuss electronic commerce and the stakeholders and their capabilities and limitations in the strategic convergence of technology and business.
2	Appreciate the global nature and issues of electronic commerce as well as understand the rapid technological changes taking place.
3	Identify advantages and disadvantages of technology choices such as merchant server software and electronic payment options
4	Demonstrate awareness of ethical, social and legal aspects of e-commerce

UNIT-I	
Introduction to Electronic Commerce: learning objectives, dot-com era, Amazon.com : Synonymous with E-commerce, Dell: An evolutionary E-commerce, The changing times in E-commerce, Present scenario, Future of E-commerce, Constituents of E-commerce, E-commerce web design, E-business and E-commerce web portals, Case studies.	**08 Hrs**
UNIT-II	
Technologies for E-commerce: learning objectives, Basic architecture of Internet, TCP/IP, Ipv4 versus Ipv6, Evolution of Internet, Uniform resource locator, Hypertext Transfer Protocol, Cookies, Client side or web programming, HTML programming techniques, Links, Images, Tables, Frames, Form, Style sheets, Javascript, Case studies.	**08 Hrs**
UNIT-III	
Concepts in E-commerce: learning objectives, concepts and definitions, Different types of E-commerce, Understanding M-commerce, Factors affecting E-commerce, E-commerce components, E-commerce and consumers, Business transaction through E-commerce, E-commerce applications, E-commerce in developing countries, Role of Govt in development of E-commerce, Regulatory monitoring for E-commerce, Policies for SME's for E-commerce adoption, Case studies.	**09 Hrs**
UNIT-IV	
Understanding E-commerce product design strategy : learning objectives, Benefits of web enabled channels, E-commerce considerations, Case study of dell computers, strategic initiatives by Indian railways, Brand equity through E-commerce. **Channels in E-commerce :** learning objectives, Importance of E-commerce in multichannel marketing, Automation in E-commerce portals, Using E-commerce for order fulfilling in supply chain management, case studies.	**10 Hrs**
UNIT-V	
Future trends: Social commerce : learning objectives, social power and civilization, understanding social commerce, advantages of social commerce, pitfalls, future of social commerce, social commerce challenges in India, case studies. **Drivers of on line-selling diffusion :** Drivers of on line selling B2C, Internet community, technology and legal frame work, business strategy, design of a secure value proposition, empirical study, Interpolation study and trend analysis.	**09 Hrs**

Assignment:
Case study, Design and Emerging Technologies to be discussed pertaining to the course.

Course Outcomes: After completing the course, the students will be able to	
CO1	Appreciate the basic terminologies, methods and procedures used in electronic market and market place.
CO2	Explain Internet trading relationships including Business to Consumer, Business-to-Business, Intra-organizational.
CO3	Analyze features of existing e-commerce businesses, and propose future directions or innovations for specific businesses
CO4	Recognize and discuss global E-commerce issues

Reference Books	
1.	E-commerce Startegy, Sanjay Mahapatra, 1st Edition, 2013, Springer, ISBN: 978-1-4614-4142.
2.	The E-commerce book, Steffano Korper, 2nd Edition, 2000, Academic press, ISBN: 0-12-421161-5,
3.	E-commerce, Kenneth C Laudon, 12th Edition, 2016, Pearson Education, ISBN: 9780133938951
4.	The Economic and Social Impacts of e-commerce, Sam Lubbe, 1st Edition, 2003, Idea Group Publishing, ISBN: 1591400775

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1				3					1		
CO2					3							
CO3		3										
CO4										1		

Low-1 Medium-2 High-3

VI Semester		
USER INTERFACE DESIGN **(Group D : Professional Core Elective)**		
Course Code: 16IM6D6		**CIE Marks: 100**
Credits:L:T:P:S: 4:0:0:0		**SEE Marks: 100**
Hours: 44L		**SEE Duration: 3Hrs**
Course Learning Objectives: The students will be able to		
1	Develop an appreciation for concepts and sensibilities of user interface design	
2	Develop skills in the use and application of specific methods in user interface design.	
3	Improve individual and collaborative skills in design problem solving.	

UNIT-I	
The User Interface—an Introduction and Overview: The Importance of the User Interface, Defining the User Interface, the Importance of Good Design, the Benefits of Good Design, a Brief History of the Human-Computer Interface, Introduction of the Graphical User Interface, A Brief History of Screen Design. Case study: The Blossoming of the World Wide Web.	**08 Hrs**
UNIT-II	
The User Interface Design Process: Obstacles and Pitfalls in the Development Path, Designing for People: The Five Commandments, Usability, Usability Assessment in the Design Process, Common Usability Problems, Some Practical Measures of Usability, Some Objective Measures of Usability, The Design Team.	**08 Hrs**
UNIT-II	
Human Considerations in Design: The User's Knowledge and Experience, the User's Tasks and Needs, The User's Psychological Characteristics, The User's Physical Characteristics. Case studies. **Human Interaction Speeds**: Performance versus Preference, Methods for Gaining an Understanding of Users. Case studies.	**08 Hrs**
UNIT-IV	
The Psychopathology of Everyday Things: The Complexity of Modern Devices, Human-Centered Design, Fundamental Principles of Interaction, the System Image, the Paradox of Technology, The Design Challenge. **The Psychology of Everyday Actions:** How People Do Things: The Gulfs of Execution and Evaluation, The Seven Stages of Action, Human Thought: Mostly Subconscious, Human Cognition and Emotion, The Seven Stages of Action and the Three Levels of Processing, People as Storytellers, Blaming the Wrong Things, Falsely Blaming Yourself, The Seven Stages of Action: Seven Fundamental Design Principles	**10 Hrs**
UNIT-V	
Knowing What to Do: Constraints, Discoverability, and Feedback: Four Kinds of Constraints: Physical, Cultural, Semantic, and Logical, Applying Affordances, Signifiers, and Constraints to Everyday Objects, Constraints That Force the Desired Behavior, Conventions, Constraints, and Affordances, The Faucet: A Case History of Design, Using Sound as Signifiers. **Human Error? No, Bad Design:** Understanding Why There Is Error, Deliberate Violations, Two Types of Errors: Slips and Mistakes, The Classification of Slips, The Classification of Mistakes, Social and Institutional Pressures, Reporting Error, Detecting Error, Designing for Error, When Good Design Isn't Enough, Resilience Engineering, The Paradox of Automation, Design Principles for Dealing with Error.	**10 Hrs**

Assignment:
Case study, Design and Emerging Technologies to be discussed pertaining to the course.

Course Outcomes: After completing the course, the students will be able to	
CO1	Appreciate the importance and benefits of a good design.
CO2	Identify the shortcomings in any design development process and suggest measures to control.
CO3	Understand the differences between usability and user experience
CO4	Explain the need for human factors in design.
CO5	Analyze an interaction design problem and propose a user-centered process, justifying the process and identifying the trade-offs.

Reference Books	
1.	The Essential Guide to User Interface Design, Wilbert O. Galitz, 3rd Edition, 2007, John Wiley & Sons, Inc., ISBN: 0470146222. (first three units)
2.	The design of Everyday Things, Don Norman, 2013, Basic Books Publication, ISBN 978-0-465-00394-5.
3.	Sketching User Experiences: Getting the Design Right and the Right Design, Buxton, B., 1st Edition, 2007, Morgan Kaufmann, eBook ISBN: 9780080552903, Paperback ISBN: 9780123740373
4.	Sketching User Experiences: The Workbook, Greenberg, S., Carpendale, S., Marquart, N., and Buxton B, 1st Edition, 2012, Morgan Kaufmann, ISBN: 978-0-12-381959-8

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1						2	1		1			1
CO2		3	1	2	2			1	1	1		2
CO3						2			1	1		1
CO4			3			2	1					
CO5		2	1	2		2	2	1			2	

Low-1 Medium-2 High-3

VI Semester		
BIOINSPIRED ENGINEERING (Group E: Global Elective)		
Course Code: 16G6E01		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:0		**SEE Marks: 100**
Hours: 36L		**SEE Duration: 3Hrs**

Course Learning Objectives:	
1	To familiarize engineering students with basic biological concepts
2	Utilize the similarities noted in nature for a particular problem to bring inspiration to the designer.
3	Explain applications such as smart structures, self-healing materials, and robotics relative to their bio logical analogs
4	To gain an understanding that the design principles from nature can be translated into novel devices and structures and an appreciation for how biological systems can be engineered by human design

Unit-I	
Introduction to Biology: Biomolecules-Proteins, carbohydrates, lipids and Nucleic acids. Cell types- Microbial, plant, animal.Organ system- Circulatory, digestive, respiratory, excretory and nervous system. Sense organs. Plant process- Photosynthesis.	**06 Hrs**
Unit – II	
Introduction to Biomimetics: Wealth of invention in nature as inspiration for human innovation: Mimicking and inspiration of nature- synthetic life. Nature as a model for structure and tools: Biological clock, honey comb as strong light weight structure. Materials and processes in biology- Spider web, honey bee as a multi-material producer, fluorescent materials in fire flies. Bird and insect as source of inspiring flight. Robotics as beneficiary for biomimetic technologies.	**08 Hrs**
Unit -III	
Biological materials in Engineering mechanisms: Introduction, Comparison of biological and synthetic materials: Silk processing and assembly by insects and spiders- High performance fibers from nature, Seashells- High performance organic and inorganic composites from nature. Shark skin- Biological approaches to efficient swimming via control of fluid dynamics, Muscles- Efficient biological conversion from chemical to mechanical engineering.	**08 Hrs**
Unit –IV	
Biological inspired process and products: Artificial neural networks, genetic algorithms, medical devices. Biosensors. Plant as Bioinspirations: Energy efficiency, Biomimetic super hydrophobic surfaces- lotus leaf effect. Bionic leaf and Photovoltaic cells.	**08 Hrs**
Unit –V	
Implants in Practice: Artificial Support and replacement of human organs-Introduction, Artificial kidney, liver, blood, lung, heart, skin and pancreas. Total joint replacements- Visual prosthesis -artificial eye. Sense and sensors: Artificial tongue and nose, Biomimetic echolation. Limitations of organ replacement systems.	**07 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1:	Remember and explain the fundamentals of Biology
CO2:	Describe the basic principles of design in biological systems.
CO3:	Differentiate biological phenomena to support inspiration for visual and conceptual design problems
CO4:	Create engineered solutions to customer needs utilizing a variety of bio-inspiration techniques.

Reference Books	
1	Jenkins, C.H. Bioinspired Engineering, NY: Momentum press, 2012 ISBN: 97816066502259
2	C.C.Chatterjee, Human Physiology Volume 1 (11th Edition), 2016, ISBN 10: 8123928726 / ISBN 13: 9788123928722
3	Yoseph Bar-Cohen, Biomimetics: Biologically Inspired technologies, 2005, CRC press, ISBN: 9780849331633
4	Donald Voet, Charlotte W. Pratt. Principles of Biochemistry: International Student Version. Wiley John and Sons, 2012. ISBN: 1118092449.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	1	1	1	1	1	1	1	2
CO2	2	1	2	1	1	1	1	1	1	1	1	2
CO3	3	3	3	2	1	1	1	1	1	1	1	3
CO4	3	3	3	1	1	1	1	1	1	1	1	2

High-3 : Medium-2 : Low-1

VI Semester		
GREEN TECHNOLOGY (Group E: Global Elective)		
Course Code: 16G6E02		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:0		**SEE Marks: 100**
Hours: 36L		**SEE Duration: 3Hrs**

Course Learning Objectives:	
1	Learn the tools of green technology
2	Know various forms of renewable energy
3	Study the environmental consequences of energy conversation
4	Understand energy audits and residential energy audit
5	Understand the application of green technology in various industries

Unit-I	
Current Practices and Future Sustainability: Need for green technology, fundamentals of energy and its impact on society and the environment, the mechanics, advantages and disadvantages of renewable energy sources, energy conservation and audits, zero waste technology, life cycle assessment, extended product responsibility, concept of atom economy, tools of Green technology **Cleaner Production:** Promoting cleaner production, benefits and obstacles of cleaner production, cleaner production technologies.	**07 Hrs**
Unit – II	
Solar Radiation and Its Measurement: Solar constant, solar radiation at the earth's surface, solar radiation geometry, solar radiation measurements **Applications of Solar Energy**: Introduction, solar water heating, space-heating (or solar heating of buildings), space cooling (or solar cooling of building), solar thermal electric conversion, agriculture and industrial process heat, solar distillation, solar pumping, solar cooking **Geothermal Energy:** Resource identification and development, geothermal power generation systems, geothermal power plants case studies and environmental impact assessment.	**08 Hrs**
Unit -III	
Energy From Biomass (Bio-Energy): Introduction, biomass conversion technologies, wet Processes, dry Processes, biogas generation, factors affecting biodigestion, types of biogas plants (KVIC model & Janata model), selection of site for biogas plant **Bio Energy (Thermal Conversion):** Methods for obtaining energy from biomass, thermal gasification of biomass, classification of biomass gasifiers, chemistry of the gasification process, applications of the gasifiers.	**07 Hrs**
Unit –IV	
Wind Energy: Introduction, basic components of WECS (Wind Energy Conversion system), classification of WEC systems, types of wind machines (Wind Energy Collectors), horizontal-axial machines and vertical axis machines. **Ocean Thermal Energy**: OTEC-Introduction, ocean thermal electric conversion (OTEC), methods of ocean thermal electric power generation, open cycle OTEC system, the closed or Anderson, OTEC cycle, Hybrid cycle **Energy from Tides**: Basic principles of tidal power, components of tidal power plants, operation methods of utilization of tidal energy, advantages and limitations of tidal power generation	**07 Hrs**

Unit –V	
Hydrogen, Hydrogen Energy: Introduction, methods of hydrogen production (principles only), storage transportation, utilization of hydrogen gas, hydrogen as alternative fuel for motor vehicle, safety and management, hydrogen technology development in India **Application of Green Technology:** Electronic waste management, bioprocesses, green composite materials, green construction technology **Sustainability of industrial waste management:** Case studies on cement industry, iron and steel industry, petroleum sectors, marble and granite industry, sugar industry	**07 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1:	Recall the fundamentals of various forms of energy
CO2:	Explain the principles of various forms of renewable energy
CO3:	Apply the concept of zero waste, atom economy for waste management
CO4:	Create a waste management plan incorporating tools of green technology in various industries

Reference Books	
1	Non-Conventional Energy Sources, G.D.Rai, 5th Edition, 2016, Khanna Publications, ISBN: 8174090738
2	Renewable Energy-Power for a Sustainable Future, Edited by Godfrey Boyle, 3rd Edition, 2012, Oxford University Press, ISBN: 9780199545339
3	Energy Systems and Sustainability: Power for a Sustainable Future, Godfrey Boyle, Bob Everett, and Janet Ramage, 2nd Edition, 2012, Oxford University Press, ISBN: 0199593744
4	Renewable Energy resources , John Twidell and Tony Weir, 3rd Edition, 2015, Routledge publishers, ISBN:0415584388

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

VI Semester		
SOLID WASTE MANAGEMENT (Group E: Global Elective)		
Course Code:16GE6E03		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:0		**SEE Marks: 100**
Hours: 36L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	Impart the knowledge of present methods of solid waste management system and to analyze the drawbacks.
2	Understand various waste management statutory rules.
3	Analyze different elements of solid waste management, design and develop recycling options for biodegradable waste by composting.
4	Identify hazardous waste, e-waste, plastic waste and bio medical waste and their management systems.

UNIT-I	
Introduction: Land Pollution. Scope and importance of solid waste management. Present solid waste disposal methods. Merits and demerits of open dumping, feeding to hogs, incineration, pyrolysis, composting, sanitary landfill. Definition and functional elements of solid waste management. **Sources**: Sources of Solid waste, types of solid waste, composition of municipal solid waste, generation rate, Numerical Problems. **Collection and transportation of municipal solid waste:** Collection of solid waste-services and systems, Municipal Solid waste (Management and Handling) 2000 rules with 2016 amendments. Site visit to collection system.	**08 Hrs**
UNIT-II	
Composting Aerobic and anaerobic composting - process description, process microbiology, Vermicomposting, Site visit to compost plant, Numerical problems. **Sanitary land filling**: Definition, advantages and disadvantages, site selection, methods, reaction occurring in landfill- Gas and Leachate movement, Control of gas and leachate movement, Site visit to landfill site.	**08 Hrs**
UNIT-III	
Hazardous waste management: Definitions, Identification of hazardous waste, Classification of hazardous waste, onsite storage, collection, transfer and transport, processing, disposal, hazardous waste (Management and handling) rules 2008 with amendments. Site visit to hazardous landfill site	**06 Hrs**
UNIT-IV	
Bio medical waste management: Classification of bio medical waste, collection, transportation, disposal of bio medical waste, Bio medical waste (Management and Handling) rules 1998 with amendments. Site visit to hospital to see the collection and transportation system and visit to biomedical waste incineration plant.	**06 Hrs**
UNIT-V	
E-waste management: Definition, Components, Materials used in manufacturing electronic goods, Recycling and recovery integrated approach. E- waste (management and handling) rules 2011.Site visit to e- waste processing facility. **Plastic waste management:** Manufacturing of plastic with norms. Plastic waste management. Plastic manufacture, sale & usage rules 2009 with amendments.	**06 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Understand the existing solid waste management system and to identify their drawbacks.
2	Analyze drawbacks in the present system and provide recycling and disposal options for each type of waste.
3	Distinguish Hazardous waste, Biomedical waste, E waste and to provide scientific management system.

4	Evaluate and monitor the Biomedical waste, Hazardous waste, E waste, Plastic and Municipal waste management as per the rules laid by Ministry of Environment & Forest.

Text Books	
1.	Integrated Solid Waste Management : Engineering principles and management issues George Tchobanoglous, Hilary Theisen , Samuel A Vigil, published by M/c Graw hill Education . Indian edition 2014. ISBN – 13: 978- 9339205249, ISBN-10 : 9339205243
2.	Environmental Engineering, Howard S Peavy, Donald R Rowe and George Tchobanoglous, Tata Mcgraw Hill Publishing Co ltd., 2013, ISBN-13 9789351340263.
3.	Electronic waste management, R.E. Hester, Roy M Harrison,, Cambridge, UK, RSC Publication, 2009, ISBN 9780854041121

Reference Books	
1.	Municipal Solid waste (Management & Handling Rules) 2000. Ministry of Environment & Forest Notification, New Delhi, 25th Sept 2000 and 2016 amendments.
2.	Hazardous waste (management, handling) rules 2008.Ministry of Environment and Forest Notification, New Delhi, 25th February 2009.
3.	Biomedical waste (Management & Handling) rules, 1998. Ministry of Environment and Forest Notification, New Delhi, 20thJuly 1998, and amendment.
4.	E- waste (management and handling) rules 2011.Ministry of Environment and Forest Notification, New Delhi, 12th May 2011.
5.	The Plastic Manufacture, Sale and usage Rules2009. Ministry of Environment and Forest Notification, New Delhi, amendment on February 4, 2011

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	3	1	2	2	2	-	-	-	2
CO2	2	3	1	2	1	2	2	2	1	-	-	2
CO3	2	1	-	2	1	1	2	2	-	-	-	-
CO4	3	-	1	1	-	2	2	2	-	-	-	1

Low-1 Medium-2 High-3

VI Semester		
INTRODUCTION TO WEB PROGRAMMING (Group E: Global Elective)		
Course Code:16G6E04		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:0		**SEE Marks: 100**
Hours: 36L		**SEE Duration: 3 Hrs**

Course Learning Objectives: The students will be able to	
1	Understand the basic concepts used in web programming.
2	Learn the definitions and syntax of different web technologies.
3	Utilize the concepts of JavaScripts, XML and PHP.
4	Design and develop web pages which are quick, easy and well-presented using different techniques such as CSS,XML and JavaScripts.

UNIT-I	
Introduction to Web Concepts Fundamentals of Web, HTML 5 - Core HTML attributes, headings, paragraphs and breaks, divisions and centering, quotations, preformatted text, lists, horizontal rules, block-level elements, text-level elements.XHTML – 1: Internet, WWW, Web Browsers and Web Servers, URLs, MIME, HTTP, Security, the Web Programmers Toolbox. XHTML: Basic syntax, Standard structure, Basic text markup, Images, Hypertext Links.XHTML (continued): Lists, Tables, Forms, Frames.	**07 Hrs**
UNIT-II	
Cascading Style Sheets (CSS): Introduction, Levels of style sheets, Style specification formats, Selector forms, Property value forms, Font properties, List properties, Color, Alignment of text, The box model, Background images, The and tags, Conflict resolution. **The Basics of JavaScript:** Overview of JavaScript; Object orientation and JavaScript; General syntactic characteristics; Primitives, operations, and expressions; Screen output and keyboard input; Control statements	**09 Hrs**
UNIT-III	
JavaScript (continued): Object creation and modification; Arrays; Functions; Constructor; Pattern matching using regular expressions; Errors in scripts. **JavaScript and HTML Documents:** The JavaScript execution environment; The Document Object Model; Element access in JavaScript; Events and event handling; Handling events from the Body elements, Button elements, Text box and Password elements; The DOM 2 event model; The navigator object; DOM tree traversal and modification.	**09 Hrs**
UNIT-IV	
Dynamic Documents with JavaScript: Introduction to dynamic documents; Positioning elements; Moving elements; Element visibility; Changing colors and fonts; Dynamic content; Stacking elements; Locating the mouse cursor; Reacting to a mouse click; Slow movement of elements; Dragging and dropping elements. **Introduction to PHP:** Origins and uses of PHP; overview of PHP; General syntactic characteristics; Primitives, Operations and Expressions; Output; Control statements; Arrays; Functions; Pattern Matching; Form Handling; Files; Cookies; Session Tracking.	**06 Hrs**

UNIT-V	
XML: Introduction; Syntax; Document structure; Document Type definitions; Namespaces; XML schemas; Displaying raw XML documents; Displaying XML documents with CSS; XSLT Style sheets; XML processors; Web services.	**05 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1.	Understand and explore internet related concepts that are vital for web development.
CO2.	Apply HTML tags for designing static web pages and forms using Cascading Style Sheet.
CO3.	Utilize the concepts of XML, JavaScripts along with XHTML for developing web pages.
CO4.	Design and develop web based applications using JavaScripts, CSS, XHTML, PHP and XML.

Reference Books	
1.	Programming the World Wide Web – Robert W. Sebesta, 7th Edition, 2013,Pearson Education, ISBN-13:978-0132665810
2.	Web Programming Building Internet Applications , Chris Bates, 3rd Edition, , 2006, Wiley India, ISBN : 978-81-265-1290-4
3.	Internet & World Wide Web How to H program , M. Deitel, P.J. Deitel, A. B. Goldberg, 3rd Edition,2004, Pearson Education / PHI, ISBN-10: 0-130-89550-4
4.	Thomas A Powell, The Complete Reference to HTML and XHTML, 4th Edition, 2003, Tata McGraw Hill publisher. ISBN: 978-0- 07-222942- 4.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**1**	**-**	**2**	**-**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**1**
CO2	**-**	**-**	**2**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**2**
CO4	**-**	**-**	**3**	**-**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**2**

Low-1 Medium-2 High-3

VI Semester			
AUTOMOTIVE ELECTRONICS (Group E: Global Elective)			
Course Code: 16G6E05			**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:0			**SEE Marks: 100**
Hours:36L			**SEE Duration: 3Hrs**
Course Learning Objectives: The students will be able to			
1	Understand the application of principles of sensing technology in automotive field		
2	Apply control systems in the automotive domain		
3	Understand automotive specific communication protocols / techniques		
4	Analyze fault tolerant real time embedded systems		

UNIT-I	
Power Train Engineering and Fundamentals of Automotive: Fundamentals of Petrol, diesel and gas engines, electric motors and control systems. Basic Automotive System, System Components, Evolution of Electronics in Automotive. Alternators and charging, battery technology, Ignition systems. Working principles of various electronic components and accessories used in Automotive. Developments in existing engine forms and alternatives. Hybrid designs (solar power, electric/gasoline, LPG, CNG, fuel cells). Basic Transmission systems.	**08 Hrs**
UNIT-II	
Sensor Technologies in Automotive: In-vehicle sensors: Working principles, Characteristics, limitations and use within the automotive context of the following: Temperature sensing e g. coolant, air intake. Position sensing e.g. crankshaft, throttle plate. Pressure sensing e.g. manifold, exhaust differential, tyre. Distance sensing e.g. anti-Collision, Velocity sensing e.g. speedometer, anti-skid. Torque sensing e.g. automatic transmission. Vibration sensing e.g. Airbags. flow sensing and measurement e.g. fuel injection. Interfacing principles: Operation, topologies and limitations of all sensors covered in the above to in-vehicle processing or communications nodes. Use of Actuators: Types, working principle, Characteristics, limitations and use within the automotive context of each type.	**07 Hrs**
UNIT-III	
Automotive Control Systems: Control system approach in Automotive: Analog and Digital control methods, stability augmentation, control augmentation. Transmission control, System components and functions. Cruise control, traction control, actuator limiting, wind-up, gain scheduling, adaptive control. Special Control Schemes: Vehicle braking fundamentals, Antilock systems. Variable assist steering and steering control. Controls for Lighting. Wipers, Air conditioning /heating. Remote keyless Entry and Anti-theft System, Emission Course-system control. Control techniques used in hybrid system. Electronic Engine control: Motion equations, modeling of linear and non-linear systems, numerical methods, system responses Objective of Electronic Engine control. Spark Ignition and Compression Ignition Engines and their electronic controls. Engine management testing: Engine management system strategies and implementation. Simulation and implementation methods. Methods of improving engine performance and efficiency. Model Based Development (MBD) Technology. AUTOSAR: Objectives and Architecture.	**07 Hrs**
UNIT-IV	
Automotive Communication Systems: Communication interface with ECU's: Interfacing techniques and interfacing with infotainment gadgets. Relevance of internet protocols, such as TCP/IP for automotive applications. Wireless LANs standards, such as Bluetooth, IEEE802.11x. Communication protocols for automotive applications. Automotive Buses: Use of various buses such as CAN, LIN, Flex Ray. Recent trends in automotive buses (Such as OBDI1. MOST, IE, IELI.I, D2B and DSI). Application of Telematics in	**07 Hrs**

Automotive: Global Positioning Systems (GPS) and General Packet Radio Service (GPRS), for use in an automotive environment. Vehicle to Vehicle Communication Higher End Technology: Comparative Study and applications of ARM Cortex-Ascries/M-scries. ARM 9 and ARM11.	
UNIT-V	
Diagnostics and Safety in Automotive: Fundamentals of Diagnostics: Basic wiring system and Multiplex wiring system. Preliminary checks and adjustments, Self-Diagnostic system. Fault finding and corrective measures. Electronic transmission checks and Diagnosis, Diagnostic procedures and sequence. On board and off board diagnostics in Automotive. Safety in Automotive: Safety norms and standards. Passenger comfort and security systems. Future trends in Automotive Electronics.	**07 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1:	Acquire the knowledge of automotive domain fundamentals and need of electronics in Automotive systems
CO2:	Apply various sensors and actuators for Automotive applications
CO3:	Analyze different control systems and communication interfaces used in automotive systems.
CO4:	Evaluate the performance of telematics Diagnostics and safety norms in Automotive Systems.

Reference Books	
1.	Understanding Automotive Electronics, Williams. B. Ribbens, 6th Edition, 2003, Elsevier science, Newness publication, ISBN-9780080481494.
2.	Automotive Electronics Handbook, Robert Bosch, 2004, John Wiley and Sons,
3.	Automotive Embedded Systems Handbook, Nicolas Navet, F Simonot-Lion, Industrial Information Technology Series, CRC press.
4.	Automotive Control Systems Engine, Driveline and vehicle, Uwekiencke and lars Nielsen, Springer, 2nd Edition, 2005, ISBN 0-387-95368X

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and Self-Study(S). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Self-study is 20. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**1**	**2**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**1**
CO2	**3**	**2**	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**1**
CO3	**3**	**2**	**2**	**1**	**-**	**1**	**-**	**-**	**2**	**-**	**1**	**1**
CO4	**3**	**1**	**2**	**1**	**2**	**1**	**-**	**-**	**1**	**-**	**-**	**-**

Low-1 Medium-2 High-3

VI Semester		
INDUSTRIAL ELECTRONICS (Group E: Global Elective)		
Course Code: 16G6E06		**CIE Marks:** 100
Credits: L:T:P:S: 3:0:0:0		**SEE Marks:** 100
Hours: 36L		**SEE Duration:** 3Hrs

Course Learning Objectives: The students will be able to	
1	Explain the working of the devices used in power electronic circuits in industrial applications
2	Analysing and designing power electronic circuits which handle the electrical energy efficiently and economically and Identify the typical practical problems with industrial exposure acquired
3	Use basic concepts of design and working of electronic circuits for conversion and control of electrical energy.
4	Apply the knowledge to work as part of teams on multidisciplinary projects and to discuss industrial problems with regard to application of Power Electronics.

Unit-I	
Power semi-conductor Devices and static characteristics: Construction, working & characteristics of MOSFET, SCR, IGBT. Comparison of Power BJT, MOSFET, SCR, IGBT. Turn on methods of Power BJT, MOSFET and IGBT. Design of R, R-C, and UJT (pulse train) Gate triggering methods of SCR.	**08 Hrs**
Unit-II	
Thyristor Dynamic characteristics, Specifications and Protection: Gate characteristics of SCR, Dynamic characteristics of SCR. Design of Snubber circuit for SCR, Line Commutation and Forced Commutation circuits with design, Gate protection & overvoltage protection of SCR.	**07 Hrs**
Unit-III	
Converters: Single Phase Controlled Convertor- Full wave Half and Fully controlled line commutated bridge converters, Derivation of average load voltage and current. Three phase converters – Six pulse converters- with R load- Active inputs to the convertors with and without Freewheeling diode, Derivation of average load voltage and current. **Converter applications:** Industrial Applications of Half and Fully controlled converters to DC drives (Control of DC drives)	**06 Hrs**
Unit-IV	
Choppers – Step down, Step up Chopper, Step up/Down Chopper, Time ratio control and Current limit control strategies –Derivation of load voltage and currents with R, RL of Step down, Step up Chopper, Step up/Down Chopper – load voltage expression. Application of choppers to subway cars, Industrial drives , battery operated vehicles.	**07 Hrs**
Unit-V	
Classification of Choppers and Applications: Type A, Type B, Type C, Type D, Type E choppers and their industrial Applications, AC Chopper –phase control type. Inverters – Single phase inverter – Basic series inverter – Basic parallel Capacitor inverter, bridge inverter(single phase) – Voltage control techniques for inverters Pulse width modulation techniques. – UPS-online, offline (Principle of operation only	**08 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the comprehensive working of different devices and their applications.
CO2:	Analyze the application of skills in controlling and conversion of electrical energy.
CO3:	Evaluate and distinguish the performance of converters and inverters.

CO4:	Ability to implement their knowledge and skills in design of applications.

Reference Books	
1.	"Power Electronics", M. D. Singh & K. B. Kanchandhani, Tata Mc Graw – Hill Publishing company, ISBN : 978-0-07-058389-4, 2008
2.	"Power Electronics : Circuits, Devices and Applications",M. H. Rashid, Prentice Hall of India, 2nd Edition, ISBN : 0131228153, 9780131228153, 2004
3.	"Power Electronics", P.C. Sen, Tata McGraw-Hill Publishing, ISBN: 978-0-07-462400-5, 2008.
4	"Power Electronics"P S Bimbra P.S Bimbra ,Khanna Publication ,ISBN:978-7409-279-3,5th Edition.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO 12**
CO1	3	2	2	2	1	2	2	1	1	2		1
CO2	3	2	2	3	3		1				2	1
CO3	3	2	2	3	2	2		1			1	2
CO4	3	3	3	3	2	3	2		1			1

High-3: Medium-2: Low-1

VI Semester		
PROJECT MANAGEMENT (Group E: Global Elective)		
Course Code : 16G6E07		**CIE Marks : 100**
Credits : L: T: P: S:3:0:0:0		**SEE Marks : 100**
Hours : 33L		**SEE Duration : 03 Hrs**
Course Learning Objectives: The students will be able to		
1.	To understand the principles and components of project management.	
2.	To appreciate the integrated approach to managing projects.	
3.	To explain the processes of managing project cost and project procurements.	

Unit – I	
Introduction: What is project, what is 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.	**06 Hrs**
UNIT – II	
Organizational influences & Project life cycle: Organizational influences on project management, project state holders & governance, project team, project life cycle. **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.	**08 Hrs**
UNIT – III	
Project Scope Management: Project scope management, collect requirements define scope, create WBS, validate scope, control scope. **Project Time Management:** Plan schedule management, define activities, sequence activities, estimate activity resources, estimate activity durations, develop schedule, control schedule.	**07 Hrs**
UNIT – IV	
Project Cost management: Project Cost management, estimate cost, determine budget, control costs. **Project Quality management:** Plan quality management, perform quality assurance, control quality.	**06 Hrs**
UNIT – V	
Project Risk Management: Plan risk management, identify risks, perform qualitative risk analysis, perform quantitative risk analysis, plan risk resources, control risk. **Project Procurement Management:** Project Procurement Management, conduct procurements, control procurements, close procurement.	**06 Hrs**

Course Outcomes: After going through this course the student will be able to	
CO1	Understand the concepts, tools and techniques for managing large projects.
CO2	Explain various sub processes in the project management frameworks.
CO3	Analyze and evaluate risks in large and complex project environments.
CO4	Develop project plans for various types of organizations.

Reference Books:
1. A Guide to the Project Management Body of Knowledge(PMBOK Guide), Project Management Institute, 5th Edition, 2013, ISBN: 978-1-935589-67-9
2. Project Planning Analysis Selection Financing Implementation & Review, Prasanna Chandra, 7th Edition, 2010, Tata McGraw Hill Publication, ISBN 0-07-007793-2.

3. Project Management A System approach to Planning Scheduling & Controlling, Harold Kerzner, 10th Edition, 2009, CBS Publishers and Distributors, ISBN 047027806.
4. Strategic Project Management Made Simple: Practical Tools for Leaders and Teams, Terry Schmidt, 1st Edition, 2009, John Wiley & Sons, ISBN: 978-0470411582

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2											
CO2	2	2		1	1							
CO3							1	1				
CO4	2		3		1							

Low-1 Medium-2 High-3

VI Semester		
VIRTUAL INSTRUMENTATION (Group E: Global Elective)		
Course Code:16G6E08		**CIE Marks: 100**
Credits/Week: L:T:P:S: 3:0:0:0		**SEE Marks: 100**
Hours:35L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	Understand the difference between conventional and graphical programming, basic data acquisition concepts.
2	Differentiate the real time and virtual instrument.
3	Develop ability for programming in LabVIEW using various data structures and program structures.
4	Analyze the basics of data acquisition and learning the concepts of data acquisition with LabVIEW.

UNIT-I	
Graphical Programming Environment: Basic of Virtual Instrumentation, Conventional and Graphical Programming. Introduction to LabVIEW, Components of LabVIEW and Labels. **Fundamentals:** Data Types, Tool Pallets, Arranging Objects, Color Coding, Code Debugging, Context Help, Creating Sub-VIs Boolean, Mechanical action- switch, and latch actions, String data types, enum, ring, Dynamics.	**06 Hrs**
UNIT-II	
Fundamentals of Virtual Instrumentation Programming: For Loop, While Loop, shift registers, stack shift register, feedback node, and tunnel. **Timing function**: Timing VI, elapsed time, wait function. Case structures, formula node, Sequence structures, Arrays and clusters, visual display types- graphs, charts, XY graph. Local and Global variables.	**09 Hrs**
UNIT-III	
Error Handling- error and warning, default error node, error node cluster, automatic and manual error handling. **String Handling:** Introduction, String Functions, LabVIEW String Formats. **File Input/ Output:** Introduction, File Formats, File I/O Functions and file Path functions. **Design patterns:** Producer/consumer, event handler, derived design pattern, Queued message handler, Producer/consumer (events), Producer/consumer (state machine).	**08 Hrs**
UNIT-IV	
Data Acquisition: Introduction to data acquisition, Analog Interfacing Connecting signal to board, Analog Input/output techniques digital I/O, counters, NI-DAQmx tasks. **DAQ Hardware configuration:** Introduction, Measurement and Automation Explorer, DAQ Assistants, Analysis Assistants. **Interfacing Instruments: GPIB and RS232:** Introduction, RS232 Vs. GPIB, Handshaking, GPIB Interfacing, RS232C/RS485 Interfacing, and VISA.	**06 Hrs**
UNIT-V	
Advanced Topics In LabVIEW: Use of analysis tools and application of VI: Fourier transforms Power spectrum, Correlation methods, windowing & filtering. Inter-Process Communication, Notifier, Semaphore, Data Sockets. **Simulation of systems using VI:** Development of Control system, Image acquisition and processing.	**06 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1:	Remember and Understand the fundamentals of Virtual Instrumentation and data Acquisition.
CO2:	Apply the theoretical concepts to realize practical systems.
CO3:	Analyze and evaluate the performance of Virtual Instrumentation Systems.
CO4:	Create a VI system to solve real time problems using data acquisition.

Reference Books	
1	Virtual instrumentation Using LabVIEW, Jovitha Jerome, 4th Edition, 2010, PHI Learning Pvt. Ltd., ISBN: 978-812034035.
2	Virtual Instrumentation Using LabVIEW, Sanjay Gupta & Joseph John, 2nd Edition, New Delhi, 2010,Tata McGraw Hill Publisher Ltd., ISBN: 978-0070700284
3	LabVIEW for Everyone: Graphical Programming made easy and fun,Jeffrey Travis, Jim Kring, 3rd Edition, 2006, Prentice Hall,ISBN: 978-0131856721.
4	Data Acquisition using LabVIEW,Behzad Ehsani, 1st Edition,2017, Packt Publishing, ISBN: 978-1782172161.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marksis executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO MAPPING												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**1**	**1**	**1**	**2**	**-**	**-**	**-**	**2**	**2**	**-**	**1**
CO2	**1**	**1**	**1**	**1**	**2**	**-**	**-**	**-**	**2**	**2**	**-**	**1**
CO3	**1**	**-**	**1**	**1**	**2**	**-**	**-**	**-**	**2**	**2**	**-**	**1**
CO4	**2**	**1**	**1**	**2**	**3**	**-**	**-**	**-**	**2**	**2**	**-**	**2**

Low-1 Medium-2 High-3

VI Semester		
INTRODUCTION TO MOBILE APPLICATION DEVELOPMENT (Group E: Global Elective)		
Course Code: 16G6E09		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:0		**SEE Marks: 100**
Hours : 36L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	Learn Android application development platform for mobile devices and use it.
2	Understand mobile application architecture and its components.
3	Define Android specific programming concepts such as activities, intents, fragments, services, broadcast receivers and content providers.
4	Describe sensors like motion sensors, environmental sensors, and positional sensors; most commonly embedded in Android devices along with their application programming interface.

UNIT I	
Overview of Software platforms and Development: Mobile OS: Android development platform and tools, Programming language, Emulator, SDK and Development Environments **Creating Applications and Activities:** Introducing the Application Manifest File; Creating Applications and Activities; Architecture Patterns (MVC); Android Application Lifecycle.	**07 Hrs**
UNIT II	
User Interface Design: Fundamental Android UI Design; Introducing Layouts; Introducing Fragments. **Intents and Broadcasts**: Introducing Intents; Creating Intent Filters and Broadcast Receivers.	**07 Hrs**
UNIT III	
Database and Content Providers: Introducing Android Databases; Introducing SQLite; Content Values and Cursors; Working with SQLite Databases; Creating Content Providers; Using Content Providers; Case Study: Native Android Content Providers.	**07 Hrs**
UNIT IV	
Location Based Services, Telephony and SMS: Using Location-Based Services; Using the Emulator with Location-Based Services; Selecting a Location Provider; Using Proximity Alerts; Using the Geocoder; Example: Map-based activity; Hardware Support for Telephony; Using Telephony; Introducing SMS and MMS.	**08 Hrs**
UNIT V	
Hardware Support and Devices (AUDIO, VIDEO, AND USING THE CAMERA): Using Sensors and the Sensor Manager; Monitoring a Device's Movement and Orientation; Introducing the Environmental Sensors; Playing Audio and Video; Using Audio Effects; Using the Camera; Recording Video	**07 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1:	Assess the basic framework and usage of SDK to build GUI and apply advanced technologies in developing Android mobile applications.
CO2:	Differentiate techniques for persisting user data, such as shared preferences, traditional file systems (internal and external storage), and SQLite database
CO3:	Articulate the communication programming features and capabilities of Android platforms.
CO4:	Design and create innovative, sophisticated mobile applications using Android platform.

Reference Books	
1.	Professional Android 4 Application Development, Reto Meier, WROX Press, 2012, Wiley Publishing, ISBN: 9781118102275
2.	Android Application Development: Programming with the Google SDK, John Lombardo, Blake Meike, Rick Rogers and Zigurd Mednieks, 2009, O'Reilly Media, Inc. ISBN: 9788184047332
3.	Hello Android, Introducing Google's Mobile Development Platform, Ed Burnette, 3rd Edition, Pragmatic Programmers, LLC.ISBN: 9781934356562
4.	Android Studio Development Essentials - Android 6, Neil Smyth, 2015, Createspace Independent Publishing Platform, ISBN: 9781519722089

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Self-Study(S). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Self-study is 20. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	3	-	-	3	-	-	-	-	-	-	2
CO2	3	3	3	-	3	1	-	-	-	2	-	2
CO3	-	3	3	-	3	2	-	-	-	2	1	3
CO4	3	3	3	2	3	2	2	2	2	2	1	3

Low-1 Medium-2 High-3

VI Semester		
AUTOMOTIVE ENGINEERING (Group E: Global Elective)		
Course Code: 16G6E10		**CIE Marks: 100**
Credits: L:T:P:S 3:0:0:0		**SEE Marks: 100**
Hours: 36L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	Identify the different sub-systems in automobiles.
2	Describe the functions of each of the sub-systems and its effect.
3	Discuss fuel injection, transmission, braking, steering, suspension, air intake and exhaust systems.
4	Explain the importance of selection of suitable sub-system for a given performance requirement.

UNIT-I	
Automobile Engines Classifications of Internal Combustion Engines based on no. of cylinders, Arrangement of cylinders, Type of fuel and no. of strokes**.** Engine construction and nomenclature. Thermodynamic principles of Otto and Diesel cycle. Operation in a 4 stroke engine. Direct and indirect injection. Combustion stages in engines. Fuels: Gasoline, Diesel, LPG and Natural Gas For automotive applications. Fuel properties- Octane number and Cetane number. Pollutants and Emission norms- Regulated pollutants and its effects, Regulations as per emission norms.	**06 Hrs**
UNIT-II	
Engine Auxiliary Systems: AirIntake and Exhaust System- Working principle ofAir filters, Intake manifold, Turbocharger, Intercooler, Exhaust manifold, Catalytic convertor, Exhaust Gas Recirculation system, Muffler. Cooling system- Components, working principle, Coolant. Lubrication system- Components, Properties of lubricating oil, Viscosity numbers. Fuel system- Working principle of Fuel Injection Pump, Injector, Nozzle, Fuel filter. Working of ignition system, Battery, Immobilizer.	**08 Hrs**
UNIT-III	
Transmission: Clutch- Classification and working, Gear box- Classification, Working of sliding mesh and Synchromesh transmission, Automatic transmission. Propeller shaft, Differential assembly and rear axle- Working. Wheels and Tyres- Wheel alignment and balancing classification of tyres, Radial, Tubeless.	**08 Hrs**
UNIT-IV	
Vehicular Auxiliary Systems: Suspension- Front and rear suspension working, Types of springs. Brake- Classification and Components - Disc and drum brakes, Hydraulic, parking brake, Front and rear wheel brakes. Antilock Braking Systems. Steering- components and operation of power steering. Vehicle frame and body classification- Hatchback, Sedan, SUV. Safety systems- Passive safety systems, Active safety systems- Principle of Electronic Stability Program, Air bags, Crash testing methods.	**06 Hrs**
UNIT-V	
Demonstrations of Automobile Systems: Engine performance measurement in terms of Brake power, Emission measurement and principle, Drawing Valve Timing Diagram for multi-cylinder engine, Production and properties of biodiesel.	**06 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe the different types of automotive systems. (L1- L2)
CO2	Construct the Valve Timing Diagram for multi-cylinder engines. (L3)
CO3	Detect the automotive exhaust pollutants using gas analyzer. (L4)
CO4	Evaluate the performance of engines by determining Brake Power. (L6)

Reference Books	
1.	Automotive Engineering Fundamentals, Richard Stone and Jeffrey K. Ball, 2004 , SAE International , ISBN: 0768009871
2.	Bosch Automotive Handbook, Robert Bosch, 9th Edition, 2004, ISBN: 9780768081527.
3.	Automotive Engineering e-Mega Reference, David Crolla, Butterworth-Heinemann, 1st Edition , 2009 , ISBN: 9781856175784.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**1**	**1**		**1**			**2**		**2**			**1**
CO2		**2**										
CO3		**2**	**1**			**2**		**1**			**2**	**1**
CO4	**2**	**2**	**1**	**1**	**1**	**1**	**2**	**1**	**1**	**2**	**2**	

Low-1 Medium-2 High-3

VI Semester		
MOBILE NETWORK SYSTEMS AND STANDARDS (Group E: Global Elective)		
Course Code: 16G6E11		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:0		**SEE Marks: 100**
Hours: 34L		**SEE Duration: 03Hrs**

Course Learning Objectives: The students will be able to	
1	Understand land mobile concepts, radio link design and cellular network.
2	Compare the standards of WPAN, WLAN and WMAN.
3	Analyze WPAN, WLAN and WMAN standards and their architecture.
4	Design and demonstrate wireless networks for various applications.

UNIT-I	
Cellular Wireless Networks: Principles of cellular Networks, cellular system components and Operations, channel assignment, Attributes of CDMA in cellular system.	**06 Hrs**
UNIT-II	
Second generation Cellular Networks: GSM architecture, IS-95, GPRS, EDGE.	**08 Hrs**
UNIT-III	
Third generation cellular systems: WCDMA, IMT 2000 and LTE, Convergence in the network.	**06 Hrs**
UNIT-IV	
Wireless Personal Area Networks: Network architecture, components, Applications, Zigbee, Bluetooth. **Wireless Local Area networks:** Network Architecture, Standards, Applications.	**08 Hrs**
UNIT-V	
Wireless Metropolitan Area Networks: IEEE 802.16 standards, advantages, WMAN Network architecture, Protocols, Applications.	**06 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe the architectures and characteristics of different mobile networks. (L1- L2)
CO2	Apply the Network standards to a suitable application (L3)
CO3	Analyze the operation of various network technologies and standards (L4)
CO4	Evaluate the performance of various network technologies (L5)

Reference Books	
1	Wireless Communication, Upena Dalal, 1st Edition , 2009, Oxford higher Education, ISBN-13:978-0-19-806066-6.
2	Wireless and Mobile Networks Concepts and Protocols, Dr. sunil Kumar s Manvi, 2010, Willey India Pvt. Ltd., ISBN: 978-81-265-2069-5.
3	Wireless Communications Principles and practice, Theodore S Rappaport, 2nd Edition, Pearson, ISBN 97881-317-3186-4.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2		2			2		2		1
CO2	3	3	2		2			2		2		1
CO3	3	3	3		2			2		2		2
CO4	3	3	3		3			2		2		2

Low-1 Medium-2 High-3

VI Semester		
APPLIED PARTIAL DIFFERENTIAL EQUATIONS (Group E: Global Elective)		
Course Code:16G6E12		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:0		**SEE Marks: 100**
Hours: 35L		**SEE Duration: 3Hrs**

Course Learning Objectives:

1	Adequate exposure to learn basics of partial differential equations and analyze mathematical problems to determine the suitable analytical technique.
2	Use analytical techniques and finite element technique for the solution of elliptic, parabolic and hyperbolic differential equations.
3	Solve initial value and boundary value problems which have great significance in engineering practice using partial differential equations.
4	Identify and explain the basics of partial differential equations and use the same to analyze the behavior of the system.

Unit-I	
Partial Differential Equations of first order: Introduction to formation of partial differential equations, Cauchy problem, Orthogonal surfaces, First order non-linear partial differential equations-Charpit's method, Classification and canonical forms of partial differential equations.	**07 Hrs**
Unit – II	
Elliptic Differential Equations: Derivation of Laplace and Poisson equation, Separation of variable method, Dirichlet problem, Neumann problem, Solution of Laplace equation in cylindrical and spherical coordinates.	**07 Hrs**
Unit -III	
Parabolic Differential Equations: Formation and solution of Diffusion equation, Dirac-Delta function, Separation of variable method, Solution of Diffusion equation in cylindrical and spherical coordinates.	**07 Hrs**
Unit –IV	
Hyperbolic Differential Equations: Formation and solution of one dimensional wave equation, D'Alembert's solution, vibrating string, Forced vibration, Periodic solution of one dimensional wave equation in cylindrical and spherical coordinates, Vibration of Circular membrane.	**07 Hrs**
Unit –V	
Numerical solutions of Partial Differential Equations: Finite difference method for Elliptic, Parabolic and Hyperbolic partial differential equations, Introduction to the finite element method-simple problems.	**07 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1:	Identify and interpret the fundamental concepts of formation and solution of parabolic, hyperbolic and elliptic differential equations using analytical and numerical methods.
CO2:	Apply the knowledge and skills of analytical and numerical methods to solve the parabolic, hyperbolic and elliptic differential equations arising in the field of science and engineering.
CO3:	Analyze the physical problem to establish mathematical model and use appropriate method to solve and optimize the solution using the appropriate governing equations.
CO4:	Distinguish the overall mathematical knowledge to demonstrate and analyze the solution of parabolic, hyperbolic and elliptic differential equations arising in practical situations.

Reference Books	
1	Partial Differential Equations, K. Sankara Rao, Prentice-hall of India, 3rd Edition, 2012, ISBN: 978-81-203-3217-1.
2	Advanced Engineering Mathematics, Erwin Kreyszig, Wiley, 10th Edition, 2016, ISBN: 978-81-265-5423-2.
3	Numerical methods for scientific and engineering computation, M K Jain, S. R. K. Iyengar, R. K. Jain, New Age International Publishers, 6th Edition, 2012, ISBN-13: 978-81-224-2001-2.
4	An Introduction to the finite element method, J. N. Reddy, McGraw Hill, 3rd Edition, 2005, ISBN 13: 9780072466850.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO2	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**2**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO4	**3**	**3**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**

High-3: Medium-2: Low-1

VI Semester		
AIRCRAFT SYSTEMS (Group E: Global Elective)		
Course Code: 16GE6B13		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:0		**SEE Marks: 100**
Hours: 36L		**SEE Duration: 3Hrs**

Course Learning Objectives: To enable the students to	
1	List the various systems involved in the design of an aircraft
2	Demonstrate the technical attributes of all the subsystems of an aircraft
3	Explain the significance of each systems and its subsystems for developing an airplane
4	Demonstrate the integration of the systems with the airplane

Unit-I	
Flight Control Systems : Primary and secondary flight controls, Flight control linkage system, Conventional Systems, Power assisted and fully powered flight controls.	**07 Hrs**
Unit – II	
Aircraft Hydraulic & Pneumatic Systems : Components of a typical Hydraulic system, Working or hydraulic system, Power packs, Hydraulic actuators. Pneumatic system and components, Use of bleed air, Landing gear and braking, Shock absorbers-Retraction mechanism.	**08 Hrs**
Unit -III	
Aircraft Fuel Systems : Characteristics of aircraft fuel system, Fuel system and its components, Gravity feed and pressure feed fuel systems, Fuel pumps-classification, Fuel control unit.	**07 Hrs**
Unit -IV	
Environmental Control Systems : Air-conditioning system, vapour cycle system, de-icing and anti-icing system, Fire detection- warning and suppression. Crew escape aids. **Engine Systems :** Engine starting sequence, Starting and Ignition systems, Engine oils and a typical lubricating system.	**07 Hrs**
Unit -V	
Aircraft Instruments : Instruments displays, panels & layouts, Instrumentation grouping, Navigation instruments, Radio instruments, Hydraulic and Engine instruments. **Air Data Instruments :** Basic air data system and probes, Mach meter, Air speed indicator, Vertical speed indicator, Barometric pressure sensing, Altimeter, Air data alerting system- angle of attack sensing, stall warning, Mach warning, altitude alerting system.	**07 Hrs**

Course Outcomes: At the end of this course the student will be able to :	
CO1	Categorise the various systems required for designing a complete airplane
CO2	Comprehend the complexities involved during development of flight vehicles.
CO3	Explain the role and importance of each systems for designing a safe and efficient flight vehicle
CO4	Demonstrate the different integration techniques involved in the design of an air vehicle

Reference Books	
1	John D. Anderson, Introduction to Flight, 7th Edition, 2011, McGraw-Hill Education, ISBN 9780071086059.
2	Moir, I. and Seabridge, A.,Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration, 3rd Edition, 2008, Wiley Publications, ISBN- 978-0470059968

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

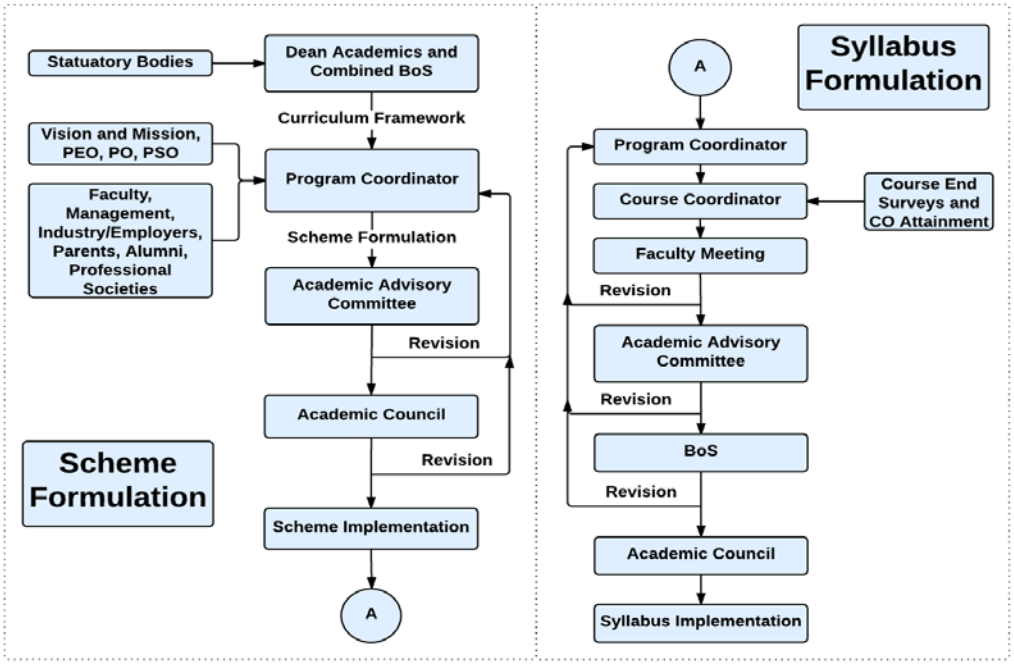
Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

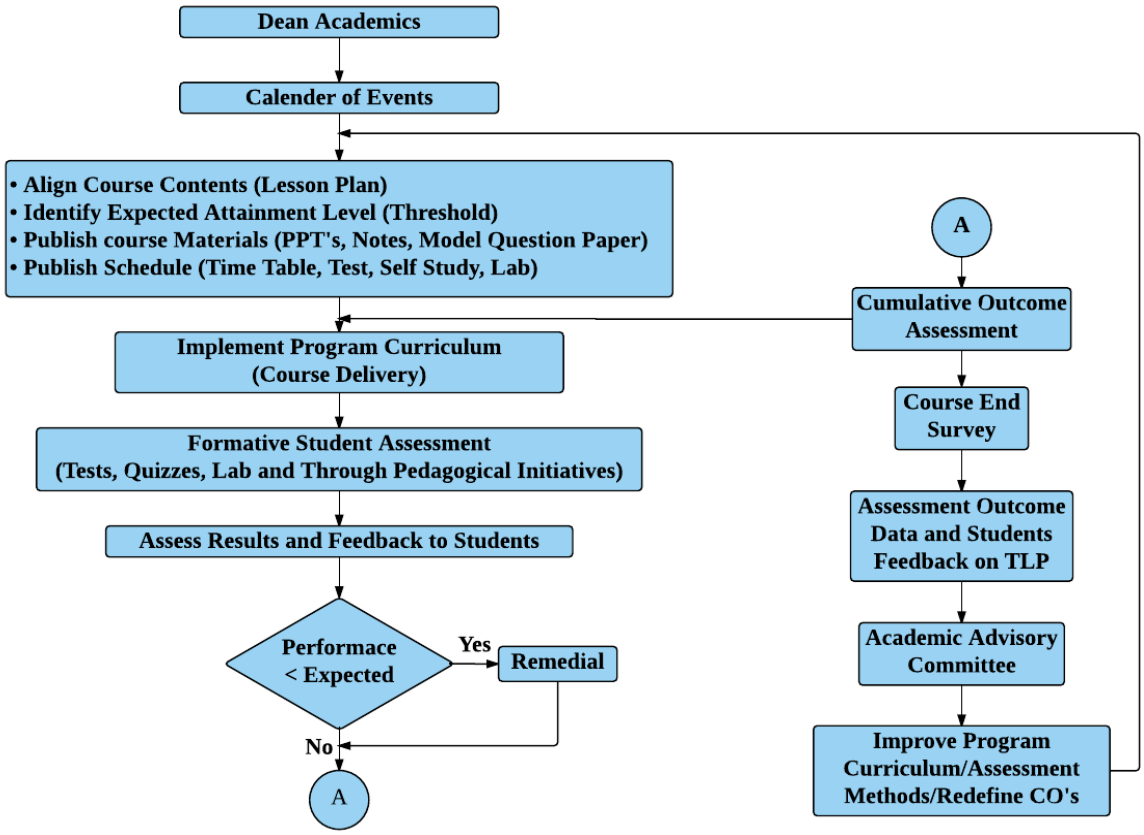
CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**1**	**1**	**3**	**2**	**2**				**1**
CO2	**2**	**3**	**3**	**3**	**1**	**1**	**1**	**1**				**1**
CO3	**2**	**2**	**3**	**3**	**1**							**2**
CO4	**3**	**3**	**3**	**3**	**1**	**2**	**1**	**2**				**1**

High-3 : Medium-2 : Low-1

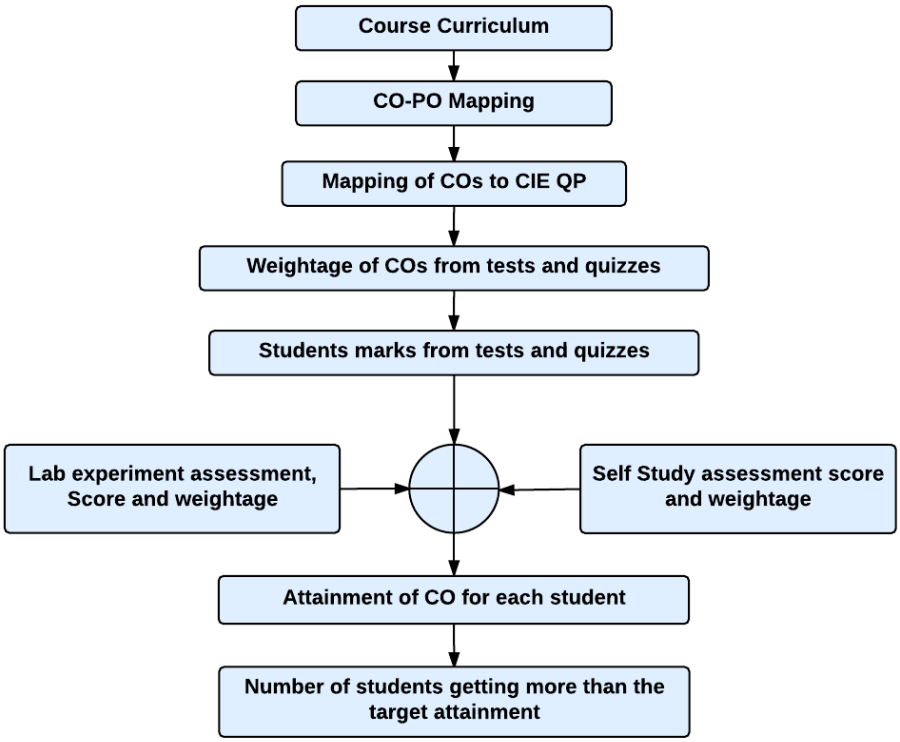
Curriculum Design Process



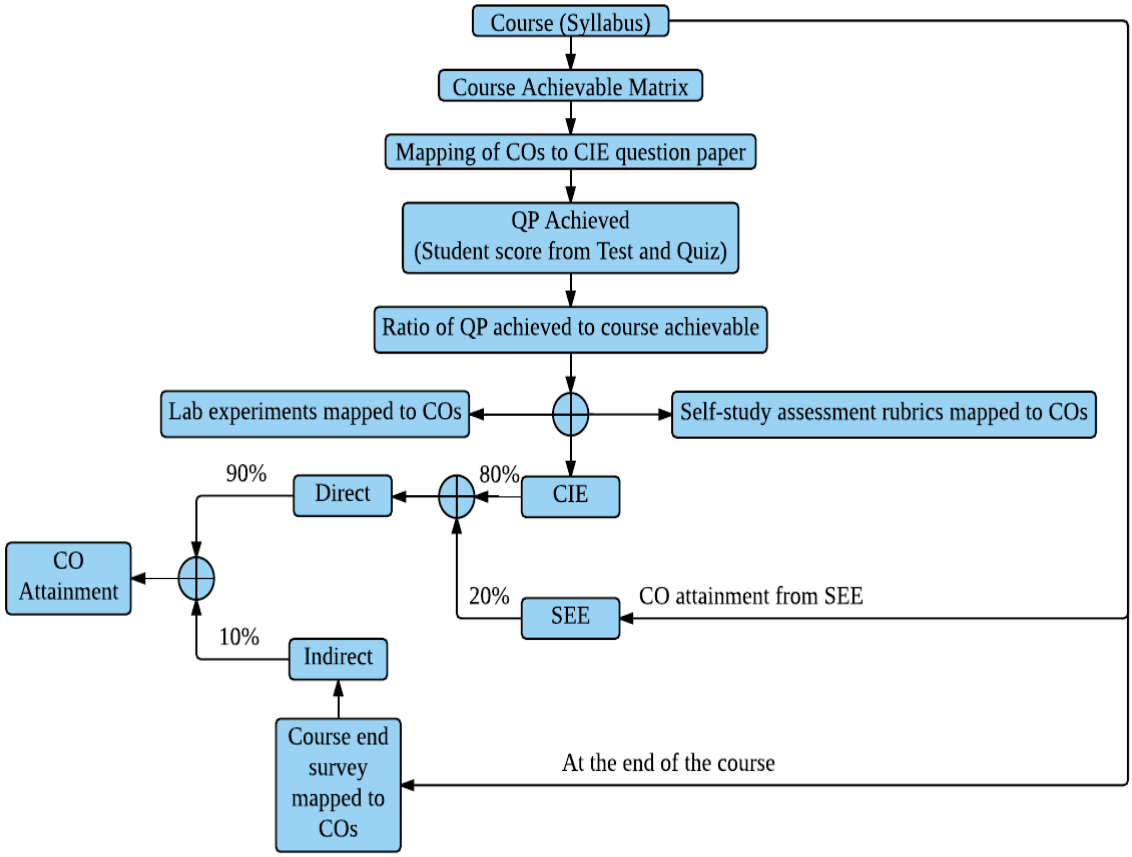
Academic Planning and Implementation



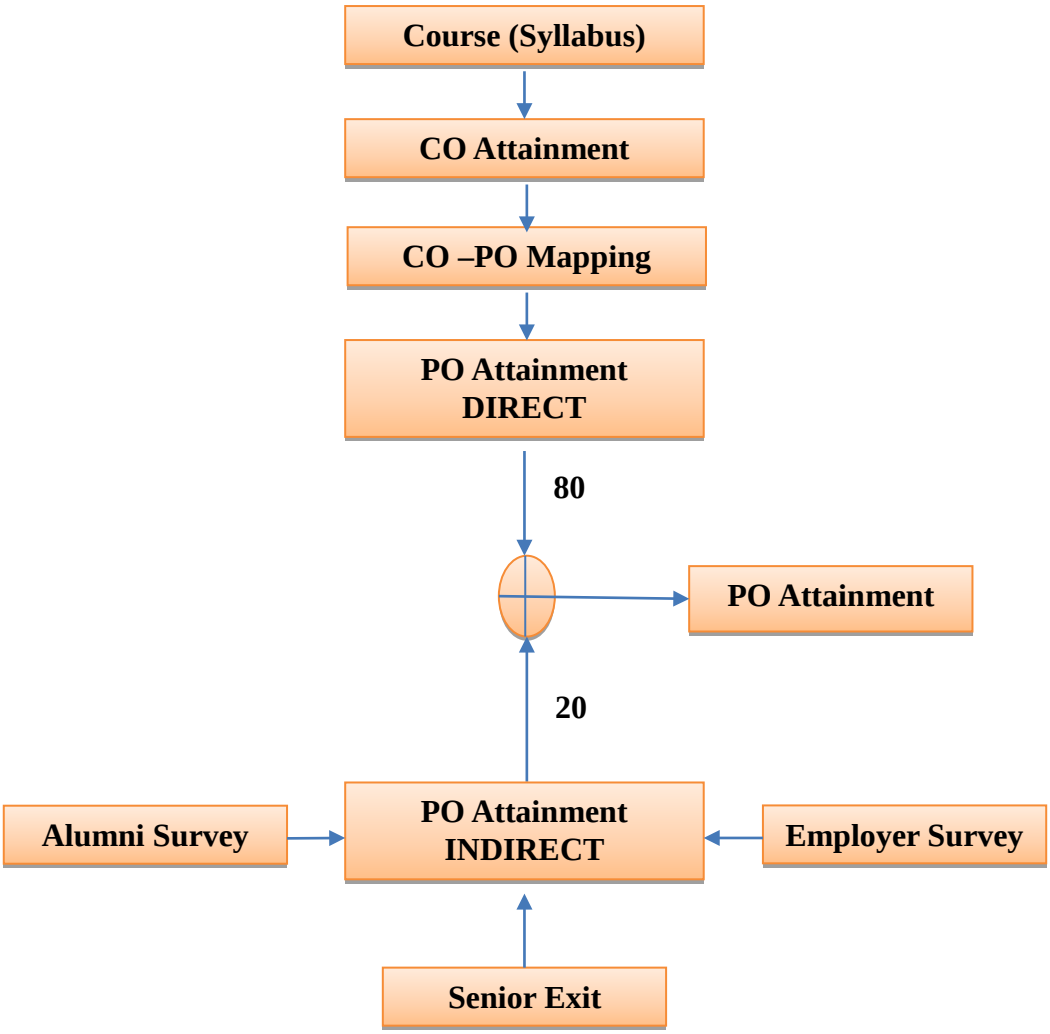
Process for Course Outcome Attainment



Final CO Attainment Process



Program Outcome Attainment Process



Guidelines for Fixing Targets

- The target may be fixed based on last 3 years' average attainment

PROGRAM OUTCOMES (PO)

PO1: **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: **Problem analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.