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

MECHANICAL ENGINEERING

Department Vision

Quality Education in Design, Materials, Thermal and Manufacturing with emphasis on Research, Sustainable technologies and Entrepreneurship for Societal Symbiosis.

Department Mission

1. Imparting knowledge in basic and applied areas of Mechanical Engineering
2. Providing state-of-art laboratories and infrastructure for academics and research
3. Facilitating faculty development through continuous improvement programs
4. Promoting research, education and training in frontier areas of nanotechnology, advanced composites, surface technologies, MEMS and sustainable technology
5. Strengthening collaboration with industries, research organizations and institutes for internship, joint research and consultancy
6. Imbibing social and ethical values in students, staff and faculty through personality development programs

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Successful professional careers with sound fundamental knowledge in Mathematics, Physical Sciences and Mechanical Engineering leading to leadership, entrepreneurship or pursuing higher education.

PEO2: Expertise in specialized areas of Mechanical Engineering such as Materials, Design, Manufacturing and Thermal Engineering with a focus on research and innovation.

PEO3: Ability of problem solving by adopting analytical, numerical and experimental skills with awareness of societal impact.

PEO4: Sound communication skills, team working ability, professional ethics and zeal for life-long learning.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO	Description
PSO1	Demonstrate basic knowledge in Mathematics, basic science, Materials Science and Engineering to formulate and solve mechanical engineering problems
PSO2	Design mechanical and thermal systems by adopting numerical, analytical and experimental techniques and analyse the results.
PSO3	Function in multidisciplinary teams with sound communication skills.
PSO4	Self-learn to acquire and apply allied knowledge and update the same by engaging in life-long learning, practice profession with ethics and promote entrepreneurship

Lead Society: American Society of Mechanical Engineers – ASME

PROGRAM OUTCOMES (POs)

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

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

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

4. **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.

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

6. **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.

7. **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.

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

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

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with t h e 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.

11. **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.

12. **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.

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

MECHANICAL ENGINEERING

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

INDEX

R V COLLEGE OF ENGINEERNG, BENGALURU-560 059
(Autonomous Institution Affiliated to VTU, Belagavi)

DEPARTMENT OF MECHANICAL ENGINEERING

FIFTH SEMESTER CREDIT SCHEME								
Sl. No	**Course Code**	**Course Title**	**BOS**	**Credit Allocation**				**Total Credits**
				L	**T**	**P**	**S**	
1	16HEM51	Foundations of Management and Economics	HSS	2	0	0	0	2
2	16ME52/16IM52	Design of Machine Elements – I	ME	3	0	1	0	4
3	16ME53	Heat and Mass Transfer	ME	3	0	1	1	5
4	16ME54	CAD/CAM	ME	3	1	1	0	5
5	16ME55	Dynamics of Machines	ME	3	0	0	1	4
6	16ME5AX	Elective A (PE)	ME	3	0	0	1	4
7	16G5BXX	Elective B (OE)*	Respective BOS	4	0	0	0	4
Total Number of Credits								**28**
Total Number of Hours / Week				**21**	**1**	**6**	**12****	**40**

SIXTH SEMESTER CREDIT SCHEME								
Sl. No.	**Course Code**	**Course Title**	**BOS**	**Credit Allocation**				**Total Credits**
				L	**T**	**P**	**S**	
1	16HSI61	IPR & Entrepreneurship	HSS	3	0	0	0	3
2	16ME62	Design of Machine Elements II	ME	3	0	1	0	4
3	16ME63	Turbo machinery	ME	3	0	1	0	4
4	16ME64	Finite Element Methods	ME	3	0	1	1	5
5	16ME6CX	Elective C (PE)	ME	3	0	0	1	4
6	16ME6DX	Elective D (PE)	ME	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	1	0	0	0	1
Total Number of Credits								**28**
Total Number of Hours / Week				**22**	**2**	**4**	**12****	**28**

*Students should take other department Global Elective courses **Non-contact hours

V Semester		
GROUP A: PROFESSIONAL CORE ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
1.	16ME5A1	Mechanics of Composite Materials
2.	16ME5A2	Industrial Robotics
3.	16ME5A3	Refrigeration and Air conditioning
4.	16ME5A4	Advanced Solid Mechanics

GROUP B: GLOBAL ELECTIVES				
Sl. No.	**HostDept**	**Course Code**	**Course Title**	**Credits**
1.	BT	16G5B01	Bioinformatics	4
2.	CH	16G5B02	Fuel Cell Technology	4
3.	CV	16G5B03	Geoinformatics	4
4.	CSE	16G5B04	Graph Theory	4
5.	ECE	16G5B05	Artificial Neural Networks & Deep Learning	4
6.	EEE	16G5B06	Hybrid Electric Vehicles	4
7.	IEM	16G5B07	Optimization Techniques	4
8.	E&I	16G5B08	Sensors & Applications	4
9.	ISE	16G5B09	Introduction To Management Information Systems	4
10.	ME	16G5B10	Industrial Automation	4
11.	TCE	16G5B11	Telecommunication Systems	4
12.	MAT	16G5B12	Computational Advanced Numerical Methods	4
13.	AE	16G5B13	Basics of Aerospace Engineering	4

VI Semester		
GROUP C: PROFESSIONAL CORE ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
1.	16ME6C1	Hydraulics and Pneumatics
2.	16ME6C2	Computational Fluid Dynamics
3.	16ME6C3	Energy Conversion Engineering
4.	16ME6C4	Advanced Machine Design
5.	16ME6C5	Product Design and Development
GROUP D: PROFESSIONAL CORE ELECTIVES		
1.	16ME6D1	Gas dynamics and Combustion
2.	16ME6D2	Non Traditional Processes
3.	16ME6D3	Theory of Plates and Shells
4.	16ME6D4	Cutting Tool Design
5.	16ME6D5	Quality Assurance

GROUP E: GLOBAL ELECTIVES				
Sl. No.	**Host Dept**	**Course Code**	**Course Title**	**Credits**
1.	BT	16G6E01	Bioinspired Engineering	3
2.	CH	16G6E02	Green Technology	3
3.	CV	16G6E03	Solid Waste Management	3
4.	CSE	16G6E04	Introduction to Web Programming	3
5.	ECE	16G6E05	Automotive Electronics	3
6.	EEE	16G6E06	Industrial Electronics	3
7.	IEM	16G6E07	Project Management	3
8.	E&I	16G6E08	Virtual Instrumentation	3
9.	ISE	16G6E09	Introduction to Mobile Application Development	3
10.	ME	16G6E10	Automotive Engineering	3
11.	TCE	16G6E11	Mobile Network System and Standards	3
12.	MAT	16G6E12	Applied Partial Differential Equations	3
13.	AE	16G6E13	Aircraft Systems	3

V SEMESTER **FOUNDATIONS OF MANAGEMENT AND ECONOMICS** **(Theory)** **(Common to BT, CHE, CV, E&I, IEM, ME)**		
Course Code: 16HEM51/61		**CIE Marks:** 50
Credits: L:T:P:S: 2:0:0:0		**SEE Marks:** 50
Hours: 23L		**SEE Duration:** 02 Hrs
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

Semester: V		
DESIGN OF MACHINE ELEMENTS - I (Theory & Practice)		
Course Code: 16ME52/16IM52		**CIE Marks: 100 + 50**
Credits: L:T:P:S: 3:0:2:0		**SEE Marks: 100 + 50**
Hours: 36L + 24T		**SEE Duration: 3 + 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Describe functions of mechanical elements in a machine	
2	Explain relationship among properties and dimensions of components	
3	Analyze and quantify forces, stresses and related parameters for the design of shafts, springs, drive systems, clutches and joints	
4	Demonstrate ability to develop design of mechanical components	

PART A	
UNIT-I	
Design for Static Strength: Codes and Standards, Principal Stress, Principal Planes, Stress Tensor, 2D and 3D stresses, Static Load, Factor of Safety, Stress Concentration, Stress Concentration Factor, Theory of Failures: Failure of Brittle and Ductile Materials	**06 Hrs**
UNIT-II	
Design for Fatigue: Introduction, Definitions, S-N Curve, Low & High Cycle Fatigue, Endurance Limit, Modifying factors for Endurance Strength, Size Effects, Load & surface Effects; Stress Concentration Effects, Fluctuating Loads, Derivation of Goodman and Soderberg Relationship; Impact loads, stresses due to axial and bending **Design of Shafts:** Design for Strength and Rigidity with Steady Loading, Torsion of Shafts, Design of Transmission Shafts, Shafts under fluctuating loads	**10 Hrs**
UNIT-III	
Design of Keys & Couplings Key Design – rectangular & square keys, Types of Couplings, Design of Rigid and Flexible Couplings flanged coupling, bush and pin type of couplings **Design of Cotter and Knuckle Joints** Introduction, Applications, Design of Cotter and Knuckle joints	**09 Hrs**
UNIT-IV	
Design of Springs Types of spring, stresses in helical springs, deflection in helical springs - circular, Tension and compression springs, springs subjected to fluctuating and impact loads; Design leaf springs	**06 Hrs**
UNIT-V	
Design of Riveted, Welded Joints Types of riveted joints, failure of riveted joints, design of boiler joints; Types of welded joints, strength of butt, fillet welds, eccentric loaded welds	**05 Hrs**

PART – B–LABORATORY	
COMPUTER AIDED MACHINE DRAWING	
SECTION – I	**10 Hrs**
Introduction to Machine Drawing; Sections of Solids – cubes, pyramids, cones, cylinders;	
1. Orthographic Projections – Conversion of pictorial views into orthographic views	
2. Threaded Forms-Internal, External, Square, Acme, Bolts, Nuts and Washers	
3. Riveted Joints – Single, Double, Triple, Lap and Butt Joints	
SECTION – II	**14 Hrs**
Assembly Drawings: Screw Jack, Connecting Rod, Tail Stock of Lathe, Plummer Block, Machine Vice, Tool head of shaper	

Course Outcomes: After completing the course, the students will be able to	
1	Explain the design procedure for mechanical elements and sub-systems
2	Design mechanical elements for specifications
3	Analyze types of forces and their influence on component design
4	Design Assembly based on component design

Reference Books	
1.	Mechanical Engineering Design, Shigley J.E, Mischke C.R., 6th Edition, McGraw Hill International, ISBN: 0070494620
2.	Design of Machine Elements, Spotts. M.F, Shoup T.E, Hornberger. L.E, Jayram.S.R., Venkatesh .C.V., 8th Edition , Pearson Education, ISBN9788177584219
3.	Design of Machine Elements, Bhandari. V.B., 2nd Edition, Tata McGraw Hill Publishing Company Ltd. , ISBN: 9780070611412
4.	Machine Drawing, K.R. Goplakrishna, 2005 , 19th Edition, Subhas Stores,
5.	Design Data Hand Book , K. Mahadevan, Balaveera Reddy, Volume I and II, CBS publishers

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**	**2**	**1**	**2**	**1**		**1**					
CO2			**1**		**2**	**1**						
CO3	**1**	**3**		**2**			**2**					
CO4	**2**	**2**	**2**	**3**	**1**	**2**						

Low-1 Medium-2 High-3

Semester: V		
HEAT AND MASS TRASFER (Theory & Practice)		
Course Code: 16ME53		**CIE Marks: 100 + 50**
Credits: L:T:P:S: 3:0:2:4		**SEE Marks: 100 + 50**
Hours: 36L + 24T		**SEE Duration: 3 + 3 Hrs**

Course Learning Objectives: The students should be able to	
1	Understand conduction, convection and radiations mode heat transfer
2	Compute heat transfer by conduction, convection and radiation
3	Develop heat transfer models for simple systems
4	Estimate performance of heat exchangers
5	Describe the process of boiling and condensation
6	Explain the principles of mass diffusion

PART A	
UNIT-I	
Basic Concepts: Modes of heat transfer: Basic laws governing conduction, convection and radiation heat transfer, Thermal conductivity; Convective heat transfer co-efficient; Boundary conditions - I, II and III kind, General 3 – dimensional heat conduction equation in Cartesian co-ordinates **Steady state heat conduction:** Steady state heat conduction in plane wall and multilayer walls, Thermal contact resistance, discussion on 3-D conduction in cylindrical and spherical coordinate systems (No derivation), plane and multilayer Cylinders, plane and multilayer Spheres, Overall heat transfer coefficient, Critical radius of insulation	**07 Hrs**
UNIT-II	
Heat transfer from finned surfaces: Governing equations, solutions for different boundary conditions, fin efficiency and effectiveness, Selection of fins. Numerical problems **Transient Heat Conduction:** Lumped system analysis, transient heat conduction in large plane walls, long cylinders, use of charts for Transient heat conduction in semi and infinite solids. Numerical problems	**08 Hrs**
UNIT-III	
Fundamentals of Convection: Physical mechanism of convection, classification of fluid flow, concepts of velocity boundary layer; General expressions for drag coefficient and drag force; thermal boundary layer, general expression for local heat transfer coefficient, Average heat transfer coefficient **Natural Convection:** Physical mechanism of natural convection, dimensional analysis, natural convection over surfaces - Vertical plates, cylinders, horizontal and inclined plates. Numerical problems **Forced Convection:** Dimensional analysis, Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers. External forced convection: Dimensional analysis, flow over flat plates, and flow across cylinders, Spheres; Internal forced convection: Laminar and turbulent flow in tubes with entry length concepts. Problems	**09 Hrs**
UNIT-IV	
Radiation Heat Transfer: Thermal radiation, Black body radiation, Radiation intensity, View factor and its relations, Black Surfaces and grey surfaces, Radiation shields and the radiation effect. Problems	**06 Hrs**

Boiling and Condensation: Boiling heat transfer, pool boiling, Nusselt's theory for laminar condensation on a vertical flat surface, Use of correlations for condensation on horizontal tube, film condensation, drop wise condensation, Problems	
UNIT-V	
Heat Exchangers: Types of heat exchangers, overall heat transfer co-efficient, Log Mean Temperature Difference; Analysis of heat exchangers, fouling and fouling factor, effectiveness, NTU method, Problems **Mass Transfer:** Definition, Mass diffusion, analogy between heat and mass transfer, terms used in mass transfer analysis; Fick's First law of diffusion (no Numericals)	**06 Hrs**
Experiential learning component: Modelling (Prototyping) of thermodynamic systems, Industry based case studies, Internship, Survey of Areas pertaining to thermal systems, innovative projects related to energy, state-of-the-art in emerging areas related to thermal engineering	**4** Hrs/Week

PART – B- LABORATORY	
HEAT TRANSFER LABORATORY	
SECTION – I	**10 Hrs**
1. Determination of thermal conductivity of metal rod	
2. Determination of thermal conductivity of insulating powder	
3. Determination of Stefan Boltzmann constant	
4. Determination of emissivity of a surface	
SECTION – II	**14 Hrs**
1. Determination of heat transfer co-efficient in free convection for vertical cylinder	
2. Determination of heat transfer co-efficient in forced convection flow through a circular pipe	
3. Determination of heat transfer co-efficient in forced and free convection for pin –fin equipment.	
4. Determination of overall heat transfer co-efficient and effectiveness in parallel flow and counter flow heat exchanger	
5. Performance test on a Vapor Compression Air-Conditioner	
6. Experiments on Boiling of liquid and Condensation of Vapor	

Course Outcomes: After completing the course, the students will be able to	
1	Explain the process of conductive, convective and radiation heat transfer. (L1 & L2)
2	Formulate and solve conduction problems. (L3 & L4)
3	Identify and analyze flow regime and use correlation for solving heat transfer. (L5)
4	Design and analyze performance of heat exchangers. (L6)

Reference Books	
1.	Fundamentals of Heat and Mass Transfer , M Thirumaleshwar , 2nd Edition , 2009 , ISBN :9788177585193
2.	Heat and Mass Transfer, Yunus A Cengel , 4th Edition , 2011 , Tata McGraw Hill , ISBN : 978007107786
3.	Heat Transfer , J P Holman , 10th Edition , 2011, Tata McGraw Hill , ISBN: 9780071069670
4.	Heat Transfer , P K Nag , 2002 , Tata McGraw Hill , ISBN : 0070473374

Continuous Internal Evaluation (CIE): Total marks: 100+50=150

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 CIE for theory is 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): Total marks: 100+50=150

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**	**2**		**1**	**2**							
CO2	**3**	**2**		**1**	**2**							
CO3	**3**	**1**		**2**	**1**							
CO4	**3**	**2**		**2**	**1**							

Low-1 Medium-2 High-3

Semester: V		
CAD/CAM **(Theory and Practice)**		
Course Code: 16ME54		**CIE Marks: 100 + 50**
Credits: L:T:P:S: 3:1:2:0		**SEE Marks: 100 + 50**
Hours: 36L + 24T		**SEE Duration: 3 + 3 Hrs**
Course Learning Objectives: The students should be able to:		
1	Understand Product Life Cycle and Applications of CAD/CAM	
2	Explain software components of CAD/CAM	
3	Understand Numerical control, CNC machine structure, control drives and DNC	
4	Evaluate transformation for simple geometric entities	
5	Develop part programs using APT and CNC codes	
6	Study basic types of robots and applications in industry	

PART A	
UNIT-I	
Fundamentals of CAD/CAM Definition, Product life cycle, Types of production, Plant layout and automation, Creating manufacturing database, Production concepts and Mathematical models and Numerical problems **Graphics Software and Geometric Modelling** Operating system, Graphics software, Application software, Evaluation criteria, geometric, Construction methods, Wireframe and solid modelling basics, Numerical problems	**06 Hrs**
UNIT-II	
Geometric Transformation Formulation, Two dimensional translation, Scaling, Rotation, Reflection. Concatenation, Derivation for rotation about arbitrary point. Three dimensional transformations, Rotation of 3D object about arbitrary axis, Reflection about arbitrary line, Mathematics of projections, Numerical problems using homogeneous coordinates.	**07 Hrs**
UNIT-III	
NC,CNC and DNC Introduction, NC coordinate system, control modes, CNC elements, Types of CNC, DNC components, drive systems, Classification and features of turning and machining centres, ISO coding for turning tool, Automatic tool changer. **Industrial Robots** Basic structure of Robots – fixed and mobile robots, Types of motions of robotic arm, end effectors, sensors, Cartesian, Cylindrical and Spherical Co-ordinate Systems, Resolution, Accuracy and Repeatability; work cell layouts and functions, Robot Programming, Simple exercises using VAL, Applications	**06 Hrs**
UNIT-IV	
Computer Aided part programming Programming languages, APT structure, Rules, geometry statements for point, line, plane, circle and pattern, point to point and continuous control motion statements, postprocessor statement, auxiliary statements, macro statements. Programming exercises on APT with milling and drilling operations.	**08 Hrs**
UNIT-V	
Manual part programming Fundamentals, NC words, Canned cycles (G70 to G76 for turning) and (G80-G86 for drilling operations), tool length compensation (Use of G43), cutter radius	**06 Hrs**

compensation, sub-programming. Typical programming exercises using canned cycles for turning centres and Machining centres. **Macro Programming** Application of Macros, Variables, Arithmetic expressions, Flow control statements, Unconditional and Conditional branching, Programming exercises.	

PART – B–LABORATORY	
CAD/CAM	
SECTION – I	**10 Hrs**
Simulation of part programming for turning operations using canned cycles (Facing, Plane turning, Grooving, Thread cutting, Peck drilling, Boring and combination)	
SECTION – II	**14 Hrs**
Simulation of part programming for milling and drilling operations (Profile milling with and without sub program, Slab milling, Circular pocket, Rectangular pocket, Scaling, Mirroring, Rotation, Peck drilling, Deep hole drilling on bolt circle, datum shift and combination)	
(Demonstration only) One model with all operations combined on CNC lathe. One model with milling and drilling on CNC machining centres	

Course Outcomes: After completing the course, the students will be able to	
1	Explain the fundamental concepts of CAD / CAM / Robotics
2	Apply the knowledge of representation and transformation techniques to create programming codes that generate and transform geometric entities
3	Design parts in a modern parametric CAD system for manufacturing machine and/or a CNC machining system
4	Develop Manual part programs and APT programs for 2D complex profiles and test the programs by simulation

Reference Books	
1.	CAD/CAM , PN Rao, 3rd Edition , 2010 , Tata McGraw Hill Publication, ISBN: 978-0-07-068193-4
2.	CAD/CAM , Mikell P Groover, Emory W. Zimmers Jr , 2nd Edition, 2003 , Pearson Education Inc., ISBN:81-7758-416-2
3.	CNC fundamentals and programming , PM Agarwal, VJ Patel, 1st Edition, 2009, Charotar Publishing, ISBN:978-81-85594-98-9

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.

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**	**2**		**1**			**1**			**2**		
CO2	**2**	**3**		**2**	**2**			**1**	**1**		**2**	**1**
CO3	**2**		**2**	**2**	**3**	**1**	**2**	**1**	**2**			
CO4				**1**	**2**	**2**		**2**	**3**	**3**	**1**	**2**

Low-1 Medium-2 High-3

Semester: V		
DYNAMICS OF MACHINES (Theory)		
Course Code: 16ME55		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 35L		**SEE Duration: 3 Hrs**

Course Learning Objectives: The students should be able to:	
1	Describe the need for performing static and dynamic analysis on a system
2	Calculate ratio of belt tensions in flat and V belt
3	Explain the working of flywheel, cam and the importance of balancing in machines with rotating members
4	Analyse forces with friction and without friction. Speed of Governor. Sensitiveness, stability, isochronism, hunting, controlling force curves for governor
5	Study Gyroscopic couple, effect of gyroscopic couple on plane disc, aeroplane and ship

UNIT-I	
Static Analysis Static equilibrium, equilibrium of two and three force members; members with two forces and torque, free body diagram, static force analysis of four bar mechanism and slider crank mechanism without friction **Dynamic Analysis:** Dynamic force analysis of four bar mechanism and slider crank mechanism, dynamically equivalent system	**06 Hrs**
UNIT-II	
Belt & Rope Drives Types of belt drives – flat and V belt – Open belt and Cross belt. Velocity ratio, slip and creep and its effects on velocity ratio. Ratio of belt tensions. Initial tension, centrifugal tension**.** Power transmitted by belt drive. Condition for maximum power transmission **Rope drive:** Ratio of tensions, Initial tension and centrifugal tension. Power transmitted. Condition for maximum power transmission **Flywheels:** Types of flywheel, Energy stored, Determination of size of flywheel for engine, Machines performing intermittent operation in a punching press	**08 Hrs**
UNIT-III	
Governors Types of governors, Centrifugal and Inertia types. Porter Governor and Hartnell Governor. Force analysis with friction and without friction. Speed of Governor. Sensitiveness, stability, Isochronism, Hunting, Controlling force curves for governor **Balancing of Reciprocating Masses** Inertia effect of crank and connecting rod of single cylinder engine, partial balancing of multi-cylinder engine (Primary and Secondary forces and couples), Balancing of V engine, Direct and Reverse crank method	**09 Hrs**
UNIT-IV	
Balancing of Rotating Masses Static and Dynamic balancing, Balancing of single rotating mass, Balancing in same plane and in different plane, Balancing of several rotating masses rotating at different speeds	**06 Hrs**
UNIT-V	
Gyroscope Vectorial representation of angular motion. Basic definitions. Gyroscopic couple. Effect of gyroscopic couple on plane disc, Aeroplane, Ship Effect of gyroscopic couple on stability of a two wheeler and a four wheeler	**06 Hrs**

Self-Learning Component: It is the process of learning through experience, and is more specifically defined as "learning through reflection on doing". Working model of Open belt and cross belt, Rope drive, Gyroscope, Synthesis of linkages	**4** Hrs/Week

Course Outcomes: After completing the course, the students will be able to	
1	Define the basics of force analysis, flywheel, balancing and vibration
2	Analyze flywheels, rotating and reciprocating mechanism, damping and external excitation
3	Evaluate kinematics and kinetics for various mechanisms
4	Design and synthesise industrial mechanisms

Reference Books	
1.	Theory of Machines , Thomas Bevan, 3rd Edition, 1984, CBS Publishers, ISBN: 9788131729666
2.	Theory of Machines , Rattan S.S., 3rd Edition, 2008, TMH Publishing , ISBN:9780070144774
3.	Theory of Machines , Sadhu Singh, Pearson Education , 2nd Edition , 2007 , ISBN:9788177581270
4.	Theory of Vibration with Applications , Thomson W.T., 5th Edition, 2003, Pearson Education Inc., ISBN: 0044450699
5.	Mechanical Vibrations, Rao. S.S, 2007 , 5th Edition, Prentice Hall, 2007, ISBN:0201526867

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**	**2**	**1**								
CO2	**3**	**2**	**2**	**1**								
CO3	**2**	**2**		**2**								
CO4	**2**	**2**		**2**						**1**		**1**

Low-1 Medium-2 High-3

Semester: V		
MECHANICS OF COMPOSITE MATERIALS **(Group A: Professional Core Elective)**		
Course Code: 16ME5A1		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 34L		**SEE Duration: 3 Hrs**

Course Learning Objectives: The students will be able to	
1	Understand composite materials and their properties for appropriate application
2	Compute composite properties of lamina based on properties of matrix and reinforcements
3	Evaluate the properties of laminates based on properties of laminae and stacking sequence
4	Develop stress strain relationship using macro-mechanical analysis of laminate
5	Understand failure theories related to polymer composites

UNIT-I	
Introduction to composite materials: Classification, Polymer Matrix composites, Metal Matrix composites, Ceramic Matrix composites, Carbon-Carbon composites, Matrix and Reinforcements, Mechanics terminology	**05 Hrs**
UNIT-II	
Macro-mechanical analysis of a lamina: Hooke's law for different types of materials – Anisotropic, Monoclinic, Orthotropic, Transversely isotropic and Isotropic materials, Hooke's law for a two dimensional Unidirectional lamina - Plane stress assumption, Reduction of Hooke's law in 3D to 2D, Relationship of compliance and stiffness matrix to engineering elastic constants of a lamina Hooke's law for a two dimensional Angle lamina, Engineering constants of an Angle lamina, Invariant form of stiffness and compliance matrices for an angle lamina. Strength failure theories of angle lamina	**09 Hrs**
UNIT-III	
Micromechanical analysis of a lamina: Volume fraction, Mass fraction, Density and void content, Evaluation of four elastic Moduli using Strength of materials approach, Semi empirical approach, Elasticity approach, Elastic moduli of lamina with transversely isotropic fibres, Ultimate strength of Unidirectional lamina, Co-efficient of thermal expansion	**10 Hrs**
UNIT-IV	
Macro-mechanical analysis of a laminate: Laminate code, Stress – Strain relation for a laminate, In-plane and flexural modulus of a laminate.	**05 Hrs**
UNIT-V	
Failure, Analysis and design of laminates Special cases of laminates; Symmetric laminates, Cross-ply laminates, Angle-ply laminates, Antisymmetric laminates, Balanced laminates, Quasic-Isotropic laminates, Failure criterion for a laminate, Design of a laminated composite.	**05 Hrs**
Experiential Learning Development of application oriented polymer composites. Design and analysis of composite parts. Evaluation of service life of composite components.	**4** Hrs/Week

Course Outcomes: After completing the course, the students will be able to	
1	Explain types of composite materials, their properties and advantages.
2	Compute properties of lamina and laminate.
3	Derive stress strain relationship of polymer composites.
4	Apply failure criterion and design of laminated composite for specific applications.

Reference Books	
1.	Mechanics of Composite Materials , Autar Kaw, Taylor & Francis, 2006, ISBN: 9780849313431
2.	Mechanics of Composite Materials, R. M. Jones, Taylor & Francis , 2nd Edition , 2015,

	ISBN-13**:** 978-1560327127
3.	Composite Materials, Science & Engg., Krishan K. Chawla, 3rd Edition, Springer publication, ISBN : 978-0-387-74364-6
4.	Composite Materials and Processing, M. Balasubramanian, CRC Press, ISBN 9781439879351
5.	Engineering Mechanics of Composite Materials, Isaac M Daniel, Oxford University Press, ISBN 9780195150971

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**				**2**		**2**		**1**		**1**
CO2	**3**	**3**	**3**	**1**	**1**				**1**			**1**
CO3	**3**	**3**	**3**	**2**	**1**							
CO4	**3**		**3**	**3**						**2**		

Low-1 Medium-2 High-3

Semester: V		
INDUSTRIAL ROBOTICS **(Group A: Professional Core Elective)**		
Course Code: 16ME5A2		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 35L		**SEE Duration: 3 Hrs**

Course Learning Objectives: The students should be able to:	
1	Understand the theory of transformation.
2	Explain the concept of direct kinematics.
3	Explain the concept of inverse kinematics.
4	Understand the workspace analysis and trajectory planning
5	Describe the mathematical model behind the manipular dynamics

UNIT-I	
INTRODUCTION: Introduction, position and orientation of objects, objects coordinate frame Rotation matrix, Euler angles Roll, pitch and yaw angles coordinate Transformations, Joint variables and position of end effector, Dot and cross products, coordinate frames, Rotations, Homogeneous coordinates	**05 Hrs**
UNIT-II	
DIRECT KINEMATICS: Link coordinates D-H Representation, The ARM equation. Direct kinematic analysis for Four axis, SCARA Robot and three, five and six axis Articulated Robots	**08 Hrs**
UNIT-III	
INVERSE KINEMATICS: The inverse kinematics problem, General properties of solutions. Tool configuration, Inverse kinematics of four axis SCARA robot and three and five axis, Articulated robot	**07 Hrs**
UNIT-IV	
WORKSPACE ANALYSIS AND TRACJECTORY PLANNING: Workspace Analysis, work envelope of a Four axis SCARA robot and five axis articulated robot workspace fixtures, the pick and place operations, Joint space technique - continuous path motion, Interpolated motion, straight line motion and Cartesian space technique in trajectory planning	**07 Hrs**
UNIT-V	
MANIPULATOR DYNAMICS: Introduction, Lagrange's equation kinetic and potential energy. Link inertia Tensor, link Jacobian Manipulator inertia tensor. Gravity, Generalized forces, Lagrange-Euler Dynamic model, Dynamic model of a Two-axis planar robot, Newton Euler formulation, Lagrange - Euler formulation, problems.	**08 Hrs**
Experiential Learning component: **Open ended Laboratory Experiments using ADAMS for specific applications:** Kinematic analysis (position, orientation, velocity and acceleration) of Manipulators, Dynamic Analysis of Robotic arms, Trajectory planning of robotic arms, Design of Robotic Arm for Workspace Calculation	**4** Hrs/week

Course Outcomes: After completing the course, the students will be able to:	
1	Explain the transformation involved in positioning and orienting the manipulator.
2	Apply the related mathematical model to analysis the kinematics of industrial robot.
3	Analyze the workspace and trajectory planning required for the manipulator.
4	Solve problems related to forward, inverse and dynamic conditions.

Reference Books	
1.	A Robot Engineering Textbook , Mohsen Shahinpoor, Harper & Row Publishers, 3rd Edition, New York , ISBN:006045931X
2.	Robotics, control vision and intelligence, Fu, Lee and Gonzalez, 5th Edition, McGraw Hill International , ISBN:0070226253
3.	Introduction to Robotics , John J. Craig , 5th Edition , Addison Wesley Publishing, ISBN:0201543613
4.	Autonomous mobile robots , Roland Illah R , Siegwart Nourbakhsh , 6th Edition, 2004 , The MIT Press Cambridge , Massachusetts London , England, ISBN:0262015358

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**	**3**			**1**		**1**			
CO2	**2**	**2**	**3**		**2**							**1**
CO3	**1**	**3**		**3**	**2**							
CO4	**2**		**2**		**1**		**1**		**1**		**1**	

Low-1 Medium-2 High-3

Semester: V		
REFRIGERATION AND AIR-CONDITIONING **(Group A: Professional Core Elective)**		
Course Code: 16ME5A3		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 34L		**SEE Duration: 3 Hrs**

Course Learning Objectives: The students will be able to	
1	Describe the basic refrigeration and air-conditioning systems.
2	Analyze simple vapour compression system.
3	Practice use of psychrometric charts and estimation of cooling loads.
4	Explain applications of refrigeration and air-conditions.

UNIT-I	
Vapor Compression Refrigeration System Review of thermodynamic principles of refrigeration, Different types of refrigerants, Boot stage systems; Performance of simple vapour compression system, single and multi-load system, COP	**06 Hrs**
UNIT-II	
Absorption Refrigeration System Basic absorption system, COP, Refrigerator, Advantage and limitation over vapour compression system, Binary mixtures, Temperature concentration diagram, Aqua ammonia system and energy balance	**08 Hrs**
UNIT-III	
Refrigeration Equipment and Control Compressor-principle of operation, specifications, condenser – types and specification, selection, Evaporator, Expansion devices, high and low pressure sensors, defrosting, types of defrosting devices, capacity control devices.	**08 Hrs**
UNIT-IV	
Psychrometric Charts and Cooling Loads Psychometric processes, Use of Charts, Summer and winter air-conditioning; Comfort air-conditioning, sensible heat loads, latent heat loads, sensible heat factors, cooling coils, de-humidifiers	**06 Hrs**
UNIT-V	
Types of Air-Conditioning Systems Central, unitary, split air-conditioner, layout of sub-systems, selection of air-conditioner for a room; **Applications of Refrigeration and Air-Conditioning** Principles of ice production, food preservation, transport air conditioning and milk chilling plant	**06 Hrs**
Self-Learning component: Application of RAC & HVAC. Heat load calculation. Design of RAC components to meet techno-commercial aspects with positive impact on environment. Design changes to make more energy efficient systems.	**4 Hrs/week**

Course Outcomes: After completing the course, the students will be able to	
1	Describe vapour compression/absorption refrigeration and air-conditioning systems.
2	Analyze effect of different parameters on simple and advanced vapour compressors.
3	Categorise design of various elements of VC and AC
4	Evaluate performance of VCs and AC systems

Reference Books	
1.	Refrigeration and Air conditioning, Stoecker. W.F., Jones. J.W, 2nd Edition, 1982 , Tata McGraw Hill , ISBN: 0070616191
2.	Refrigeration and Air-conditioning, Arora. C.P., 3rd Edition, 2009 , Tata McGraw Hill, ISBN: 978007008390-5
3.	Principles of Refrigeration, Dossat. R.J. Horan. T.J., 5th Edition, 2006 , Prentice Hall, ISBN: 013027270
4.	A Text Book of Refrigeration and Air-Conditioning, Rajput. R.K., 2009 , S.K. Katraia, New Delhi, ISBN: 098869007-1

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**		**1**	**2**							
CO2	**3**	**2**		**1**	**2**							
CO3	**3**	**1**		**2**	**1**							
CO4	**3**	**2**		**2**	**1**							

Low-1 Medium-2 High-3

Semester: V		
ADVANCED SOLID MECHANICS **(Group A: Professional Core Elective)**		
Course Code: 16ME5A4		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 36L		**SEE Duration: 3 Hrs**

Course Learning Objectives: The students should be able to:	
1	Understand concepts of stress, strain and constitutive relations
2	Evaluate the stress conditions for failure based on yield criteria
3	Apply energy methods in theory of Solid Mechanics
4	Evaluate stress and deformation due to bending, torsion and thermal conditions

UNIT-I	
Analysis of Stress: Body Force, Surface Force and Stress Vector, The State of Stress at a Point, Normal and Shear Stress Components, Rectangular Stress Components, Stress Components on an Arbitrary Plane, Principal Stresses, Stress Invariants, Mohr's Circles for the Three-Dimensional State of Stress, Octahedral Stresses, The State of Pure Shear , Decomposition into Hydrostatic and Deviatoric, Differential Equations of Equilibrium, Boundary Conditions, Equations of Equilibrium in Cylindrical Coordinates	**06 Hrs**
UNIT-II	
Analysis of Strain: Deformations, Deformation in the Neighbourhood of a Point, Change in Length of a Linear Element, Change in Length of a Linear Element—Linear Components, Rectangular Strain Components, The State of Strain at a Point, Change in Direction of a Linear Element, Cubical Dilatation, Principal Strains, Plane Strains in Polar Coordinates, Compatibility Conditions, Strain Invariants **Stress–Strain Relations for Linearly Elastic Solids:** Generalized Statement of Hooke's Law, Stress–Strain Relations for Isotropic Materials, Modulus of Rigidity, Bulk Modulus Young's Modulus and Poisson's Ratio, Relations between the Elastic Constants, Displacement Equations of Equilibrium	**09 Hrs**
UNIT-III	
Yield Criteria's: Theories of Failure, Use of Factor of Safety in Design, Mohr's Theory of Failure, Ideally Plastic Solid, Stress Space and Strain Space, General Nature of the Yield Locus, Yield Surfaces of Tresca and Von Mises, Stress–Strain Relations (Plastic Flow), Prandtl–Reuss Equations, Saint Venant–Von Mises Equations **Energy Methods:** Hooke's Law and the Principle of Superposition, Work Done by Forces and Elastic Strain Energy Stored, Maxwell–Betti–Rayleigh Reciprocal Theorem, Generalised Forces and Displacements, Beggs deformeter, First Theorem of Castigliano, Expressions for Strain Energy, Statically Indeterminate Structures, Theorem of Virtual Work , Kirchhoff 's Theorem, Second Theorem of Castigliano and its Generalisation, Maxwell–Mohr Integrals	**09 Hrs**
UNIT-IV	
Bending of Beams: Straight Beams and Asymmetrical Bending, Regarding Euler–Bernoulli Hypothesis, Shear Centre or Centre of Flexure, Shear Stresses in Thin-Walled Open Sections: Shear Centre, Shear Centres for a Few Other Sections, Bending of Curved Beams , (Winkler-Bach Formula), Deflections of Thick Curved Bars **Torsion:** Torsion of General Prismatic Bars–Solid Sections, Torsion of bars with different cross sections, Membrane Analogy, Torsion of Thin-Walled Tubes, Torsion of Thin-Walled Multiple-Cell Closed Sections, Torsion of Bars with Thin Rectangular Sections, Torsion of Rolled Sections, Multiply Connected Sections, Centre of Twist and Flexural Centre	**06 Hrs**
UNIT-V	
Axisymmetric Problems: Thick-Walled Cylinder Subjected to Internal and External Pressures—Lame's Problem, Stresses in Composite Tubes—Shrink Fits, Sphere with Purely Radial Displacements, Stresses Due to Gravitation, Rotating Disks of Uniform	**06 Hrs**

Thickness, Disks of Variable Thickness, Rotating Shafts and Cylinders, Summary of Results for use in Problems. **Thermal Stresses:** Thermo elastic Stress–Strain Relations, Equations of Equilibrium, Strain–Displacement Relations, Thin Circular Disk: Temperature Symmetrical about Centre, Long Circular Cylinder ,The Problem of a Sphere, Normal Stresses in Straight Beams due to Thermal Loading, Stresses in Curved Beams due to Thermal Loading.	

Course Outcomes: After completing the course, the students will be able to:	
1	Analyze solid mechanics problems using classical methods and energy methods
2	Solve torsion and bending problems in beams and thin walled members
3	Solve stress and deflection for unsymmetrical loading and locate shear centre for thin walled beams
4	Apply various yield criteria for obtaining yield stresses and deformations

Reference Books	
1.	Advanced Mechanics of Solids , L.S. Srinath , 3rd Edition , 2009 , McGraw Hill, ISBN:978007139886,
2.	Solid Mechanics , S.M.A. Kazimi , 2nd Revised edition , 2001, McGraw Hill , ISBN: 978-0074517154 ,

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**	**2**	**3**	**1**			**1**		**1**	**3**	**3**	**2**
CO2				**2**		**1**	**3**	**2**		**2**	**1**	**3**
CO3	**3**	**1**	**1**				**1**	**2**				**3**
CO4	**1**	**2**		**3**	**3**	**1**	**1**	**1**		**2**	**2**	**3**

Low-1 Medium-2 High-3

Semester: V		
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:** 3 Hrs

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)

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	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

Semester: V		
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:** 3 Hrs

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												
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
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

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

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

Semester: V		
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 colouring 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.	**09Hrs**

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)

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**	**-**	**-**
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

Semester: V		
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)

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**	**-**	**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

Semester: V		
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:** 3 Hrs

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):

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**	**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 **(Theory)** **(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:** 3 Hrs

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 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**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**2**	**3**	**-**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**1**	**2**	**2**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**-**	**-**	**-**	**-**	**1**	**1**	**-**	**-**	**-**	**3**	**-**	**1**

Low-1 Medium-2 High-3

Semester: V		
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:** 3 Hrs

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

Semester: V		
INDUSTRIAL AUTOMATION (Theory)		
Course Code: 16GB510		**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	**08 Hrs**

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	
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 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.	**10 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Illustrate applications of sensors actuators, switching elements and inspection technologies in industrial automation
2	Build circuit diagrams for fluid power automation, Ladder diagrams for PLC and identify its application areas
3	Evaluate CNC programs for 2D complex profiles performed on machining and turning centres interfaced with Robots
4	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

Semester: V		
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: 46 L		**SEE Duration:** 03 Hrs

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

Semester: V		
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: 44 L		**SEE Duration:** 3 Hrs

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)

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**
CO2	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**2**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO4	**3**	**3**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**

High-3: Medium-2: Low-1

Semester: V		
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: 44 L		**SEE Duration:** 3 Hrs

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 :	
1	Appreciate and apply the basic principles of aviation
2	Apply the concepts of fundaments of flight, basics of aircraft structures, aircraft propulsion and aircraft materials during the development of an aircraft
3	Comprehend the complexities involved during development of flight vehicles.
4	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 AE, CSE, ECE, EEE, ISE, TE)		
Course Code: 16HSI51/61		**CIE Marks:** 100
Credits: L:T:P:S: 3:0:0:0		**SEE Marks:** 100
Hours: 36L		**SEE Duration:** 03 Hrs
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

Semester: VI		
Course Title: DESIGN OF MACHINE ELEMENTS – II (Theory and Practice)		
Course Code: 16ME62		**CIE Marks: 100 + 50**
Credits: L:T:P:S: 3:0:2:0		**SEE Marks: 100 + 50**
Hours: 34L + 20P		**SEE Duration: 3 + 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Describe different types of power screws and their applications.	
2	Examine the forces & stresses developed in thin and thick cylinders.	
3	Distinguish between straight beams and curved beams and analyze the stresses.	
4	Analyze and quantify the forces, stresses in clutches and brakes.	
5	Design bevel and worm gear based on static, dynamic and wear strength.	
6	Select suitable bearings based on rated life & operation conditions.	

PART A	
UNIT-I	
Design of Curved Beams: Difference between straight beam and curved beams, stresses in straight beam and curved beam, derivation of bending stress equation for curved beam, problems on crane hook, punching presses, clamps (symmetric and unsymmetric sections), closed rings.	**06 Hrs**
UNIT-II	
Design of Clutches and Brakes: **Clutches:** Torque transmitting capacity, Types, uniform wear and pressure theory, friction, bearing pressure, single and multi-plate clutches. **Brakes:** Energy absorbed by brake, materials of brake, pivoted block or shoe brake, simple and differential band brake. **Design of Power Screws** Stresses in power screws, efficiency of power screw and self-locking screws	**08 Hrs**
UNIT-III	
Design of Spur & Helical Gears: **Spur Gears**: Definition, Stresses in Gear Tooth, Lewis Equation, Form Factor, Design for Strength, Dynamic Load and wear load, material selection for different velocity ratios, types of tooth systems **Helical Gears:** Number of teeth, design based on strength, dynamics and wear loads, normal and transverse pitch, module, Herringbone gears, different forces on helical gear teeth	**08 Hrs**
UNIT-IV	
Design of Bevel & Worm Gears: **Bevel Gear:** Definition, Formative Number of Teeth, Design based on Strength, Dynamics and Wear Loads, Cone Pitch Angle, Back Cone Radius, Acute, Obtuse and right angle bevel gears **Worm Gears:** Definition, Design based on strength, dynamic wear load and efficiency of gear drives, self-locking of worm gear drives.	**06 Hrs**
UNIT-V	
Lubrication & Bearings: Basic modes of lubrication, viscosity, properties of lubricant, Petroff's equation, bearing materials, Sommerfield number, bearing modulus, Coefficient of friction, Minimum oil film thickness, Heat generated and dissipated. **Anti-friction Bearings -** Materials, types, ball and roller bearings, static and dynamic capacity, equivalent load, selection based on rated life and application.	**06 Hrs**

PART – B- LABORATORY	
DESIGN LABORATORY	
SECTION – I	**10 Hrs**
1. Determination of Principal Stresses & Strains using strain rosette analysis.	
2. Determination of Fringe Constant – Circular and Rectangular Specimens	
3. Determination of Stress Concentration Factor.	
SECTION – II	**10 Hrs**
1. Determination of Natural Frequency, Damping Ratio, Damping co-efficient for single degree freedom systems.	
2. Balancing of rotating masses using force and coupling polygons.	
3. Determination of critical speed of rotating shaft.	
4. Determination of Equilibrium speed of governors.	
5. Experiments with gyroscope.	

Course Outcomes: After completing the course, the students will be able to	
1	Understand basic procedure to design a system component, or process to meet desired needs within realistic constraints. (L1 & L2)
2	Select suitable material and size for design of components in machines.(L3 & L4)
3	Identify, explain, formulate, and solve design engineering problems. (L5)
4	Analyze forces and stresses within a mechanical system. (L6)

Reference Books	
1.	Mechanical Engineering Design , Shigley J.E, Mischke.C.R., 6th Edition, McGraw Hill International , ISBN: 0070494620
2.	Design of Machine Elements , Spotts .2.F, Shoup .T.E, Hornberger .L.E, Jayaram .S.R., Venkatesh C.V., 8th Edition , Pearson Ed., ISBN: 9788177584219
3.	Design of Machine Elements , Bhandari .V.B , 2nd Edition , Tata McGraw Hill Publishing Company Ltd, ISBN: 9780070611412

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**	**2**	**3**								
CO2		**2**		**1**	**1**	**2**						
CO3	**3**		**1**				**2**					
CO4		**1**		**2**	**2**	**1**						

Low-1 Medium-2 High-3

Semester: VI		
Course Title: TURBOMACHINERY (Theory and Practice)		
Course Code: 16ME63		**CIE Marks: 100 + 50**
Credits: L:T:P:S: 3:0:2:0		**SEE Marks: 100 + 50**
Hours: 34L + 20P		**SEE Duration: 3 + 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Classify and analyze different types of turbo machines	
2	Evaluate energy transfer in turbo machines.	
3	Perform basic design calculation for power absorbing and generating turbo machines.	
4	Perform experiments on hydraulic turbines and pumps to evaluate the performance.	

PART A	
UNIT-I	
Introduction to Turbo Machinery: Introduction to fluid machines, Classification, Comparison with positive displacement machines, Dimensional analysis, Dimensionless parameters and their physical significance; Specific speed; One dimensional analysis and model studies, Numericals **Energy Transfer in Turbo Machines** Basic Euler turbine equation and its alternate forms, Components of energy transfer, General expression of degree of reaction, Construction of velocity triangles for different values of degree of reaction, Relation between degree of reaction and utilization factor, Numericals	**06 Hrs**
UNIT-II	
Compression Process: Overall isentropic efficiency of compression, Stage efficiency, Comparison and relation between overall efficiency and stage efficiency; Polytropic efficiency and pre-heat factor, Numericals **Expansion Process** Overall isentropic efficiency for a turbine, Stage efficiency for a turbine, Comparison and relation between stage efficiency and overall efficiency for expansion process; Polytropic efficiency for expansion process and reheat factor for expansion process, Numericals	**08 Hrs**
UNIT-III	
Centrifugal Pumps: Definition of terms used in the design of centrifugal pumps like manometric head, suction head, delivery head, manometric efficiency, hydraulic efficiency, volumetric efficiency, overall efficiency, multi-stage centrifugal pumps. **Centrifugal Compressors** Expression for overall pressure ratio, Width and blade angle at impeller inlet and outlet, Slip factor and power input factor, Surging and its control.	**08 Hrs**
UNIT-IV	
Axial Flow Compressor: Classification, expression for stage pressure ratio, work done factor, radial equilibrium conditions, determination of air angle distribution with respect to blade height using free vortex flow theory. **Steam Turbines** Impulse and reaction turbines, velocity and pressure compounding; condition for maximum utilization factor for multi stage turbine with equiangular blades, effect of blade and nozzle losses	**07 Hrs**
UNIT-V	
Hydraulic Turbines: Pelton wheel, velocity triangle, bucket dimensions, turbine efficiency; Francis and Kaplan Turbines, Velocity triangles, Effect of rotational speed on blade shape, Draft	**05 Hrs**

tubes and their function, Types of draft tube.	

PART – B- LABORATORY	
TURBOMACHINES LABORATORY	
SECTION – I	**10 Hrs**
1. Determination of co-efficient of friction due to flow of fluids in pipes	
2. Determination of forces developed due to impact of jets on vanes	
3. Calibration of flow measuring devices: Orifice, Venturi and V-Notch	
4. Determination of co-efficient of minor losses due to flow of fluids through pipes.	
SECTION – II	**10 Hrs**
1. **Performance Testing of Turbines:** Pelton, Francis and Kaplan Turbines	
2. **Performance Testing of Pumps:** Single and Multistage Centrifugal pump, Reciprocating Pump and Gear pump	

Course Outcomes: After completing the course, the students will be able to	
1	Explain working principles of turbines and compressors.
2	Analyze the characteristics of power absorbing and generating turbo machines.
3	Evaluate performance of turbo machines.
4	Discuss selection of turbo machine for industrial application.

Reference Books	
1.	Principles of Turbo Machinery, Shephered.D.G, 10th Edition, 2009, McMillan Company, ISBN: 078623241-2
2.	Turbine Compressors and Fans, Yahya. S.M., 2nd Edition , 2002 , Tata McGraw Hill, ISBN: 99862228-0
3.	Introduction to Energy Conversion , Kadambi and Manohar Prasad, 7th Edition, 2003, Wiley Eastern, ISBN: 765329176-x
4.	A Treatise on Turbo Machines , Gopalakrishna G and Prithviraj D , 3rd Edition, 2002 , SciTech Publications, ISBN: 8793452172-1

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	**3**	**3**		**2**	**1**							
CO2	**3**	**3**		**2**	**1**							
CO3	**3**	**3**		**2**	**1**							
CO4	**3**	**3**		**2**	**1**							

Low-1 Medium-2 High-3

Semester: VI		
Course Title: FINITE ELEMENTS METHODS (Theory and Practice)		
Course Code: 16ME64		**CIE Marks: 100 + 50**
Credits: L:T:P:S: 3:0:2:1		**SEE Marks: 100 + 50**
Hours: 34L + 20P		**SEE Duration: 3 + 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Introduce students to the concept of finite element methods in engineering design.	
2	Selection elements and boundary conditions for analysis.	
3	Discuss 1D & 2D solutions for simple components such as bars, trusses and beams.	
4	Apply FEM for heat transfer problems.	
5	Analyse simple components using ANSYS or Equivalent Software	

PART A	
UNIT-I	
Introduction to Finite Element Methods: General description of FEM, Steps involved in FEM, Engineering applications of FEM, Advantages of FEM, Rayleigh Ritz Method, Galerkin's Method, Gauss-Elimination Method; Basic Equations of Elasticity: Stress-strain relationship, differential equations of equilibrium, plane stress and strain conditions, Strain displacement relations	**08 Hrs**
UNIT-II	
One Dimensional Finite Elements- Bar and Truss elements Linear element, principles of minimum potential energy, admissible displacement function, stiffness matrix, strain matrix, static analysis using **e**limination method, penalty method, boundary conditions and assemblage load vector, Convergence and Compatibility conditions, Shape functions for 1D linear, quadratic and Truss elements	**08 Hrs**
UNIT-III	
Two Dimensional CST Elements : Iso, super and sub-parametric representation, Shape functions, element stiffness and load vectors	**06 Hrs**
UNIT-IV	
Analysis of Beam Elements: Hermitian shape functions, formulations of element stiffness matrices, load vectors, Analysis bending moment and shear force **Dynamic Analysis 1-D bar element:** Equations of motion, mass and stiffness matrices, distributed and consistent mass matrices, Eigen values and Eigen vectors.	**06 Hrs**
UNIT-V	
Analysis of Heat Transfer 1-D element: Steady State Heat Transfer, Galerkin's Formulation of Element Equations for Heat Conduction, Heat flux boundary condition, Analysis of composite slabs **Analysis of thin Fin:** Formulation of element equation for Heat conduction, Heat flux boundary condition, Analysis of heat transfer through fins	**06 Hrs**
Experiential Learning component: Model and simulate 1D, 2D and 3D real-time models as per industrial applications using ANSYS	**4 Hrs/Week**

PART – B- LABORATORY	
ANSYS LABORATORY	
SECTION – I	**10 Hrs**
Introduction to ANSYS, pre-processor, solver, post-processor, element library, applicability for engineering analysis.	
• One dimensional FEM and Analysis of Bars, Trussess, Beams and Shafts	
• Static Analysis of 2D plates – subject to plane load and bending load	
• Shells with internal pressure	

SECTION – II	10 Hrs
Dynamic and Thermal Analysis –	
• Normal mode analysis: modal analysis of beam, bars and truss elements; Harmonic analysis of beam structures	
• Elements used for Thermal analysis; conductive, convective and radioactive heat transfer in coupled field analysis	

Course Outcomes: After completing the course, the students will be able to	
1	Define the fundamentals of finite element methods. (L1 & L2)
2	Develop the knowledge to analyse structures in static and dynamic conditions (L3 & L4).
3	Assess numerical techniques for solving engineering problems. (L5)
4	Formulate finite element model to implement industrial projects. (L6)

Reference Books	
1.	Fundamentals of FEM , Hutton, 4th Edition , 2005 , Tata McGraw Hill Education Pvt. Ltd., ISBN: 0070601224
2.	First Course in Finite Element Methods , Daryl L Logon, Thomson Brooks, 5th Edition, 2011, ISBN-10: 0495668257
3.	Finite Element Analysis , George R Buchanan, 5th Edition , 2004 , Tata McGraw Hill, ISBN: 0070087148
4.	Introduction to FE in Engineering , T.R. Chandrapatla, A D Belegundu, , 3rd Edition, 2004 , Prentice hall Publications, ISBN: 0065472876

Continuous Internal Evaluation (CIE): Total marks: 100+50=150

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 CIE for theory is 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): Total marks: 100+50=150

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**			**2**	**1**		**2**			**3**	**2**	**3**
CO2	**2**	**2**	**3**	**1**	**2**	**2**	**1**	**2**		**3**	**2**	**2**
CO3	**1**	**3**	**3**	**1**	**3**	**3**		**3**	**3**	**2**	**1**	**3**
CO4	**1**	**3**	**3**	**1**	**3**	**3**	**1**	**3**	**3**	**2**	**2**	**3**

Low-1 Medium-2 High-3

Semester: VI		
Course Title: HYDRAULICS AND PNEUMATICS **(Group C: Professional Core Elective)**		
Course Code: 16ME6C1		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 34 L		**SEE Duration: 3 Hrs**

Course Learning Objectives: The students will be able to	
1	Explain the fundamental concepts used in hydraulic and pneumatic applications.
2	Solve numerical problems on sizing and selection of hydraulic valves.
3	Draw the symbolic representation of hydraulic and pneumatic components.
4	Design simple circuit diagrams for manufacturing applications using fluid power.

UNIT-I	
Introduction to hydraulic power Pascal's law and its application, Structure of hydraulic power pack, Applications, pumping theory, Working of gear, vane and piston pumps, Accumulators, Numerical problems on pump performance. **Hydraulic actuators and motors** Classification and working of hydraulic cylinders, Working of gear, vane and piston motors, Numerical problems on cylinder and motor performance.	**06 Hrs**
UNIT-II	
Control Components of hydraulic system Symbolic representation and constructional features of Directional control valves (spool type) valves, Check valve, Pressure relief valve (direct and pilot), Pressure reducing valve, Unloading valve counterbalance valve, Pressure sequence valves, Throttle valves and flow control valves. Numerical problems on hydraulic valves. **Maintenance of Hydraulic systems** Hydraulic oils (properties and types), Reservoir construction, Sealing devices, Filters and strainers, Problem caused by gases in hydraulic fluids, Troubleshooting, numerical problems on filter rating.	**08 Hrs**
UNIT-III	
Design of hydraulic circuits I Control of Single and Double Acting Cylinder, Regenerative Circuit application, Pump unloading circuit, Double Pump Hydraulic System. Counter Balance Valve Application, problems **Design of hydraulic circuits II** Hydraulic Cylinder Sequencing Circuit, Locked Cylinder using Pilot Check Valve, Cylinder Synchronizing circuits, Speed control circuits, Accumulator Circuits, problems.	**08 Hrs**
UNIT-IV	
Introduction to Pneumatic Power Structure of Pneumatic control system, End position cushioning, Production of compressed air – compressors, Preparation of compressed air- driers, Filters, Regulators, Lubricators, Distribution of compressed air.ISO 5599 symbolic representation. **Design of pneumatic circuits I** Direct and indirect actuation pneumatic cylinders, Use of memory valve, Speed control of cylinders supply air throttling and exhaust air throttling, Application of quick exhaust valve, Practical examples involving the use of AND and OR gates.	**06 Hrs**
UNIT-V	
Design of pneumatic circuits II Practical applications of pressure dependent controls and time dependent controls, Cascading principle, Coordinated motion control, Signal elimination using reversing valves (two cylinders) **Electro pneumatics:** Electrical switching devices, symbolic representation, direct and indirect control of single	**06 Hrs**

acting and double acting cylinders, relay control circuit, latching circuit, auto return using limit switch, control of double acting cylinder using timer, cyclic operation of double acting cylinder, circuit for stamping device.	
Experiential Learning Component: Simulation of hydraulic and pneumatic circuits using automation studio. Working on hydraulic and pneumatic power packs	**4** Hrs/Week

Course Outcomes: After completing the course, the students will be able to	
1	Explain the basic components of hydraulic and pneumatic power pack and structure of circuits.
2	Identify the hydraulic and pneumatic power symbolic representations and troubleshoot the problems.
3	Determine the performance parameters of hydraulic pumps, actuators, filters and valves.
4	Design an efficient hydraulic and pneumatic circuit diagrams for industrial applications.

Reference Books	
1.	Introduction to Hydraulics and Pneumatics , S. Ilango , V. Soundararajan , 2nd Edition, 2011, PHI learning, ISBN – 978–81–203–4406–8
2.	Hydraulics and Pneumatics , Andrew Parr , Elsevier , 3rd Edition , 2011 , ISBN – 978–0– 08–096674–8
3.	Fluid Power with Applications , Anthony Esposito , 7th Edition , 2013 , ISBN: 13 978-9332518544
4.	Hydraulic and Pneumatic controls , R. Srinivasan , 2nd Edition, 2010 , McGraw Hill Education, ISBN: 978–81–8209–138–2

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**						**1**		**1**		**1**
CO2	**1**	**2**	**2**				**1**				**1**	
CO3	**2**	**2**	**2**	**1**			**1**			**1**	**3**	
CO4			**1**	**2**	**1**	**1**		**2**	**2**	**2**		**1**

Low-1 Medium-2 High-3

Semester: VI		
Course Title: COMPUTATIONAL FLUID DYNAMICS **(Group C: Professional Core Elective)**		
Course Code: 16ME6C2		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 36L		**SEE Duration: 3 Hrs**

Course Learning Objectives: The students will be able to	
1	Introduce the importance of computational fluid dynamics in solving fluid flow problems.
2	Differentiate between finite volume and finite difference method in CFD.
3	Discuss application of CFD methods to compressible and in-compressible fluids.
4	Explain use of numerical methods in CFD analysis.
5	Analysis of simple sub-systems using CFD techniques.

Prerequisites: Thermodynamics, Fluid Dynamics, Heat Transfer, Differential Calculus and Integral Calculus, Vector Calculus, Differential Equations, Tensor Algebra, Linear Algebra

UNIT-I	
Introduction to CFD: The need for computer simulations of fluid flows; Brief history of CFD; A few examples of contribution of CFD to engineering design; **Governing equations of fluid flows:** Navier-Stokes equations, Equations of inviscid compressible and incompressible flows; Concepts of convection and diffusion.	**05 Hrs**
UNIT-II	
Analysis of the governing equations of fluid flows: Navier-Stokes to Burgers equation, Convection-diffusion equation, Linear convection equation, Diffusion equation, Unsteady and steady state heat conduction equations. **Mathematical classification of Partial Differential Equations (PDEs):** Elliptic, Parabolic and Hyperbolic equations; Physical significance of the equation; Method of Characteristics; diffusion, Burgers and linear convection equations.	**10 Hrs**
UNIT-III	
Finite difference method (1D): Introduction to Finite Difference Method (FDM) and its application to unsteady heat conduction and steady heat conduction equations; Explicit and implicit methods; FDM for linear convection equation and upwind differencing method. **Properties of numerical methods**: Consistency, Stability, Convergence, Order of accuracy, Modified equations, Artificial viscosity or Numerical diffusion, Numerical dispersion.	**10 Hrs**
UNIT-IV	
Finite volume method: Introduction, application to unsteady and steady heat conduction equations, Linear convection equation; Central discretization and upwind discretization. **Grid generation:** Basics of grid generation , 2-D cartesian, quadrilateral and triangular grids	**06 Hrs**
UNIT-V	
Numerical methods for incompressible flows: Basic problem of the pressure updating; stream function and vorticity formulation, Pressure correction methods, SIMPLE algorithm, Artificial compressibility formulation. **Solution of algebraic equations:** Gauss-Seidel iteration method, Tri-diagonal matrix (Thomas) algorithm, Alternating Direction Implicit (ADI) method.	**05 Hrs**
Self-Learning Component: To generate appropriate grids. Project on understanding flow physics Comparative study of various models. Demonstrate the near wall turbulence.	**4** Hrs/Week

Course Outcomes: After completing the course, the students will be able to	
1	Understand importance of applying CFD to solving engineering design problems. (L1 & L2)
2	Apply and analyse the basic rules to develop CFD Models with appropriate boundary conditions. (L3 & L4)
3	Divide CFD domain into discretization for getting numerical solutions and compute the errors. (L5)
4	Develop novel CFD models for Industrial problems. (L6)

Reference Books	
1.	Computational Fluid Dynamics - The Basics with Applications , John D Anderson , 6th Edition , 1995 , McGraw –Hill , ISBN: 0070016852
2.	Computational Fluid Dynamics: A Practical Approach , J. Tu, G. Yeoh, C. Liu , 2nd Edition , 2013 , Elsevier ISBN-13: 9780750685634
3.	Computational Methods for Fluid Dynamics , Joel Ferziger and Peric , 2nd Edition, 1999, Springer , ISBN :3540653732
4.	Numerical Fluid flow and Heat Transfer , SV Patankar , 1980 , Hemisphere Publishing Corporation , ISBN**:** 0891165223
5.	Numerical Computation of Internal and External Flows , The Fundamentals of Computational Fluid Dynamics , Charles Hirsch Elsevier , ISBN-13: 978-9381269428

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**		**1**	**2**							
CO2	**3**	**2**		**1**	**2**							
CO3	**3**	**1**		**2**	**1**							
CO4	**3**	**2**		**2**	**1**							

Low-1 Medium-2 High-3

Semester: VI		
Course Title: ENERGY CONVERSION ENGINEERING (Group C: Professional Core Elective)		
Course Code: 16ME6C3		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 35L		**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	To understand the working of energy conversion process.	
2	To analyze the energy conversion processes with respect to thermal, potential, chemical, and nuclear energy systems.	
3	To describe the working of various systems and subsystems of energy conversion processes.	
4	To evaluate the factors affecting the energy conversion processes.	
5	To quantify the power generation from different sources.	
6	To develop hybrid and conceptual models for high efficiency power generation.	

UNIT-I	
Thermal Power Plant: General layout of thermal power plant; Types of coal, Pulverizing coal, Equipment for burning coal, Types of stokers, Oil burners, Unit and bin system of burning coal, Cyclone separator, Coal and ash handling, Steam Generators &its Accessories**:** Benson, Velox and Schmidt Steam generators, Operating principles, Super-heaters, Pre-heater, Re-heaters, Economizers; Cooling Towers & Chimney Design: Natural, Forced, Induced and Balanced draft, Calculation of chimney height, Cooling towers and ponds.	**06 Hrs**
UNIT-II	
Hydroelectric Power Plant Design: General layout of hydroelectric power plants, Run off, Hydrographs and flow duration curves, Mass curve, Unit hydrographs, Selection of site for hydroelectric power plant, Classification of hydro power plants: Storage plants, Runoff river plants pumped storage plants. Penstock, Water hammer, Surge tanks, Gates and valves. Types of underground power stations, Prime movers, Specific speed of turbines, Types of draft tubes, Cavitation, Methods to avoid cavitation, Factors affecting the selection of turbine.	**08 Hrs**
UNIT-III	
Nuclear Power Plant: General layout of Nuclear Power Plant; Principles of release of nuclear energy, Fission and Fusion reactions; Nuclear fuels used in reactors, Multiplication and thermal utilization factors, Elements of nuclear reactors, Moderator, Control rod, Fuel rods, Coolants, Pressurized water reactor, Boiling water reactor, Fast breeder reactor, Radiation hazards, Shielding and waste disposal	**08 Hrs**
UNIT-IV	
Diesel Power Plants: Operating principle, Basic types of IC engines, Advantages and Disadvantages of diesel power plant, Application of diesel power plant, General layout of diesel power plants, Fuel system, Lubrication system, Air intake and admission system, Supercharging system, Exhaust system, Cooling system, Diesel plant operation, Efficiency of diesel power plant, Heat balance sheet, Engine capacity calculations	**06 Hrs**
UNIT-V	
Solar and Wind Power Plants: Solar thermal power plant layout, Solar towers, Solar dishes. Solar photovoltaic technology, Different types of solar cells, Modules, Arrays. Stand-alone PV systems, Grid- connected systems. V-I characteristics, Design of solar arrays for domestic purpose. Wind resources, Wind speed variation with height, Weibull statistics and rotational anemometers. Classification of wind turbine: HAWT and HAWT, Wind turbine	**07 Hrs**

anatomy: Rotors, Yawing, Drive train, Types of generators, Towers. Power output from an ideal turbine and practical turbine, Wind farms, Environmental effects of wind power	
Experiential Learning Component: Simulation of thermal power plants, optimum design of cooling towers, Advancements in Hydro and Nuclear power plant (Case study). A small prototype model of PV for different application and wind power plant. Simulation models of Solar and wind energy. A small instrument to measure some energy in IC engines.	**4** Hrs/Week

Course Outcomes: After completing the course, the students will be able to	
1	Evaluate the performance of different energy conversion processes.
2	Interpret the differences in the physics of different energy conversion processes.
3	Calculate the performance parameters of various energy conversion processes.
4	Calculate power, efficiency, and heat balance sheet for various energy conversion processes.

Reference Books	
1.	Principles of Energy Conversion , Culp A. W. , 2nd Edition , 1991 , McGraw Hill, ISBN: 9780070149021
2.	Power Plant Engineering , Nag P. K., 4th Edition, 2014 , Tata McGraw Hill , ISBN-13: 9789339204051
3.	Power Systems Engineering , Rajput R. K., 3rd Edition, 2016 , Laxmi Publications , ISBN: 9788131808795

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**		**1**	**2**							
CO2	**3**	**2**		**1**	**2**							
CO3	**3**	**1**		**2**	**1**							
CO4	**3**	**2**		**2**	**1**							

Low-1 Medium-2 High-3

Semester: VI		
Course Title: ADVANCED MACHINE DESIGN **(Group C: Professional Core Elective)**		
Course Code: 16ME6C4		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 34L		**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Understand modes of failure and its prediction	
2	Conceptualize fatigue failure and compute fatigue life based on experiments	
3	Understand both stress based and strain based approaches	
4	Understand the concepts of LEFM	

UNIT-I	
Introduction: Role of failure prevention analysis in mechanical design, Modes of mechanical failure, Review of failure theories for ductile and brittle materials including Mohr's theory and modified Mohr's theory. Numerical examples. **Fatigue of Materials:** Introductory concepts, High cycle and low cycle fatigue, Fatigue design models, Fatigue design methods, Fatigue design criteria, Fatigue testing, Test methods and standard test specimens, Fatigue fracture surfaces and macroscopic features, Fatigue mechanisms and microscopic features.	**06 Hrs**
UNIT-II	
Stress-Life (S-N) Approach: S-N curves, Statistical nature of fatigue test data, General S-N behavior, Mean stress effects, Different factors influencing S-N behaviour, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using S- N approach. **Strain-Life (ε-N) approach:** Monotonic stress-strain behavior, Strain controlled test methods, Cyclic stress-strain behavior, Strain based approach to life estimation, Determination of strain life fatigue properties, Mean stress effects, Effect of surface finish, Life estimation by ε-N approach.	**08 Hrs**
UNIT-III	
LEFM Approach: LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects, Crack growth life estimation. **Notches and their effects**: Concentrations and gradients in stress and strain, S-N approach for notched membranes, Mean Stress effects and Haigh diagrams, Numerical examples.	**08 Hrs**
UNIT-IV	
Fatigue from Variable Amplitude Loading: Spectrum loads and cumulative damage, Damage quantification and the concepts of damage fraction and accumulation, Cumulative damage theories, Load interaction and sequence effects, Cycle counting methods, Life estimation using stress life approach. Numerical examples. **Notch strain analysis:** Strain – life approach, Neuber's rule, Glinka's rule, applications of fracture mechanics to crack growth at notches. Numerical examples.	**06 Hrs**
UNIT-V	
Surface Failure: Introduction, Surface geometry, Mating surface, Friction, Adhesive wear, Abrasive wear, Corrosion wear. **Surface fatigue**: Spherical contact, Cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength, Surface fatigue failure modes, Design to avoid Surface failures.	**06 Hrs**
Experiential Learning Component: Developing models in software and to validate the results obtained theoretically and using the software models. Develop LEFM's for a notch and analyze practically. Apply the concepts of design in household appliances and to understand them practically.	**4** Hrs/Week

Course Outcomes: After completing the course, the students will be able to	
1	Predict failure based on failure theories.
2	Estimate the fatigue life band on high cycle and low cycle fatigue.
3	Compute crack growth and estimate failure.
4	Estimate contact stresses and resulting failure.

Reference Books	
1.	Metal Fatigue in engineering , Ralph I. Stephens, Ali Fatemi, Robert, Henry o. Fuchs, 2nd Edition , 2001 , John Wiley , New York , ISBN: 9870827312
2.	Failure of Materials in Mechanical Design, Jack. A. Collins, 3rd Edition , 1992 , John Wiley, New York, ISBN: 768290378349
3.	Machine Design , Robert L. Norton , 3rd Edition, 2000 , Pearson Education India, ISBN: 987901782-1
4.	Fatigue of Materials , Suresh , 3rd Edition , 1998 , Cambridge University Press,
5.	Fundamentals of Metal Fatigue Analysis, Julie. A. Benantine , Prentice Hall, I4th Edition, 1990 , SBN: 8972178481-x
6.	Fatigue and Fracture, ASM Hand Book, Volume 19, 2002

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**	**3**	**2**	**2**								
CO2	**3**	**3**	**2**	**2**								
CO3	**2**	**3**	**3**	**1**								
CO4	**2**	**3**	**2**	**1**								

Low-1 Medium-2 High-3

Semester: VI		
Course Title: Product Design and Development **(Group C: Professional Core Elective)**		
Course Code: 16ME6C5		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 36L		**SEE Duration: 3 Hrs**

Course Learning Objectives: The students will be able to	
1.	To understand the structured product development processes
2.	To understand the contributions and role of multiple organizational functions for creating a new product
3.	To apply engineering knowledge for the development of innovative and market acceptable products
4.	To expose the tenets of design and development of a manufacturing process that builds the product at the scales and quality as demanded by the customer and the market
5.	To develop an ability to coordinate multiple, interdisciplinary tasks in order to achieve the mission and goals of the product development organizations

UNIT-I	
Introduction: Characteristics of successful product development, Design and development of products, The Morphology of Design (The seven phases), who Designs and develops products, Duration and cost of product development, Challenges of product development. **Development Processes and Organizations:** A generic development process, Concept development: Front-end process, Adapting the generic product development process, The AMF development process, Product development organizations, The AMF organization.	**06 Hrs**
UNIT-II	
Product Planning: Product planning process, Identify opportunities, Product strategies, Analysis of a product, Three S's, Evaluate and prioritize projects, Allocate resources and plan timing, Complete pre project planning, Reflect all the results and the process. **Identifying Customer Needs:** Gather raw data from customers, Interpret raw data in terms of customer needs, Organize the needs into a hierarchy, Establish the relative importance of the needs and reflect on the results and the process. Quality function deployment. **Product Specifications:** Specifications, Basic design considerations and constraints, Various types of specification, Establishing specifications, Establishing target specifications, Setting the final specifications.	**09 Hrs**
UNIT-III	
Concept Generation: The activity of concept generation, Clarify the problem, Search externally, Search internally, Benchmarking, Explore systematically, Reflect on the results and the process. **Concept Selection:** Overview of methodology, Concept screening, Concept scoring. **Concept Testing:** Define the purpose of concept test, Choose a survey population, Choose a survey format, Communicate the concept, Measure customer response, Interpret the result, Reflect on the results and the process. **Product Architecture:** What is product architecture, Implications of the architecture, Establishing the architecture, Variety and supply chain considerations, Platform planning, Related system level design issues.	**09 Hrs**
UNIT-IV	
Industrial Design: Assessing the need for industrial design, Impact of industrial design, Industrial design process, Managing the industrial design process, Assessing the quality of industrial design. Problems faced by Industrial design Engineer. **Design for Manufacturing:** Definition, Approach to design, Production Requirements, Estimation of manufacturing cost, Reducing the cost of components, Assembly,	**06 Hrs**

Supporting production, VCP, Overview of Design for production - Metal parts, Designing with plastics, Rubber, ceramics and wood, Impact of DFM & DFX on other factors. Concurrent engineering, reasons for adopting concurrent engineering, factors preventing the adoption of Concurrent engineering.	
UNIT-V	
Prototyping: Prototyping basics, Principles of prototyping, Technologies, Planning for prototypes. **Product Development Economics:** Elements of economic analysis, Base case financial mode. Sensitive analysis, Project trade-offs, Influence of qualitative factors on project success, Qualitative analysis. **Managing Projects:** Understanding and representing task, Baseline project planning, Accelerating projects, Project execution, Post-mortem project evaluation.	**06 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Explain the structured approaches to Product design and development of projects.
2	Understand the challenges faced by product designers and appreciate the need for adapting a development mind set.
3	Develop the capability to work in teams and apply the structured product design and development methodologies for solving problems.
4	Analyze the need for integrated product design and process development frameworks.

Reference Books	
1.	Product Design and Development, Karl. T. Ulrich , Steven D Eppinger, 5th Edition , 2009 , Tata McGraw Hill Publications , ISBN – 0-07058513-X
2.	Product Design and Manufacturing , A C Chitale and R C Gupta, 4th Edition , 2007, HI , ISBN: 9788120333178.
3.	New Product Development, Tim Jones, Butterworth Heinemann, 1997, Oxford. UCI, ISBN – 0750624273.
4.	Product Design for Manufacture and Assembly , Geoffrey Boothroyd, Peter Dewhurst and Winston A Knight, M. Dekker, 3rd Edition, 1994, ISBN: 0824791762

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**	**3**									
CO2	**1**	**2**	**3**									
CO3		**2**	**3**	**2**								
CO4		**2**	**3**	**2**								

Low-1 Medium-2 High-3

Semester: VI		
Course Title: GAS DYNAMICS AND COMBUSTION (Group D: Professional Core Elective)		
Course Code: 16ME6D1		**CIE Marks: 100**
Credits: L:T:P:S: 4:0:0:0		**SEE Marks: 100**
Hours: 46L		**SEE Duration: 3 Hrs**

Course Learning Objectives: The students will be able to	
1	Differentiate between compressible and incompressible flows.
2	Explain the influence of parametric changes on gas flows.
3	Evaluate gas flows at subsonic and supersonic conditions.
4	Compare different fuels and discuss the process of combustion.

Prerequisites: Thermodynamics, Fluid Dynamics, Calculus

UNIT-I	
Introduction to Gas Dynamics: Compressible Flows, Isentropic flow, Stagnation, Static and Dynamic Pressure, Pressure Co-efficient; Acoustic speed, Mach Number, Governing Equations for Compressible Flows.	**08 Hrs**
UNIT-II	
Shock Waves: Normal Shock Waves, Rankine-Hugoniot Equation, Rayleigh Flow, Fanno Flow. Oblique Shock Waves, supersonic flow over wedges and cones, reflection and interaction of shock waves; Prandtl Meyer Flow.	**14 Hrs**
UNIT-III	
Nozzles: Isentropic flow through variable area ducts, Convergent and divergent nozzles, Over expanded and under expanded nozzles; Subsonic wind tunnels, Shock tunnels and super-sonic wind tunnels.	**08 Hrs**
UNIT-IV	
Combustion: Types of fuels and modes of combustion; Stoichiometry, Chemical Equilibrium, Thermo-Chemistry, Basic reactor kinetics, Elementary Reactions, Chain Reactions, Multi-Step Reaction.	**08 Hrs**
UNIT-V	
Physics of Combustion: Laws of transport mechanism, Premixed flames, Ignition and flame stabilization and extinction; Combustion and Emission, Atmosphere, Chemical Emission from Combustion, Quantification and Control of Emission.	**08 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Understand and develop ability to explain gas dynamics relations. (L1 & L2)
2	Apply engineering concepts to arrive at solutions. (L3)
3	Analyze and evaluate a given situation for find optimal solutions. (L4 & L5)
4	Develop an ability to predict performance of a system. (L6)

Reference Books	
1.	Fundamentals of Gas Dynamics , Robert D Zucker , Oscar Biblarz , 4th Edition, 2010, John Wiley & Sons, New York, ISBN-13:978-8126529124
2.	Fundamentals of Combustion Processes , Sara McAllister, Jyh-Yuan Chen, Carlos Fernandez, 5th Edition , 2013 , Springer , New York , ISBN-13: 978-1461428657
3.	Combustion , Irvin Glassmann, Richard Yetter, 3rd Edition , 2009 , Elsevier Publication, ISBN-13: 978-8131220290
4.	Compressible Fluid Dynamics , P. Balachandarn, 2nd Edition, 2006 , Prentice Hall of India, ISBN-13: 978-8120328570

5.	Babu. V, 'Fundamentals of Gas Dynamics', Athena Academic Ltd, 4th Edition, 2014, ISBN-13: 978-1910390009

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**							
CO2	**3**	**2**		**1**	**2**							
CO3	**3**	**1**		**2**	**1**							
CO4	**3**	**2**		**2**	**1**							

Low-1 Medium-2 High-3

Semester: VI		
Course Title: NON TRADITIONAL PROCESSES **(Group D: Professional Core Elective)**		
Course Code: 16ME6D2		**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 will be able to	
1	Apply the working principles of ultra-precision machining and non-traditional machining for producing precision components.
2	Demonstrate the need for development of non-traditional machining processes.
3	Identify different energy sources like fluid motion, electric current, high speed electrons and high energy radiation.
4	Analyze the concept, mechanism, parameters associated with non-traditional machining processes.
5	Demonstrate the operational principles of various non-traditional machining processes.
6	Apply the basic principles of rapid prototyping (RP) and reverse engineering (RE) technologies for product development.

UNIT-I	
Introduction: Need for non-traditional machining processes. Processes selection c1assification on – comparative study of different processes. **Mechanical Process**: Ultrasonic Machining-Definition-Mechanism of metal elements of the process- Tool feed mechanism. Theories of mechanics of causing effect of parameter applications. **Abrasive Jet Machining**: Principles - parameters of the process applications-advantages and advantages.	**08 Hrs**
UNIT-II	
Thermal Metal Removal Process: Electric discharge machining Principle of operation – mechanism of meta removal basic EDM circuitry-spark erosion get Analysis of relaxation type of circuit material removal rate in relaxation circuits- critical resistance parameters in Ro Circuit-Die electric fluids-Electrodes for sparl surface finish. Applications. **Electro chemical and chemical processes**: Electro chemical machining (ECM) Classification ECM process – Principle of ECM Chemistry of the ECM parameters of the processes- Determination of the metal removal rate - Dynamics of ECM process-Hydrodynamics of ECM process – Polarization-.Tool Design -Advantages and Disadvantages - Applications. Electro Chemical Grinding-Electro Chemical holding, Electrochemical deburring	**10 Hrs**
UNIT-III	
Chemical Machining: Introduction- Fundamental principle types of chemical machining Maskants –Etchenes- Advantages and disadvantages- Applications. **Plasma arc Machining**: Introduction – Plasma-Generation of Plasma and equipment Mechanism of metals removal, PAN parameters- Process characteristics - Type of torches applications. **Electron Beam Machining (EBM)**: Introduction-Equipment for production of Electron beam - Theory of electron beam machining Thermal and Non thermal types characteristics - Applications.	**10 Hrs**
UNIT-IV	
Laser Beam Machining (LBM): Introduction- Principle of generation of lasers Equipment and Machining procedure-Types of Lasers-Process characteristics-advantages and limitations- Applications **Ion Beam Machining**: Introduction-Mechanism of metal removal and associated equipment- Process characteristics - Applications **High Velocity forming process**: Introduction - Development of specific process	**08 Hrs**

selection- Comparison of conventional and high velocity forming methods - Types of high velocity forming methods - Explosion forming process, Electro-hydraulics forming, Magnetic pulse forming.	
UNIT-V	
Additive Manufacturing: Basics and definitions: Principle of layer-based technology, Advantages, Classification. Rapid Prototyping Process Chain: 3D Modeling, Data Conversion and Transmission, Checking and Preparing, Model building, Post processing. **Rapid prototyping techniques:** Stereolithography, Solid Ground Curing (SGC), Fused Deposition Modeling (FDM), Selective Laser Sintering (SLS), Three-dimensional printing, Laminated Object Modeling (LOM).	**08 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Classify the various Non-Traditional Machining process to machine new novel materials.
2	Choose an appropriate Non Traditional Machining technique to machine the given material.
3	Identify the Process parameters affecting the functioning of various Non-Traditional Machines.
4	Describe various types of rapid prototyping systems for product development.

Reference Books	
1.	Production Technology - HMT , R K Jain and S C Gupta, Tata Mc Graw Hill, 16th Edition, 2004 , ISBN-10; 0070964432
2.	Modern Machining Process , P.C Pandy & H.S. Shan, 5th Edition, 2008 , Tata McGraw Hill, ISBN: 0070965536
3.	Modern Manufacturing Methods , Adithan , 3rd Edition, 2007, New Age International Pvt. Limited, , ISBN**:** 8122408176
4.	Modern Machining Processes , P.K. Mishra , 3rd Edition, 1997 , Narosa Publishing House, New Delhi, ISBN: 8221948176

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

Semester: VI		
Course Title: THEORY OF PLATES AND SHELLS **(Group D: Professional Core Elective)**		
Course Code: 16ME6D3		**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 will be able to	
1	To understand the classical structural mechanics approximations of membrane, plate and shell theories.
2	To apply energy formulations to demonstrate the consistent derivation of approximate boundary conditions and edge effects.
3	To identify the deformation of Shells without Bending for different surfaces and loadings.
4	To evaluate the deformation of cylindrical tanks and pressure vessels.

UNIT-I	
Bending of plates: Introduction- Slope and curvature of slightly bent plates – relations between bending moments and curvature in pure bending of plates – strain energy in pure bending – Differential equation for cylindrical bending of plates – Differential equation for symmetrical bending of laterally loaded circular plates – uniformly loaded circular plates with and without central cut outs, with two different boundary conditions (Simply supported and clamped). Centrally loaded clamped circular plate - Circular plate on elastic foundation.	**08 Hrs**
UNIT-II	
Simply supported rectangular plates: Differential equation of the deflection surface – boundary conditions. Simply supported rectangular plates subjected to harmonic loading. Navier's solution for simply supported plate subjected to UDL, patch UDL, point load and hydrostatic pressure –Bending of rectangular simply supported plate subjected to a distributed moments at a pair of opposite edges.	**10 Hrs**
UNIT-III	
Rectangular plates with different Edge conditions: Bending of rectangular plates subjected to UDL (i) two opposite edges simply supported and the other two edges clamped, (ii) three edges simply supported and one edge built-in and (iii) all edges built-in. Bending of rectangular plates subjected to uniformly varying lateral load (i) all edges built-in and (ii) three edges simply supported and one edge built-in.	**10 Hrs**
UNIT-IV	
Deformation of Shells without Bending: Definitions and notation, Shells in the form of a surface of revolution, Displacements, Unsymmetrical loading, and spherical shell supported at isolated points, Membrane theory of cylindrical shells, Use of stress function in calculating membrane forces of shells.	**08 Hrs**
UNIT-V	
General Theory of Cylindrical Shells: A circular cylindrical shell loaded symmetrically with respect to its axis, Symmetrical deformation, Pressure vessels, Cylindrical tanks, Thermal stresses in extensional deformation, General case of deformation, Cylindrical shells with supported edges, Approximate investigation of the bending of cylindrical shells, Use of a strain and stress function, Stress analysis of cylindrical roof shells.	**08 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Apply the structural mechanics approximations of membrane, plates and shells.
2	Develop simple modifications to the membrane plate and shell theories.
3	Describe the static and dynamic conditions of membrane, plates and shell structures.
4	Analyze cylindrical tanks, pressure vessels for different boundary conditions and stresses.

Reference Books	
1.	Theory of Plates and Shells, S.P Timoshenko and S.W Krieger , 2nd Edition ,1989 , McGraw Hill , ISBN: 0070647798
2.	Theory of Plates and Shells, S.S. Bhavikatti , 3rd Edition , 2017, New Age International, ISBN: 978-93-86070-81-4
3.	Theory of Plates, Chandrasekhar. K.L , 4th Edition , 2001 , University press, ISBN: 9788173712531

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**	**2**	**3**	**1**			**3**	**1**	**1**		**1**	**1**
CO2				**2**		**1**		**2**	**2**	**1**		**3**
CO3	**3**	**1**	**1**		**3**		**2**	**2**	**1**			
CO4	**1**	**2**		**3**	**3**	**1**			**2**	**2**	**3**	**3**

Low-1 Medium-2 High-3

Semester: VI		
Course Title: CUTTING TOOL DESIGN (Group D: Professional Core Elective)		
Course Code: 16ME6D4		**CIE Marks: 100**
Credits: L:T:P:S: 4:0:0:0		**SEE Marks: 100**
Hours: 48L		**SEE Duration: 3 Hrs**

Course Learning Objectives: The students will be able to	
1.	Understand the mechanism of material removal using different cutting tools
2.	Measure cutting forces for different machining process
3.	Understand design features of various cutting tool inserts and tool holders
4.	Design of various cutting tools for industry applications.
5.	Compute the economics of cutting tools and machining process

UNIT-I	
Introduction: Mechanism of chip formation, Mechanism of yielding, Concept of shearing strain, Fracture, Overview of chip formation, Mechanism of Metal Cutting. **Force system during turning:** Velocity relationships – Force analysis in turning, milling, drilling.	**08 Hrs**
UNIT-II	
Tool dynamometers: Design requirements of tool force dynamometer, Turning tool dynamometer, Milling tool dynamometer, Grinding tool dynamometer. **Cutting tool Inserts:** Design features of inserts, Indexable inserts, Chip breakers, ISO and ANSI classification of inserts and tool holders.	**10 Hrs**
UNIT-III	
Turning Tool: Design of shank cross section, Classification of form tools, Design characteristics, Graphical and analytical method for profile calculation, chip breakers purpose and types **Milling Tool:** Nomenclature, Design principles of plain milling cutter, Life and wear.	**10 Hrs**
UNIT-IV	
Drilling Tool: Drills with Indexable insert, Deep hole drill, Carbide tipped drill, Core drill, Counter pores, and Counter sinks. **Broaching Tool:** Elements, Types of broach, Broach design aspects, Broach strength.	**08 Hrs**
UNIT-V	
Boring: Types of boring tool, Boring heads, Cartridges. **Reamer:** Types of reamers, Geometry of flutes. **Economics of machining:** Elements of machining cost, Tool cost, Cutting speed for minimum cost, Cutting speed for maximum productivity.	**08 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Understand mechanism of chip formation, measurement of cutting forces.
2	Analyze the different types of machining operations.
3	Design cutting tools based on analytical and graphical method for industrial requirements.
4	Apply engineering knowledge for development of cutting tools for various operations.

Reference Books	
1	Metal Cutting and Tool Design, Dr. B. J. Ranganath, 2nd Revised Edition, 2009. Vikas Publishing House Pvt. Ltd., New Delhi , ISBN: 0706975103, 9780706975109
2	Tool Design , Herman W. Pollack , 2nd Edition, 1988, Prentice Hall PTR, ISBN: 0139251812
3	Cutting tools for productive machining , T A Sadasivan, D Sarathy, 1st Edition, 1999, Widia (India) Limited , ISBN: 82937319-1
4	Metal Cutting Theory and Cutting Tool Design , Arshinov, MIR Publication

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**		**1**			**2**			**1**	**1**		
CO2	**3**	**3**	**1**	**2**								
CO3	**3**	**2**	**3**	**2**	**1**		**1**					
CO4	**1**			**2**	**1**							

Low-1 Medium-2 High-3

Semester: VI		
Course Title: Quality Assurance **(Group D: Professional Core Elective)**		
Course Code: 16ME6D5		**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 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	Perform Reliability evaluation of Mechanical, Electrical, Electronics and Software Technology Systems.
5	Develop strategies for conducting design of experiments in process improvements

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	**08 Hrs**
UNIT-II	
Control Charts for Variable and Attribute Data: Controls charts for Mean, Range and Standard deviation σ. 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}	**10 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	**10 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	**08 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	**08 Hrs**

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 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 , 1997, McGraw-Hill International Editions , ISBN0070188521
4	Quality Planning & Analysis, T J M Juran, Frank M Gryna, 4th Edition, Tata McGraw Hill, ISBN – 0070393680.

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

Semester: VI		
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: 3 Hrs**

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 Bio-inspirations: 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

Semester: VI		
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:** 3 Hrs

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.

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

Semester: VI		
SOLID WASTE MANAGEMENT **(Group E: Global Elective)**		
Course Code:16G6E03		**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	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.

Reference 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
4.	Municipal Solid waste (Management & Handling Rules) 2000. Ministry of Environment & Forest Notification, New Delhi, 25th Sept 2000 and 2016 amendments.
5.	Hazardous waste (management, handling) rules 2008.Ministry of Environment and Forest Notification, New Delhi, 25th February 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

Semester :VI		
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)

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**	**-**	**2**	**-**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**1**
CO2	**-**	**-**	**2**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**2**
CO4	**-**	**-**	**3**	**-**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**2**

Low-1 Medium-2 High-3

Semester: VI			
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 Automotive: Global Positioning Systems (GPS) and General Packet Radio Service (GPRS),	**07 Hrs**

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

SEMESTER – VI		
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:** 3 Hrs

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**	**PO12**
CO1	**3**	**2**	**2**	**2**	**1**	**2**	**2**	**1**	**1**	**2**	**0**	**1**
CO2	**3**	**2**	**2**	**3**	**3**	**0**	**1**	**0**	**0**	**0**	**2**	**1**
CO3	**3**	**2**	**2**	**3**	**2**	**2**	**0**	**1**	**0**	**0**	**1**	**2**
CO4	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**0**	**1**	**0**	**0**	**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 : 33 L		**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

Semester: VI		
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:** 3 Hrs

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)

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	**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

Semester: VI		
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:** 3 Hrs

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

Semester: VI		
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	**06 Hrs**

Stability Program, Air bags, Crash testing methods.	
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	
1	Describe the different types of automotive systems. (L1- L2)
2	Construct the Valve Timing Diagram for multi-cylinder engines. (L3)
3	Detect the automotive exhaust pollutants using gas analyzer. (L4)
4	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)

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**			**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

Semester: VI		
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: 03 Hrs**

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)

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**	**---**	**---**	**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

Semester: VI		
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)

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**
CO2	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**2**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO4	**3**	**3**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**

High-3: Medium-2: Low-1

Semester: VI		
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:** 3 Hrs

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 :	
1	Categorise the various systems required for designing a complete airplane
2	Comprehend the complexities involved during development of flight vehicles.
3	Explain the role and importance of each systems for designing a safe and efficient flight vehicle
4	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

V/VI Semester		
PROFESSIONAL PRACTICE – III **EMPLOYABILITY SKILLS AND PROFESSIONAL DEVELOPMENT OF ENGINEERS**		
Course Code: 16HS68		**CIE Marks:** 50
Credits: L:T:P:S: 0:0:1:0		**SEE Marks:** NA
Hours: 18 Hrs		**CIE Duration:** 02 Hrs

Course Learning Objectives: The students will be able to	
1	Improve qualitative and quantitative problem solving skills.
2	Apply critical and logical thinking process to specific problems.
3	Ability to verbally compare and contrast words and arrive at relationships between concepts, based on verbal reasoning.
4	Applying good mind maps that help in communicating ideas as well as in technical documentation

V Semester	
UNIT-I	
Aptitude Test Preparation- Importance of Aptitude tests, Key Components, Quantitative **Aptitude** – Problem Solving, Data Sufficiency, Data Analysis - Number Systems, Math Vocabulary, fraction decimals, digit places etc. **Reasoning and Logical Aptitude**, - Introduction to puzzle and games organizing information, parts of an argument, common flaws, arguments and assumptions. Analytical Reasoning, Critical Reasoning.	**06 Hrs**
UNIT-II	
Verbal Analogies - What are Analogies, How to Solve Verbal Analogies & developing Higher Vocabulary, Grammar, Comprehension and Application, Written Ability. Non-Verbal Reasoning, Brain Teasers. Creativity Aptitude. **Group Discussion**- Theory &Evaluation : Understanding why and how is the group discussion conducted, The techniques of group discussion, Discuss the FAQs of group discussion, body language during GD.	**06 Hrs**
UNIT-III.A	
Resume Writing- Writing Resume, how to write effective resume, Understanding the basic essentials for a resume, Resume writing tips Guidelines for better presentation of facts.	**06 Hrs**
VI Semester	
UNIT-III.B	
Technical Documentation - Introduction to technical writing- Emphasis on language difference between general and technical writing, Contents in a technical document, Report design overview & format Headings, list & special notes, Writing processes, Translating technical information, Power revision techniques, Patterns & elements of sentences, Common grammar, usage & punctuation problems.	**06 Hrs**
UNIT-IV	
Interview Skills -a) Personal Interviews , b) Group Interviews , c) Mock Interviews - Questions asked & how to handle them, Body language in interview, Etiquette, Dress code in interview, Behavioral and technical interviews, Mock interviews - Mock interviews with different Panels. Practice on stress interviews, technical interviews, General HR interviews etc.	**06 Hrs**
UNIT-V	
Interpersonal Relations - Optimal Co-existence, Cultural Sensitivity, Gender sensitivity Adapting to the Corporate Culture- Capability & Maturity Model, Decision Making Analysis, Brain Storm. Adapting to the Corporate Culture.	**06 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1:	Inculcate employability skill to suit the industry requirement.
CO2:	Analyze problems using quantitative and reasoning skills
CO3:	Exhibit verbal aptitude skills with appropriate comprehension and application.
CO4:	Focus on Personal Strengths and Competent to face interviews and answer
Reference Books	
1.	The 7 Habits of Highly Effective People, Stephen R Covey Free Press, 2004 Edition, ISBN: 0743272455
2.	How to win friends and influence people, Dale Carnegie General Press, 1st Edition, 2016, ISBN: 9789380914787
3.	Crucial Conversation: Tools for Talking When Stakes are High, Kerry Patterson, Joseph Grenny, Ron Mcmillan 2012 Edition, McGraw-Hill Publication ISBN: 9780071772204
4.	Aptimithra: Best Aptitude Book ,Ethnus,2014 Edition, Tata McGraw Hill ISBN: 9781259058738

Scheme of Continuous Internal Examination (CIE)
Evaluation of CIE will be carried out in TWO Phases.

Phase	Activity	Weightage
I	Test 1 is conducted in V Sem for 50 marks (15 Marks Quiz and 35 Marks Descriptive answers) after completion of Unit-1, Unit-2 and Unit -3.A for 18 hours of training sessions.	50%
II	Test 2 is conducted in VI Sem for 50 marks ((15 Marks Quiz and 35 Marks Descriptive answers) after completion of Unit -3B, Unit - 4 and Unit-5 for 18 hours of training sessions.	50%
	At the end of the VI sem Marks of Test 1 and Test 2 is consolidated for 50 marks (Average of Test1 and Test 2 (T1+T2/2). The grading is provided by the Coe. The final CIE marks is scrutinized by the committee comprising of HSS- Chairman, Training Co-ordinator, respective department Staff Placement co-ordinator before submitting to CoE.	

SEE: NA

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

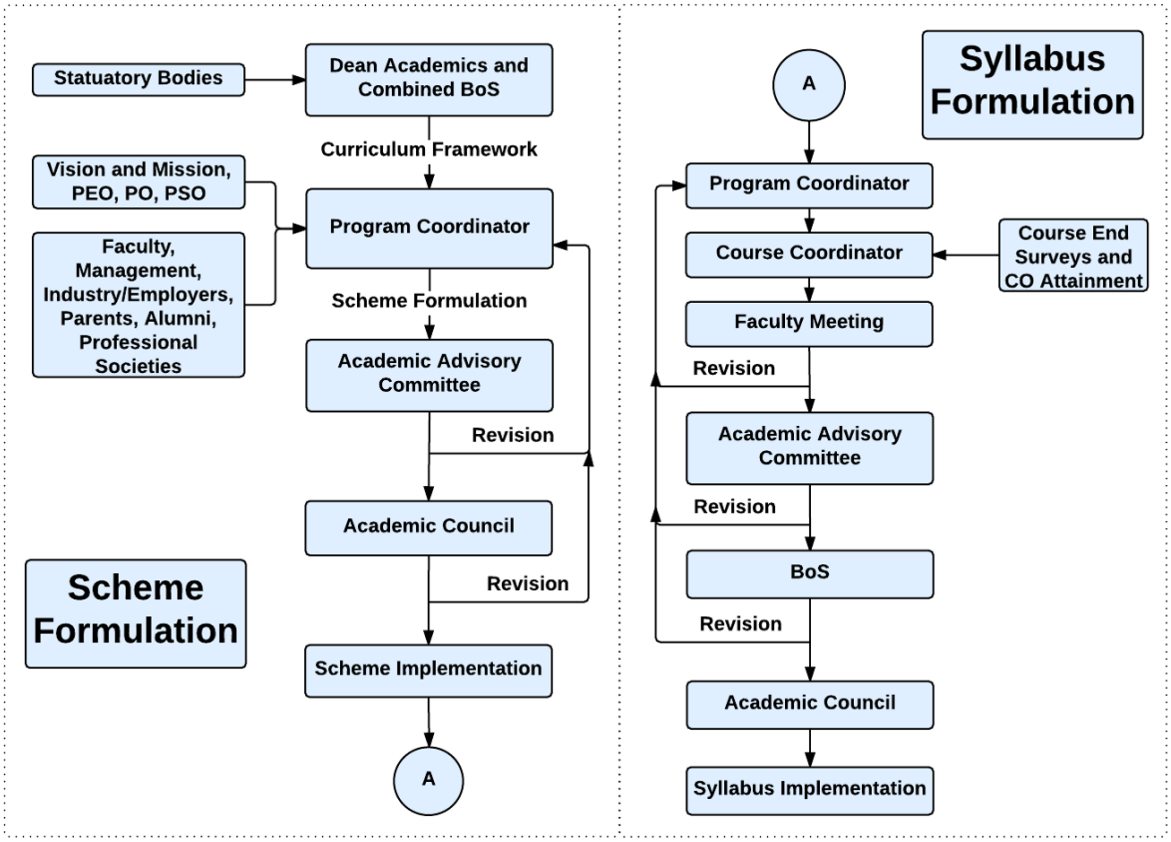
Low-1 Medium-2 High-3

Credits Distribution as per UGC/VTU

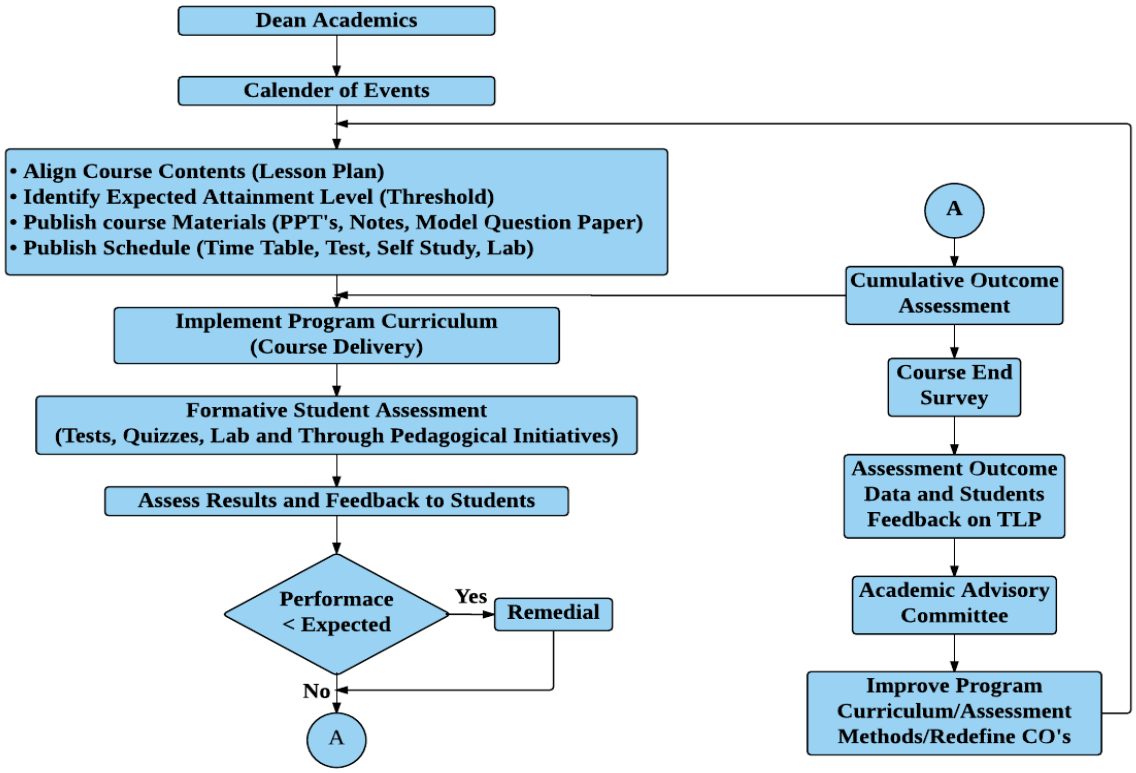
Sl. No.	Category	Percentage (%)	Minimum No. of credits	Assigned No. Of credits 2012	2016 scheme	
					Without Mini Project	With Mini Project
1	Humanities	5-10	10	10	9+2	9+2
2	Basic Science	15-20	30	28	30	30
3	Engineering Science	15-20	30	28	30	30
4	Professional Core Courses (PC)	30-40	60	80	78+3=81 (3 credits core in place of Minor project in 7th semester)	81-3=78 (3 Credits for minor project in 7th semester)
5	Professional Elective Courses	10-15	20	20	20	20
6	Other Electives	5-10	10	11	10	10
7	Project Work	10-15	20	23 + 2	16+2 Major project +Tech. Seminar	16+2+3 Major project +Tech. Seminar +Mini Project
Total No. of Credits					200	200

SEMESTER WISE CREDIT DISTRIBUTION (SELF STUDY CREDIT INCLUDED EXCEPT FOR VII SEM)								
I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**TOTAL**
25 (P)/25(C)	25/25	25	25	29	28	23	20	200

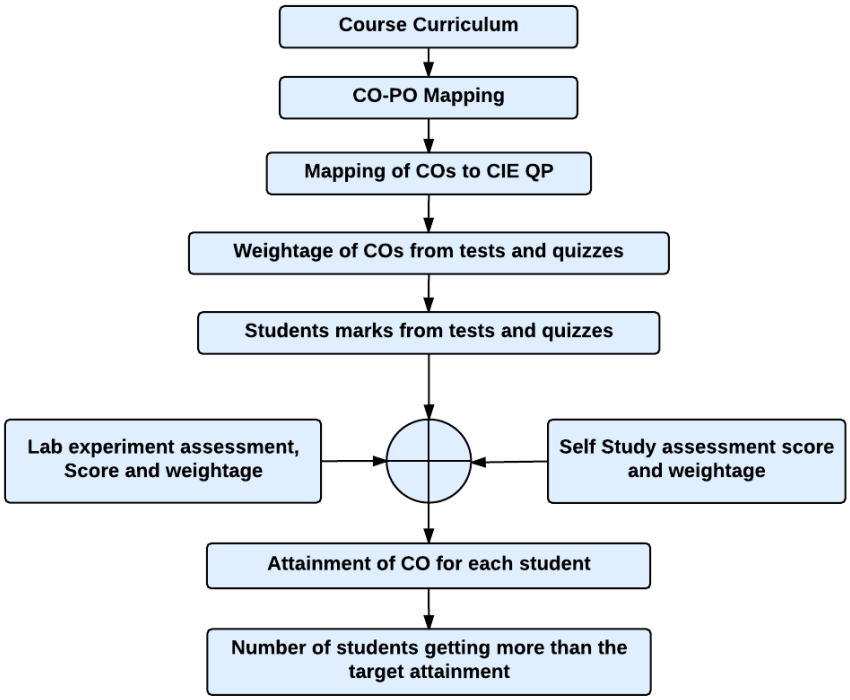
Curriculum Design Process



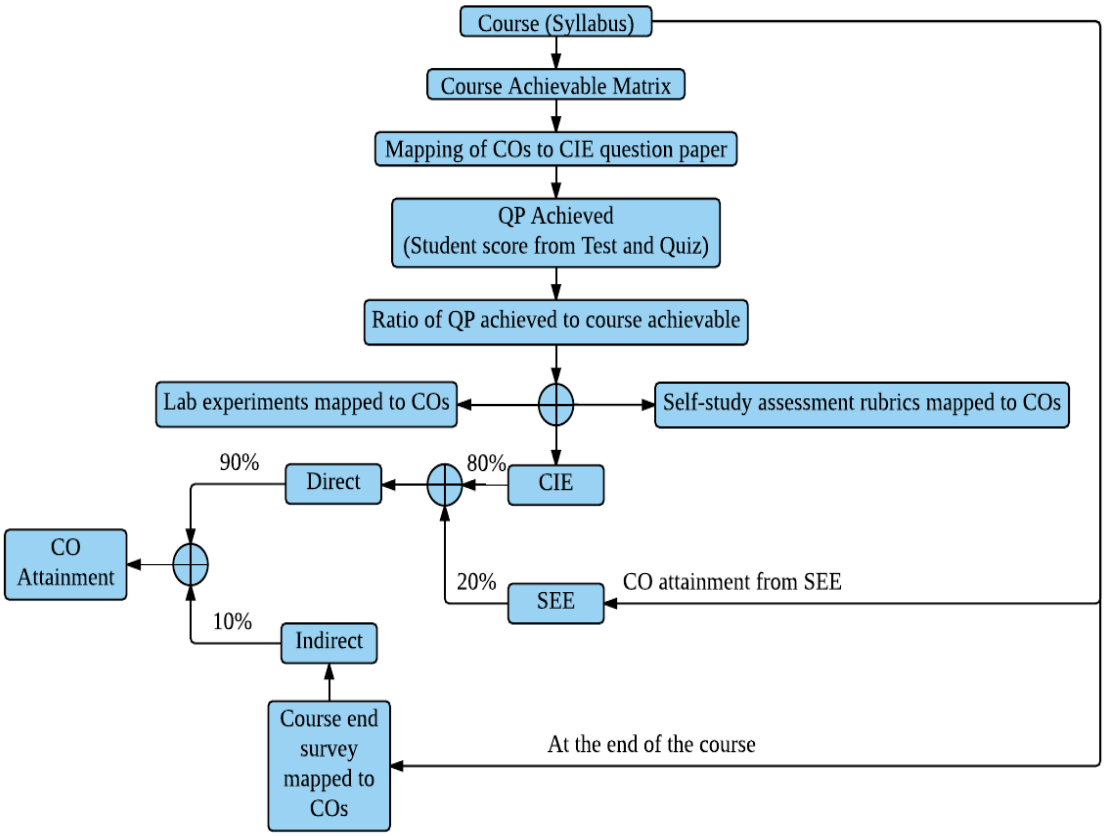
Academic Planning and Implementation



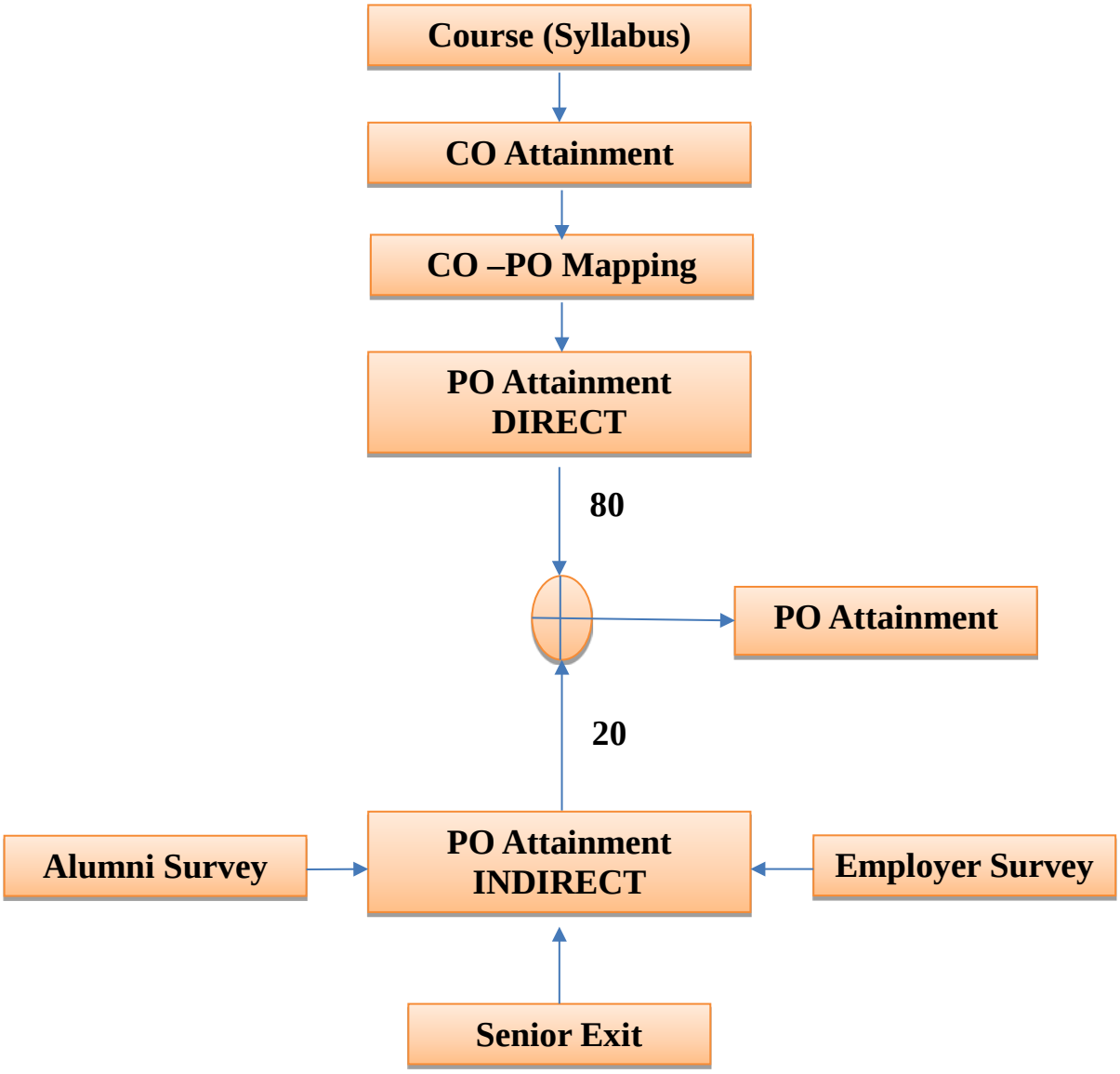
PROCESS FOR COURSE OUTCOME ATTAINMENT



Final CO Attainment Process



Program Outcome Attainment Process



Guidelines for Fixing Targets

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