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

CIVIL ENGINEERING

Department Vision

Excel in Education, Research and Consultancy in Civil Engineering with emphasis on Sustainable Development

Department Mission

- Disseminating and integrating the knowledge of civil engineering and allied fields.
- Enhancing industry-institute interaction leading to interdisciplinary research.
- Imbibing wide-range of skills in cutting-edge technology for sustainable development.
- Motivate entrepreneurship and professional ethics to serve the society.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Successfully address technological and managerial challenges.

PEO2: Professionally design and execute Civil Engineering projects.

PEO3: Pursue advanced education, research and continue life-long learning process to remain active professionals.

PEO4: Play key roles in addressing societal needs through interdisciplinary approach.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO	Description
PSO1	Apply knowledge of fundamental aspects to analyze and design civil engineering structures
PSO2	Provide sustainable solutions to civil engineering problems
PSO3	Employ codal provisions to arrive at comprehensive solutions to address societal needs
PSO4	Exhibit communication and teamwork skills

Lead Society: American Society of Civil Engineers (ASCE)

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2016 SCHEME

CIVIL 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

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

FIFTH SEMESTER								
Sl. No	**Course Code**	**Course Title**	**BOS**	**Credit Allocation**				**Total Hours**
				Lecture	**Tutorial**	**Practical**	**SS (EL)**	
1	16HEM51	Foundations of Management and Economics	HSS	2	0	0	0	2
2	16CV52	Structural Analysis	CV	3	1	0	0	4
3	16CV53	Design and Drawing of RCC Structures	CV	3	0	1	1	5
4	16CV54	Highway Engineering	CV	3	0	1	0	4
5	16CV55	Irrigation and Hydraulic Structures	CV	3	0	0	1	4
6	16CV5AX	Elective A (PCE)	CV	3	0	0	1	4
7	16G5BXX	Elective B (GE)	CV	4	0	0	0	4
		Total No. of Hours						27
		No. of Hrs.		21	2	4	12**	27

**Non-contact hours

SIXTH SEMESTER								
Sl. No.	**Course Code**	**Course Title**	**BOS**	**Credit Allocation**				**Total Hours**
				Lecture	**Tutorial**	**Practical**	**SS (EL)**	
1	16HSI61	Intellectual Property Rights and Entrepreneurship	HSS	3	0	0	0	3
2	16CV62	Geotechnical Engineering	CV	3	1	1	0	5
3	16CV63	Prestressed Concrete Structures	CV	3	0	0	1	4
4	16CV64	Transportation Engineering	CV	3	0	0	0	3
5	16CV6CX	Elective C (PCE)	CV	3	0	0	1	4
6	16CV6DX	Elective D (PCE)	CV	3	0	0	1	4
7	16G6EXX	Elective E(GE)	CV	3	0	0	0	3
8	16HS68	Professional Practice-III (Employability Skills and Professional Development of Engineers)	HSS	1	0	0	0	1
		Total No. of Hours						27
		No. of Hrs.		22	2	2	12**	26

**Non-contact hours

V Sem		
GROUP A: PROFESSIONAL CORE ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
1.	16CV5A1	Numerical methods in Civil Engineering
2.	16CV5A2	Environmental Impact Assessment
3.	16CV5A3	Ground Water Hydrology
4.	16CV5A4	Alternative Building Materials And Technologies

GROUP B: GLOBAL ELECTIVES				
Sl. No.	**Host Dept**	**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 Sem		
GROUP C: PROFESSIONAL CORE ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
1.	16CV6C1	Structural Masonry
2.	16CV6C2	Traffic Engineering and transportation Planning
3.	16CV6C3	Air pollution& control Engineering
4.	16CV6C4	Watershed Management
GROUP D: PROFESSIONAL CORE ELECTIVES		
1.	16CV6D1	Structural Dynamics
2.	16CV6D2	Remote sensing & GIS
3.	16CV6D3	Construction Management
4.	16CV6D4	Advanced Concrete Technology

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	Partial Differential Equations	3
13.	AE	16G6E13	Aircraft Systems	3

V/VI 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: 02Hrs**

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

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

Course Outcomes: After completing the course, the students will be able to	
1	Explain the principles of management theory & recognize the characteristics of an organization.
1	Demonstrate the importance of key performance areas in strategic management and design appropriate organizational structures and possess an ability to conceive various organizational dynamics.
3	Select & Implement the right leadership practices in organizations that would enable systems orientation.
4	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		
STRUCTURAL ANALYSIS (Theory)		
Course Code:16CV52		**CIE Marks: 100**
Credits: L:T:P:S: 3:1:0:0		**SEE Marks: 100**
Hours: 36L + 24T		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	Understand the basic concepts of plastic analysis and matrix method of analysis
2	Understand the concept of influence line diagram and its application under rolling loads
3	Analyse the structural system under static and rolling loads
4	Evaluate the behaviour of structures by conventional, strain energy and plastic methods of analysis
5	Develop flexibility matrix and stiffness matrix for beam element

UNIT-I	
Redundant Trusses: Introduction, Analysis of statically indeterminate structures using strain energy method, Analysis of trusses (Redundant up to second degree), Lack of fit in member & temperature stress in redundant truss.	**08 Hrs**
UNIT-II	
Moment – Distribution Method: Introduction, Stiffness factor, Distribution Factor, Distribution moment and Carry-over moment; Analysis of Continuous beams with and without settlement of supports. Single bay, Single storey, Orthogonal Portal frames with and without sway.	**07 Hrs**
UNIT-III	
Rolling loads and influence lines: Rolling load analysis for simply supported beams (No overhanging beams), for the case of several point loads and UDL, Influence line diagrams for reactions, Shear forces and Bending moments at a given section for simply supported beams (No overhanging beams).	**07 Hrs**
UNIT-IV	
Plastic Analysis: Introduction to plastic hinge, plastic collapse load, conditions of plastic analysis. Redistribution of moments. Theorems of plastic collapse, plastic analysis of beams and orthogonal portal frames by mechanism method.	**07 Hrs**
UNIT-V	
Introduction to Matrix Methods: Flexibility method and Stiffness method – Introduction, concept of flexibility and stiffness, Development of stiffness and flexibility matrices for determinate structures by basic approach. (Only derivations)	**07 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Illustrate the concepts of various methods of analysis
2	Apply the basic concepts of analysis methods in determining unknown reactions of the structures
3	Analyze the different forms of structural elements by suitable methods of analysis
4	Evaluate the behavior of structure under various loading conditions

Reference Books	
1.	Structural Analysis, R C Hibbler, 8th edition, Pearson Publications, **ISBN-13:** 978-0132570534
2.	Theory of Structures, S. Ramamrutham, Dhanpat Rai Publishing Company Private Limited-New Delhi; Ninth edition (2014), ISBN-13: 978-9384378103

3.	Limit State Design of Steel Structures, Duggal S K, Tata McGraw-Hill Education, 2014, ISBN-13: 978-9351343493

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

Low-1 Medium-2 High-3

Semester: V		
DESIGN AND DRAWING OF RCC STRUCTURES (Theory)		
Course Code:16CV53		**CIE Marks: 100+50**
Credits: L:T:P:S: 3:0:1:1		**SEE Marks: 100+50**
Hours: 48L		**SEE Duration: 3Hrs + 3 Hrs**

Course Learning Objectives: The students will be able to	
1	Distinguish working stress method and limit state method specifications for RCC structures
2	Analysis problems on RCC structural elements such as beams, columns, slabs staircase and footings
3	Evaluate and design problems on various specifications of relevant IS codes
4	Design and details of reinforcements for RCC structures

UNIT-I	
Principles of Limit State Design and Ultimate Strength of RC Sections Philosophy of limit state design, Principle of limit states, Factor of safety , Characteristic and design loads, Characteristic and design strength, General aspects of ultimate strength, Stress block parameters for limit state of collapse, Ultimate flexural strength of rectangular sections- singly reinforced and doubly reinforced, Ultimate flexural strength of flanged sections, Ultimate torsional strength and shear strength of RC sections, Concept of development length and anchorage, Analysis problems using IS 456:2000	**10 Hrs**
UNIT-II	
Design of beams Practical requirements of RCC beam, Size, Cover, Spacing of bars, Design of rectangular and flanged RC beams for flexure, shear, deflection, Anchorage etc(Simply supported and Cantilever beams only) using IS 456:2000 and SP16.	**10 Hrs**
UNIT-III	
Design of slabs: General considerations for design of slabs, Rectangular slabs spanning in one direction, Rectangular slabs spanning in two directions for various boundary conditions, Torsion reinforcement design for two way slabs, Design of simply supported and cantilever slabs as per IS 456:2000.	**10 Hrs**
UNIT-IV	
Design of columns: General aspects, effective length of column, loads on columns, slenderness ratio, Minimum eccentricity, Design of short axially loaded columns, Design of columns subjected to axial load and uni-axial moment, Design of columns subjected to axial load and uniaxial moment.	**08 Hrs**
UNIT-V	
Design of stairs and Footings **Design of stairs:** Loading on stairs, Design of doglegged stairs, design of open-well stairs **Design of Footings:** Introduction, Load on footing, Design of square and rectangular isolated footings for axial load and uni-axial moment	**10 Hrs**
PART B (Laboratory)	
Preparation of salient drawings and schedule of bars using the given data: **1.** Singly and Doubly reinforced beams - Simply supported and cantilever beams. **2.** T- Beam and slab arrangement. **3.** One-way and two-way slab with and without torsion reinforcement. **4.** Dog legged and Open well staircase. **5.** Square, rectangular and Circular Isolated column with footing.	

Course Outcomes: After completing the course, the students will be able to	
1	Apply the philosophy and principles of methods to design RCC elements
2	Analyze RC elements using working stress method and limit state method in the analysis of singly and doubly reinforced RC sections.
3	Design RC structural elements as per codal provisions
4	Sketch reinforcement details and evaluate the quantity of steel for RC structural elements.

Reference Books	
1.	Design of Reinforced Concrete Structures, Krishnaraju N and Pranesh. R.N, 2nd Edition, CBS Publishers and Distributors, New Delhi, 2003, ISBN 978-81-224-1460-8
2.	Limit State Design of Reinforced Concrete, Varghese P.C, 2nd Edition, Eastern Economy Edition, Prentice –Hall of India Pvt Ltd, New Delhi, 2004, ISBN 9788120320390
3.	Design of Reinforced Concrete Structures, Unnikrishnan and DevadasMenon, 4th Edition, PHI New Delhi, 2003,ISBN 978-0070495043
4.	RCC Designs (Reinforced Concrete Structures), Punmia B.C., Ashok Kumar Jain, Arun Kumar Jain, 10th Edition, 2011, Laxmi Publications (P) Ltd, New Delhi, ISBN 978-81-318-0942-6

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.

Laboratory- 50 Marks

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

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

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

Laboratory- 50 Marks

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

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

Low-1 Medium-2 High-3

Semester: V		
HIGHWAY ENGINEERING (Theory)		
Course Code:16CV54		**CIE Marks: 100+50**
Credits: L:T:P:S: 3:0:1:0		**SEE Marks: 100+50**
Hours: 36L		**SEE Duration: 3Hrs + 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Classify roads and describe geometric design elements	
2	Understand material properties and factors affecting pavement design	
3	Analyze flexible and rigid pavement design	
4	Understand and assess highway drainage system	

UNIT – I	
Principles of Transportation Engineering: Importance of Transportation, IV Road development plan highlights, Jayakar committee recommendations and implementation, Concept of Expressways and PMGSY – for rural connectivity, Golden Quadrilateral and NSEW Corridor. **Highway Geometric Design:** Importance, Factors controlling the design of Geometric elements, Geometric design consistency	**07 Hrs**
UNIT – II	
Geometric Design Elements: Sight distances-Types, analysis, Factors affecting, measurements. Numerical on above. (Note: Derivation not required). **Cross Section Elements:** Right of way and width consideration, roadway, shoulders, kerbs, traffic barriers, medians, Facilities for pedestrians, buses and trucks, Horizontal alignment, superelevation, Gradients.	**07 Hrs**
UNIT – III	
Pavements: Types, Functions of pavement, choice, Factors affecting design and performance of flexible and rigid pavements – Subgrade, Materials, Axle Load Distribution, ESWL, EWL, VDF, Environmental conditions.	**07 Hrs**
UNIT – IV	
Pavement Design: Flexible pavement design as per IRC: 37 – 2012. Design of rigid pavement as per IRC: 58 – 2015, types of joints, (excluding design of joints).	**08 Hrs**
UNit – V	
Highway Drainage System: Importance and requirements, Surface and Subsurface drainage system - methods, Design of filters.	**07 Hrs**

Laboratory

Determination of

1. California Bearing Ratio of soil sample
2. Specific gravity of bitumen
3. Penetration value of bitumen
4. Ductility value of bitumen
5. Softening Point of bitumen
6. Viscosity of bitumen-Rotational Viscometer
7. Impact Value of aggregates
8. Los Angeles Abrasion Value of aggregates
9. Crushing value of aggregates
10. Specific gravity and water absorption of aggregates

11. Ten percent fines value of aggregates 12. Proportioning of aggregates for dense bituminous mixes 13. Determination of bitumen content by Centrifuge Bitumen Extractor 14. Determination of the Marshall stability and flow value of Bituminous mixes

Course Outcomes: After completing the course, the students will be able to	
1	Explain suitable geometry, materials and drainage system for design and construction of pavements.
2	Compute the design requirements for geometry, drainage and pavements.
3	Select suitable geometry, materials and drainage for design and construction of pavements.
4	Evaluate and recommend geometry materials and design for pavements.

Reference Books	
1.	Highway Engineering, Khanna, S.K. and Justo, C.E.G, Veeraragavan A, 10th Edition, Nemechand and Bros. Roorkee, 2014 ISBN: 9788185240633, 8185240639
2	L. R. Kadiyali, N.B. Lal Principles And Practices Of Highway Engineering: , Khanna Publishers,2004,ISBN-13: 978-8174091659
3	Highway Material Testing, Khanna, Justo and Veeraragavan – 5th Edition, Nemechand Bros, Roorkee, 2009, ISBN 9788185240213
4	Principles of Pavement Design, E. J. Yoder and M. W. Witczak, Wiley Publication, Print ISBN: 9780471977803
5	IRC -37-2012, IRC-58-2015, Indian Roads Congress, New Delhi

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

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

Low-1 Medium-2 High-3

Semester: V		
IRRIGATION AND HYDRAULIC STRUCTURES (Theory)		
Course Code:16CV55		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 36L		**SEE Duration: 3Hrs**
Course Learning Objectives: The students will be able to		
1	Study of scientific application of water to soils to raise food crops, Problems extending from watershed to agricultural farming.	
2	Estimation of Crop water requirement to determine storage capacity of reservoir.	
3	Design of storage structures, canal head works, outlet for reservoirs and impermeable foundations for weirs	
4	Design of outlets for reservoir for such as spillways, energy dissipaters, river protection works for flood prone rivers.	

UNIT-I	
Introduction: Benefits and ill effects of irrigation. Sources of water for irrigation. Systems of irrigation, Methods of irrigation. **Irrigation and water requirements of crops:** Definition of duty, Delta and Base period, Relationship between Duty, Delta and Base period, Factors affecting Duty of Irrigation water, Types of Duty, Crops and crop seasons in India, Consumptive use, Irrigation efficiency, Frequency of irrigation, Numerical problems.	**08 Hrs**
UNIT-II	
Canal: Types of canals. Canal alignment. Command area, Intensity of irrigation, Time factor, Capacity factor, Unlined and lined canals standard sections. Design of canals by Lacey's and Kennedy's Silt Theories. **Canal works:** Canal regulators - Classification and suitability. Canal drop – Classification, Hydraulic principles and design of notch type drop. Cross drainage works: Classification. Hydraulic principles and design of an aqueduct.	**08 Hrs**
UNIT-III	
Reservoirs: Investigation for reservoir site, Storage zones, Determination of storage capacity and yield of reservoir using mass curve, Economical height of dam, Reservoir evaporation losses. **Diversion works:** Layout, types of weirs and Barrages. Design of Impermeable floors- Bligh's and Lacey's theories- Simple design problems. Khosla's theory- Method of independent variables, Exit gradient (No design problem)Sensitivity, numerical problem	**07 Hrs**
UNIT-IV	
Gravity dams: Forces acting on a gravity dam, Modes of failures, Elementary and practical profile, Low and high gravity dams, Stability analysis and related problems, Principal stresses, Drainage galleries. **Earthen dams:** Types, Failure of earthen dams, Preliminary design, Drainage arrangements, Phreatic line, seepage analysis (no numerical problems)	**07 Hrs**
UNIT-V	
Spillways: Types of spillways, Design Principles for an Ogee Spillway, Energy dissipaters: Types of Stilling basins (No design problem)	**06 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Describe various irrigation practices in use, canal, canal works, reservoirs and dams.(L1)
2	Understand the concepts of irrigation water management and design of various hydraulic structures. (L2)
3	Determine the crop water requirement, storage capacity of a reservoir.(L3)
4	Analyze the conveyance system, canal works, diversion works and spillways. (L4)

Reference Books	
1.	Irrigation Engineering and Hydraulic Structures, S.K.Garg, Khanna publications, New Delhi.2006, ISBN-10: 8174090479, ISBN-13: 978-8174090478.
2.	Irrigation water resources and water Power Engineering, P.N.Modi, 9th edition, Standard book house, 2008, ISBN 8189401297, ISBN-13: 978-8189401290
3.	Irrigation Engineering, R.K. Sharma, S Chand & company; Revised edition 2007, ISBN-10: 8121921287, ISBN-13: 978-8121921282.
4.	Irrigation Engineering and Hydraulic Structures, S.R. Sahasrabudhe, S.K. Kataria & Sons, 2013 Edition, ISBN-10: 9350141310, ISBN-13: 978-9350141311.
5.	Engineering for Dams Vol I, Creager, Justin and Hinds, Hesperides Press, 2006, ISBN 9781406717082.

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

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

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

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

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

Low-1 Medium-2 High-3

Semester: V		
NUMERICAL METHODS IN CIVIL ENGINEERING (Group A: Professional Core Elective)		
Course Code:16CV5A1		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 34L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	Impart students the concept of numerical methods and its application to various civil engineering problems
2	Help students formulate the mathematical models for a given physical problem
3	Provide students the basic skill for solving civil engineering problems using simple arithmetic operations
4	Promote the use of coding and programming tools and its implementation in solving everyday civil engineering problem

UNIT-I	
Introduction: Historical development of Numerical techniques, Sources of error in numerical solutions: Truncation error, Round Off error. **Methods for Solution of System of Linear Equations:** Gaussian elimination method**,** Gauss-Jordan method**,** Gauss-Siedel method**,** Factorization method	**07 Hrs**
UNIT-II	
Application of solution of linear system of equations to Civil Engineering problems: Construction planning, Truss analysis, Beam analysis. **Numerical Integration:** Trapezoidal rule and Simpson's one third rule and its application for computation of area of BMD drawn for statically determinate beams.	**07 Hrs**
UNIT-III	
Application of Root Finding to Civil Engineering problems: Picard's Iteration method**,** Bisection method**,** Regula-Falsi Method**,** Newton- Raphson method and applications for solution of Nonlinear algebraic and transcendental equations for problems in Civil Engineering	**06 Hrs**
UNIT-IV	
Finite difference Method as a method to solve partial differential equations: Introduction, Forward, backward and central difference technique, application of the method to obtain the bending moment and deflections of determinate and indeterminate beams for different load combinations.	**07 Hrs**
UNIT-V	
Integration technique applied to Structural analysis using New Mark's method: Introduction, Application of the method to obtain the shear force, bending moment, slope and deflections of determinate and indeterminate beams for different load combinations.	**07 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Formulate numerical models and find its relevance in solving civil engineering problems.
2	Apply the concepts of differential equation, numerical integration and solutions for system of equations in solving various civil engineering problems
3	Analyze structures, both determinate and indeterminate by various numerical methods
4	Evaluate shear force, bending moment and deflection for various structural members

Reference Books	
1.	Numerical methods for Engineers - Chapra S.C&R.P. Canale: Mc Graw Hill,1990. ISBN-13:978-0-07-063416-9
2.	Numerical methods in engineering Problem - N. Krishna Raju, K.U. Muthu: Mac Millon Indian Limited,1990 ISBN-0333924240
3.	Numerical Methods for Engineers and Scientists, Iqubal H Khan.Q.Hassan, Galgotia, New delhi.1997.ISBN62-187-0745-4
4.	Jain, Iyenger and Jain, "Numerical Methods for Scientific and Engineering Computation", Wiley, New Delhi. 2000.ISBN81-224-0597-5

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

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

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

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

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

Low-1 Medium-2 High-3

Semester: V		
ENVIRONMENTAL IMPACT ASSESSMENT **(Group A: Professional Core Elective)**		
Course Code:16CV5A2		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 36L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	To study factors to be considered for preparing an Environmental Impact Statement
2	To study the principles, methodologies and techniques of Environmental Impact Assessment (EIA)
3	To study mitigation techniques and study of alternatives.
4	To prepare EIA for specific case studies.

UNIT-I	
Introduction: Impact of developmental projects – sustainable development – Need for Environmental Impact Assessment (EIA), Rapid and Comprehensive EIA, Environmental Impact statement (EIS) – EIA capability and limitations – Legal provisions on EIA – stages of EIA.	**08 Hrs**
UNIT-II	
Role of NEPA in EIA, CEQ, Environmental documents. EIA/ EIS& FONSI relationship, processing of EIA/EIS, Environmental attributes. **Methodologies**: Criteria to be considered for the selection of EIA methodologies, Adhoc, overlays, Check lists – Matrices – Networks – Cost-benefit analysis with their advantages and limitations.	**07 Hrs**
UNIT-III	
Guidelines for preparation of EIA **Prediction and Assessment**: Assessment of Impact on land, water, air and noise. social and cultural activities and on flora and fauna – mathematical models – public participation.	**07 Hrs**
UNIT-IV	
Environment management plan : Plan for mitigation of adverse impact on Environment – Options for mitigation of impact on water, air, land and on flora and fauna – Addressing the issues related to project affected people. Post project monitoring. ISO 9000, 14000 & 18000.	**07 Hrs**
UNIT-V	
Case Studies **EIA for the infrastructure projects** –Airport, Dam, Highway, Multi- storey buildings, water supply and drainage projects, Hazardous waste landfill site.	**07 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Carryout scoping and screening of developmental projects for environmental and social assessments.
2	Explain different methodologies for environmental impact prediction and assessment.
3	Prepare environmental management plans.
4	Evaluate environmental impact assessment reports and roles, actions that citizens and interest groups can take to influence the EIA process and outcome.

Reference Books	
1.	Environmental Impact Analysis, 2nd Edition, R.K.Jain, Mc Graw- Hill , Newyork, 2002, ISBN - 9780071370080
2.	Environmental Impact Assessment, Y.Anjaneyulu CRC press, ISBN 10- 0415665566, 13- 9780415665568, 2011.

3.	Environmental Impact Assessment, Larry W Canter, McGraw-Hill Inc. ISBN: 10- 0071141030, 13- 9780071141031, 1996,
4.	Environmental Impact Analysis Handbook, John G. Rau and David C Hooten (Ed), McGraw-Hill Book Company, 10- 0070512175, 13- 9780070512177, 1980 Reprint 2013.
5.	Concepts in Environmental Impact Analysis, Shukla, S.K. and Srivastava, P.R., Common Wealth Publishers, New Delhi, 10- 8171692087, 13- 9788171692088, 1992 Reprint 2013.

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

High-3 : Medium-2 : Low-1

Semester: V		
GROUND WATER HYDROLOGY **(Group A: Professional Core Elective)**		
Course Code: 16CV5A3		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 36L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	Understand the structural formation of water bearing strata.
2	Study of Ground Water flow phenomenon in steady & unsteady strata.
3	Experimental methods of determining Aquifer parameters with limitations.
4	The importance of Ground Well Hydraulics.
5	Application of Geophysics in determination of Ground Water Resources.

UNIT-I	
Vertical distribution of subsurface water. Types of water bearing formation. Aquifer parameters, specific yield, specific retention, porosity, storage coefficient, land subsidence due to withdrawal of ground water, Darcy's law, intrinsic permeability, Hydraulic conductivity, Transmissivity, permeability determination by lab & traces methods.	**08 Hrs**
UNIT-II	
Steady unidirectional flows in confined aquifers, unconfined aquifers- Dupit's equation, Base flow to a stream, Steady Radial flow to well – Confined aquifer, unconfined aquifer with uniform recharge.	**06 Hrs**
UNIT-III	
Unsteady radial flow in a confined aquifer - Non equilibrium pumping equation, Theis method, Cooper-Jacob method and Chow method, unsteady radial flow in an unconfined aquifer, Image well theory.	**07 Hrs**
UNIT-IV	
Geophysical investigation and well design: Wenner's and Schlumberger method. Seismic refraction method. Well design- design of diameter, depth, spacing and casing. Well losses.	**07 Hrs**
UNIT-V	
Ground water pollution: Sources Attenuation of pollution (Filtration, Sorption, Dilution) Mass transport of pollution Fick's law. Advection-Dispersion equation in Saturated porous media. Monitoring of ground water quality and methods of remediation.	**08 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Describe the concepts of ground water flow phenomenon. (L1)
2	Understand the different flow conditions and problems associated with ground water pollution.(L2)
3	Apply the concepts, techniques necessary to determine aquifer parameters. (L3)
4	Analyze the various aspects of groundwater assessment, development and management.(L4)

Reference Books	
1.	Ground water Hydrology, Todd and Mays, 3rd Edition, Wiley Indian Pvt. Ltd , Reprint 2014, ISBN 9788126530038
2.	Ground water Hydrology, H.M.Raghunath, 3rd Edition, New Age international Pvt.Ltd., New Delhi, Reprint 2014, ISBN 9788122419047
3.	Ground water Assessment development and Management, Karanth.K.R., 2nd Edition, Tata Mc Graw Hill company Ltd., New Delhi, twelfth reprint 2008, ISBN 9780074517123.

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

Low-1 Medium-2 High-3

Semester: V		
ALTERNATIVE BUILDING MATERIALS AND TECHNOLOGIES (Group A: Professional Core Elective)		
Course Code:16CV5A4		**CIE Marks: 100**
Credits: L:T:P:S :3:0:0:1		**SEE Marks: 100**
Hours: 36L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	To study process that is environmental appropriate and resource-efficient throughout a building's life-cycle
2	To study innovative solutions using state-of-the-art technologies and building materials
3	To study how to minimize environmental impact by facilitating to use local and recycled materials to lessen energy in buildings
4	To study the behavior of masonry materials and structures
5	To study the cost effective methods in building technology and design
6	To induce sustainable and inclusive technology

UNIT-I	
Introduction to Energy in building materials and buildings Energy in building materials, Environmental issues concerned to building materials, Global warming, Environmental friendly and cost effective building technologies, Buildings in different climatic region. Energy evaluation of building materials.	**08 Hrs**
UNIT-II	
Introduction to Masonry units, materials and Types: Types and Characteristics of alternative masonry units - stabilized mud blocks, Geo polymer, FaL- G Blocks, Aerated concrete blocks - strength, modulus of elasticity and water absorption. Mortars, Types, Preparation, Properties, Masonry materials-Classification and properties of mortars, selection of mortars.	**07 Hrs**
UNIT-III	
Alternative Building Technologies Alternative Technology for wall construction, Types, Construction Techniques , Masonry mortars, Types, Preparation, Properties, Ferro cement and ferroconcrete building, components, Materials and specifications, Properties, Construction methods, Applications, Alternative roofing systems-Concepts, Filler slabs, Composite beam panel roofs, Masonry vaults and domes.	**07 Hrs**
UNIT-IV	
Fibre Reinforced Cement composites: Introduction, Materials, Mechanical Properties of FRC, and Applications. **Fibre Reinforced Polymer Composites:** Introduction, Materials, Manufacturing process, Applications	**07 Hrs**
UNIT-V	
Cost Effective Building Design: Concept of Cost Effectivebuildings and Cost saving techniques adopted in planning, design and construction	**07 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Understand need of Alternative Building Materials in Construction industry
2	Analyze embodied energy, structural behavior of alternative materials
3	Evaluate properties of mortar and other alternative construction materials
4	Design methods for cost effective buildings by adopting cost effective materials and cost saving techniques

Reference Books	
1.	Alternative building Materials and Technologies, K.S.Jagadish, B.V.Venkatarama Reddy and K.S.NanjundaRao, New Age International Publishers. 2009;ISBN 978-81-224-2037-1
2.	Building Alternatives for housing. Lecture notes on Alternative Building, K.S .Jagadish, Dept of Civil Engg, Indian Institute of Science ,1997
3.	Adobe and Rammed Earth Buildings: Design and Construction, Paul Graham McHenry, New edition (15 September 1989), Publisher: University of Arizona Press; ISBN-10: 0816511241, ISBN-13: 978-0816511242
4.	Structural Masonry, A.W.Hendry, Macmillan Press, London, ISBN 9780333733097
5.	Structural Masonry, Sven Sahlin, Prentice Hall Inc., Englewood Cliffs, New Jersey,ISBN 9780138539375

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

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

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

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

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:04		**SEE Duration: 3Hrs**

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

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

Unit –V	
BioPerl: Introduction to BioPerl, BioPerl Modules, Applications of BioPerl – Sequence retrieval from Database and submission of sequence to online Database, Indexing and accessing local databases, Transforming formats of database record, Sequence alignments BioPerl and Sequence Analysis - Pair wise and Multiple sequence alignment, Restriction mapping. Identifying restriction enzyme sites, acid cleavage sites, searching for genes and 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.	**09 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Understand the Architecture and Schema of online databases including structure of records in these databases.
2	Explore the Mind crunching Algorithms, which are used to make predictions in Biology, Chemical Engineering, and Medicine.
3	Apply the principles of Bioinformatics and Programming to the problems related to process simulation and process engineering in Biological system.
4	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: 3Hrs**

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

UNIT-I	
Introduction: Fuel cell definition, historical developments, working principle of fuel cell, components of fuel cell, EMF of the cell, Fuel Cell Reactions, fuels for cells and their properties.	09Hrs
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 .	09Hrs
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.	09Hrs
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.	09Hrs
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**
Credits: 48L		**SEE Duration: 3Hrs**

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

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

UNIT-V	
Applications of GIS, Remote Sensing and GPS: Land use land cover (LULC) mapping. Case studies on infrastructure planning and management- Case studies on urban sprawl. Change detection studies – case studies on forests and urban area. Case studies on agriculture. **Applications of geo-informatics in natural resources management: Geo Technical case Studies**, site suitability analysis for various applications.	**09 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Understand the principle of Remote Sensing (RS) and Geographical Information Systems (GIS) data acquisition and its applications.
2	Apply RS and GIS technologies in various fields of engineering and social needs.
3	Analyze and evaluate the information obtained by applying RS and GIS technologies.
4	Create a feasible solution in the different fields of application of RS and GIS.

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

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

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

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

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

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

Low-1 Medium-2 High-3

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 coloring of graphs	**09 Hrs**
UNIT-V	
Graph algorithms Graph connectivity algorithms, Breadth first search and Depth first search, Shortest path algorithms, Dijikstra's shortest path algorithm, Minimum cost spanning tree algorithms, Algorithm of Kruskal's and Prim's.	**09Hrs**

Course Outcomes: After completing the course, the students will be able to	
1.	Understand and explore the basics of graph theory.
2.	Analyse the significance of graph theory in different engineering disciplines
3.	Demonstrate algorithms used in interdisciplinary engineering domains.
4.	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	
1	Model Neuron and Neural Network, and to analyze ANN learning, and its applications.
2	Perform Pattern Recognition, Linear classification.
3	Develop different single layer/multiple layer Perception learning algorithms
4	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 : 3Hrs**

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

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

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.	08Hrs

Course Outcomes: After completing the course, the students will be able to	
1	Explain the basics of electric and hybrid electric vehicles, their architecture, technologies and fundamentals.
2	Evaluate the performance of electrical machines and power electronics converters in HEVs.
3	Analyse the different energy storage devices used for hybrid electric vehicles, their technologies and control and select appropriate technology
4	Design and evaluate the sizing of subsystem components and Energy Management strategies in HEVs.
Reference Books:	
1.	Hybrid Electric Vehicle: Principles and Applications with Practical Perspectives, Mi Chris, Masrur A.and Gao D.W. Wiley Publisher, 1st Edition, 2011,*ISBN*:0-824-77653-5
2.	Ali, Modern Electric, Hybrid electric and Fuel Cell Vehicles, Ehsani Mehrdad, Gao Yimin, E. Gay Sebastien, Emadi CRC Press, 1st Edition, 2005, ISBN: *0-8493-3154-4.*
3.	Modern Electric Vehicle Technology, Chan, C.C.,Chau, K.T. Oxford University Press, 2001, ISBN 0 19 850416 0.
4.	Hybrid Electric Vehicles: Energy Management Strategies, Simona Onori, Lorenzo Serrao, Giorgio Rizzoni, *ISBN*: 978-1-4471-6779-2.

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

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

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

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

High-3 : Medium-2 : Low-1

V Semester		
OPTIMIZATION TECHNIQUES **(Group B: Global Elective)**		
Course Code : 16G5B07		**CIE Marks : 100**
Credits : L: T: P: S:4:0:0:0		**SEE Marks : 100**
Hours : 44L		**SEE Duration : 03 Hrs**

Course Learning Objectives: The students will be able to	
1.	To understand the concepts behind optimization techniques.
2.	To explain the modeling frameworks for solving problems using optimization techniques.
3.	To design and develop optimization models for real life situations.
4.	To analyze solutions obtained using optimization methods.
5.	To compare models developed using various techniques for optimization.

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

Course Outcomes: After going through this course the student will be able to	
1	Understand the various optimization models and their areas of application.
2	Explain the process of formulating and solving problems using optimization methods.
3	Develop models for real life problems using optimization techniques.
4	Analyze solutions obtained through optimization techniques.
5	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)

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

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

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

Low-1 Medium-2 High-3

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

Course Learning Objectives: The students will be able to

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

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

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

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

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

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

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

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

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

Low-1 Medium-2 High-3

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: 3Hrs**

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

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

Course Outcomes: After completing the course, the students will be able to	
1	Understand and apply the fundamental concepts of information systems.
2	Develop the knowledge about management of information systems.
3	Interpret and recommend the use information technology to solve business problems.
4	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)

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

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

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	3	-	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 (Group B: Global Elective)		
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 **Industrial Robotics** Components of Robots, base types, classification of robots, end of arm tooling, robot precision of movement, programming, justifying the use of a robot, simple numericals	**08 Hrs**

UNIT-V	
Programmable logic control systems Difference between relay and PLC circuits, PLC construction, principles of operation, latching, ladder diagrams, programming instructions, types of timers, forms of counters, writing simple 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)

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

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

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3				2	1	2	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: 46L		**SEE Duration: 03Hrs**

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

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

Course Outcomes: After completing the course, the students will be able to	
1	Describe the basics of communication systems.
2	Analyze the importance of modulation and multiple access schemes for communication systems.
3	Compare different telecommunication generations, wired and wireless communication.
4	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)

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

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

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1	---	1	1	---	---	---	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: 44L		**SEE Duration: 3Hrs**

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

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

Course Outcomes: After completing the course, the students will be able to	
1	Identify and interpret the fundamental concepts of polynomial equations, Interpolation, Eigen value problems, Differential equations and corresponding computational techniques.
2	Apply the knowledge and skills of computational techniques to solve algebraic and transcendental equations, Ordinary differential equations and eigen value problems.
3	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.
4	Distinguish the overall mathematical knowledge gained to demonstrate and analyze the problems of finding the roots of equations, Interpolation, Differential equations, Eigen value

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

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

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

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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: 44L		**SEE Duration: 3Hours**

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

Unit-I	
Introduction to Aircraft : History of aviation, International Standard atmosphere, Atmosphere and its properties, Temperature, pressure and altitude relationships, Classification of aircrafts, Anatomy of an aircraft & Helicopters, Basic components and their functions, Introduction to Unconventional and Autonomous Air vehicles.	**08 Hrs**
Unit – II	
Basics of Aerodynamics : Bernoulli's theorem, Aerodynamic forces and moments on an Airfoil, Lift and drag, Types of drag, Centre of pressure and its significance, Aerodynamic centre, Aerodynamic Coefficients, Wing Planform Geometry, Airfoil nomenclature, Basic characteristics of airfoils, NACA nomenclature, Simple problems on lift and drag.	**08 Hrs**
Unit -III	
Aircraft Propulsion : Introduction, Classification of powerplants, Piston Engine: Types of reciprocating engines, Principle of operation of turbojet, turboprop and turbofan engines, Introduction to ramjets and scramjets, Comparative merits and demerits of different types Engines.	**07 Hrs**

Unit -IV	
Introduction to Space Flight : History of space flight, Evolution of Indian Space Technology, The upper atmosphere, Introduction to basic orbital mechanics, some basic concepts, Kepler's Laws of planetary motion, Orbit equation, Space vehicle trajectories**.** **Rocket Propulsion :** Principles of operation of rocket engines, Classification of Rockets, Types of rockets.	**08 Hrs**
Unit -V	
Aerospace Structures and Materials : Introduction, General types of construction, Monocoque, Semi-Monocoque and Geodesic structures, Typical wing and fuselage structure; Metallic and non-metallic materials for aircraft application. Use of aluminum alloy, titanium, stainless steel and composite materials, Low temperature and high temperature materials.	**07 Hrs**

Course Outcomes: At the end of this course the student will be able to :	
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

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

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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

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

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

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

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)	
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	
1	Comprehend the applicable source, scope and limitations of Intellectual Property within the purview of engineering domain.
2	Knowledge and competence related exposure to the various Legal issues pertaining to Intellectual Property Rights with the utility in engineering perspectives.
3	Enable the students to have a direct experience of venture creation through a facilitated learning environment.
4	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		
GEOTECHNICAL ENGINEERING (Theory)		
Course Code:16CV62		**CIE Marks: 100+50**
Credits: L:T:P:S: :: 3:1:1:0		**SEE Marks: 100+50**
Hours: 36L + 24T		**SEE Duration: 3Hrs + 3 Hrs**

Course Learning Objectives: The students will be able to	
1	Understand the importance of soil and its properties in Civil Engineering applications
2	Demonstrate the index properties and engineering properties of different soils and Soil Structure
3	Intrepret the various factors influencing the soil behavior
4	Summarize the significance of soils and its behaviour in various applications of Civil engineering

UNIT-I	
Index Properties : Definition, Basic Terminology, Phase Systems of Soil Mass, Void ratio, Porosity, Degree of saturation, Air content, Percentage Air Voids, Water content, Unit weight, Specific gravity – Interrelations and related problems, Tests for water content and specific gravity, Particle Size Distribution (Sieve analysis and Hydrometer analysis), Consistency of Soils- Atterberg Limits, Field Density and Density Index. **Clay Mineralogy and Soil Structure**- Common clay minerals in soil and their structures- Kaolinite, Illite and Montmorillonite.	**08 Hrs**
UNIT-II	
Classification of Soil and Permeability: Soil Classification Purpose, Unified Soil Classification System, Indian Standard Soil Classification System Darcy's Law and its Limitations, Discharge Velocity and Seepage Velocity, Factors affecting Permeability, Aquifers and flow through aquifers, Determination of Coefficient of Permeability, Permeability of Stratified Soil Deposits, related problems.	**07 Hrs**
UNIT-III	
Compaction: Introduction, Differences between Compaction and Compressibility, Standard Proctor Test, Modified Proctor Test, Zero air voids line, Field Compaction Method, Placement Water Content, Field Compaction Control, Factors affecting Compaction, Effect of Compaction on Soil Properties, Compaction equipments**.**	**06 Hrs**
UNIT-IV	
Consolidation: Introduction, Piston-Spring Analogy, Primary and Secondary Consolidation, Terzaghi's Theory of One Dimensional Consolidation (no derivation), Normally consolidated, under consolidated and over consolidated soils, Pre-consolidation pressure and its determination by Casagrande's method. Laboratory one dimensional consolidation test – Determination of Compression index and co-efficient of consolidation, Determination of co-efficient of consolidation by square root of time fitting method and logarithmic time fitting method .	**07 Hrs**
UNIT-V	
Shear Strength of Soils: Introduction, Mohr Circle for Two Dimensional Stress System, Mohr-coulomb failure theory, Effective stress theory, Total and effective shear strength parameters, Determination of Shear Parameters - Direct Shear Test, Triaxial Compression Test, Types of Shear Test based on Drainage Conditions, Unconfined Compression Test, Vane Shear Test, Shear Strength of sands and clays, Sensitivity and Thixotropy	**08 Hrs**
LABORATORY	
5. Moisture Content Determination 6. Specific Gravity Determination 7. Grain size distribution for Coarse-grained and fine grained Soils 8. Atterberg Limits and Indices	

9. Compaction Test
10. Field Density Test (Core Cutter Method and Sand Replacement Method)
11. Determination of permeability of soils (Constant Head & Variable Head Tests)
12. Determination of strength of soils
    a) Direct Shear Test b) Triaxial Test (UU only) c) Unconfined Compression Test
    d) Vane shear Test
13. Demonstration
    a) Rapid Moisture Meter
    b) Proctor Needle
    c) Relative density apparatus
    d) Standard Penetration Test
    e) Differential Free Swell Test
    f) Consolidation of soils

Course Outcomes: After completing the course, the students will be able to	
1	Interpret the type of soil in the field or in the laboratory
2	Predict the Suitability of soil for a particular project based on its Engineering properties
3	Calculate the rate and amount of settlement of foundation and compaction behaviour of soils
4	Evaluate the index and engineering properties and application to Civil engineering problems

Reference Books	
1.	Soil Engineering in Theory and Practice, Alam Singh and Chowdhary G.R, CBS Publishers and Distributiors ltd., New Delhi, 2001, ISBN 9788123900391
2.	Foundation Analysis and Designs, Bowles JE , 5th Edition, McGraw Hill Publishing co., New York,1996, ISBN 978-0071188449
3.	Soil Mechanics and Foundation Engineering, VNS Murthy, First Edition, UBS Publishers and Distributors, New Delhi,2007, ISBN 9788174763228

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
CO2	2	2	-	-	-	1	-	-	-	-	-	1
CO3	-	2	2	-	-	-	-	-	-	-	-	1
CO4	-	2	1	-	-	-	-	-	-	-	-	1

Low-1 Medium-2 High-3

Semester: VI		
PRE STRESSED CONCRETE (Theory)		
Course Code:16CV63		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 36L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	Explain the fundamental concepts of stress analysis
2	Apply systems of pre-stressing for various sections of structural elements
3	Evaluate and analyze the stresses under various conditions
4	Design and detail the prestressed concrete members for various loading conditions

UNIT-I	
Introduction to Pre stressed concrete and codal provisions **Introduction:** Historic development- general principles of Prestressing, Types of pre stressing, pre-tensioning and post tensioning, advantages and limitation of prestressed concrete, Materials for pre stressed concrete- high strength steel and concrete, properties, Stress-strain characteristics of high strength steel and concrete **Codal Provisions:** Basic principles of pre stressing, fundamentals of prestressing, Load balancing concept, Stress concept, center of thrust, Pretensioning and post tensioning methods-Analysis of post tensioning, Systems of pre stressing, End anchorages	**07 Hrs**
UNIT-II	
Analysis of sections for Flexure: Elastic analysis of pre stressed concrete beams with straight, parabolic, triangular, trapezoidal cable profiles, Eccentric and concentric pre stressing, Numerical problems	**07 Hrs**
UNIT-III	
Losses of Pre stress: Loss of prestress in pretensioned and post tensioned members due to elastic shortening of concrete, shrinkage of concrete, creep of concrete, relaxation of steel, slip in anchorage and frictional losses, Numerical problems	**08 Hrs**
UNIT-IV	
Deflection of pre stressed concrete beams: Short term and long term deflections, Elastic deflections under transfered loads and due to different cable profiles, Deflection limits as per IS 1343, Effect of creep on deflection, Load versus deflection curve, methods of reducing deflection, Numerical problems. **Limit state of Collapse:** Flexure- IS code recommendations, Ultimate flexural strength of sections, IS code recommendations on shear strength, Shear resistance of sections, shear reinforcement, Limit state of serviceability- Control of deflection and cracking, Numerical Problems	**07 Hrs**
UNIT-V	
Design of Beams: Design of pre stressing force and eccentricity for post tensioned prismatic beams, permissible stresses, Limiting zone and cable profile	**07 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Understand the fundamental concepts of stress analysis
2	Apply systems of pre-stressing for various sections of structural elements
3	Analyse and evaluate the stresses under various conditions
4	Design the prestressed concrete members for various loading conditions

Reference Books	
1	Pre stressed concrete, N Krishna Raju, Tata McGraw Hill Publishers, 2009,ISBN 9780070634442
2	Pre stressed Concrete, P Dayarathnam, Oxford and IBH Publishing Co., 2000, ISBN 9780136916352
3.	Design of pre stressed concrete structures, T Y Lin and Ned H Burns, John Wiley & Sons, New York, 2008, ISBN 9789812531179
4.	Fundamental of pre stressed concrete, N C Sinha and S K Roy, 3rd Edition, S Chand and Company Ltd, 2011, ISBN 9788121924276
5.	Code Books: IS 1343:2012; Pre stressed Concrete: Code of practice

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

Low-1 Medium-2 High-3

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Semester VI		
TRANSPORTATION ENGINEERING (Theory)		
Course Code: 16CV64		**CIE Marks: 100**
Credits: L:T:P:S:: 3:0:0:0		**SEE Marks: 100**
Hours: 36L		**SEE Duration :03Hrs**

Course Learning Objectives:	
1	Understand the components of various transportation systems
2	Evaluate the characteristics of transportation system
3	Analyze various factors for planning of transportation system
4	Design various components of transportation system.

UNIT – I	**07 Hrs**
Railway Engineering - Location surveys and alignment - Permanent way - Gauges - Components - Functions and requirements - Geometric design	
UNIT – II	**07 Hrs**
Geometric Design: Track Junctions-Points and crossings - types and functions - design and layout - simple problems - Railway stations and yards. Signaling and interlocking - control systems of train movements.	
UNIT – III	**07 Hrs**
Airport Engineering-Aircraft characteristics - Airport obstructions and zoning - Runway - taxiways and aprons- Terminal area planning	
UNIT – IV	**07 Hrs**
Docks and Harbours - Types - Layout and planning principles- breakwaters - docks- wharves and quays - Transit sheds- warehouses- navigation aids	
UNIT – V	**08 Hrs**
Tunnels-Classification of Tunnels, Size and shape of a tunnel, Alignment of a Tunnel, Methods of Tunneling in Hard Rock and Soft ground, Lighting and Ventilation in tunnel, Dust control, Drainage of tunnels.	

Reference Books	
1.	M.M. Agarwal, "Railway Engineering" , Prabha & Co. 2007.
2.	Robert M Joronjeff, "Planning and design of Airports" , 5th edition, 2010, Mc Graw-ill publication, ISBN:-13;978:0071446419
3.	Oza and Oza, "Elements of Dock and Harbour Engineering" , Charotar Publishing House, 1996.
4.	Thomas R Kuesel, " Tunnel Engineering Handbook"Springer US,1995, ISBN:0412992914

Course Outcomes: After completing the course, the students will be able to	
1	Classify and discuss different modes of transportation
2	Understand surveys and geometric elements for different modes of transportation.
3	Identify various design principles of different modes of transportation.
4	Examine the applications of various modes of transportation

Reference Books	
1	Railway Engineering, M.M. Agarwal, Prabha & Co. 2007.
2	Planning and design of Airports, Robert M Joronjeff , 5th edition, 2010, Mc Graw-ill publication, ISBN:-13;978:0071446419
3.	Elements of Dock and Harbour Engineering, Oza and Oza, Charotar Publishing House, 1996.
4.	Tunnel Engineering Handbook, Thomas R Kuesel, Springer US,1995, ISBN:0412992914

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	-	-	-	-	-	-	-	1	-	-
CO2	-	2	2	2	-	-	-	-	-	1	-	-
CO3	-	2	2	2	-	-	-	-	-	1	-	-
CO4	-	-	2	2	-	-	-	-	-	-	1	-

Low-1 Medium-2 High-3

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Semester: VI		
STRUCTURAL MASONRY **(Group C: Professional Core Elective)**		
Course Code:16CV6C1		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 36L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	To understand masonry materials and its mechanical properties
2	To understand the factors influencing the performance of masonry structures
3	To understand the behavior of masonry structures under various loading conditions
4	To present the analysis and design methodology adopted for masonry buildings
5	To understand the Construction specifications and field inspection of masonry buildings

UNIT-I	
Introduction to Masonry units, materials and Types: History of masonry, characteristics of masonry units- strength, modulus of elasticity and water absorption .Masonry materials-Classification and properties of mortars, selection of mortars.	**06 Hrs**
UNIT-II	
Strength of Masonry in Compression: Behaviour of masonry under compression , strength and elastic properties, influence of masonry unit and mortar characteristics, effect of masonry unit height on compressive strength, influence of masonry bonding patterns on strength , prediction of strength of masonry in Indian context.	**08 Hrs**
UNIT-III	
Failure theories of masonry under compression: Effects of slenderness and eccentricity, effect of rate of absorption, effect of curing, effect of ageing, workmanship on compressive strength. **Permissible stresses:** Permissible compressive, tensile and shear stresses, stress reduction and shape reduction factors, increase in permissible stresses for eccentric vertical and lateral loads.	**08 Hrs**
UNIT-IV	
Flexural and shear bond, flexural strength and shear strength: Bond between masonry unit and mortar, tests for determining flexural and shear bond strengths , factors affecting bond strength , effect of bond strength on compressive strength, orthotropic strength properties of masonry in flexure, shear strength of masonry, test procedures for evaluating flexural and shear strength.	**08 Hrs**
UNIT-V	
Design of load bearing masonry buildings: Effective height of walls and columns, opening of walls , effective length, effective thickness, slenderness ratio, eccentricity, load dispersion, arching action, lintels, walls carrying Axial loads, eccentric loads with different eccentric ratios, wall with openings , freestanding wall; Design of load bearing masonry for building up to 2 to 3storeys for gravity loading using IS- 1905 Codal provisions	**06 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Understand the concept of structural masonry, failure theories and strength under compression
2	Define different masonry units, mortars and factors influencing masonry strength
3	Choose appropriate masonry unit and mortar mixes for masonry construction and design
4	Apply codal provision for design of load bearing masonry building based on IS 1905 – 1987

Reference Books	
1.	Structural Masonry, K.S.Jagadish, I K International Publishing House Pvt. Ltd (30 November 2015), ISBN-10: 9384588660, ISBN-13: 978-9384588663
2.	Sinha.B.P& Davis S R " Design of masonry structures " E & FN Spon
3.	A.W.Hendry, Structural Masonry Macmillan Press, London, ISBN 9780333733097
4.	Sven Sahlin, Structural Masonry, Prentice Hall Inc., Englewood Cliffs, New Jersey, ISBN 9780138539375. IS:1905.SP-20 (S & T) , New Delhi
5.	Robert G. Drysdale, Ahmad A. Hamid, Lawrie R. Baker, Masonry Structures: Behavior and Design, Prentice Hall College Div; 2nd edition (May 1993), ISBN-10: 0135620260, ISBN-13: 978-0135620267

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

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

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

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

Low-1 Medium-2 High-3

R. V. College of Engineering – Bengaluru-59

Semester: VI		
TRAFFIC ENGINEERING AND TRANSPORTATION PLANNING (Group C: Professional Core Elective)		
Course Code:16CV6C2		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 36L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	Understand need and importance traffic studies
2	Analyse traffic characteristics and suggest suitable traffic control measures
3	Suggest suitable measure to reduce accidents and Understand the concept of level of service
4	Understand stages in urban transport planning and analyse travel demand by various methods
5	Understand mode choice methods for trip assignment.

UNIT-I	
Introduction & traffic studies. Definition-Objectives, Scope, National Urban Transport Policy of India. Transportation planning in the developing world; international transportation policies. Road User and Vehicle Characteristics: -Static and Dynamic characteristics. Data collection and analysis of - Volume, spot speed, Origin and Destination, Speed and Delay	**07 Hrs**
UNIT-II	
Traffic Control: Road controls, Traffic Regulations-One Way- Traffic Signs- Traffic markings-Traffic signals- vehicle actuated and synchronized signals -Signal Co-ordination - Webster's method of signal Design, IRC Method, - Numerical Problems except vehicle actuated signals. Parking: -On Street and off Street Parking.	**07 Hrs**
UNIT-III	
Highway capacity and level of service: Factors affecting, capacity analysis and level of service criteria and estimation **Intersections**- Types including rotaries, design principles, Accident Studies: Causes, data collection, Analysis, Measures to reduce Accidents, Numerical Problems	**07 Hrs**
UNIT-IV	
Introduction Inter dependency of land use and traffic, System Approach to urban planning. Stages In Urban Transport Planning**.** **Urban Transport Survey** - Definition of study area, Zoning- Inventory of Transportation facilities. **Trip Generation:** Trip purpose, Factors governing trip generation and attraction, Category analysis, No numerical on above.	**07 Hrs**
UNIT-V	
Trip Distribution: Methods, Growth factors methods, Synthetic methods. **Modal Split:** Factors affecting, characteristics of split, Model split in urban transport planning, No numerical problems on above. **Trip Assignment**-Introduction, Assignment Techniques.	**08 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Identify and predict the scope for traffic engineering and transport planning.
2	Illustrate and analyse the need for traffic and planning surveys.
3	Suggest traffic control measures and evaluate level of service.
4	Predict trip distribution and assignment in modal split.

Reference Books	
1.	Highway Engineering, Khanna, S.K. and Justo, C.E.G, Nemchand and Bros. Roorkee, 8th

	Edition, 2002, ISBN 8185240434, 9788185240435
2.	Traffic Engineering, Kadiyali, L.R., 7th Edition, Khanna Publishers, 2001, ISBN 8174091653,97881740916
3.	Traffic Engineering, Matson, Smith and Hurd. , 3rd Edition, McGraw Hill and Co , 2003 ,ISBN 0070409102
4.	Principles of urban transport system planning, Hutchinson BG, Scripta Book Co., Washington D.C. & McGraw Hill Book Co.1974, ISBN 0-07-031539-6

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.

Mapping of COs with POs

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

Low-1 Medium-2 High-3

R. V. College of Engineering – Bengaluru-59

Semester: VI		
AIR POLLUTION AND CONTROL ENGINEERING **(Group C: Professional Core Elective)**		
Course Code:16CV6C3		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 36L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	To study the sources and effects of air pollution.
2	To learn the meteorological factors influencing air pollution.
3	To analyse air pollutant dispersion models.
4	To illustrate particulate and gaseous pollution control methods.

UNIT-I	
Introduction: Definition, Sources and classification of Air Pollutants, Photochemical smog, Effects of air pollution on health, vegetation & materials, Global effects of air pollution.	**07 Hrs**
UNIT-II	
Meteorology: Temperature lapse rates and Stability, Wind velocity and turbulence, plume behavior, Measurement of meteorological variables. Windrose diagram. Air pollution episodes.	**08 Hrs**
UNIT-III	
Modeling of Dispersion of Air Pollutants: Dispersion of Air pollutants. Theories on modeling of Air pollutants. Gaussian dispersion model. Equations for estimation of pollutant concentrations. Plume Rise – Equations for estimation. Effective stack height and mixing depths. Numerical problems.	**07 Hrs**
UNIT-IV	
Sampling and Particulate Pollution Control Methods: Atmospheric sampling and stack sampling methods. Air quality standards. Types of particulate pollution control methods – Settling chambers, Cyclone separators, Scrubbers, Filters and Electrostatic precipitators, design aspects and principle of these air pollution control units.	**07 Hrs**
UNIT-V	
Gaseous pollution control methods: Types of gaseous pollution control methods – absorption, adsorption and combustion processes. Emission standards for automobile pollution. Noise Pollution: Causes, Effects and control. Noise standards.	**07 Hrs**
SELF STUDY	
Measurement of ambient air quality parameters. Measurement of Automobile exhaust emission. Effect of air pollution on different parameters.	**12 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Identify the major sources of air pollution and understand their effects on environment, economics and health.
2	Evaluate the dispersion of air pollutants in the atmosphere and to develop air quality models.
3	Ascertain and evaluate sampling techniques for atmospheric and stack pollutants.
4	Choose and design control techniques for particulate and gaseous emissions.

Reference Books	
1.	Air Pollution, M. N. Rao and H V N Rao., Tata Mc-Graw Hill Publication, ISBN 10-0074518712, 13- 9780074518717, 2001,reprint 2013.
2.	Air Pollution, H. C. Perkins, Tata McGraw Hill, ISBN 10- 0070493022, 13- 978-0070493025, 1974, Reprint 2013.
3.	Air Pollution Control Engineering, Noel De Nevers, Waveland Pr Inc, ISBN 10- 1577666747, 13- 978 -1577666745, 2010.
4.	Text book of Air Pollution and Control Technologies, Anjaneyulu Y, Allied Publishers, ISBN 13- 9788177641844, 2002.

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

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

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

CO-PO Mapping

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

High-3 : Medium-2 : Low-1

R. V. College of Engineering – Bengaluru-59

Semester: VI		
WATERSHED MANAGEMENT **(Group C: Professional Core Elective)**		
Course Code:16CV6C4		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 36L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	Introduce the concepts of watershed management and its impact on the natural water cycle.
2	Preparation of different thematic maps and its analysis.
3	Determination of watershed characteristics, runoff and soil loss estimation.
4	Introduce various methods of water conservation and water harvesting in watershed.

UNIT-I	
Introduction: Watershed definition and importance, delineation of watershed, watershed characteristics, causes, consequences of watershed deterioration. Watershed management plan-identification of problems, objectives and priorities, steps in developing watershed. Issues in watershed management-land degradation.	**08 Hrs**
UNIT-II	
Map Preparation: Introduction, different approaches, thematic maps-base map, drainage map, land use/land cover, hydrogeomorphology, soil, slope, lineament etc., map updation, change detection and analysis. **Drainage analysis**: Definition, drainage pattern-different types, Horton's and Strahler's method of stream ordering, analysis of linear aspects, areal aspects, relief aspects and inferences.	**07 Hrs**
UNIT-III	
Runoff Estimation: Introduction, necessity, runoff different methods, factors affecting runoff, SCS Curve Number method. **Soil Loss Estimation**: Introduction, importance, types of erosion, resources mapping, urbanization effect on hydrological cycle, soil loss estimation (USLE method).	**07 Hrs**
UNIT-IV	
Erosion Control: measures and land reclamation, Management techniques-vegetation measures, forest lands, grass lands, structural measures- erosion control, sediment control and flood control. **Water conservation**: Introduction, conservation, methods for crop land, treatment for catchments, small storage structures, objectives and data required types of storage structures, design data.	**07 Hrs**
UNIT-V	
Water Harvesting: Small earthen dams –planning, construction sequence, computation of storage capacity, small weirs,, drought from ponds, nala bunds, groundwater recharge, extraction.	**07 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Describe the process of implementing land use and water management practices within a watershed.
2	Understand the methods of watershed management to protect and improve the quality of the water and other natural resources.
3	Determine the watershed characteristics, runoff and soil loss estimation.
4	Analyse various technique of conserving natural resources within the watershed .

Reference Books	
1.	Watershed Management – Guidelines for Indian Conditions, Tideman E.M, 1st Edition, Omega Publishers, New Delhi,2011, ISBN-9788185399348
2.	Remote Sensing and Image Interpretation, Thomas M. Lillisand and R.W.Kiefer, 5th Edition, John Wiley and Sons, New York,2004,I S B N : 0 - 4 7 1 - 1 5 2 2 7 - 7
3.	Remote Sensing: The Quantitative Approach , Ven Te Swain and Shirley M .Davis. Mc Grawl Hill Book Company, Fifth Edition.
4.	Engman E T and Gurney R J "Remote Sensing in Hydrology", Springer Netherlands, ISBN: 9789401066709.

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

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

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

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

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

Low-1 Medium-2 High-3

R. V. College of Engineering – Bengaluru-59

Semester: VI		
STRUCTURAL DYNAMICS **(Group D: Professional Core Elective)**		
Course Code:16CV6D1		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 36L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	Understand principles of structural dynamics
2	Describe the dynamics of single, multi degree and responses of shear buildings
3	Evaluate the responses of various systems using different approaches
4	Apply the structural dynamics theory to real world problems like seismic analysis

UNIT-I	
Introduction: Introduction to dynamic problems of Civil Engineering, Concept of degrees of freedom, D'Alemberts principle, Principle of virtual displacement and energy, Single degree of freedom systems, Examples of Single degree of freedom systems in Engineering,	**07 Hrs**
UNIT-II	
Dynamics of Single-degree-of-freedom systems: Mathematical models of un-damped and damped SDOF system, Free vibration response of damped and un-damped systems, response to harmonic loading, support motion.	**08 Hrs**
UNIT-III	
Evaluation of damping, vibration isolation, transmissibility, response to periodic forces. Response of Single degree of freedom systems to arbitrary excitation, Duhamel integral solution, Response to suddenly applied load and triangular pulse loading.	**07 Hrs**
UNIT-IV	
Mathematical models of un-damped and damped MDOF systems, Free vibration of un-damped MDOF systems, Natural frequencies and mode shapes, Orthogonality conditions.	**07 Hrs**
UNIT-V	
Introduction to engineering seismology, seismic waves, characteristics of earthquake and its quantification – Magnitude and Intensity scales, seismic instruments. Seismic response of buildings, structures and sites, study of response of buildings and structures during earthquakes.	**07 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Apply knowledge of mathematics and mechanics for solving problems on structural dynamics.
2	Develop equations of motion for discrete and vibratory systems.
3	Evaluate the frequencies for various undamped and damped structures subjected to free excitation.
4	Understand and implement concepts of engineering seismology and working principles of vibration measuring instruments.

Reference Books	
1.	Structural Dynamics : Vibrations and Systems, 1st Edition, Madhujit Mukophadhyay, Publisher: ANE Books ISBN: 9788180520907, 8180520900, 2008
2.	Structural Dynamics: Theory and Computation, Mario Paz, 2nd Edition, CBS Publisher ISBN: 9788123909783, 8123909780, 2004
3.	Dynamics of Structures, R,W.clough and J.Penzien, 2nd revised Edition, McGraw – Hill Education, 1993, ISBN -10: 0071132414, ISBN -13: 978-0071132411.

4.	Theory of vibration with applications, Willaim Thomson, 4th Edition, CRC Press, 1996, ISBN -10: 0748743804, ISBN -13: 978-0748743803.

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

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

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

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

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

Low-1 Medium-2 High-3

R. V. College of Engineering – Bengaluru-59

Semester: VI		
REMOTE SENSING & GIS **(Group D: Professional Core Elective)**		
Course Code:16CV6D2		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 36L		**SEE Duration: 3Hrs**

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

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- 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	**07 Hrs**
UNIT-II	
Photogrammetry: Introduction types of Photogrammetry, Advantages of Photogrammetry, Introduction to digital Photogrammetry. Photogrammetry- Locating points from two phases determination of focal length. **Aerial Photogrammetry:** Advantages over ground survey methods- geometry of vertical photographs, scales of vertical photographs. relief displacement, scale ground coordinates – flight planning.	**07 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.	**07 Hrs**
UNIT-IV	
Applications of GIS, Remote Sensing and GPS: Case studies on Water Resources engineering and management (prioritization of river basins, water prospectus zones and its mapping), **Case studies on applications of GIS and RS in** Highway and transportation (highway alignment, Optimization of routes, accident analysis), Environmental Engineering (Geo-statistical analysis of water quality, rainfall analysis) **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.	**08 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	**07 Hrs**

agriculture. **Applications of geo-informatics in natural resources management: Geo-Technical case Studies**, site suitability for dams, solid waste disposal. GPS applications in land survey.	

Course Outcomes: After completing the course, the students will be able to	
1	To remember and understand the principle of Remote Sensing (RS) and Geographical Information Systems (GIS) data acquisition and its applications.
2	To apply RS and GIS technologies in various fields of engineering and social needs
3	To analyze and evaluate the information obtained by applying RS and GIS technologies.
4	To 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)

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

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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

R. V. College of Engineering – Bengaluru-59

Semester: VI		
CONSTRUCTION MANAGEMENT **(Group D: Professional Core Elective)**		
Course Code: 16CV6D3		**CIE Marks: 100**
Credits: L:T:P:S: 3:0:0:1		**SEE Marks: 100**
Hours: 36L		**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	Study the construction planning and scheduling methods
2	To study the applications of operations research to Construction Industries
3	Study the principles and applications of Engineering Economics to Construction Industries
4	Understand importance of construction quality and safety

UNIT-I	
Construction planning: Introduction to construction project management, time estimates, planning methods of projects- Bar and Mile stone charts, PERT and CPM network analysis including numerical problems on CPM and PERT.	**07 Hrs**
UNIT-II	
Network crashing and cost time relationship: Construction cost-Direct cost, indirect cost, total cost, optimum cost. Optimum duration of project by network crashing, including simple numerical problems.	**07 Hrs**
UNIT-III	
Transportation problems: Introduction, Mathematical formulation, optimal solution of Transportation Problem -methods for initial basic feasible solution, summary of methods of initial BFS, North west corner method, Lowest cost entry method, Vogel‘s approximation method. Optimization using MODI method.	**08 Hrs**
UNIT-IV	
Introduction to Engineering economics: Basic Concepts of economic analysis, Micro and Macro analysis, project feasibility, economic and financial feasibility, , interest formula, present worth, future worth, Annual equivalent. Basis for comparison of alternatives, rate of return method, break even analysis, benefit cost ratio problems on above.	**07 Hrs**
UNIT-V	
QUALITY AND SAFETY MANAGEMENT - Construction Quality, Inspection and Testing, Quality Control, Quality Assurance, Total Quality Management, Critical Factors of TQM; Benchmarking, , third party certification. Safety laws and standards. Safety Hazards . Safety Management in Construction Industry- Safety rules in construction, Types and use of personal protective equipment’s.	**07 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Understand the elements of engineering economics, selection of equipment’s, transportation and project planning & scheduling
2	Apply the principles of engineering economics and planning and scheduling techniques in construction project management
3	Analyze the applications of various techniques of planning in construction projects
4	Evaluate the applied techniques /methods/safety and quality factors of planning in construction projects

Reference Books	
1.	Construction Engineering and management, S.Seetharaman, 2nd Edition, Umesh Publications, Delhi, 2000, ISBN 9788188114061.
2.	Construction Project Management , Chitkara McGraw Hill Education, 3rd edition (30 June 2014), ISBN-13: 978-9339205447
3.	Operations Research Concepts, Problems and Solutions, V.K.Kapoor, 5th Revised Edition, Sultan Chand & Sons, New Delhi, 2011, ISBN 9788180548543.
4.	Engineering Economics, Pannerselvam, 2nd Revised Edition, Prentice Hall India Learning Private Limited; (2013). **ISBN-13:** 978-8120348370
5.	Safety Management in Construction and Industry, David Gold Smith, Mc Graw Hill Publications.

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

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

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

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

Low-1 Medium-2 High-3

R. V. College of Engineering – Bengaluru-59

Semester: VI		
ADVANCED CONCRETE TECHNOLOGY **(Group D: Professional Core Elective)**		
Course Code: 16CV6D4		**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	Analyze the suitability of concrete for filed applications
2	Assess the methods of determining ingredients for making concrete
3	Outline the importance of durability and proportioning
4	Describe various types of modern concretes

UNIT-I	
Microstructure and Dimensional stability -Structure of a Hydrated Cement Paste, porosity of paste and concrete, transition Zone, Elastic Modulus, factors affecting strength and elasticity of concrete. Shrinkage, creep and thermal effects.	**08 Hrs**
UNIT-II	
Chemical admixtures- Mechanism of chemical admixture, Plasticizers and super Plasticizers, dosage and their effect on concrete properties in fresh and hardened state, Mineral admixture-Fly ash, Silica fume, GGBS, metakoalin.	**07 Hrs**
UNIT-III	
Durability of concrete - Introduction, impermeability of concrete, acid attack, efflorescence, Corrosion- Factors influencing corrosion, pH, carbonation, Freezing and thawing, Alkali Aggregate Reaction, IS456-2000 requirement for durability. Remedial measures.	**07Hrs**
UNIT-IV	
Mix design : Concrete Mix Design by ACI and other methods – Numerical examples. Differences between ACI and IS methods of proportioning. **Geopolymer** Properties and applications Geopolymer concrete, **Self-compacting concrete** Properties and applications of self-compacting concrete.	**07 Hrs**
UNIT-V	
Fiber reinforced concrete - Fibers types and properties, Behavior of FRC in compression, Applications. **Light weight concrete**-materials properties and types. Typical light weight concrete mix **High density concrete**, **High performance concrete and High strength concrete** - materials, properties and applications, typical mix. Concept of disaster resistant concrete structures – Effect of ground shaking on structures-Ground failure, Tsunami and tidal waves, fire.	**07 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Understand dimensional stability, microstructure and properties of cement concrete
2	Assess the methods of determining the suitable admixture and ingredients for making concrete
3	Outline the importance of durability of conventional and other concretes
4	Describe properties and applications of concretes

Reference Books	
1.	Shanthakumar.A.R, Concrete technology, Oxford University Press, New Delhi, 2007,ISBN 978 0195671537
2.	Shetty. M.S., Concrete Technology Theory and Practice, S.Chand& Co Ltd., New Delhi, 2007 ISBN-13: 978-8121900034

3.	Kumar Mehtha.P and Paulo J M Monteiro., Concrete Microstructre, Properties and Materials, Indian Edition, Indian Concrete Institute, Chennai, 1997 ISBN-13: 978-9339204761 Publisher: McGraw Hill Education; 4 edition (1 April 2014)
4.	Neville. A.M, Properties of concrete V Edition,(2012) Peaerson Education, Inc, and Dorling Kindersley Publishing Inc. ISBN-13: 978-8131791073
5.	Gambhir M L., Concrete Technology theory and Practice, Fifth Edition, Tata McGraw Hill Education private Ltd, New Delhi. 2013 ISBN-13: 978-1259062551

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

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

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

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

Low-1 Medium-2 High-3

R. V. College of Engineering – Bengaluru-59

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: 3Hrs**

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

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

Course Outcomes: After completing the course, the students will be able to	
1	Remember and explain the fundamentals of Biology
2	Describe the basic principles of design in biological systems.
3	Differentiate biological phenomena to support inspiration for visual and conceptual design problems
4	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

R. V. College of Engineering – Bengaluru-59

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: 3Hrs**

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

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

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	

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	
1	Recall the fundamentals of various forms of energy
2	Explain the principles of various forms of renewable energy
3	Apply the concept of zero waste, atom economy for waste management
4	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.

R. V. College of Engineering – Bengaluru-59

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: 3Hrs**

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

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

Course Outcomes: After completing the course, the students will be able to	
1	Understand the existing solid waste management system and to identify their drawbacks.
2	Analyze drawbacks in the present system and provide recycling and disposal options for each type of waste.
3	Distinguish Hazardous waste, Biomedical waste, E waste and to provide scientific management system.
4	Evaluate and monitor the Biomedical waste, Hazardous waste, E waste, Plastic and Municipal waste management as per the rules laid by Ministry of Environment & Forest.

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 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-1Medium-2 High-3

R. V. College of Engineering – Bengaluru-59

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.	**06 Hrs**

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.	

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.

R. V. College of Engineering – Bengaluru-59

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

R. V. College of Engineering – Bengaluru-59

Semester: VI (Global Elective-E)		
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:	**07 Hrs**

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

Course Outcomes: After completing the course, the students will be able to	
1	Acquire the knowledge of automotive domain fundamentals and need of electronics in Automotive systems
1	Apply various sensors and actuators for Automotive applications
3	Analyze different control systems and communication interfaces used in automotive systems.
4	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

R. V. College of Engineering – Bengaluru-59

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: 3Hrs**

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

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

Classification of Choppers and Applications:	**08 Hrs**
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	

Course Outcomes: After completing the course, the students will be able to	
1	Understand the comprehensive working of different devices and their applications.
1	Analyze the application of skills in controlling and conversion of electrical energy.
3	Evaluate and distinguish the performance of converters and inverters.
4	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)

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

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VI Semester		
PROJECT MANAGEMENT **(Group E: Global Elective)**		
Course Code : 16G6E07		**CIE Marks : 100**
Credits : L: T: P: S:3:0:0:0		**SEE Marks : 100**
Hours : 33L		**SEE Duration : 03 Hrs**

Course Learning Objectives: The students will be able to	
1.	To understand the principles and components of project management.
2.	To appreciate the integrated approach to managing projects.
3.	To explain the processes of managing project cost and project procurements.

Unit – I	
Introduction: What is project, what is project management, relationships among portfolio management, program management, project management, and organizational project management, relationship between project management, operations management and organizational strategy, business value, role of the project manager, project management body of knowledge.	**06 Hrs**
UNIT – II	
Organizational influences & Project life cycle: Organizational influences on project management, project state holders & governance, project team, project life cycle. **Project Integration Management:** Develop project charter, develop project management plan, direct & manage project work, monitor & control project work, perform integrated change control, close project or phase.	**08 Hrs**
UNIT – III	
Project Scope Management: Project scope management, collect requirements define scope, create WBS, validate scope, control scope. **Project Time Management:** Plan schedule management, define activities, sequence activities, estimate activity resources, estimate activity durations, develop schedule, control schedule.	**07 Hrs**
UNIT – IV	
Project Cost management: Project Cost management, estimate cost, determine budget, control costs. **Project Quality management:** Plan quality management, perform quality assurance, control quality.	**06 Hrs**
UNIT – V	
Project Risk Management: Plan risk management, identify risks, perform qualitative risk analysis, perform quantitative risk analysis, plan risk resources, control risk. **Project Procurement Management:** Project Procurement Management, conduct procurements, control procurements, close procurement.	**06 Hrs**

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

Reference Books:	
1.	A Guide to the Project Management Body of Knowledge(PMBOK Guide), Project Management Institute, 5th Edition, 2013, ISBN: 978-1-935589-67-9
2.	Project Planning Analysis Selection Financing Implementation & Review, Prasanna Chandra, 7th Edition, 2010, Tata McGraw Hill Publication, ISBN 0-07-007793-2.
3.	Project Management A System approach to Planning Scheduling & Controlling, Harold Kerzner, 10th Edition, 2009, CBS Publishers and Distributors, ISBN 047027806.
4.	Strategic Project Management Made Simple: Practical Tools for Leaders and Teams, Terry Schmidt, 1st Edition, 2009, John Wiley & Sons, ISBN: 978-0470411582

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

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

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

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

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

Low-1 Medium-2 High-3

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

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

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

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Course Outcomes: After completing the course, the students will be able to	
1	Remember and Understand the fundamentals of Virtual Instrumentation and data Acquisition.
1	Apply the theoretical concepts to realize practical systems.
3	Analyze and evaluate the performance of Virtual Instrumentation Systems.
4	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: 3Hrs**
Course Learning Objectives: The students will be able to		
1	Learn Android application development platform for mobile devices and use it.	
2	Understand mobile application architecture and its components.	
3	Define Android specific programming concepts such as activities, intents, fragments, services, broadcast receivers and content providers.	
4	Describe sensors like motion sensors, environmental sensors, and positional sensors; most commonly embedded in Android devices along with their application programming interface.	
UNIT I		
Overview of Software platforms and Development: Mobile OS: Android development platform and tools, Programming language, Emulator, SDK and Development Environments **Creating Applications and Activities:** Introducing the Application Manifest File; Creating Applications and Activities; Architecture Patterns (MVC); Android Application Lifecycle.		**07 Hrs**
UNIT II		
User Interface Design: Fundamental Android UI Design; Introducing Layouts; Introducing Fragments. **Intents and Broadcasts**: Introducing Intents; Creating Intent Filters and Broadcast Receivers.		**07 Hrs**
UNIT III		
Database and Content Providers: Introducing Android Databases; Introducing SQLite; Content Values and Cursors; Working with SQLite Databases; Creating Content Providers; Using Content Providers; Case Study: Native Android Content Providers.		**07 Hrs**
UNIT IV		
Location Based Services, Telephony and SMS: Using Location-Based Services; Using the Emulator with Location-Based Services; Selecting a Location Provider; Using Proximity Alerts; Using the Geocoder; Example: Map-based activity; Hardware Support for Telephony; Using Telephony; Introducing SMS and MMS.		**08 Hrs**
UNIT V		
Hardware Support and Devices (AUDIO, VIDEO, AND USING THE CAMERA): Using Sensors and the Sensor Manager; Monitoring a Device's Movement and Orientation; Introducing the Environmental Sensors; Playing Audio and Video; Using Audio Effects; Using the Camera; Recording Video		**07 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Assess the basic framework and usage of SDK to build GUI and apply advanced technologies in developing Android mobile applications.
1	Differentiate techniques for persisting user data, such as shared preferences, traditional file systems (internal and external storage), and SQLite database
3	Articulate the communication programming features and capabilities of Android platforms.
4	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

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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:	**06 Hrs**

Suspension- Front and rear suspension working, Types of springs. Brake- Classification and Components - Disc and drum brakes, Hydraulic, parking brake, Front and rear wheel brakes. Antilock Braking Systems. Steering- components and operation of power steering. Vehicle frame and body classification- Hatchback, Sedan, SUV. Safety systems- Passive safety systems, Active safety systems- Principle of Electronic Stability Program, Air bags, Crash testing methods.	
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)

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

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

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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

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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: 03Hrs**

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

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

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

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

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

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

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

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

Low-1 Medium-2 High-3

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Semester: VI		
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, Direchlet 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	
1	Identify and interpret the fundamental concepts of formation and solution of parabolic, hyperbolic and elliptic differential equations using analytical and numerical methods.
1	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.
3	Analyze the physical problem to establish mathematical model and use appropriate method to solve and optimize the solution using the appropriate governing equations.
4	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

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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: 3Hrs**

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

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

Course Outcomes: At the end of this course the student will be able to :	
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

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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**

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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	
1	Inculcate employability skill to suit the industry requirement.
1	Analyze problems using quantitative and reasoning skills
3	Exhibit verbal aptitude skills with appropriate comprehension and application.
4	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.

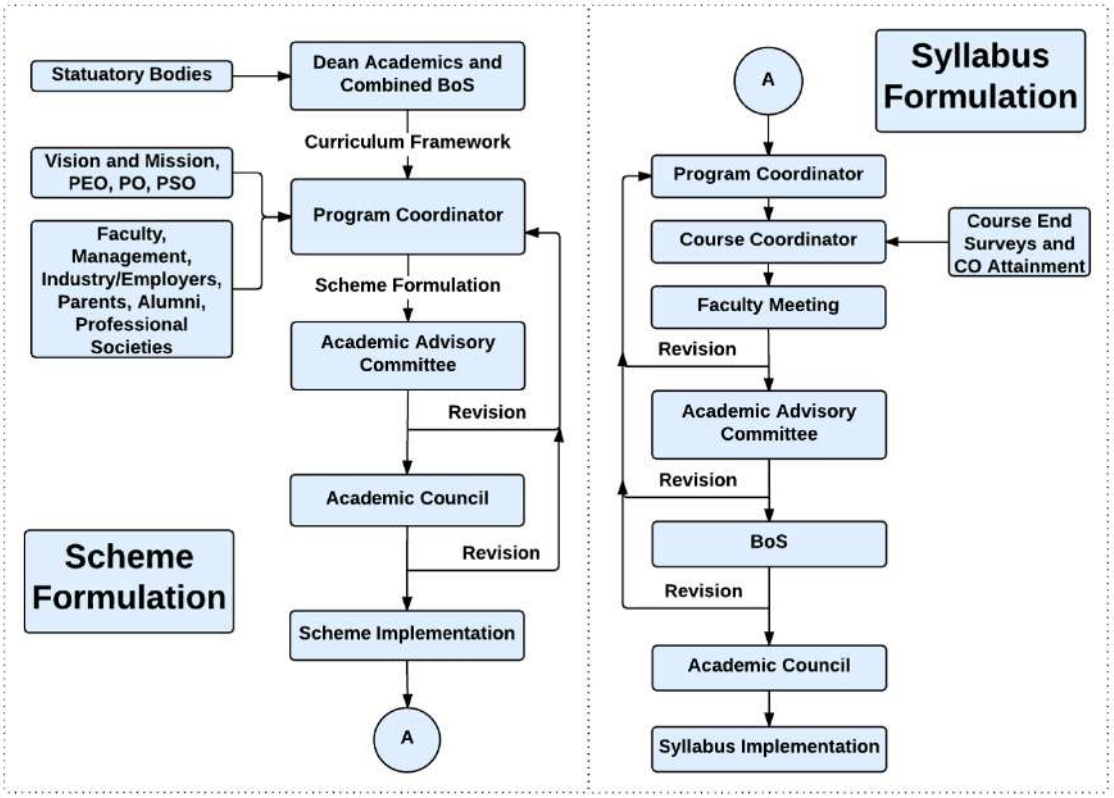
Phase	Activity	Weightage
I	Test 1 is conducted in V Sem for 50 marks (15 Marks Quiz and 35 Marks Descriptive answers) after completion of Unit-1, Unit-2 and Unit -3.A for 18 hours of training sessions.	50%
II	Test 2 is conducted in VI Sem for 50 marks ((15 Marks Quiz and 35 Marks Descriptive answers) 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

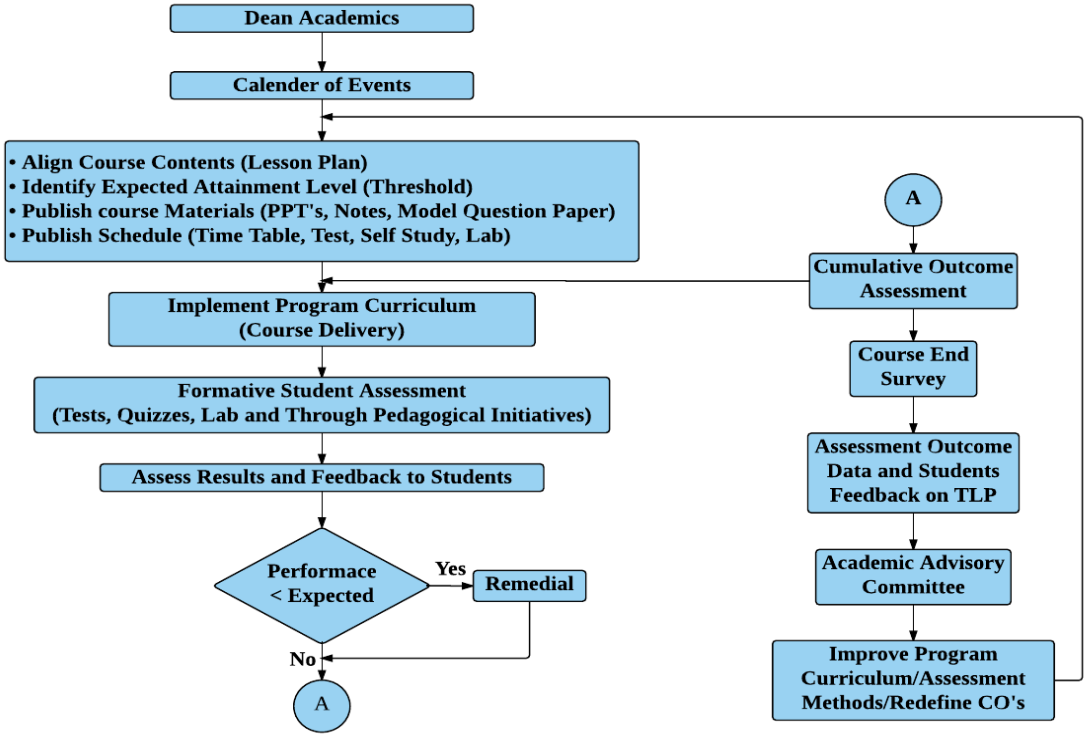
CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	---	___	---	----	1	----	1	1	1	2	1
CO2	1	2	2	---	---	---	----	1	2	1	2	1
CO3	---	---	3	---	---	1	---	2	1	2	1	---
CO4	---	---	___	---	----	1	3	1	1	1	1	---

Low-1 Medium-2 High-3

Curriculum Design Process



Academic Planning and Implementation



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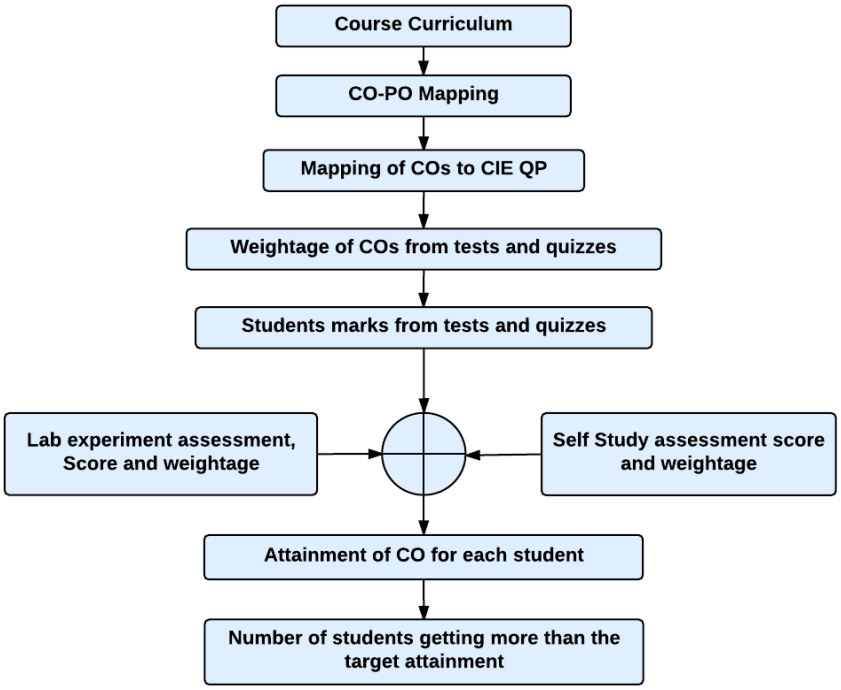
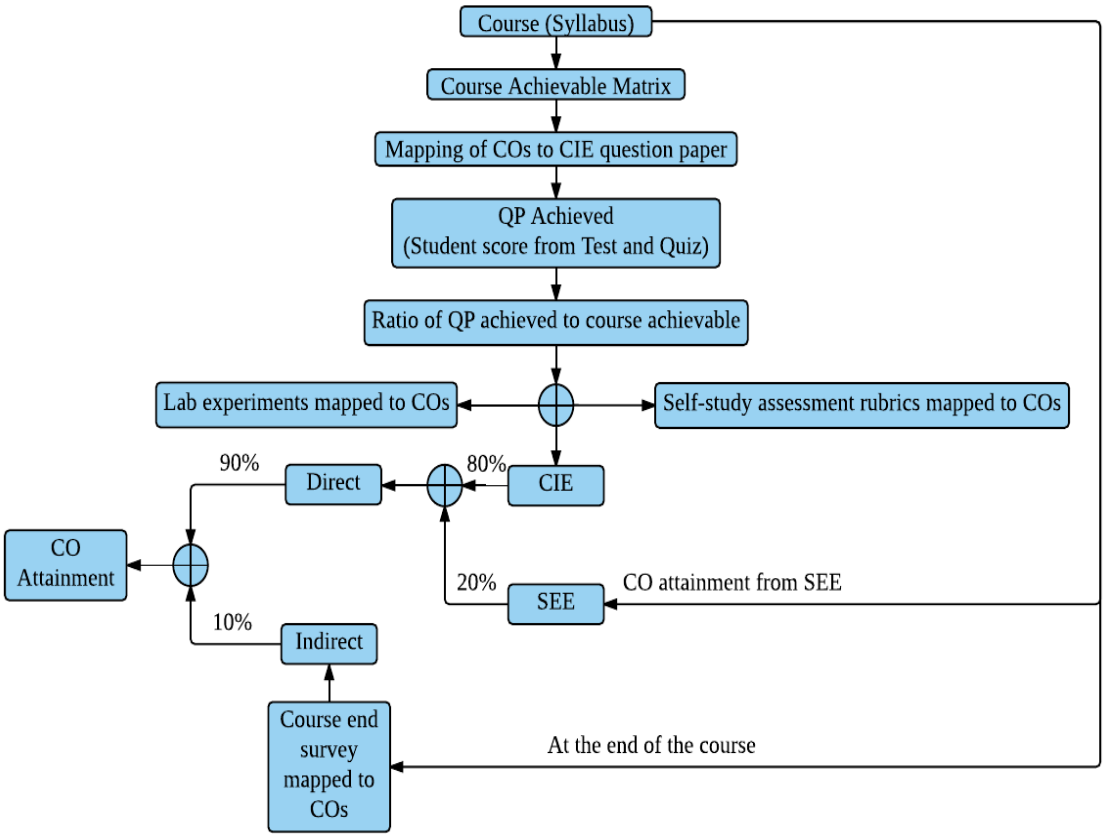
PROCESS FOR COURSE OUTCOME ATTAINMENT



Final CO Attainment Process



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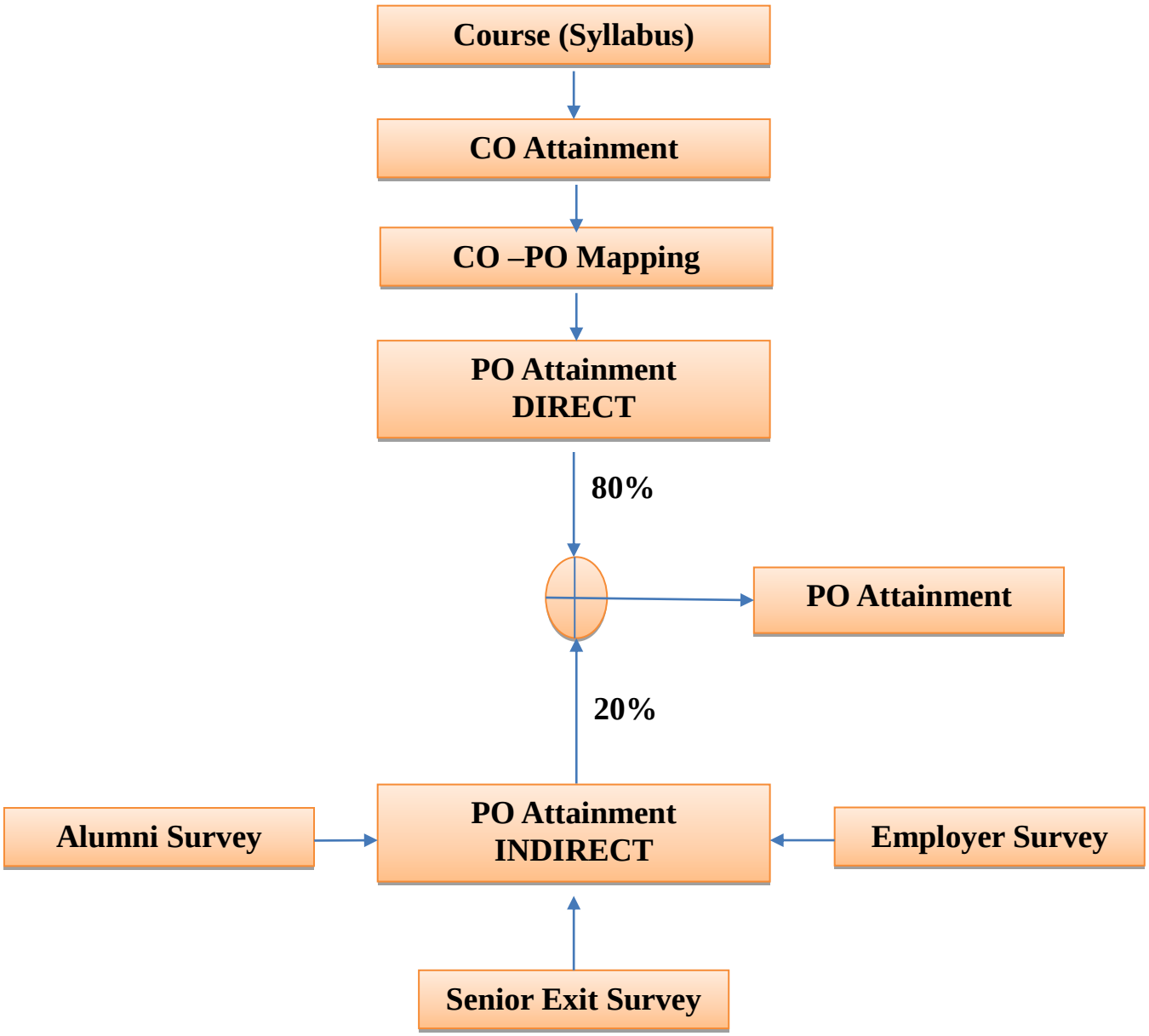
Program Outcome Attainment Process



Guidelines for Fixing Targets

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

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PROGRAM OUTCOMES (POs)

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

2. **Problem analysis:** Identify, formulate, research literature, and analyse 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:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.