Go, change the world

RV Educational Institutions ®

RV College of Engineering ®

Autonomous Institution Affiliated to Visvesvaraya Technological University, Belagavi

Approved by AICTE, New Delhi

Bachelor of Engineering (B.E)

Scheme and Syllabus of VII & VIII Semesters

2018 SCHEME

INDUSTRIAL ENGINEERING AND MANAGEMENT

2021-2022

VISION

Leadership in Quality Technical Education, Interdisciplinary Research & Innovation, with a Focus on Sustainable and Inclusive Technology

MISSION

1. To deliver outcome based Quality education, emphasizing on experiential learning with the state of the art infrastructure.
2. To create a conducive environment for interdisciplinary research and innovation.
3. To develop professionals through holistic education focusing on individual growth, discipline, integrity, ethics and social sensitivity.
4. To nurture industry-institution collaboration leading to competency enhancement and entrepreneurship.
5. To focus on technologies that are sustainable and inclusive, benefiting all sections of the society.

QUALITY POLICY

Achieving Excellence in Technical Education, Research and Consulting through an Outcome Based Curriculum focusing on Continuous Improvement and Innovation by Benchmarking against the global Best Practices.

CORE VALUES

Professionalism, Commitment, Integrity, Team Work, Innovation

RV 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 of VII & VIII Semesters

2018 SCHEME

DEPARTMENT OF
INDUSTRIAL ENGINEERING & MANAGEMENT
(2021-2022)

DEPARTMENT VISION

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

DEPARTMENT MISSION

- To impart scientific knowledge, engineering and managerial skills for driving organizations to global excellence.
- To promote culture of training, consultancy, research and entrepreneurship interventions among the students & faculty.
- To institute collaborative academic and research exchange programs with National and globally renowned Universities, industries and other organizations.
- To establish and nurture Center of Excellence in the niche area of Industrial and Systems Engineering.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

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

PROGRAM SPECIFIC OUTCOMES (PSOS)

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

Lead Society: Institute of Industrial Engineers (IIE)

ABBREVIATIONS

Sl. No.	Abbreviation	Meaning
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	SEE	Semester End Examination
5.	PE	Professional Core Elective
6.	GE	Global Elective
7.	HSS	Humanities and Social Sciences
8.	CV	Civil Engineering
9.	ME	Mechanical Engineering
10.	EE	Electrical & Electronics Engineering
11.	EC	Electronics & Communication Engineering
12.	IM	Industrial Engineering & Management
13.	EI	Electronics & Instrumentation Engineering
14.	CH	Chemical Engineering
15.	CS	Computer Science & Engineering
16.	TE	Telecommunication Engineering
17.	IS	Information Science & Engineering
18.	BT	Biotechnology
19.	AS	Aerospace Engineering
20.	PY	Physics
21.	CY	Chemistry
22.	MA	Mathematics

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RV COLLEGE OF ENGINEERING®

(Autonomous Institution Affiliated to VTU, Belagavi)

INDUSTRIAL ENIGNEERING AND MANAGEMENT

SEVENTH SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			**Total Credits**
				L	**T**	**P**	
1.	18HS71	Constitution of India and Professional Ethics	HSS	3	0	0	**3**
2.	18IM72	Product Design and Development	IM	4	0	1	**5**
3.	18IM73	Foundations of Robotics and Automation	IM	3	0	1	**4**
4.	18IM7FX	Elective F (PE)	IM	3	0	0	**3**
5.	18IM7GX	Elective G(PE)	IM	3	0	0	**3**
6.	18G7H09	Elective H (GE)*	Respective BoS	3	0	0	**3**
Total Number of Credits				**19**	**0**	**2**	**21**
Total number of Hours/Week				**19**	**0**	**5**	

Note:**Students should take other department Global Elective courses.

EIGHT SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			**Total Credits**
				L	**T**	**P**	
1.	18IMP81	Major Project	IM	0	0	16	16
Total Number of Credits				**0**	**0**	**16**	**16**
Total number of Hours/Week						**32**	

VII Semester			
PROFESSIONAL ELECTIVES (GROUP F)			
Sl. No.	**Course Code**	**Course Title**	**Credits**
30.	18IM7F1	Financial Management	03
31.	18IM7F2	Data Mining & Predictive Analytics	03
32.	18IM7F3	Design of Experiments	03
33.	18IM7F4	Smart Manufacturing for Industry 4.0	03
34.	18IM7F5	E-Commerce	03

VII Semester			
PROFESSIONAL ELECTIVES (GROUP G)			
Sl. No.	**Course Code**	**Course Title**	**Credits**
1.	18IM7G1	Quality Management	03
2.	18IM7G2	Project Planning & Control	03
3.	18IM7G3	Principles of Systems Engineering	03
4.	18IM7G4	Lean Manufacturing Systems	03
5.	18IM7G5	Digital Supply Chain Management	03

VII Semester				
OPEN ELECTIVES (GROUP H)				
Sl. No.	**Course Code**	**Host**	**Course Title**	**Credits**
1.	18G7H01	AS	Unmanned Aerial Vehicles	03
2.	18G7H02	BT	Bioinformatics	03
3.	18G7H03	CH	Industrial Safety and Risk Management	03
4.	18G7H04	CS	Web Programming	03
5.	18G7H05	CV	Solid Waste Management and Statutory Rules	03
6.	18G7H06	EC	Image Processing and Machine Learning	03
7.	18G7H07	EE	Renewable Energy Sources and Storage System	03
8.	18G7H08	EI	Mems & Applications	03
9.	18G7H09	IM	Project Management	03
10.	18G7H10	IS	Cyber Forensics and Digital Investigations	03
11.	18G7H11	ME	Robotics and Automation	03
12.	18G7H12	TE	Space Technology and Applications	03
13.	18G7H13	PY	Introduction to Astrophysics	03
14.	18G7H14	CY	Materials for Advanced Technology and Spectroscopic Characterization	03
15.	18G7H15	HSS	Applied Psychology for Engineers	03
16.	18G7H16	HSS	Advanced Course in Entrepreneurship	03

Semester: VII						
CONSTITUTION OF INDIA AND PROFESSIONAL ETHICS (Common to All Programs)						
Course Code	**:**	18HS71		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	39L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Apply the knowledge of the constitutional literacy to become aware of the fundamental rights and duties in their role as Engineers.
2	Understanding of ethical and legal aspects of advertising, consumer problems and their redressal mechanism related to product and service standards.
3	Discuss the knowledge of substantive Labor law and to develop skills for legal reasoning and statutory interpretations.
4	Evaluate individual role, responsibilities and emphasize on professional/ engineering ethics in shaping professions.

Unit – I	**10 Hrs**
Indian Constitution- Salient features of Indian Constitution ,Preamble to the Constitution of India; Provisions Relating to Citizenship in India- at the Commencement of the Constitution and Later with latest amendments, Modes of Acquisition and Termination of Citizenship of India. Scope & Extent of Fundamental Rights-Articles 14-32 with case studies; Right to Information Act, 2005 with Case studies.	
Unit – II	**10 Hrs**
Directive Principles of State Policy- Significance of Directive Principles of State Policy, Fundamental Duties in the Constitution of India; Union Executive- President and State Executive-Governor; Parliament & State Legislature; Council of Ministers; Anti-defection law; Union and State Judiciary; Emergency provisions; Elections, Administrative tribunals. Human Rights & Human Rights Commission.	
Unit –III	**06 Hrs**
Consumer Protection Law - Definition and Need of Consumer Protection; Consumer Rights under the Consumer Protection Act, 2019; Unfair Trade Practice, Defect in goods, Deficiency in services; Product liability and Penal Consequences, False and Misleading Advertisement, E-Commerce**,** Alternate dispute Redress mechanism**;** Redresses Mechanisms under the Consumer Protection Act, 2019. **An overview of Indian Penal Code 1860 (Law Of Crimes)**	
Unit – IV	**06 Hrs**
Introduction to Labour Legislations - Industrial Relation, Labour Problem and Labour Policy in India; Labour Welfare and Social Security- Factories Act, 1948, Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) Act, 2013; the Child Labour (Prohibition and Regulation) Act, 1986, Maternity Benefit (Amendment) Act, 2017; Industrial Dispute Act, 1947, Reference of Disputes to Boards, Courts or Tribunals.	
Unit –V	**07 Hrs**
Scope and aims of engineering ethics (NSPE Code of Ethics), Responsibility of Engineers, Impediments to responsibility. Honesty, Integrity and reliability, Risks, Safety and Liability in Engineering. Corporate Social Responsibility. Statutory Provision regarding prohibition and prevention of Ragging.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Demonstrate the citizen's fundamental Rights, duties & consumer responsibility capability and to take affirmative action as a responsible citizen.
CO2	Identify the conflict management in legal perspective and judicial systems pertaining to professional environment, strengthen the ability to contribute to the resolve of human rights & Ragging issues and problems through investigative and analytical skills.
CO3	Understanding process of ethical and moral analysis in decision making scenarios and inculcate ethical behavior as a trait for professional development.
CO4:	Apply the knowledge to solve practical problems with regard to personal issues & business Enterprises.

Reference Books	
1	Dr. J. N Pandey, Constitutional Law of India, Central Law Agency, 2020 edition
2	Avtar Singh: Law of Consumer Protection: Principles and Practice, Eastern Book Company, 5th Edition, 2015, ISBN -13:978-9351452461
3	S.C. Srivastava: Industrial Relation and Labour Laws, Vikas Publishing House, 6th Edition, 2012, ISBN: 9789325955400
4	Jr. Charles E Harris, Michael. S. Pritchard and Michael J Rabins, Engineering Ethics, Wadsworth Cengage Learning, 5th Edition, 2009, ISBN-978-0495502791

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). 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 experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the 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	-	-	-	-	-	1	-	1
CO4	3	3	3	3	-	-	-	-	-	1	-	1

High-3: Medium-2 : Low-1

Semester: VII						
PRODUCT DESIGN & DEVELOPMENT						
Course Code	**:**	18IM72		**CIE**	**:**	**100 + 50 Marks**
Credits: L:T:P	**:**	4:0:1		**SEE**	**:**	**100 + 50 Marks**
Total Hours	**:**	52L + 24P		**SEE Duration**	**:**	**03 + 03 Hours**

Course Learning Objectives: The students will be able to

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

Unit-I	**09 Hrs**
Introduction: Definition of product design, design by evolution, design by innovation, Essential factors of Product design, Characteristics of successful product development, Stage gate decision making, Design thinking approach to product design. **Development Processes and Organizations:** A generic development process, concept development: the front-end process, adapting the generic product development process, the AMF development process, product development organizations, the AMF organization. **Product Planning:** The product planning process, identify opportunities. Product strategies, Analysis of a product, The three S's, Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect on the results and the process.	
Unit – II	**11 Hrs**
Identifying Customer Needs: Gather raw data from customers; interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process. Quality Function Deployment. **Product Specifications:** What are specifications, Basic design considerations and constraints, Various types of specification, when are specifications established, establishing target Specifications, setting the final specifications. **Concept Generation:** The activity of concept generation, clarify the problem, search Externally, search internally, Benchmarking, explore systematically, reflect on the results and the process.	
Unit –III	**11 Hrs**
Concept Selection: Overview of methodology, concept screening, concept scoring, caveats. Concept Testing: Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process. **Product Architecture:** What is product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues.	
Unit –IV	**10 Hrs**
Industrial Design: Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, assessing the quality of industrial design. Problems faced by Industrial design Engineer. **Design for Manufacturing:** Definition, Approach to design, Production Requirements, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, VCP, Overview of Design for production - Metal parts, Designing	

with plastics, Rubber, ceramics and wood, Impact of DFM & DFX on other factors. Concurrent engineering, reasons for adopting concurrent engineering, factors preventing the adoption of Concurrent engineering.

Prototyping: Prototyping basics, principles of prototyping, technologies, planning for prototypes.

Unit –V	**11 Hrs**

Ergonomics: Description of human-machine interface, ergonomics and its area of application in the product design systems, Aesthetics & ergonomics tradeoff decisions, ergonomics in automotive design, Ergonomics in IoT environment.

Anthropometric Principles in Workspace and Equipment Design: Anthropometry and its use, types of anthropometric data, principles of applied anthropometry in ergonomics, application of anthropometry in product design, case studies.

Cognitive Ergonomics: Problem solving and decision-making, cognitive control of systems, Modeling of human operator control strategy, user models of interactive systems, the human operator as a decision maker, improving human decision making and problem solving.

Product design and development laboratory

Cycle I

Empirical formulae Based product design

1. Stress calculation
2. Snap fit and bolt calculation
3. Calculating per unit cost of the product

Review existing products and services

1. Product Analysis and appreciation/ Product failure analysis
2. Benchmarking of product features and identify the future scope
3. Norman Doors- Identifying design issues in existing products

New concept generation- Sketching/ Rendering

- Scouting for product idea (Cross over learning)
- Mind mapping of futuristic products
- Concept Generation using Morph matrix
- Concept selection using Pugh matrix
- Product dissection for Reverse Engineering
- Idea Stimulator using Value Engineering
- Generating ideas from lead users

Tools for Functional Innovation

Eliminate, Combine, Separate, Copy, Segment, vary, Maximize, Invert, Adapt, Magnify, Import

User Interface design /User Experience (UI/UX)

1. User flow layout
2. Create a Wireframe of a Page

Cycle II (Ergonomics aspects in product design)

- Overview of PLM using wind chill- (Product Data Management)
- Creation of virtual prototype for a physical product
- Capturing of anthropometric data for product design using composite integrated anthropometer
- Simulation of a manufacturing process using PLM
- Ergonomical assessment of a 3D prototype using ergofellow and PLM
- Assessment of Human elements in PLC using JACK (Nextgen)
- Human machine interaction-I using HTML (Cognitive ergonomics)

• Ergonomics in Automotive design process such as discomfort glare and dimming request prediction, percentile value computation, and visibility prediction model.

Course Outcomes: After completing the course, the students will be able to	
CO1:	Explain the structured approaches to Product design and development projects.
CO2:	Understand the challenges facing product designers and appreciate the need for adapting a development mind set
CO3:	Develop the capability to work in teams and apply the structured product design and development methodologies for solving problems.
CO4:	Analyze the need for integrated product design and process development frameworks.
CO5:	Create product solutions and develop prototypes of concepts generated.

Reference Books	
1	Product Design and Development, Karl.T.Ulrich, Steven D Eppinger, edition 2009, 2008, Tata McGrawHill, ISBN – 0-07058513-X.
2	Product Design and Manufacturing, A C Chitale and R C Gupta, 4th Edition, 2007, PHI, ISBN: 9788120333178.
3	Product Design, Kevin Otto and Kristen Wood, 1st edition, 2001, Pearson Education-, ISBN-10: 0130212717.
4	Introduction to Ergonomics, R S Bridger, 4th Edition, 2017, CRC Press, ISBN: 9781498795944.
5	Human Factors in Engineering and Design; Mark S. Sanders and Ernest J McCormick; 7th Edition, McGraw-Hill Education, 2013, ISBN-10: 1259064727 /13: 978-1259064722.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). 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 experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

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

High-3: Medium-2 : Low-1

Semester: VII						
FOUNDATIONS OF ROBOTICS AND AUTOMATION						
Course Code	**:**	18IM73		**CIE**	**:**	**100 + 50 Marks**
Credits: L:T:P	**:**	3:0:1		**SEE**	**:**	**100 + 50 Marks**
Total Hours	**:**	39L + 24P		**SEE Duration**	**:**	**03 + 03 Hours**

Course Learning Objectives: The students will be able to

1	To remember the basic concept of industrial automation.
2	To select suitable major control components required to automate a process or an activity
3	To provide the student with some knowledge and skills associated with robot control.
4	To develop the student's knowledge in various robot structures and their workspace.
5	To remember the basic concept of industrial automation.

Unit-I	**06 Hrs**
Automation: Introduction, Definition of Automation, Mechanization vs. Automation, Advantages of Automation, Goals of Automation, Social Issues of Automation, Low Cost Automation, Types of Automation Current Emphasis in Automation, Reasons for Automation, Reasons for not Automation, Issues for Automation in Factory Operations, Strategies for Automation.	
Unit – II	**10 Hrs**
Transfer Devices & Feeders: Introduction, Fundamentals of Production Lines, Types of Assembly Lines, Transfer Systems in Assembly Lines, Automatic Machines, Transfer Devices/Machines, Selection of Transfer Devices, Transfer Mechanism in Transfer Devices, Linear Transfer Mechanism, Rotary Transfer Mechanism, Classification of Transfer Devices, Advantages and Disadvantages of Transfer Machines, Conveyor Systems used in Transfer Devices, Feeders, Classification of Feeders, Criteria for Feeder Selection, Parts Feeding Devices, Types of Feeders	
Unit –III	**08 Hrs**
Robotics: Introduction, History of Robots, Definition of a Robot, Industrial Robot, Laws of Robotics Motivating Factors, Advantages and Disadvantages of Robots, Characteristics of an Industrial Robot, Components of an Industrial Robot, Comparison of the Human and Robot Manipulator, Robot Wrist and End of Arm Tools, Robot Terminology, Robotic Joints, Classification of Robots, Robot Selection	
Unit –IV	**07 Hrs**
Robotic Sensors & Robot End Effectors: Introduction, Types of Sensors in Robots, Exteroceptors or External Sensors, Tactile Sensors, Proximity Sensors (Position Sensors), Range Sensors, Machine Vision Sensors, Velocity Sensors, Introduction to End Effector, Classification of End Effectors, Grippers, Selection of Gripper, Gripping Mechanisms, Tools, Types of Tools Characteristics of End- of- Arm Tooling, Elements of End- of- Arm Tooling, Types of Grippers Finger Grippers, Mechanical Grippers, Vacuum /Suction Grippers Magnetic Grippers	
Unit –V	**08 Hrs**
Robot Programming: Introduction, Robot Programming, Robot Programming Techniques, On-line Programming, Lead-Through Programming, Walk-Through Programming or Teaching, Off-line Programming, Task-level Programming, Motion Programming, Overview of Robot Programming Languages, Requirements for a Standard Robot Language, Robot Languages Types of Robot Languages.	

Robotics and Automation laboratory
• Experiments on using hydraulic and pneumatic interface. • Experiments on robot programing to perform simple task.

Course Outcomes: After completing the course, the students will be able to	
CO1:	Describe the basic goal of automation.
CO2:	Summarize the different types of transfer and feeder devices used in automation.
CO3:	Have an understanding of the functionality and limitations of robotic actuators and sensors
CO4:	Will understand robot kinematics and robot programming.

Reference Books	
1	Industrial Automation and Robotics, A. K. Gupta, S. K. Arora 3rd Edition, 2013, University Science press.
2	Automation, Production System and Computer Integrated Manufacturing, Mikell.P.Groover, 3rd Edition, 2007, PHI New Delhi, ISBN – 0132393212
3	Industrial Robotics, Mikell P. Groover , Mitchel Weiss , Roger N. Nagel , Nicholas G. Odrey , Ashish Dutta McGraw Hill 2rd Edition ISBN 9781259006210

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). 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 experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

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CO-PO Mapping												
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CO1	2	-	1	-	-	-	3	-	-	-	-	-
CO2	-	2	1	1	3	-	-	-	-	-	-	-
CO3	-	-	1		-	-	-	1	2	-	-	-
CO4	-	2	-	1	1	-	1	-	1	-	-	-

High-3: Medium-2 : Low-1

Semester: VII						
FINANCIAL MANAGEMENT (Group F: Professional Core Elective)						
Course Code	**:**	18IM7F1		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	39L		**SEE Duration**	**:**	**3.0 Hours**

Course Learning Objectives: The students will be able to	
1	Explain the nature of finance and its interaction with other management functions.
2	Highlight the use of understanding time value of money in financial decisions.
3	Discuss the pros and cons of various sources of long term finance and working capital.
4	Recognize the importance of knowing contemporary aspects in the financial world.

UNIT-I	**06 Hrs**
Financial Management-An overview: Financial Decisions in a firm, Goals of a firm, Fundamental principle of finance, Organization of finance function and its relation to other functions, Regulatory framework. **The financial System:** Functions, Assets, Markets, Market returns, Intermediaries, regulatory framework, Growth and trends in Indian financial system. **Financial statements, Taxes and cash flow:** Balance sheet, statement of profit and loss, items in annual report, manipulation of bottom line, Profits vs Cash flows, Taxes. **(Conceptual treatment only)**	
UNIT-II	**10 Hrs**
Time Value of Money: Future value of a single amount, future value of an annuity, present value of a single amount, present value of an annuity. **Valuation of securities:** Basic valuation model, bond valuation, equity valuation-dividend capitalization approach and other approaches. **Risk and Return:** Risk and Return of single assets and portfolios, measurement of market risk, relationship between risk and return, implications **(Conceptual and Numerical treatment)**	
UNIT-III	**10 Hrs**
Techniques of Capital Budgeting: Capital budgeting process, project classification, investment criteria, Net present value, Benefit-Cost ratio, Internal Rate of return, Payback period, Accounting rate of return. **Cost of Capital:** Preliminaries Cost of debt and preference, cost of retained earnings, cost of external equity, determining the proportions, weighted average cost of capital, weighted marginal cost of capital schedule. **Capital structure and cost of capital:** Assumptions and concepts, net income approach, net operating income approach, traditional position, Modigliani and Miller Position, Taxation and Capital structure, Other imperfections and Capital structure **(Conceptual and Numerical treatment)**	
UNIT-IV	**07 Hrs**
Long term finance: Sources- Equity capital, Internal accruals, preference capital, term loans, debentures. Raising long term finance- Venture capital, Initial Public Offer, Follow on Public Offer, Rights Issue, Private Placement, Term Loans, Investment Banking **Securities Market:** Primary market vs Secondary market, Trading and Settlements, Stock market quotations and Indices, Govt. securities market, Corporate debt market. **Working Capital – Policy and Financing:** Factors influencing working capital requirements, Current assets financing policy, operating cycle and cash cycle. Accruals, trade credit, banks, public deposits, inter-corporate deposits, short term loans, right debentures, commercial paper, Factoring **(Conceptual treatment only)**	
UNIT-V	**06 Hrs**
Contemporary topics in Finance: Reasons and Mechanics of a merger, Takeovers, Divestures, Demergers, World monetary system, Foreign exchange markets, raising foreign currency finance,	

International capital budgeting, Options market, Futures market, Warrants, Venture capital financing framework, Indian venture capital scenario. (Conceptual treatment only)

Reference Books	
1.	Fundamentals of Financial Management, Prasanna Chandra, 6th Edition, 2018, McGraw Hill Education(India) Pvt. Ltd, ISBN: 978-93-392-0313-9, 93-392-0313-5
2.	Financial Management-Text, Problems and Cases, Khan M Y & Jain P K, 8th Edition, 2018, McGraw Hill Education(India) Pvt. Ltd, ISBN: 9353162181 , 9789353162184
3.	Financial Management, I M Pandey, 11th Edition, 2015, Vikas Publishing House, ISBN: 9789325982291
4.	Fundamentals of Financial Management, James C. Van Horne, 13th Edition, 2008, Prentice Hall, ISBN: 978-0273713630

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the features of financial system and basic principles of financial management.
CO2	Describe the processes and techniques of capital budgeting and theories of capital structure.
CO3	Demonstrate an understanding of various sources of long term and working capital financing by organizations.
CO4	Analyze the trends in global financial scenarios.

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

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. 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 marks component for experiential learning is 20. **Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.**

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

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

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

Low-1 Medium-2 High-3

Semester: VII						
DATA MINING & PREDICTIVE ANALYTICS (Group F : Professional Core Elective)						
Course Code	**:**	18IM7F2		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	40L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand various multivariate techniques for analysis of real life processes
2	Use techniques such as regression, factor analysis, clustering to describe and infer about processes through analysis of data
3	Compare processes by analyzing them by using specific multivariate techniques.

Unit-I	**06 Hrs**
Data Preparation: An Introduction to Data Mining and Predictive Analytics, The Need For Human Direction of Data Mining, The Cross-Industry Standard Process for Data Mining: CRISP-DM, Fallacies of Data Mining, What Tasks can Data Mining Accomplish **Data Preprocessing:** Why do We Need to Preprocess the Data, Data Cleaning, Handling Missing Data, Identifying Misclassifications, Graphical Methods for Identifying Outliers, Measures of Center and Spread, Z-Score Standardization, Transformations to Achieve Normality, Numerical Methods for Identifying Outliers	
Unit – II	**09 Hrs**
Dimension-Reduction Methods: Need for Dimension-Reduction in Data Mining, Principal Components Analysis, Applying PCA to the Houses Data Set, How Many Components Should We Extract?, Profiling the Principal Components, Validation of the Principal Components, Factor Analysis	
Unit –III	**09 Hrs**
Preparing to Model the Data: Supervised Versus Unsupervised Methods, Cross-Validation, Over fitting, Bias–Variance Trade-Off, Balancing The Training Data Set, Establishing Baseline Performance **Classification:** k-Nearest Neighbor Algorithm, Classification Task, k-Nearest Neighbor Algorithm, Distance Function, Combination Function, Quantifying Attribute Relevance: Stretching the Axes, Database Considerations, k-Nearest Neighbor Algorithm for Estimation and Prediction, Choosing k, Application of k-Nearest Neighbor.	
Unit –IV	**09 Hrs**
Clustering: Hierarchical and K-Means Clustering, The Clustering Task, Hierarchical Clustering Methods, Single-Linkage Clustering, Complete-Linkage Clustering, Means Clustering, Example of -Means Clustering at Work, Behavior of MSB, MSE, and Pseudo-F as the K-Means Algorithm Proceeds, Application of K-Means Clustering, **Association Rules:** Affinity Analysis and Market Basket Analysis, Support, Confidence, Frequent Item sets, and the A Priori Property, The A Priori Algorithm, Generating Frequent Item sets, Generating Association Rules, Extension From Flag Data to General Categorical Data, Information-Theoretic Approach: Generalized Rule Induction Method, Association Rules are Easy to do Badly, How Can We Measure the Usefulness of Association Rules	
Unit –V	**07 Hrs**
Decision Trees: What is a Decision Tree?, Requirements for Using Decision Trees, Classification and Regression Trees, Decision Rules, and CART Algorithms Applied to Real Data **Neural Networks:** Input and Output Encoding, Neural Networks for Estimation and Prediction, Simple Example of a Neural Network, Sigmoid Activation Function, Back-Propagation, Gradient-Descent Method, Back-Propagation Rules, Example of Back-Propagation, Termination Criteria, Learning Rate, Momentum Term, Sensitivity Analysis, Application of Neural Network Modeling	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Explain the applicability of various multivariate techniques to analyze different sample data sets
CO2:	Apply multivariate techniques to draw inferences about various processes by analyzing the data from the processes.
CO3:	Analyze and interpret data so as to describe the process and to aid in decision making.
CO4:	Evaluate processes by analyzing their data using multivariate techniques to help in predicting performance measures.

Reference Books	
1	Data Mining and Predictive Analysis, Daniel T Larose, 2nd Edition, 2015, Wiley, ISBN 978-1-118-11619-7
2	An Introduction to Multivariate Statistical Analysis, T.W. Anderson, 3rd Edition, 2003, Wiley, ISBN: 978-0-471-36091-9
3	Applied Predictive Analytics: Principles and Techniques for The Professional Data Analyst, Dean Abbott, 2014, John Wiley and Sons, ISBN: 978-1-118-72796-6
4	Fundamentals of Machine Learning for Predictive Data Analytics, John D. Kelleher, Brian Mac Namee and Aoife D'Arcy, 2015, MIT Press, ISBN: 97802620 29445

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). 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 experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

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

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

High-3: Medium-2 : Low-1

Semester: VII						
DESIGN OF EXPERIMENTS (Group F : Professional Core Elective)						
Course Code	**:**	18IM7F3		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	39L		**SEE Duration**	**:**	**3.0 Hours**

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

Unit – I	**07 Hrs**
Introduction: Strategy of experimentation, applications, Basic principles, Terminology, Guidelines, History of statistical design. **Principles of quality engineering** – Tools used in robust design, Applications and benefits, Quality loss function, Quadratic loss function, Noise factors, Optimization of product & process design, Role of various quality control activities.	
Unit – II	**10 Hrs**
Factorial Experimentation- The 2^2 design, The 2^3 design, The general 2^k design, A single replicate of the 2^k design, The 3^2 design. Problems.	
Unit – III	**10 Hrs**
Blocking and Confounding in the 2^k Factorial Design: Blocking a replicated 2^k factorial design, Confounding in the 2^k factorial design, Confounding the 2^k factorial design in 2 & 4 blocks. Problems. **Fractional Factorial Designs:** The one – half fraction & one – quarter fraction of the 2^k design, Resolution III, IV & V designs. Problems.	
Unit – IV	**06 Hrs**
Constructing Orthogonal Arrays: Counting degrees or freedom, selecting a standard orthogonal array, dummy level technique, and compound factor method. Linear graphs and interaction assignment, modification of linear graphs, column merging method, branching design. Strategy for constructing an orthogonal array. Problems.	
Unit –V	**06 Hrs**
Steps In Robust Design Case study discussion illustrating steps in Robust Design. **Signal-To-Noise Ratio**: Evaluation of sensitivity to noise. S/N ratios for static problems, S/N ratios for dynamic problems. **Advanced Techniques:** Taguchi Inner and Outer Arrays, Shainin Techniques.	

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

Reference Books	
1.	Design and Analysis of Experiments, D.C. Montgomery, 5th Edition, 2006, Wiley India, ISBN – 812651048-X.
2.	Quality Engineering Using Robust Design, Madhav S. Phadke, 1989,Prentice Hall PTR, Englewood Cliffs, New Jersey 07632, ISBN: 0137451679.

3.	Designing for Quality – an Introduction Best of Taghuchi and Western Methods or Statistical Experimental Design, Robert H. Lochner, Joseph E. Matar, 1st Edition, 1990, Chapman and Hall, ISBN – 0412400200
4.	Taguchi Techniques for Quality Engineering: Loss Function, Orthogonal Experiments, Parameter and Tolerance Design, Philip J. Ross, 2nd Edition, 1996, McGraw-Hill, ISBN: 0070539588

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. 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 marks component for experiential learning is 20. **Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the 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	3	1	1	2	-	2	-	-	-
CO2	3	2	2	2	2	-	-	-	-	-	-	-
CO3	-	2	2	3	2	-	-	-	2	2	2	-
CO4	2	2	3	2	1	2	-	1	2	1	-	-

High-3 : Medium-2 : Low-1

Semester: VII						
SMART MANUFACTURING FOR INDUSTRY 4.0 (Group F : Professional Core Elective)						
Course Code	**:**	18IM7F4		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	39L		**SEE Duration**	**:**	**3.0 Hours**

Course Learning Objectives: The students will be able to	
1	Introduction to Industry 4.0 (or the Industrial Internet), its applications in the business world.
2	Deep insights into how smartness is being harnessed from data and appreciate what needs to be done in order to overcome some of the challenges.
3	Contrast and enumerate advantages from different prototyping solutions

UNIT – I	**06 Hrs**
Introduction: Internet of Things (IoT), Industrial Internet of Things, Components of IIoT, Cloud and Fog, M2M Learning and Artificial Intelligence, Argument Reality R, Industrial Internet Architecture Framework (IIAF), Data Management.	
UNIT – II	**10 Hrs**
The Concept of IIoT: Modern Communication Protocols, Wireless Communication Technologies, Proximity Network Communication Protocols, TCP/IP, API: A Technical Perspective, Middleware Architecture.	
UNIT – III	**10 Hrs**
Data Analytics in Manufacturing: Introduction, Data Analytics for Manufacturing Applications, Power Consumption in manufacturing, Anomaly Detection in Air Conditioning, Smart Remote Machinery Maintenance Systems with Komatsu, Quality Prediction in Steel Manufacturing. Internet of Things and New Value Proposition, IoTs Value Creation Barriers: Standards, Security and Privacy Concerns. **Advances in Robotics in the Era of Industry 4.0**: Introduction, Recent Technological Components of Robots, Advanced Sensor Technologies, Artificial Intelligence, Internet of Robotic Things, Cloud Robotics.	
UNIT – IV	**07 Hrs**
Additive Manufacturing Technologies and Applications: Introduction, Additive Manufacturing (AM) Technologies, Stereo lithography, 3DP, Fused Deposition Modeling, Selective Laser Sintering, Laminated Object Manufacturing, Laser Engineered Net Shaping, Advantages of Additive Manufacturing, Disadvantages of Additive Manufacturing.	
UNIT – V	**06 Hrs**
Augmented Reality: The Role of Augmented Reality in the Age of Industry 4.0, Introduction, AR Hardware and Software Technology, Industrial Applications of AR, Maintenance, Assembly, Collaborative Operations, Training. **Smart Factories:** Introduction, Smart factories in action, Importance, Real world smart factories, The way forward. **A Roadmap for Smart Factory:** Digital Transformation, Transforming Operational Processes, Business Models, Increase Operational Efficiency, Develop New Business Models.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the concept and components of Industrial Internet of Things (IIoT).
CO2	Analyze the relevance of Data Analytics in Industrial environment.
CO3	Illustrate the applicability of Robotics, Additive Manufacturing, Augmented Reality as enabling technologies in IIoT.
CO4	Explain the road map for digitizing the industrial organizations.

Reference Books	
1.	Industry 4.0 - The Industrial Internet of Things, Alasdair Gilchrist, 2016, Apress Publisher, eBook ISBN:978-1-4842-2047-4, Softcover ISBN-978-1-4842-2046-7
2.	Industry 4.0: Managing The Digital Transformation, Alp Ustundag, Emre Cevikcan, Edition 1,

	2018, Springer, ISBN 978-3-319-57869-9.
3.	Designing the Industry - Internet of Things Connecting the Physical, Digital and Virtual Worlds, Ovidiu Vermesan and Peer Friess, 2016, Rivers Publishers, ISBN 978-87-93379-81-7.
4.	The Concept Industry 4.0 - An Empirical Analysis of Technologies and Applications in Production Logistics, Christoph Jan Bartodziej, Edition 1, 2017, Springer Gabler, ISBN 978-3-6581-6502-4.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. 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 marks component for experiential learning is 20. **Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the 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	3	1	1	2	-	2	-	-	-
CO2	3	2	2	2	2	-	-	-	-	-	-	-
CO3	-	2	2	3	2	-	-	-	2	2	2	-
CO4	2	2	3	2	1	2	-	1	2	1	-	-

High-3 : Medium-2 : Low-1

Semester: VII						
E-COMMERCE **(Group F : Professional Core Elective)**						
Course Code	**:**	18IM7F5		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	39L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Understand the basic concepts of graphs and their properties, operations of graphs, Hamiltonian and Euler graphs, trees and matrix representation of graph.
2	Apply the concepts of planar graph, matching and coloring in computer science engineering.
3	Demonstrate the understanding of descriptive statistics by practical application of quantitative reasoning and data visualization.
4	Use concepts of probability in the study of random phenomena, analyzing and interpreting data that involves uncertainties.
5	Use of mathematical IT tools to analyze and visualize the above concepts.

UNIT-I	**07 Hrs**
Introduction to Electronic Commerce: learning objectives, dot-com era, Amazon.com : Synonymous with E-commerce, Dell: An evolutionary E-commerce, The changing times in E-commerce, Present scenario, Future of E-commerce, Constituents of E-commerce, E-commerce web design, E-business and E-commerce web portals, Case studies.	
UNIT-II	**08 Hrs**
Technologies for E-commerce: learning objectives, Basic architecture of Internet, TCP/IP, Ipv4 versus Ipv6, Evolution of Internet, Uniform resource locator, Hypertext Transfer Protocol, Cookies, Client side or web programming, HTML programming techniques, Links, Images, Tables, Frames, Form, Style sheets, Javascript, Case studies.	
UNIT-III	**09 Hrs**
Concepts in E-commerce: learning objectives, concepts and definitions, Different types of E-commerce, Understanding M-commerce, Factors affecting E-commerce, E-commerce components, E-commerce and consumers, Business transaction through E-commerce, E-commerce applications, E-commerce in developing countries, Role of Govt in development of E-commerce, Regulatory monitoring for E-commerce, Policies for SME's for E-commerce adoption, Case studies.	
. **UNIT-IV**	**08 Hrs**
Understanding E-commerce product design strategy : learning objectives, Benefits of web enabled channels, E-commerce considerations, Case study of dell computers, strategic initiatives by Indian railways, Brand equity through E-commerce. **Channels in E-commerce :** learning objectives, Importance of E-commerce in multichannel marketing, Automation in E-commerce portals, Using E-commerce for order fulfilling in supply chain management, case studies	
UNIT-V	**07 Hrs**
Future trends: Social commerce : learning objectives, social power and civilization, understanding social commerce, advantages of social commerce, pitfalls, future of social commerce, social commerce challenges in India, case studies. **Drivers of on line-selling diffusion :** Drivers of on line selling B2C, Internet community, technology and legal frame work, business strategy, design of a secure value proposition, empirical study, Interpolation study and trend analysis.	

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

CO4:	Recognize and discuss global E-commerce issues

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

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

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). 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 experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the 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	2	2	2	1	-	-	-	-	-	1	-	1
CO3	2	1	2	3	-	-	-	-	-	2	-	1
CO4	3	3	3	3	-	-	-	-	-	1	-	2

High-3: Medium-2 : Low-1

Semester: VII						
QUALITY MANAGEMENT **(Group G : Professional Core Elective)**						
Course Code	**:**	18IM7G1		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	39L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

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

UNIT-I	**07 Hrs**
Quality Pioneers: Deming's approach, Juran's quality trilogy, Crosby and quality treatment, Imai's Kaizen, Ishikawa's company-wide quality control, and Feigenbaum's theory of TQC. **Evolution of Quality Concepts and Methods:** Quality concepts, Development of four fitness's, evolution of methodology, evolution of company integration.	
UNIT-II	**09 Hrs**
Four Revolutions in Management thinking, Focus on customers: Change in work concept, market-in, and customers. **Continuous Improvement:** Improvement as problem solving process: Management by process, WV model of continuous improvement. **Reactive Improvement**: Identifying the problem, standard steps, seven steps case study, General guidelines for managers diagnosing a QI story. **Proactive Improvement:** Introduction to proactive improvement, standard steps for proactive improvement, semantics, Seven Management and Planning Tools.	
UNIT-III	**09 Hrs**
Total Participation; Teamwork skill, Dual function of work, teams and teamwork, principles for activating teamwork, creativity in team processes, Initiation strategies, **Hoshin Management**: Definition, Concepts, Phases in Hoshin Management – overview. **Societal Networking:** Networking and societal diffusion, infrastructure for networking. TQM as learning system, a TQM model for skill development.	
UNIT-IV	**07 Hrs**
Introduction to Six Sigma: Benefits, fundamentals, myths, essentials and costs of Six Sigma. Assessing readiness for Six Sigma, five key players, Planning for the Six Sigma initiative. Case discussions. **Statistical Foundation:** Variation & causes, normal distribution, process capability, rolled throughput yield, Cost of poor quality. **Metrics for Six Sigma:** The critical-to-quality concept, criteria to metrics, universal standard, baselines, benchmarking, guidelines for metrics.	
UNIT-V	**07 Hrs**
Project Selection: Project selection process, evaluating projects. Project selection matrix, project review. DMAIC phases. **Design for Six Sigma:** Overview of DFSS, DMADV Method. **Beyond Six sigma:** Supply chain management using Lean and Six Sigma, Knowledge management and Six Sigma, Growth Management System – building blocks and architecture.	

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

Reference Books	
1	Shoji Shiba, Alan Graham and David Walden, A New American TQM – Four Practical Revolutions in Management, Productivity Press, Portland (USA), 2nd Edition, 1993, ISBN: 9781563270321
2	Greg Brue and Rod Howes, Six Sigma, TATA McGraw-Hill Edition 2006, ISBN: 0-07-063468-8
3	N Logothetis , Managing for total quality: from Deming to Taguchi and SPC, Prentice Hall of India, 1993, ISBN: 978-0133535127
4	Dale H. Besterfield, Carol Besterfield-Michna, Glen Besterfield, Mary Besterfield – Sacre, Total Quality Management, Pearson Education, 2002, 3rd Edition, ISBN-81-297-0260-6.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). 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 experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

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

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

High-3: Medium-2 : Low-1

VII Semester						
PROJECT PLANNING AND CONTROL (Group G : Professional Core Elective)						
Course Code	**:**	18IM7G2		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	39L		**SEE Duration**	**:**	**3.00 Hours**

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 different process groups and knowledge areas used to manage project.

Unit-I	**06 Hrs**
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.	
UNIT – II	**10 Hrs**
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.	
UNIT – III	**09 Hrs**
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.	
UNIT – IV	**07 Hrs**
Project Cost management: Project Cost management, estimate cost, determine budget, control costs. **Project Quality management**: Plan quality management, perform quality assurance, and control quality.	
UNIT – V	**07 Hrs**
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.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the concepts, tools and techniques for managing large projects.
CO2:	Explain various knowledge areas in the project management framework.
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 experiential learning (EL). 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 experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

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

SEE for 100 marks is executed by means of an examination. The Question paper for the 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	-	-	-	-	-	1	-	1
CO4	3	3	3	3	-	-	-	-	-	1	-	1

High-3: Medium-2 : Low-1

Semester: VII						
PRINCIPLES OF SYSTEMS ENGINEERING (Group G: Professional Core Elective)						
Course Code	**:**	18IM7G3		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	39L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the Life Cycle of Systems.
2	Explain the role of Stake holders and their needs in organizational systems.
3	Develop and document the knowledge base for effective systems engineering processes.
4	Apply available tools, methods and technologies to support complex high technology systems.
5	Create the frameworks for quality processes to ensure high reliability of systems.

Unit-I	**07 Hrs**
System Engineering and the World of Modem System: What is System Engineering? Origins of System Engineering, Examples of Systems Requiring Systems Engineering, System Engineering viewpoint, Systems Engineering as a Profession, The power of Systems Engineering, problems. **Structure of Complex System:** System building blocks and interfaces, Hierarchy of Complex systems, System building blocks, The system environment, Interfaces and Interactions. **The System Development Process:** Systems Engineering through the system Life Cycle, Evolutionary Characteristics of the development process, the system engineering method, Testing throughout system development, problems.	
Unit – II	**10 Hrs**
Systems Engineering Management: Managing systems development and risks, Work breakdown structure (WBS), System Engineering Management Plan (SEMP), Risk Management, Organization of Systems Engineering, Systems Engineering Capability Maturity Assessment, Systems Engineering standards, Problem. **Needs Analysis:** Originating a new system, Operations analysis, Functional analysis, Feasibility analysis, Feasibility definition, Needs validation, System operational requirements, problems. **Concept Exploration:** Developing the system requirements, Operational requirements analysis, Performance requirements formulation, Implementation concept exploration, Performance requirements validation, problems.	
Unit –III	**10 Hrs**
Concept Definition: Selecting the system concept, Performance requirements analysis, Functional analysis and formulation, Concept selection, Concept validation, System Development planning, System Functional Specifications, problems **Advanced Development:** Reducing program risks, Requirement's analysis, Functional Analysis and Design, Prototype development, Development testing, Risk reduction, problems.	
Unit –IV	**06 Hrs**
Engineering Design: Implementing the System Building blocks, requirements analysis, Functional analysis and design, Component design, Design validation, Configuration Management, problems. **Integration and Evaluation:** Integrating, Testing and evaluating the total system, Test planning and preparation, System integration, Developmental system testing, Operational test and evaluation, problems.	
Unit –V	**06 Hrs**
Production: Systems Engineering in the factory, Engineering for production, Transition from development to production, Production operations, Acquiring a production knowledge base, problems. **Operations and support:** Installing, maintenance and upgrading the system, Installation and test, In-service support, Major system upgrades: Modernization, Operational factors in system development, problems.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Recognize important systems engineering and systems thinking strategies and practices in examples and cases.
CO2:	Apply systems engineering practices and methods to relevant examples.
CO3:	Develop requirements, architectures, specifications, verifications, and tests.
CO4:	Analyze systems using systems engineering approaches to increase performance.

Reference Books	
1	Systems Engineering – Principles and Practice, Alexander Kossoaikoff, William N Sweet, Edition: 2012, John Wiley & Sons, Inc, ISBN: 978-81-265-2453-2
2	Handbook of Systems Engineering and Management, Andrew P. Sage, William B.Rouse, Edition:1999, John Wiley & Sons, Inc., ISBN 0-471-15405-9
3	Systems engineering and analysis, Blanchard, Benjamin S., Wolter J. Fabrycky, 5th Edition, 2010, USA: Prentice Hall, ISBN 013221735X
4	General System Theory: Foundation, Development, Applications, Ludwig von Bertalanffy, 1973, Penguin University Books, Revised, ISBN: 0140600043, 9780140600049.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. 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 marks component for experiential learning is 20. **Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the 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	-	-	2	1	-	-
CO2	2	1	2	1	-	-	-	-	-	-	-	1
CO3	1	2	3	-	1	-	-	-	-	1	-	-
CO4	1	2	2	2	-	1	-	-	-	1	-	1

High-3: Medium-2: Low-1

VII Semester				
LEAN MANUFACTURING SYSTEMS (Group G : Professional Core Elective)				
Course Code	**:**	18IM7G4		**CIE Marks : 100**
Credits : L: T: P	**:**	3:0:0		**SEE Marks : 100**
Hours	**:**	39L		**SEE Duration : 3 Hrs**

Course Learning Objectives: Students are expected to :

1.	Explain the practices of lean manufacturing in Toyota production system
2.	Implement lean in different projects.

UNIT – I	06 Hrs
Lean Manufacturing and the Toyota Production System: Definition of Lean, Ohno's thought about the Toyota Production System, The TPS and Lean Manufacturing Defined, The Two Pillars of the TPS, Several Revolutionary Concepts in the TPS, The TPS Is Not a Complete Manufacturing System, Where Lean Will Not Work… or Not Work Quite so Well.	
UNIT – II	**10 Hrs**
Inventory and Variation: Background, Need of the Inventory, disadvantages of Inventory, About Variation, Buffers, Kanban, Kanban Calculations, Finished Goods Inventory Calculations, Kanban Calculations, Make-to-Stock versus Make-to-Order Production Systems **Lean Manufacturing:** The Philosophy and Objectives, the Foundation of Quality Control, Quantity Control **The Significance of Lead Time:** History of Lead Time, Benefits of Lead-Time Reductions, Lead-Time Reductions, Techniques to Reduce Lead Times	
UNIT – III	**10 Hrs**
How to Do Lean—Cultural Change Fundamentals: Three Fundamental Issues of Cultural Change, Some Cultural Aspects of a Lean Implementation **How to Do Lean—the Four Strategies to Becoming Lean:** Overview of the Lean Implementation Strategies, Implementing Lean Strategies on the Production Line **Process Improvement and Lean Six Sigma:** Introduction, An LSS quality focus on the Business process, objectives of process improvement, cross functional focus, critical success factors, Nature and advantage of LSS process Improvement, Process owner, Process ownership. **Integrating LSS and DMAIC with DMADV:** Overview, Goals of lean DMADV, Lean Design, Goals of DMAIC/DMADV, comparing DMAIC and DMADV, Integrating lean with DMAIC/DMADV	
UNIT – IV	**06 Hrs**
How to Implement Lean—The Prescription for the Lean Project: An Overview on How to Implement Lean and steps: Assess the Three Fundamental Issues to Cultural Change, Complete a System wide Evaluation of the Present State, Perform an Educational Evaluation, Document the Current Condition, Redesign to Reduce Wastes, Evaluate and Determine the Goals for the Line, Implement the Kaizen Activities, Evaluate the Newly Formed Present State, Stress the System.	
UNIT – V	**07 Hrs**
Planning and Goals: Hoshin–Kanri Planning, importance of Goals and Goal Deployment, Policy Deployment, Leadership in Goal Development and Deployment. **Sustaining the Gains:** Importance of Sustaining the Gains, existence of Process gain and loss.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the principles of Lean and Toyota Manufacturing systems.
CO2	Appreciate the utility and capability of Lean thinking.
CO3	Apply the tools in lean manufacturing to analyse a manufacturing system and plan for its improvements.
CO4	Develop the skills to implement lean manufacturing in industry and manage the change process to achieve continuous improvement of efficiency and productivity.

Reference Books:	
1.	Lonnie Wilson, How to Implement Lean Manufacturing, ISBN: 978-0-07-162508-1, The McGraw-Hill Companies,
2.	Frank Voehl, H James Harrington, Chuck Mignosa, Rich Charron, The Lean Six Sigma Black Belt Hand Book-Tools and methods for process acceleration, CRC Press Taylor & Francis group,2014,ISBN-13:978-1-4665-5468-9
3.	Michael Hammer & James Champy, REENGINEERING THE CORPORATION, A Manifesto for Business Revolution, Harper Business Essentials
4.	Jeffrey K. Liker, The Toyota Way, ISBN-10:0-07-058747-7, The McGraw-Hill Companies
5.	M.G. Korgaonker, "Just In Time Manufacturing", Macmillan India Ltd., 2006, ISBN: 0333 926633.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). 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 Assignment/Presentation/Project 20. **Total CIE is 30(Q) +50(T) +20(A) =100 Marks.**

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

CO - PO Mapping

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

High-3: Medium-2: Low-1

Semester: VII						
DIGITAL SUPPLY CHAIN MANAGEMENT (Group G : Professional Core Elective)						
Course Code	**:**	18IM7G5		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3: 0: 0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	39L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	To explain the concepts and drivers of the Digital supply chain management.
2	To Understand the Building Blocks, Major Functions, Business Processes, and their relevance to Decisions in a Digital Supply Chain environment.
3	To Visualize the linkages between Supply Chain Structures and Logistical Capabilities of a firm or supply chain.
4	Explore the full array of digital technology tools including block chain to assist in the management of every business activity from Manufacturing to transaction control, to internet based trade and commerce.

Unit-I	**06 Hrs**
Introduction to Digital Supply chain management: Definition of e logistics, Historical development, Challenges, Customer interfaces, Applications. Case studies. Problems.	
Unit – II	**09 Hrs**
Digital Supply chain for Road Freight Transport Cloud computing, Telematic data, Data source, IT system development, Big data, Applications. Case studies. Problems **Electronic bills of Lading** Background of bills of lading, Bill of lading as a receipt, Service level agreements, Documentation, Legal framework, Recent global initiatives on electronic commerce.	
Unit –III	**09 Hrs**
Port-centric ICT system Importance of ICT to port systems, Port-centric ICT, information matrix of Port-centric ICT, ICT investment, Port community systems, Policy implications. **Future of e commerce and digital warehousing** The challenges, Type, Size, and location of fulfilment centres and warehouses, Location of warehouses, Outsourcing, Warehousing operations, Technology and Automation.	
Unit –IV	**07 Hrs**
Advanced warehouse management systems and innovations Warehouse functions, Need for warehouse, Information management in WMS, Interlinking WMS to ERP and MIS, RFID technology for enhance data capture.	
Unit –V	**08 Hrs**
RFID in Logistics Overview of concurrent technologies, Costs and benefits of RFID, Potential Applications, RFID for returnable asset tracking, RFID for retailing, RFID for fashion retailing. **GS1 in logistics and e procurement** History, Using GS1 codes, GS1 codes used in logistics and e procurement, GS1 barcodes, Barcode formats, Privacy concerns, GS1 EPCglobal, Privacy concerns.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Explain the building blocks of a typical Digital supply chain.
CO2:	Understand digital supply chain concepts, systemic and strategic role of DSCM in global competitive environment.
CO3:	Analyze the future course of development of Digital Supply Chain management in line with the latest solutions to business problems and assess their impact.
CO4:	Develop optimal sourcing and inventory policies in the digital supply chain context.

Reference Books	
1	E-Logistics: Managing Your Digital Supply Chains for Competitive Advantage, Stephen Pettit, Yingli Wang, ISBN: 978 0 7494 7266 5
2	Technology in Supply Chain Management and Logistics: Current Practice and future applications: Anthony M. Pagano, Matthew Liotine, Elsevier Publications, ISBN: 978-012-815956-9
3	Introduction to Supply Chain Management Technologies, David Frederick Ross, 2nd Edition CRC Press Taylor & Francis Croup Boca Raton London New York.
4	Supply Chain Information Technology, David Olson, 2012, Business Expert Express

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). 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 experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

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

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

High-3: Medium-2 : Low-1

Semester: VII						
UNMANNED AERIAL VEHICLES **(Group H: Global Elective)** **(Theory)**						
Course Code	**:**	**18G7H01**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Hours	**:**	**39L**		**SEE Duration:**	**:**	**3Hrs**

Course Learning Objectives: The students will be able to	
1	Get an overview of the history of UAV systems
2	Understand the importance of aerodynamics, propulsion, structures and avionics in the design of UAV
3	Demonstrate ability to address the various mission payloads - on-board & off-board, propulsion systems, integration with manned systems
4	Comprehend the importance of guidance and navigation of a UAV

Unit-I	**07 Hrs**
Overview of Unmanned Aerial Vehicles and Systems: History of UAVs, Need of unmanned aerial systems, Overview of UAV Systems-System Composition, Classification of UAVs based on size, range and endurance, Basic working of fixed, rotary and flapping UAVs, Applications of UAVs.	
Unit – II	**08 Hrs**
Aerodynamics of Unmanned Aerial Vehicles: Airfoil nomenclature and its characteristics, Basic aerodynamics equations, Aircraft polar, Types of drag, Aerodynamics of rotary and flapping wings, Airframe configurations-HTOL, VTOL and Hybrids.	
Unit –III	**08 Hrs**
Structures of UAV: Mechanic loading, Load calculation, Materials used for UAV (general introduction), Selection criteria for structure, Types of structural elements used in UAV their significance and characteristics. **UAV Propulsion Systems:** Thrust Generation, Powered Lift, Sources of Power for UAVs- Piston, Rotary, Gas turbine engines, electric or battery powered UAVs.	
Unit -IV	**08 Hrs**
Payloads of UAVs : Non-dispensable Payloads- Electro-optic Payload Systems, Radar Imaging Payloads, Electronic Warfare Payloads, Dispensable Payloads and other payloads. **Launch and Recovery Systems for UAVs:** UAV Launch Methods for Fixed-Wing Vehicles- Rail Launchers, Pneumatic Launchers, Hydraulic/Pneumatic Launchers, Zero Length RATO Launch of UAVs, UAV Recovery Systems-Conventional Landings, Vertical Net Systems, Parachute Recovery, VTOL UAVs, Mid-Air Retrieval, Shipboard Recovery.	
Unit -V	**08 Hrs**
UAV Navigation and Guidance Systems Navigation, Dead Reckoning, Inertial, Radio Navigation, Satellite–Way point Navigation, UAV Guidance, Types of guidance, UAV communication systems, Ground control station, Telemetry, UAS future.	

Course Outcomes: At the end of this course the student will be able to :	
CO1	Appraise the evolution of UAVs and understand the current potential benefits of UAVs
CO2	Apply the principles of Aerospace Engineering in design and development of UAVs
CO3	Determine and evaluate the performance of UAV designed for various Missions and applications
CO4	Appreciate the guidance and navigation systems for enabling the versatility of UAV systems

Reference Books	
1	Unmanned Aircraft Systems UAV design, development and deployment, Reg Austin, 1st Edition, 2010, Wiley, ISBN 9780470058190.
2	Introduction to UAV Systems, Paul G Fahlstrom, Thomas J Gleason, 4th Edition, 2012, Wiley, ISBN: 978-1-119-97866-4
3	Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy, Kimon P. Valavanis, 1st Edition,2007, Springer ISBN 9781402061141
4	Flight Stability and Automatic Control, Robert C. Nelson, 2nd Edition, October 1, 1997, McGraw-Hill, Inc, ISBN 978-0070462731.
5	Design of Unmanned Air Vehicle Systems, Dr. Armand J. Chaput, 3rd Edition, 2001, Lockheed Martin Aeronautics Company, ISBN: 978-1-60086-843-6

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

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). 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 experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

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

SEE for 100 marks is executed by means of an examination. The Question paper for the 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	-	-	-	2
CO3	1		3	3	-	-	-	-	-	-	-	2
CO4	3	3	3	3	-	2	1	2	-	-	-	2

High-3 : Medium-2 : Low-1

Semester: VII						
BIOINFORMATICS (Theory) (Common to all Courses)						
Course Code	**:**	**18G7H02**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Acquire the knowledge of biological database and its role in insilico research
2	Understand the essential algorithms behind the biological data analysis such as Dynamic programming, Dot plotting, Evolutionary and Clustering algorithms along with their implementation.
3	Use various tools and techniques for the prediction of linear & non-linear structures of both macro and micro molecules and study the dynamics of macromolecules and High Throughput Virtual Studies.
4	Perform annotation of unknown DNA and Protein sequences and explore the principles of molecular modeling
5	Apply the knowledge towards analyzing the sequences using programming languages and Drug development

Unit-I	**08 Hrs**
Biomolecules and Introduction to Bioinformatics: Introduction to Biomolecules. Structure, Types and Functions of Carbohydrates, Lipids, Nucleic Acids and Proteins. Genetic code, Codon degeneracy, Genes and Genomes. Introduction to Bioinformatics, Goals, Scope, Applications in biological science and medicine. Biological databases – Sequence, structure, Special Databases and applications - Genome, Microarray.	
Unit – II	**08 Hrs**
Sequence analysis: Introduction, Types of sequence alignments, Pairwise sequence alignment, 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	
Unit –III	**09 Hrs**
Predictive and structural bioinformatics: Gene prediction programs – ab initio and homology based approaches. ORFs for gene prediction. Detection of functional sites and codon bias in the DNA. Predicting RNA secondary structure, Protein structure basics, structure visualization, comparison and classification. Protein structure predictive methods using protein sequence, Protein identity based on composition. Structure prediction - Prediction of secondary structure.	
Unit –IV	**07 Hrs**
PERL: Introduction to Perl, writing and executing a Perl program, Operators, Variables and Special variables. Object Oriented Programming in Perl–Class and object, Polymorphism, inheritance and encapsulation. Data Types – Scalar, Array and Associative array. Regular Expressions (REGEX), Components of REGEX - Operators, Metacharacters and Modifiers.	
Unit –V	**07 Hrs**
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, Sequence alignments BioPerl and Sequence Analysis - Pair wise and Multiple sequence alignment, Parsing BLAST and FASTA results.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Demonstrate the knowledge of retrieval of the biological data in the essential formats and its analysis.
CO2:	Analyse the gene, protein and RNA data to find the degree of similarities and identifying the patterns
CO3:	Apply the drug designing methods for screening and inventing the new targets and drugs
CO4:	Predict the structure of a compound and design the molecule.

Reference Books	
1.	Essential Bioinformatics, Jin Xiong, 2006, Cambridge University Press, ISBN: 978-05-216-00828.
2.	Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins; D. Andreas Baxevanis and B. F; Francis Ouellette. 2009; Wiley-IEEE; 3rd edn; ISBN: 978-81-265-21920.
3	Bioinformatics: Sequence and Genome Analysis; D W Mount; 2014; CSHL Press; 2nd edn; ISBN: 9780879697129.
4	Computational Systems Biology; A Kriete and R Eils; 2006; Academic Press; Illustrated edn; ISBN: 978-01-208-87866.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). 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 experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the 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	-	-	-	-	-	1	-	1
CO4	3	3	3	3	-	-	-	-	-	1	-	1

High-3: Medium-2: Low-1

Semester: VII						
INDUSTRIAL SAFETY AND RISK MANAGEMENT (Group H: Global Elective) (Theory)						
Course Code	**:**	**18G7H03**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Select appropriate risk assessment techniques.
2	Analyze public and individual perception of risk.
3	Relate safety, ergonomics and human factors.
4	Carry out risk assessment in process industries

Unit-I	**08 Hrs**
Introduction: Introduction to industrial safety engineering, major industrial accidents, safety and health issues, key concepts and terminologies, Hazard theory, Hazard triangle, Hazard actuation, Actuation transition, Causal factors, Hazard recognition.	
Unit – II	**08 Hrs**
Risk assessment and control: Individual and societal risks, Risk assessment, Risk perception, Acceptable risk, ALARP, Prevention through design. **Hazard Identification Methods:** Preliminary Hazard List (PHL): Overview, methodology, worksheets, case study. Preliminary Hazard Analysis (PHA): Overview, methodology, worksheets, risk index, example.	
Unit –III	**08 Hrs**
Hazard analysis: Hazard and Operability Study (HAZOP): Definition, Process parameters, Guide words, HAZOP matrix, Procedure, Example. Failure Modes and Effects Analysis (FMEA): Introduction, system breakdown concept, methodology, example.	
Unit –IV	**08 Hrs**
Application of Hazard Identification Techniques: Case of pressure tank, system breakdown structure, safety ontology, Accident paths, HAZOP application, risk adjusted discounted rate method, probability distribution, Hiller's model	
Unit –V	**07 Hrs**
Safety in process industries and case studies: Personnel Protection Equipment (PPE): Safety glasses, face shields, welding helmets, absorptive lenses, hard hats, types of hand PPE, types of foot PPE, types of body PPE. Bhopal gas tragedy, Chernobyl nuclear disaster, Chemical plant explosion and fire.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Recall risk assessment techniques used in process industry.
CO2:	Interpret the various risk assessment tools.
CO3:	Use hazard identification tools for safety management.
CO4:	Analyze tools and safety procedures for protection in process industries.

Reference Books	
1	Functional Safety in the Process Industry: A Handbook of practical Guidance in the application of IEC61511 and ANSI/ISA-84, Kirkcaldy K.J.D Chauhan, 2012, North corolina, Lulu publication, ISBN:1291187235
2	Safety Instrumented Systems Verification Practical probabilistic calculations, Goble and William M., 2005, Pensulvania ISA publication, ISBN:155617909X
3	Industrial safety and risk Management, Laird Wilson and Doug Mc Cutche, 1st Edition,

	2003, The University of alberta press,Canada, ISBN: 0888643942.
4	Industrial Safety, Health and Environment Management Systems, R K Jain, Sunil S Rao, 4th Edition, 2005, Khanna Publishers, New Delhi, ISBN: 8174092102

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

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). 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 experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

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

SEE for 100 marks is executed by means of an examination. The Question paper for the 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	1	-	-	1	-
CO2	2	3	1	-	1	1	-	-	-	-	-	-
CO3	3	2	1	1	2	-	1	-	-	1	1	-
CO4	3	-	1	-	-	-	-	-	1	-	1	-

High-3; Medium-2; Low-1

Semester: VII						
WEB PROGRAMMING **(Group B: Global Elective)** **(Theory)**						
Course Code	**:**	**18G7H04**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the standard structure of HTML/XHTML and its differences.
2	Adapt HTML and CSS syntax & semantics to build web pages.
3	Learn the definitions and syntax of different web programming tools such as JavaScript, XML and Ajax to design web pages.
4	Design and develop interactive, client-side, server-side executable web applications using different techniques such as CSS, JavaScript, XML and Ajax.

Unit-I	**07 Hrs**
Introduction to Web, HTML and XHTML: Fundamentals of Web(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, Lists, Tables, Forms, Frames. **HTML 5:** Core HTML attributes, headings, paragraphs and breaks, quotations, preformatted text, lists, horizontal rules, block-level elements, text-level elements The audio Element; The video Element; Organization Elements; The time Element, Syntactic Differences between HTML and XHTML.	
Unit – II	**08 Hrs**
CSS (Cascading Style Sheet) 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.	
Unit –III	**09 Hrs**
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.	
Unit –IV	**08 Hrs**
Dynamic Documents with JavaScript: Introduction to dynamic documents; Positioning elements; Moving elements; Element visibility; Changing colors and fonts; Dynamic content; Stacking elements; Locating the mouse cursor; Reacting to a mouse click; Slow movement of elements; Dragging and dropping elements. **Introduction to PHP:** Origins and uses of PHP; overview of PHP; General syntactic characteristics; Primitives, Operations and Expressions; Output; Control statements; Arrays; Functions; Pattern Matching; Form Handling;Cookies; Session Tracking.	
Unit –V	**07 Hrs**
XML: Introduction; Syntax; Document structure; Document Type definitions; Namespaces; XML schemas; Displaying raw XML documents; Displaying XML documents with CSS; XSLT style sheets. **Ajax:** Overview of Ajax; Basics of Ajax: The Application; The Form Document; The Request Phase; The Response Document; The Receiver Phase.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the basic syntax and semantics of HTML/XHTML.
CO2:	Apply HTML/XHTML tags for designing static web pages and forms using Cascading Style Sheet.
CO3:	Develop Client-Side Scripts using JavaScript and Server-Side Scripts using PHP and utilize the concepts of XML & Ajax to design dynamic web pages.
CO4:	Develop web based applications using PHP, XML and Ajax.

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

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). 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 experiential learning is 20.
Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

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

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

High-3: Medium-2: Low-1

Semester: VII						
SOLID WASTE MANAGEMENT AND STATUTORY RULES (Group H: Global Elective) (Theory)						
Course Code	**:**	**18G7H05**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

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 for the present system.
3	Analyze different elements of solid waste management and 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	**08 Hrs**
Introduction: Present solid waste disposal methods. Merits and demerits of open dumping, incineration, pyrolysis, composting, sanitary landfill. Scope and importance of solid waste management. Definition and functional elements of solid waste management. **Sources**: Sources of Solid waste, types of solid waste, composition of municipal solid waste, generation rate, Problems. **Collection and transportation of municipal solid waste:** Collection of solid waste- services and systems, Municipal Solid waste (Management and Handling) 2016 rules with amendments. Site visit to collection system.	
Unit – II	**08 Hrs**
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.	
Unit –III	**08 Hrs**
Hazardous waste management: Definitions, Identification of hazardous waste, Classification of hazardous waste, onsite storage, collection, transfer and transport, processing, disposal, Hazardous and other wastes (Management and Transboundary Movement) Rules, 2016 with amendments. Site visit to hazardous landfill site	
Unit –IV	**08 Hrs**
Bio medical waste management: Classification of bio medical waste, collection, transportation, disposal of bio medical waste, Biomedical waste management (Management & Handling Rules) 2016 with amendments. Site visit to hospital to observe biomedical waste collection and transportation system and visit to biomedical waste incineration plant.	
Unit –V	**07 Hrs**
E-waste management: Definition, Components, Materials used in manufacturing electronic goads, Recycling and recovery integrated approach. e-waste (Management) Rules 2016 and amendments. Site visit to e- waste treatment plant. **Plastic waste management:** Manufacturing of plastic with norms. Plastic waste management. Plastic manufacture, sale & usage rules 2009 with amendments.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the current solid waste management system and statutory rules.
CO2:	Analyse drawbacks in the present system and provide recycling and disposal options for each type of waste in compliance to rules.
CO3:	Distinguish Hazardous waste, Biomedical waste, E waste and to provide scientific management system.
CO4:	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 and Climate change.

Reference Books :	
1	Integrated Solid Waste Management, George.C. Tchobanoglous, International edition ,1993, McGraw hill publication. ISBN 978-0070632370
2	Electronic waste management, R.E. Hester, Roy M Harrison, , Cambridge, UK, 2009, RSC Publication, ISBN 9780854041121
3	Solid Waste Management Rules 2016 , Ministry of Environment, Forest and Climate Change Notification, New Delhi, 8th April 2016
4	Hazardous and other wastes (Management and Transboundary Movement) Rules, 2016, Ministry of Environment, Forest and Climate Change Notification, New Delhi, 04th April, 2016.
5	Biomedical waste management (Management & Handling Rules) 2016,. Ministry of Environment & Forest Notification, New Delhi, amendment on 28th March, 2016.
6	E-waste (Management) Rules 2016, Ministry of Environment, Forest and Climate Change Notification, New Delhi, 23rd March , 2016.
7	Plastic Waste (Management and Handling) Rules, 2011 as amended in 2018, Ministry of Environment, Forest and Climate Change Notification, New Delhi, 27th March , 2018

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. 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 marks component for experiential learning is 20. **Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.**

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

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

High-3: Medium-2: Low-1

Semester: VII						
IMAGE PROCESSING AND MACHINE LEARNING (Group H: Global Elective) (Theory)						
Course Code	**:**	**18G7H06**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**40 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Understand the major concepts and techniques in image processing and Machine Learning
2	To explore, manipulate and analyze image processing techniques
3	To become familiar with regression methods, classification methods, clustering methods.
4	Demonstrate image processing and Machine Learning knowledge by designing and implementing algorithms to solve practical problems

Unit-I	**08 Hrs**
Introduction to image processing: Introduction to image processing, Applications of image processing, Components of an image processing system, Fundamental steps in image processing, Image formation and representation, Color imagery, basic definitions, Pixels, Image resolution, PPI and DPI, Bitmap images, Lossless and lossy compression, Image file formats, Color spaces, Bezier curve, Ellipsoid, Gamma correction, Examples of zooming and shrinking in image processing Advanced image concepts.	
Unit – II	**08 Hrs**
Basics of Python, Scikit image & Advanced Image Processing using Open CV: Basics of python, variables & data types, data structures, control flow & conditional statements, uploading & viewing an image, Image resolution, gamma correction, determining structural similarities.	
Unit –III	**08 Hrs**
Advanced Image processing using Open CV Blending Two Images, Changing Contrast and Brightness Adding Text to Images Smoothing Images, Median Filter, Gaussian Filter, Bilateral Filter, Changing the Shape of Images, Effecting Image Thresholding, Calculating Gradients, Performing Histogram Equalization	
Unit –IV	**08 Hrs**
Image Processing using Machine Learning Feature mapping using SIFT algorithm, Image registration using the RANSAC algorithm, Image classification using Artificial Neural Networks, Image classification using CNNs, Image classification using machine learning Approaches.	
Unit –V	**08 Hrs**
Real time use CASES Exhaustive vs. Stochastic Search, Shapes, Contours, and Appearance Models. Mean-shift tracking; Contour-based models, finding palm lines, Face Detection / Recognition, Tracking movements.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Gain knowledge about basic concepts of Image Processing
CO2:	Identify machine learning techniques suitable for a given problem
CO3:	Write programs for specific applications in image processing
CO4:	Apply different techniques for various applications using machine learning techniques.

Reference Books	
1	Digital Image Processing, Rafael C. Gonzalez and Richard E. Woods Pearson Education, 3rd Edition, ISBN 978-81-317-2695-2.
2	Practical Machine Learning and Image Processing: For Facial Recognition, Object Detection, and Pattern Recognition Using Python, Himanshu Singh, 1st Edition, Apress, ISBN:978-1-4842-4149-3
3	Pattern Recognition and Machine Learning, Christopher Bishop, 1st Edition Springer, 2008, ISBN: 978-0387-31073-2
4	Computer Vision: A modern Approach, David Forsyth and Jean Ponce, 2nd Edition, Prentice Hall India 2004, ISBN: 978-0136085928

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 50. The marks component for assignment is 20. The total marks of CIE are 100.

Total CIE is 30(Q)+50(T)+20(EL)=100Marks

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

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

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

High-3; Medium-2; Low-1

Semester: VII						
RENEWABLE ENERGY SOURCES AND STORAGE SYSTEM **(Group H: Global Elective)** **(Theory)**						
Course Code	**:**	**18G7H07**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**
Course Learning Objectives: The students will be able to						
1	Understand Concepts of nonconventional energy sources and allied technology required for energy conversion.					
2	Analyse the Basics of battery working and sizing of battery for a given application.					
3	Design aspects of solar and wind power systems.					
4	Energy storage techniques					

UNIT-I	**08 Hrs**
Basics of Renewable Energy: Energy balance of the earth, Solar radiation, wind energy, geothermal energy. **Geothermal Energy** – principles, technical description, heat supply by hydro-geothermal systems, heat supply by deep wells, geothermal generation, economic and environmental analysis. **Biomass Energy:** Biomass Production, Energy Plantation, Biomass Gasification, Theory of Gasification, Gasifier and Their Classifications, Updraft, Downdraft and Cross-draft Gasifiers, Applications of Biomass Gasifier. **Tidal Energy:** Introduction, Tidal Energy Resource, Tidal Power Basin, Advantages and Disadvantages of Tidal Power.	
Unit – II	**08 Hrs**
Photo Voltaic Systems: PV Cell, Module and array; Equivalent electrical circuit, Open –circuit voltage and short circuit current, I-V and P-V curves, Array design, Peak power Tracking, System Components, **Grid Connected Solar PV Power System:** Introduction to grid connected PV system, Configuration of Grid-connected solar PV system, Components of Grid –connected solar PV systems, Grid connected PV system Design for small power Applications, Grid- connected PV system design for power plants.	
Unit -III	**08 Hrs**
Wind Power: Introduction, site selection, Advantages and Disadvantages, Wind power installations in the world. **Wind Speed and Energy:** Speed and Power Relations, Power Extracted from the wind. Rotor-Swept Area, Air Density, Global Wind Patterns, Wind Speed Distribution, Weibull Probability, Distribution, Mode and Mean Speeds, Root Mean Cube Speed, Mode, Mean, and RMC Speeds, Energy Distribution, Digital Data Processing, Effect of Hub Height, Importance of Reliable Data, Wind Speed Prediction, Wind Energy Resource Maps. **Wind Power Systems:** System Components, Tower, Turbine, Blades, Speed Control, Turbine Rating, Power vs Speed and TSR.	
Unit –IV	**08 Hrs**
Wind Power Systems: Maximum Energy Capture, Maximum Power Operation Constant-TSR Scheme, Peak-Power-Tracking scheme, System-Design Trade-offs, Turbine Towers and Spacing, Number of Blades, Rotor Upwind or Downwind, Horizontal vs. Vertical Axis. **System Control Requirements**: Speed Control, Rate Control. **Environmental Aspects**: Audible Noise, Electromagnetic Interference (EMI), Effects on Birds.	

Unit –V	07 Hrs
Energy storage **Batteries:** Different types of batteries, Equivalent Electrical Circuit, Battery charging, Battery management **Flywheels**: Energy Relations, Components, Benefits over battery **Other Storage devices:** Superconducting magnetic energy storage, Compressed air, Pumped storage hydropower, Hydrogen Energy storage	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the concepts of power generation from various renewable sources.
CO2:	Design the Size of the battery required for solar PV applications.
CO3:	Design main components of solar and wind power systems.
CO4:	Execute projects in renewable power generation.

Reference Books	
1	Renewable energy: Technology, Economics and Environment, Martin Kaltschmitt, Wolfgang Streicher Andreas Wiese, Springer Publication, 2007, ISBN 978-3-540-70947-3
2	Solar photo voltaic Technology and systems, Chetan Singh Solanki, third edition(2013), PHI , Learning private limited New Delhi ISBN: 978-81-203-4711-3
3	Wind and solar power system design, Analysis and operation, Mukund R. Patel, 2nd Edition. CRC Group ,Taylor and Francis group, New Delhi ,ISBN 978-0-8493-1570-1
4	Power System Energy Storage Technologies, Paul Breeze, Academic Press, 2018, ISBN 978-0-12-812902-9

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

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). 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 experiential learning is 20.

Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

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

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

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

High-3: Medium-2: Low-1

Semester: VII						
MEMS AND APPLICATIONS **(Group H: Global Elective)** **(Theory)**						
Course Code	**:**	**18G7H08**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**
Course Learning Objectives: The students will be able to						
1	Understand the rudiments of Micro fabrication techniques.					
2	Identify and associate the various sensors and actuators to applications.					
3	Analyze different materials used for MEMS.					
4	Design applications of MEMS to disciplines.					

Unit-I	**06 Hrs**
Overview of MEMS & Microsystems: MEMS and Microsystems, Typical MEMS and micro system products, Evolution of micro fabrication, Microsystems and microelectronics, Multidisciplinary nature of Microsystems, Design and manufacture, Applications of Microsystems in automotive, healthcare, aerospace and other industries. **Working Principle of Microsystems**: Biomedical and biosensors. Micro sensors: Acoustic, Chemical, Optical, Pressure, Thermal.	
Unit – II	**09 Hrs**
Micro actuation: Using thermal forces, shape memory alloys, Piezoelectric crystals and electrostatic forces. MEMS with micro actuators: Microgrippers, micromotors, microvalves and micropumps, microaccelerometers, microfluidics**.** **Introduction to Scaling:** Scaling in Geometry, Scaling in Rigid body dynamics, Scaling in Electrostatic forces, scaling in electromagnetic forces and scaling in fluid mechanics.	
Unit –III	**09 Hrs**
Materials for MEMS and Microsystems: Substrates and wafers, Active substrate materials, Silicon as substrate material, Silicon Compounds, Si-Piezoresistors, GaAs, Quartz, Piezoelectric Crystals, Polymers and packaging materials. Three level of Microsystem packaging, Die level packaging, Device level packaging, System level packaging. Interfaces in microsystem packaging. Essential packaging technologies: die preparation, Surface bonding, Wire bonding, Sealing, 3D packaging.	
Unit –IV	**08 Hrs**
Microsystem Fabrication Process: Introduction to microsystems, Photolithography, Ion Implantation, Diffusion, Oxidation, CVD,PVD-Sputtering, Deposition by Epitaxy, Etching, LIGA process: General description, Materials for substrates and photoresists, Electroplating and SLIGA process.	
Unit –V	**07 Hrs**
Micro Sensors, Actuators, Systems and Smart Materials: An Overview Silicon Capacitive Accelerometer, Piezo resistive Pressure sensor, Fibre-optic sensors, Conductometric Gas Sensor, Electrostatic Comb drive, Magnetic Microrelay, Portable blood analyzer, Piezo electric Inkjet Print head, Micromirror array for Video projection, Micro-PCR Systems, Smart materials and systems.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the operation of micro devices, micro systems and their applications.
CO2:	Apply the principle of material science to sensor design.
CO3:	Analyze the materials used for sensor designs.
CO4:	Conceptualize and design micro devices, micro systems.

Reference Books	
1	MEMS & Microsystems Design and Manufacture, Tai-Ran Hsu, 2nd Edition, 2002, Tata McGraw Hill Education, New Delhi, ISBN-13:978-0-07-048709-3.
2	Micro and Smart Systems, G.K. Ananthasuresh, K.J .Vinoy, K.N. Bhat, V.K. Aatre, 2015, Wiley

	Publications, ISBN-:978-81-265-2715-1.
3	Foundations of MEMS, Chang Liu, 2012, Pearson Education Inc., ISBN-13:978-0-13-249736-7.
4	Smart Material Systems and MEMS, Vijay K Varadan, K. J. Vinoy, S. Gopalakrishnan, 2006, Wiley-INDIA, ISBN-978-81-265-3170-7.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). 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/Presentation/Project 10.

Total CIE is 30(Q) +60(T) +10(A) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the 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	1	-	-		-	1	-	1
CO4	3	3	3	3	1	-	-		1	1	1	1

High-3; Medium-2; Low-1

Semester: VII						
PROJECT MANAGEMENT **(Group H: Global Elective)** **(Theory)**						
Course Code	**:**	18G7H09		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	39L		**SEE Duration**	**:**	**3.0 Hours**

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 different process groups and knowledge areas used to manage project.

Unit-I	**07 Hrs**
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.	
Unit – II	**09 Hrs**
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.	
Unit –III	**09 Hrs**
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.	
Unit –IV	**07 Hrs**
Project Cost management: Project Cost management, estimate cost, determine budget, control costs. **Project Quality management**: Plan quality management, perform quality assurance, control quality.	
Unit –V	**07 Hrs**
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.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the concepts, tools and techniques for managing large projects.
CO2:	Explain various knowledge areas and process groups in the project management framework.
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 experiential learning (EL). 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 experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

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

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

Low-1 Medium-2 High-3

Semester: VII						
CYBER FORENSICS AND DIGITAL INVESTIGATIONS **(Group H: Global Elective)** **(Theory)**						
Course Code	**:**	**18G7H10**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	To provide an understanding Computer forensics fundamentals and comprehend the impact of cybercrime and forensics.
2	Describe the motive and remedial measures for cybercrime, detection and handling.
3	Demonstrate and investigate the use of Tools used in cyber forensics.
4	Analyse areas affected by cybercrime and identify Legal Perspectives in cyber security.

Unit-I	**09 Hrs**
Introduction to Cybercrime: Cybercrime: Definition and Origins of the Word, Cybercrime and Information Security, Who are Cybercriminals, Classifications of Cybercrimes, Cybercrime Era: Survival Mantra for the Netizens. **Cyber offenses: How Criminals Plan Them**: How Criminals Plan the Attacks, Social Engineering, Cyberstalking, Cyber cafe and Cybercrimes, Botnets: The Fuel for Cybercrime, Attack Vector, Cloud Computing.	
Unit – II	**08 Hrs**
Cybercrime: Mobile And Wireless Devices: Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for organizations, Organizational Measures for Handling Mobile devices, Organizational Security Policies and Measures in Mobile Computing Era, Laptops.	
Unit –III	**07 Hrs**
Tools And Methods Used In Cybercrime: Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Trojan Horses and Backdoors, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Overflow, Attacks on Wireless Networks. **Phishing and Identity Theft**: Introduction, Phishing, Identity Theft (ID Theft).	
Unit –IV	**08 Hrs**
Understanding Computer Forensics: Introduction, Historical Background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber forensics and Digital Evidence, Forensics Analysis of E-Mail, Digital Forensics Life Cycle, Chain of Custody Concept, Network Forensics, Approaching a Computer Forensics Investigation, Setting up a Computer Forensics Laboratory: Understanding the Requirements, Computer Forensics and Steganography, Relevance of the OSI 7 Layer Model to Computer Forensics, Forensics and Social Networking Sites: The Security/Privacy Threats, Computer Forensics from Compliance Perspective, Challenges in Computer Forensics, Special Tools and Techniques, Forensics Auditing, Anti-forensics.	
Unit –V	**07 Hrs**
Cybercrime And Cyber Security: The Legal Perspectives-Introduction, Why Do We Need Cyber laws: The Indian Context, The Indian IT Act, Challenges to Indian Law and Cybercrime Scenario in India, Digital Signatures and the Indian IT Act, Amendments to the Indian IT Act, Cybercrime and Punishment.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Interpret the basic concepts of cyber security, cyber law and their roles.
CO2:	Articulate evidence collection and legal challenges.
CO3:	Discuss tool support for detection of various attacks.
CO4:	Demonstrate through use of proper tools knowledge on the cyber security, Cybercrime and forensics

Reference Books :	
1	Cyber Security: Understanding Cyber Crimes, Computer Forensics And Legal Perspectives, Sunit Belapure and Nina Godbole, , Wiley India Pvt Ltd, ISBN: 978-81-265-21791, 2013.
2	Introduction to information security and cyber laws, Dr. Surya Prakash Tripathi, Ritendra Goyal, Praveen Kumar Shukla, KLSI. Dreamtech Press, ISBN: 9789351194736, 2015.
3	Cybersecurity: Managing Systems, Conducting Testing, and Investigating Intrusions, Thomas J. Mowbray, Copyright © 2014 by John Wiley & Sons, Inc, ISBN: 978 -1-118 84965 -1
4	Cyber Forensics, Technical Publications, I. A. Dhotre, 1st Edition, 2016, ISBN-13: 978-9333211475

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. 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 marks component for experiential learning is 20.
Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

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

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

High-3: Medium-2: Low-1

Semester: VII						
ROBOTICS AND AUTOMATION (Theory)						
Course Code	**:**	**18G7H11**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Understand the concepts of robotics and automation.
2	Impart the knowledge of robotic programming and robotic operation control
3	Selection and analysis of robot configuration and kinematics
4	Importance of automation manufacturing techniques and processing industries
5	Development of automation system for manufacturing and processing industries

Unit-I	**06 Hrs**
Introduction - Basics of kinematics, Anatomy of robot, Robot configuration, Robot joints, Sensors and drive system, Control modes, Specification of robots, Robot programming methods.	
Unit – II	**09 Hrs**
Robot Kinematics - Position and orientation of objects, Objects coordinate frame, Rotation matrix, Euler angles roll, pitch and yaw angles coordinate transformations, Joint variables and position of end effector, Homogeneous transformation. **D-H parameters** and conventions, D-H matrix, Direct kinematic and inverse analysis of planar and 3 DoF robots.	
Unit –III	**10 Hrs**
Trajectory planning - Introduction, Path versus trajectory, Joint-space versus Cartesian-space descriptions, Basics of trajectory planning, Joint-space trajectory planning, Third-order and Fifth-order polynomial trajectory planning. **Automation in Production Systems** - Manufacturing support systems, Automation principles and strategies, Levels of Automation, Production Concepts and Mathematical models, Numericals.	
Unit –IV	**08 Hrs**
Machine Vision - Object recognition by features, Basic features used for object identification, Moments, Template matching, Discrete Fourier descriptors, Computed Tomography (CT), Depth measurement with vision systems, Scene analysis versus mapping, Range detection and Depth analysis, Stereo imaging, Scene analysis with shading and sizes, Specialized lighting, Image data compression, Intraframe spatial domain techniques, Interframe coding, Compression techniques, Colour images, Heuristics, Applications of vision systems	
Unit –V	**06 Hrs**
Flexible Manufacturing Systems - Introduction to FMS - concepts, integration in the data processing systems, FMS scheduling. Case studies. Material Handling systems - Conveyors - AGVs – industrial robots in material handling – Automated Storage and retrieval system. Distributed data processing in FMS - Database Management System and their applications in CAD/CAM and FMS – distributed systems in FMS - Integration of CAD and CAM	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the characteristics and working principle of robots.
CO2:	Apply the related mathematical model to formulate the kinematics and trajectory planning of industrial robot.
CO3:	Analyse the machine vision for effective Flexible Manufacturing Systems.
CO4:	Develop model and integrate drives for industrial robots and automation systems.

Reference Books	
1	Mohsen Shahinpoor, "A Robot Engineering Textbook", Harper & Row Publishers, 3rd Edition, New York, ISBN:006045931X
2	John J. Craig, "Introduction to Robotics", Pearson Education International, 3rd Edition, ISBN:109876543, 1-13-123629-6
3	Mikell P Groover, "Automation, Production Systems, and Computer-integrated Manufacturing", Pearson Publishing, 3rd Edition, 2014, ISBN 978 81 203 3418 2
4	Joseph Talavage, "Flexible Manufacturing Systems in Practice Design: Analysis and Simulation", CRC Press, 1987, ISBN 9780824777180

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). 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 experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the 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	-	-	-	2	-	2
CO2	3	3	1	3	1	1	-	-	-	2	-	2
CO3	2	-	2	-	1	1	-	-	2	-	-	2
CO4	3	3	2	3	1	1	-	2	3	-	3	2

High-3: Medium-2: Low-1

Semester: VII						
SPACE TECHNOLOGY AND APPLICATIONS (GROUP H: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G7H12**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3 : 0 : 0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Define the earth environment and its behaviour, launching vehicles for satellites and its associated concepts.
2	Analyse satellites in terms of technology, structure and communications.
3	Use satellites for space applications, remote sensing and metrology.
4	Apply the space technology, technology mission and advanced space systems to nation's growth.

UNIT-I	**08 Hrs**
Earth's environment: Atmosphere, ionosphere, Magnetosphere, Van Allen Radiation belts, Interplanetary medium, Solar wind, Solar- Earth Weather Relations. **Launch Vehicles:** Rocketry, Propellants, Propulsion, Combustion, Solid, Liquid and Cryogenic engines, Control and Guidance system, Ion propulsion and Nuclear Propulsion.	
UNIT-II	**07 Hrs**
Satellite Technology: Structural, Mechanical, Thermal, Power control, Telemetry, Telecomm and Quality and Reliability, Payloads, Classification of satellites. **Satellite structure:** Satellite Communications, Transponders, Satellite antennas.	
UNIT-III	**08 Hrs**
Satellite Communications: LEO, MEO and GEO orbits, Altitude and orbit controls, Multiple Access Techniques. **Space applications:** Telephony, V-SAT, DBS system, Satellite Radio and TV, Tele-Education, Tele-medicine, Satellite navigation, GPS.	
UNIT-IV	**08 Hrs**
Remote Sensing: Visual bands, Agricultural, Crop vegetation, Forestry, water Resources, Land use, Land mapping, geology, Urban development resource Management, and image processing techniques. **Metrology:** Weather forecast (Long term and Short term), weather modelling, Cyclone predictions, Disaster and flood warning, rainfall predictions using satellites.	
UNIT-V	**08Hrs**
Space Missions: Technology missions, deep space planetary missions, Lunar missions, zero gravity experiments, space biology and International space Missions. **Advanced space systems:** Remote sensing cameras, planetary payloads, space shuttle, space station, Inter-space communication systems.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain different types of satellites, orbit and associated subsystems.
CO2	Apply the basics of launching vehicles, satellites and sub systems for space applications.
CO3	Analyze the applications of satellite in the area of communication, remote sensing, metrology
CO4	Study technology trends, satellite missions and advanced space systems.

Reference Books	
1	Atmosphere, weather and climate, R G Barry, Routledge publications, 2009, ISBN- 10 :0415465702.
2	Fundamentals of Satellite Communication, K N Raja Rao, PHI, 2012, ISBN: 9788120324015.
3	Satellite Communication, Timothy pratt, John Wiley, 1986 ISBN: 978-0- 471- 37007 -9, ISBN 10: 047137007X.
4	Remote sensing and applications, B C Panda, VIVA books Pvt. Ltd., 2009, ISBN:

	108176496308.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by the way of Tests (T), Quizzes (Q) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. 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 marks component for experiential learning is 20.
Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

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

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

High-3: Medium-2: Low-1

Semester: VII						
INTRODUCTION TO ASTROPHYSICS **(Group H: Global Elective)** **(Theory)**						
Course Code	**:**	**18G7H13**		**CIE**	**:**	**100 Marks**
Credits: L: T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Familiarize with the various celestial bodies and the laws governing their behavior
2	Understand the fundamental concepts of relativity and establish the relation between light and matter
3	Study the methods used to identify and investigate the nature of different stellar bodies
4	Determine the characteristic features of any star by understanding its spectral properties
5	Contemplate the complex system of the milky way galaxy and its components

Unit-I	**07 Hrs**
Fundamental concepts in Astronomy: Origin of the Universe, Major constituents of the universe, Cosmic Microwave Radiation (CMR) background, Geocentric Universe, Retrograde Motion of planets, Brief introduction to the Copernican Revolution, Positions of the Celestial Sphere: Altitude-Azimuth Coordinate System, Equatorial Coordinate System, Solar System, Planets - laws of motion of planets, inner planets, outer planets,	
Unit – II	**08 Hrs**
Theory of Special Relativity: Galilean Transformations, Failure of Galilean Transformations, Lorentz Transformations, Derivation, Time & Space in Special Relativity, Momentum & Energy in Relativity, Doppler Effect for light (Red & Blue Shift), The equivalence principle, the principle of minimal gravitational coupling, Schwarzschild spacetime, Past-Present-Future (Light Cone diagram).	
Unit –III	**08 Hrs**
Stellar Astrophysics: Blackbody radiation, Connection between Color and Temperature, Stellar Parallax, Magnitude Scale, Life cycle of stars (Birth, Life & Death), Hertzsprung-Russel Diagram, Classification of Binary Stars, Mass Determination using Visual Binaries, Eclipsing Spectroscopic Binaries, Formation of Spectral Lines, Schrodinger's time-dependent and independent equations, Boltzmann-Saha Equation, Chandrashekar's Limit, black holes (qualitatively).	
Unit –IV	**08 Hrs**
Light and Matter: Dispersion of light (Prism & Grating), Spectral Lines, de-Broglie's Wavelength and Frequency, Heisenberg's Uncertainty Principle, Broadening of Spectral lines **Spectral Characterization of Stars:** Description of the Radiation Field, Stellar Opacity, Transfer Equation, Profile of Spectral Lines, Optical Telescopes, Radio Telescopes (Case Studies)	
Unit –V	**08 Hrs**
Galaxy Astronomy: The Milky way Galaxy, Counting the Stars, Historical Models, Differential & Integrated Star Counts, Extrasolar planets, Methods of detection of extrasolar planets, Distance to the Galactic Centre, Galactic Coordinate System, Classification of Galaxies, Introduction to Elliptical galaxies, Irregular galaxies, Dwarf galaxies.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Contemplate the nature of our universe by identifying and studying the behavior of celestial bodies.
CO2:	Explain the usefulness of the theory of relativity, light and matter in establishing the fundamental behavior of stellar bodies.
CO3:	Utilize various techniques to discover the components of our universe and conclude their celestial properties.

CO4:	Interpret the spectral properties of any astronomical body to illustrate its properties.
CO5:	Inspect the milky way galaxy to identify the proponents and their characteristic features.

Reference Books	
1	Carroll Bradley W, and Dale A Ostlie, An Introduction to Modern Astrophysics. Reading, 2nd Edition, 1995, MA: Addison-Wesley Pub, ISBN: 9780201547306.
2	Padmanabhan, T, Theoretical Astrophysics, Vols.1-3, 2005, Cambridge University Press, ISBN-9780521016278.
3	Shu F, The Physical Universe, New Edition, 1982, University of California, ISBN- 978-0935702057.
4	Harwit M, Astrophysical Concepts, 3rd Edition, 2000, Springer-verlag, ISBN- 978-0387949437.
5	Shapiro, Stuart L, and Saul A Teukolsky, Black Holes, White Dwarfs, and Neutron Stars, 1st Edition, 1983, Wiley, ISBN: 9780471873167.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). 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 Assignment/Presentation/Project 20.
Total CIE is 30(Q) +50(T) +20(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the 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	1	2	-	-	1	-	1	-	-	2
CO2	3	2	2	2	-	-	1	-	1	-	-	2
CO3	2	3	1	2	2	1	1	-	2	1	-	2
CO4	3	3	1	2	2	1	2	-	3	3	-	2

High-3, Medium-2, Low-1

Semester: VII						
MATERIALS FOR ADVANCED TECHNOLOGY AND SPECTROSCOPIC CHARACTERIZATION **(Group H: Global Elective)** **(Theory)**						
Course Code	**:**	**18G7H14**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**40L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Apply the basic concepts of Chemistry to develop futuristic materials for high-tech applications in the area of Engineering.
2	Impart sound knowledge in the different fields of material chemistry so as to apply it to the problems in engineering field.
3	Develop analytical capabilities of students so that they can characterize, transform and use materials in engineering and apply knowledge gained in solving related engineering problems.

Unit-I	**08 Hrs**

Coating and packaging materials

Surface Coating materials:

Synthesis and applications of Polymer coating materials: Teflon, Silicone films Polyvinyl chloride & its copolymers, Poly vinyl acetate, Poly ethylene-HDPE, LDPE, Polyurethane.

Properties required in a pigment and extenders.

Inorganic pigments-titanium dioxide, zinc oxide, carbon black, chromate pigments, molybdate orange, chrome green, ultramarine blue, iron blue, cadmium red.

Corrosion inhibiting pigments- zinc phosphate, zinc and barium chromate pigments, ceramic pigments, metal flake pigments, extenders.

Developments in new polymers such as dendrimers, biopolymers & biodegradable polymers.

Packaging materials:

Food products: Cellulosic and Polymeric packaging materials and their properties – including barrier properties, strength properties, optical properties. Glass, aluminum, tin, paper, plastics, composites.

Pharmaceutical products: Injectables and tablet packaging materials.

Unit – II	**08 Hrs**

Adhesives

Introduction-Classification of Adhesives-Natural adhesives, synthetic adhesives-drying adhesives, pressure sensitive adhesives, contact adhesives, hot adhesives. One-part adhesives, multi part adhesives. Adhesive Action. Development of Adhesive strength- Physical factors influencing Adhesive Action-surface tension, surface smoothness, thickness of adhesive film, elasticity and tensile strength. Chemical Factors Influencing Adhesive action - presence of polar groups, degree of polymerization, complexity of the adhesive molecules, effect of pH. Adhesive action- specific adhesive action, mechanical adhesive action, fusion adhesion. Development of adhesive strength-adsorption theory and diffusion theory. Preparation, curing and bonding Processes by adhesives-with reference to Epoxy, phenolics, Silicone, Polyurethane, Acrylic adhesives, Poly vinyl alcohol, Polyvinyl acetate.

Unit –III	**08 Hrs**

Optical fibre materials

Fiber Optics, Advantages of optical fiber communication over analog communication, Classification based on refractive index of the core- step index and graded index optical fibres, Classification based on core radius-single mode and multimode optical fibres, Fibre fabrication. -Methods to manufacture optical glass fibres. Double crucible method and preform methods. Manufacture of perform-Chemical Vapour Deposition (CVD), Modified vapour deposition (MCVD) Plasma activated vapour deposition (PCVD), Outside vapour deposition (OVD)-Vapour-phase axial deposition (VAD). Drawing the fibres from perform, coating and jacketing process.

Ion exchange resins and membranes

Ion exchange resins-Introduction, Types-cation and anion exchange resins, examples, physical properties, chemical properties-capacity, swelling, kinetics, stability, ion exchange equilibrium,

regeneration. Applications of ion exchange resins-softening of water, demineralization of water, advantages and disadvantages of ion exchange resins-calcium sulphate fouling, iron fouling, adsorption of organic matter, bacterial contamination. Ion exchange membranes, Types-anion and cation exchange membranes. Classification of ion exchange membranes based on connection way between charged groups and polymeric matrix-homogeneous and heterogeneous ion exchange membranes, examples. Fabrication of ion exchange cottons- anion exchange cotton and cation exchange cotton. Application of ion exchange membranes in purification of water by electro dialysis method.

Unit –IV	**08 Hrs**

Spectroscopic Characterization of materials:
Electromagnetic radiation, interaction of materials with electromagnetic radiation.
UV- visible spectrophotometry**: Introduction**-Electronic transitions- factors influencing position and intensity of absorption bands-absorption spectra of dienes, polyene and α,β-unsaturated carbonyl compounds, Working of UV-Vis spectrophotometer, Theoretical calculation of λ_{max} by using Woodward-Fieser rules- for cyclic and α,β-unsaturated carbonyl compounds.
IR Spectroscopy: Introduction, principle, molecular vibrations, vibrational frequency, number of fundamental vibrations, factors influencing fundamental vibrations, instrumentation of IR spectrophotometer, sampling techniques, application of IR spectroscopy in characterization of functional groups.

Unit –V	**08 Hrs**

NMR spectroscopy:
H^1 NMR Spectroscopy: Basic concepts- relaxation process. NMR spectrometer-FT NMR-Solvents used in NMR, internal standards-Chemical equivalence -Integrals and Integrations- chemical shift-Factors affecting chemical shifts- shielding and deshielding effects – chemical and magnetic equivalent –magnetic anisotropy-spin-spin splitting rules- Application of NMR on various compounds such as alkanes, alkenes, alkynes, alkyl halides, alcohols, ethers, amines, aldehydes, ketones, carboxylic acids, esters, amides & mono substituted aromatic compounds. Problems on prediction of structure of compounds. Application of NMR in magnetic resonance imaging (MRI).

Course Outcomes: After completing the course, the students will be able to	
CO1:	Identify sustainable engineering materials and understand their properties.
CO2:	Apply the basic concepts of chemistry to develop futuristic materials for high-tech applications in different areas of engineering.
CO3:	Analyze and evaluate the specific application of materials.
CO4:	Design the route for synthesis of material and its characterization.

Reference Books	
1	Materials Science by G.K.Narula, K.S.Narula & V.K.Gupta. 38th Edtion, Tata McGraw-Hill Publishing Company Limited-2015, ISBN: 9780074517963
2	Solar Lighting by Ramachandra Pode and Boucar Diouf, Springer e-book, 2011, ISBN: 978-1-4471-2133-6 (Print) 978-1-4471-2134-3 (Online).
3	Spectroscopy of organic compounds by P.S.Kalsi, New Age International (P) ltd, Publisher, 2005, ISBN 13: 9788122415438
4	Food Packaging Materials. Mahadeviah M & Gowramma RV, Tata McGraw Hill Publishing Company Limited, 1996, ISBN :0074622382 9780074622384.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). 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 experiential learning is 20.
Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the 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	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	2	2	-	-	1	-	-
CO3	-	3	-	2	-	-	-	-	-	-	-	-
CO4	-	-	3	-	-	1	1	-	-	-	-	1

High-3: Medium-2: Low-1

Semester: VII						
APPLIED PSYCHOLOGY FOR ENGINEERS **(Group H: Global Elective)** **(Theory)**						
Course Code	**:**	**18G7H15**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	To appreciate human behavior and human mind in the context of learner's immediate society and environment.
2	To understand the importance of lifelong learning and personal flexibility to sustain personal and Professional development as the nature of work evolves.
3	To provide students with knowledge and skills for building firm foundation for the suitable engineering professions.
4	To prepare students to function as effective Engineering Psychologists in an Industrial, Governmental or consulting organization.
5	To enable students to use psychological knowledge, skills, and values in occupational pursuits in a variety of settings that meet personal goals and societal needs.

Unit-I	**07 Hrs**
Introduction to Psychology: Definition and goals of Psychology: Role of a Psychologist in the Society: Today's Perspectives (Branches of psychology). Psychodynamic, Behavioristic, Cognitive, Humanistic, Psychological Research and Methods to study Human Behavior: Experimental, Observation, Questionnaire and Clinical Method.	
Unit – II	**09 Hrs**
Intelligence and Aptitude: Concept and definition of Intelligence and Aptitude, Nature of Intelligence. Theories of Intelligence – Spearman, Thurston, Guilford Vernon. Characteristics of Intelligence tests, Types of tests. Measurement of Intelligence and Aptitude, Concept of IQ, Measurement of Multiple Intelligence – Fluid and Crystallized Intelligence.	
Unit –III	**09 Hrs**
Personality: Concept and definition of personality, Approaches of personality- psychoanalytical, Socio- Cultural, Interpersonal and developmental, Humanistic, Behaviorist, Trait and type approaches. Assessment of Personality: Self- report measures of Personality, Questionnaires, Rating Scales and Projective techniques, its Characteristics, advantages & limitations, examples. Behavioral Assessment. Psychological Stress: a. Stress- Definition, Symptoms of Stress, Extreme products of stress v s Burnout, Work Place Trauma. Causes of Stress – Job related causes of stress. Sources of Frustration, Stress and Job Performance, Stress Vulnerability-Stress threshold, perceived control	
Unit –IV	**07 Hrs**
Application of Psychology in Working Environment: The present scenario of information technology, the role of psychologist in the organization, Selection and Training of Psychology Professionals to work in the field of Information Technology. Distance learning, Psychological consequences of recent developments in Information Technology. Type A and Type B Psychological Counseling - Need for Counseling, Types – Directed, Non- Directed, Participative Counseling.	
Unit –V	**07 Hrs**
Learning: Definition, Conditioning – Classical Conditioning, Basics of Classical Conditioning (Pavlov), the process of Extinction, Discrimination and Generalization. Operant Conditioning (Skinner expt). The basics of operant conditioning, Schedules of reinforcement. Cognitive – Social approaches to learning – Latent Learning, Observational Learning, Trial and Error Method, Insightful Learning.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the application of psychology in engineering and technology and develop a route to accomplish goals in their work environment.
CO2:	Define learning and compare and contrast the factors that cognitive, behavioral, and Humanistic theorists believe influence the learning process.

CO3:	Develop understanding of psychological attributes such as intelligence, aptitude, creativity, resulting in their enhancement and apply effective strategies for self-management and self-improvement.
CO4:	Apply the theories into their own and others' lives in order to better understand their personalities and experiences.

Reference Books	
1	Understanding Psychology Feldman R. S, IV edition, (1996) McGraw Hill India
2	Psychology Robert A. Baron, III edition (1995) Prentice Hall India.
3	3. Organizational Behaviour , Stephen P Robbins Pearson Education Publications, 13th Edition, ISBN – 81-317 – 1132 – 3
4	4. Organisational Behaviour : Human Behaviour at Work ,John W.Newstrem and Keith Davis. Tata McGraw Hill India, 10th Edition, ISBN 0-07-046504-5

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). 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 experiential learning is 20.
Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the 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												
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CO1	3	2	-	-	-	-	-	-	-	1	-	1
CO2	3	2	2	1	-	-	-	-	-	1	-	1
CO3	3	3	2	2	-	-	-	-	-	1	-	1
CO4	3	3	3	3	-	-	-	-	-	1	-	1

High-3: Medium-2 : Low-1

Semester: VII						
Advanced course in Entrepreneurship (Group H: Global Elective) (Theory)						
Course Code	**:**	**18G7H16**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Acquire additional knowledge and skills for developing early customer traction into a repeatable business.
2	Learn the tools and methods for achieving sustainable growth, such as by refining their product or service and business models, building brand strategy, making a sales and financial plan
3	Develop brand strategy and create digital presence, Develop channel strategy for customer outreach.
4	Leverage social media to reach new customers cost effectively, Develop strategies to increase revenues and expand markets

Unit-I	**07 Hrs**
Intro to building Products & Value Proposition: Diagnose: Where are you today on the Product Life Cycle? Assess your Start-up's attractiveness **Competition & testing:** Conduct a Competition Analysis Identify your Competitive Advantage	
Unit – II	**06 Hrs**
Market Validation: Market validation, Customer Usability Interviews, Analyzing Customer feedback **Delivering Value:** Enlist marketing channels, Identify partners for your venture, Create a Sales plan	
Unit –III	**07 Hrs**
Customer acquisition & growth channels: Types of Marketing Channels: Targeting Blogs Unconventional PR, Search Engine Marketing, Search Engine Optimization, Social ads, display ads an existing platforms, Email Marketing, Viral Marketing, Affiliate programs, Magazines, Newspape Radio and TV ads, Offline Ads, Trade Shows	
Unit –IV	**10 Hrs**
Business model: Reiterate and Refine your Business Model Canvas, Choose the right business model for your start-up **Financial Planning:** Forecasting sales and revenue projections, Cash-flow statement	
Unit –V	**09 Hrs**
Pitching: Create your funding plan, Build your pitch deck and compose your pitch.	

Experiential Learning: Student teams will present their practice ventures: business model, business plan, growth achieved, and key learnings to their classmates, faculty, and other entrepreneurs

Course Outcomes: After completing the course, the students will be able to	
CO1:	Develop strategies to increase revenues and expand markets, Explore licensing and franchising for business expansion.
CO2:	Leverage technologies and platforms for growth stage companies, Develop key metrics to track progress.
CO3:	Basics of registering a company, Understanding business regulations and compliances.
CO4:	Advanced concepts of business finance, Financial planning.

Reference Books	
1	Running Lean: Iterate from Plan A to a Plan That Works. O'Reilly Media, Maurya, A., 2012.
2	Entrepreneurship. Roy, R., 2012. Oxford University Press
3	Intellectual Property Law in India. Gupta, T. S., 2011. Kluwer Law International
4	Flow: The Psychology of Optimal Experience. Czikszentmihalyi, M., 2008. Harper Perennial

	Modern Classics

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of tests (T) and Milestones (M). A minimum of four milestone submission have to be submitted and first three milestones (M1, M2, M3) are evaluated for 10 marks adding up to 30 marks and the final milestone (M4) is evaluated for 20 marks. All milestone submissions are online and as per format and portal prescribed by Wadhwani foundations. Faculty may adopt innovative methods for conducting quizzes effectively. 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 experiential learning is 20.
Total CIE is 30(M1, M2 and M3) +50(T) +20(M4) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the 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	-	-	-	-	-	1	-	1
CO4	3	3	3	3	-	-	-	-	-	1	-	1

High-3: Medium-2: Low-1

Semester VIII						
MAJOR PROJECT						
Course Code	**:**	**18IMP81**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**0:0:16**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**32L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1.	Acquire the ability to make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
2.	Acquire the skills to communicate effectively and to present ideas clearly and coherently to a specific audience in both written and oral forms.
3.	Acquire collaborative skills through working in a team to achieve common goals.
4.	Self-learn, reflect on their learning and take appropriate action to improve it.
5.	Prepare schedules and budgets and keep track of the progress and expenditure.

Major Project Guidelines:

1. The project topic, title and synopsis have to be finalized and submitted to their respective internal guide(s) before the beginning of the 8th semester.
2. The detailed Synopsis (approved by the department ***Project Review Committee***) has to be submitted during the 1st week after the commencement of 8th semester.

Batch Formation:

- Students are free to choose their project partners from within the program or any other program.
- Each student in the team must contribute towards the successful completion of the project. The project may be carried out In-house / Industry / R & D Institution.
- ***The project work is to be carried out by a team of two to four students , in exceptional cases where a student is placed in a company and offered an internship through the competitive process or student is selected for internship at national or international level through competitive process*****,** the student can work independently.
- ***The students are allowed to do either a project for full 5 days in the industry or full 5 days in the college.***
- ***In case the project work is carried out outside Bengaluru, such students must be available during Project Evaluation process scheduled by the respective departments and they must also interact with their guide regularly through Email / Webinar / Skype etc.***

Project Topic Selection:

The topics of the project work must be in the ***field of respective program areas or in line with CoE's(Centre of Excellence) identified by the college*** or **List of project areas as given by industry/Faculty. The projects as far as possible should have societal relevance with focus on sustainability.**

Students can select courses in ***NPTEL*** from the discipline of ***Humanities and Social Sciences, Management, Multidisciplinary and Design Engineering.*** The course chosen could be either of ***4w/8w/12w*** duration. The students need to enrol for a course, register for the exam and submit the e-certificate to the department, as and when it is released by NPTEL. ***The same will be considered as one of the components during project evaluation of phase 2 and phase 5.***

Project Evaluation:

- Continuous monitoring of project work will be carried out and cumulative evaluation will be done.
- The students are required to meet their internal guides once in a week to report their progress in project work.
- **Weekly Activity Report** (WAR) has to be maintained in the form of a diary by the project batch and the same has to be discussed with the Internal Guide regularly.
- In case of ***Industry project***, during the course of project work, the internal guides will have continuous interaction with external guides and will visit the industry at least twice during the project period.
- For CIE assessment the project groups must give a final seminar with the draft copy of the project report.
- The presentation by each group will be for 20-30 minutes and every member of the team needs to justify the contributions to the project.
- The project team is required to submit Hard copies of the detailed Project Report in the prescribed format to the department.
- For CIE 50% weightage should be given to the project guide and 50% weightage to the project evaluation committee.
- Before the final evaluations the project group is required to produce a No dues certificate from Industry, Central Library and Department.

Course Outcomes of Major Project:	
1	Apply knowledge of mathematics, science and engineering to solve respective engineering domain problems.
2	Design, develop, present and document innovative/multidisciplinary modules for a complete engineering system.
3	Use modern engineering tools, software and equipment to solve problem and engage in life-long learning to follow technological developments.
4	Function effectively as an individual, or leader in diverse teams, with the understanding of professional ethics and responsibilities.

CIE Assessment:

The following are the weightings given for the various stages of the project.

1. Selection of the topic and formulation of objectives 10%
2. Design and Development of Project methodology 25%
3. Execution of Project 25%
4. Presentation, Demonstration and Results Discussion 30%
5. Report Writing & Publication 10%

SEE Assessment:

The following are the weightages given during Viva Examination.

1. Written presentation of synopsis 10%
2. Presentation/Demonstration of the project 30%
3. Methodology and Experimental Results & Discussion 30%
4. Report 10%
5. Viva Voce 20%

Calendar of Events for the Project Work:

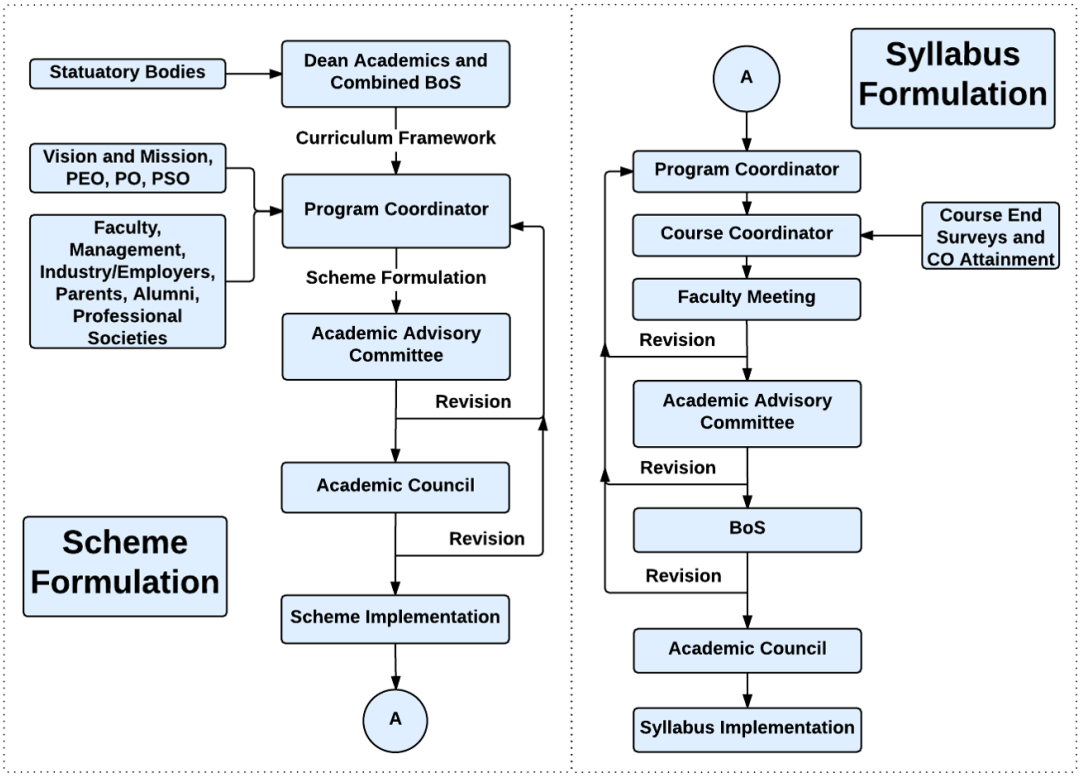
Week	Event
Beginning of 7th Semester	Formation of group and approval by the department committee.
7th Semester	Problem selection and literature survey
Last two weeks of 7th Semester	Finalization of project and guide allotment
II Week of 8th Semester	Synopsis submission and preliminary seminar

III Week	First visit of the internal guides to industry (In case of project being carried out in industry)
III to VI Week	Design and development of project methodology
VII to IX Week	Implementation of the project
X Week	Submission of draft copy of the project report
XI and XII Week	Second visit by guide to industry for demonstration. Final seminar by Department project Committee and guide for internal assessment. Finalization of CIE.

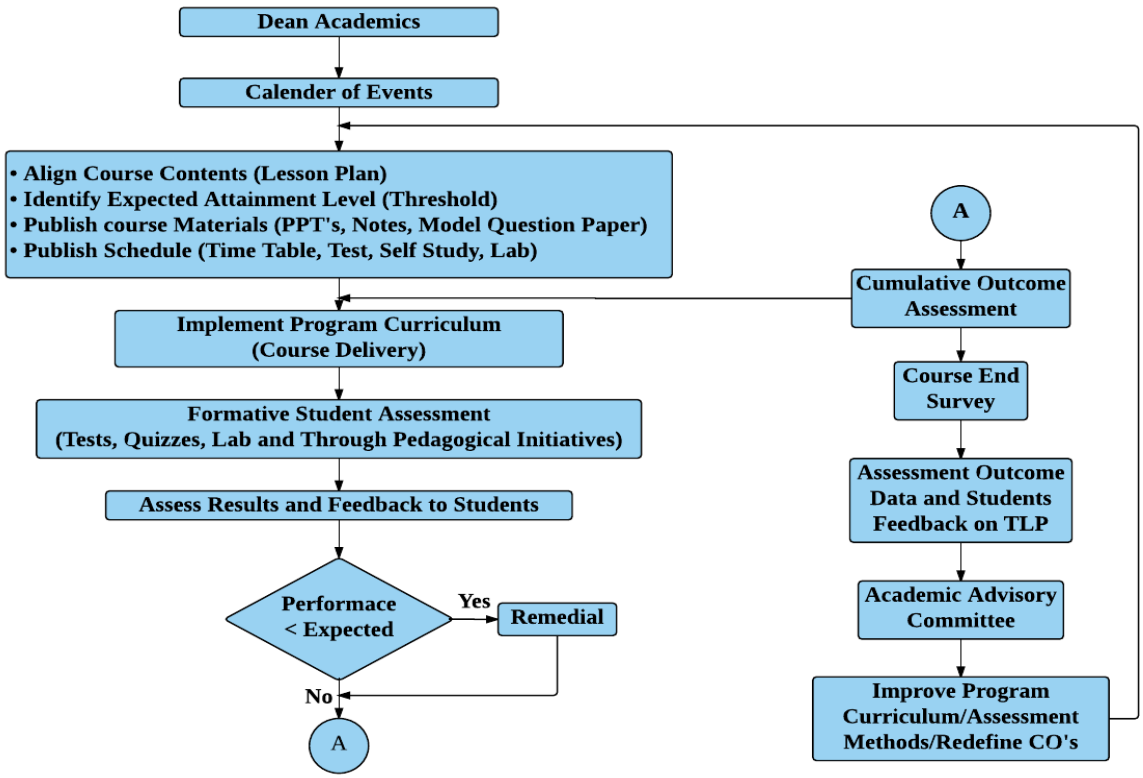
Evaluation Scheme for CIE and SEE

Scheme of Evaluation for CIE		**Scheme of Evaluation for SEE**	
Particulars	**%Marks**	**Particulars**	**%Marks**
Project Evaluation I	10%	Project Synopsis (Initial Write up)	10%
Project Evaluation II	25%	Project Demo / Presentation	30%
Project Evaluation III	25%	Methodology and Results Discussion	30%
Project Evaluation Phase-IV (Submission of Draft Project Report for Verification**)**	30%	Project Work Report	10%
Project Evaluation Phase-V (Project Final Internal Evaluation**)**	10%	Viva-voce	20%
Total	100	Total	100

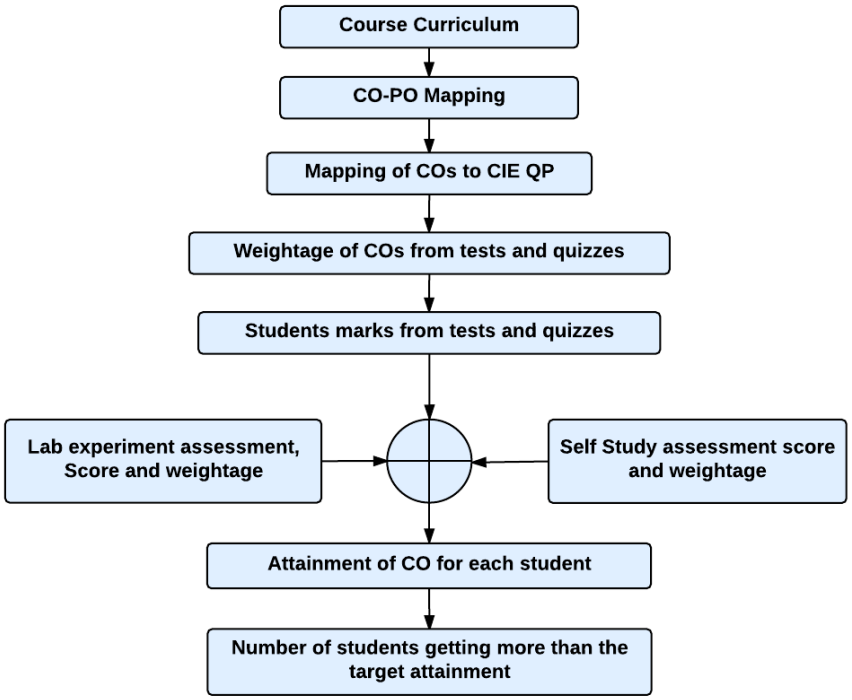
Curriculum Design Process



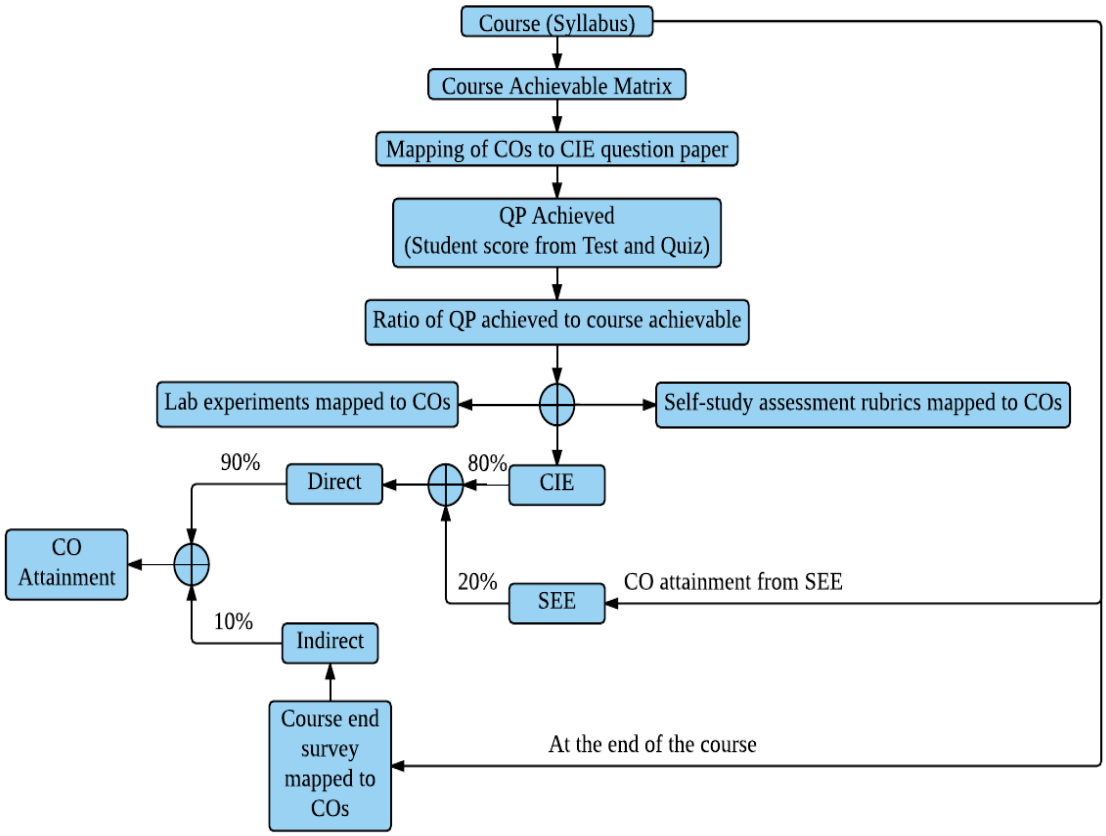
Academic Planning And Implementation



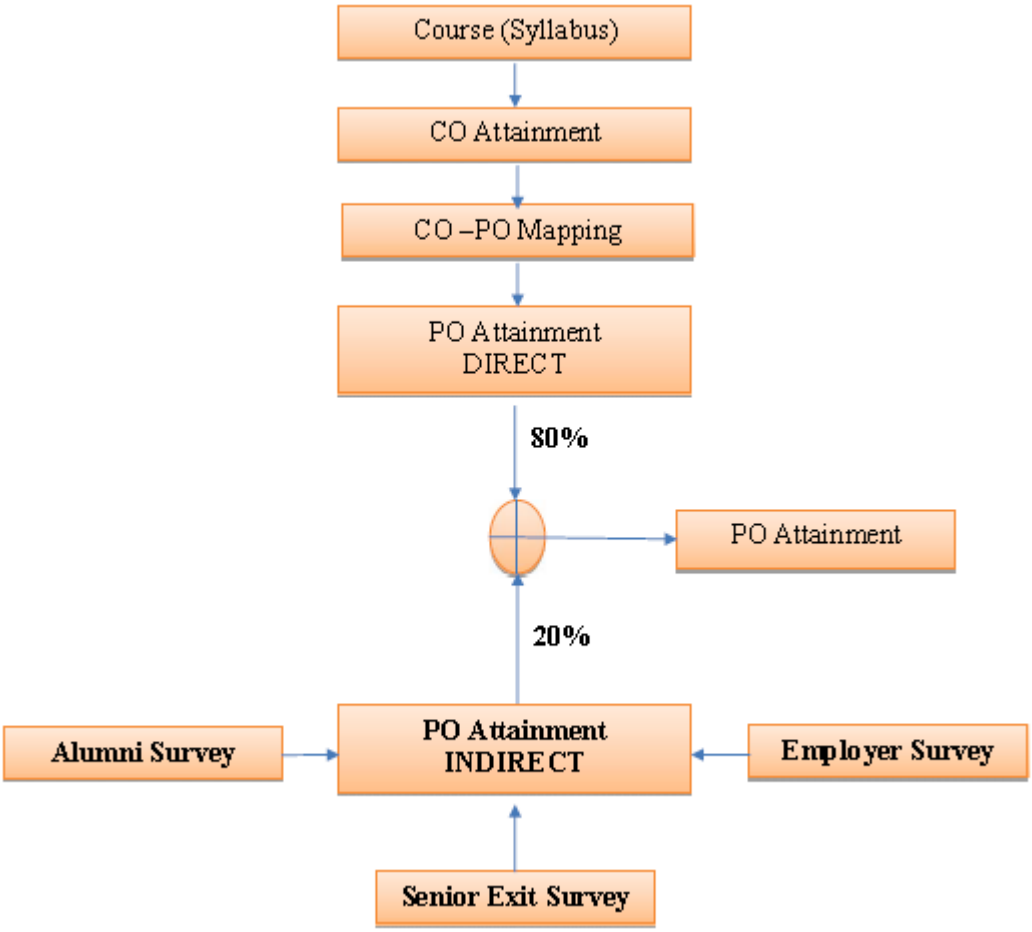
Process For Course Outcome Attainment



Final CO Attainment Process



Program Outcome Attainment Process



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 the 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 the 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.