RV Educational Institutions ®
RV College of Engineering ®

Autonomous Institution Affiliated to Visvesvaraya Technological University, Belagavi

Approved by AICTE, New Delhi

Go, change the world

BACHELOR OF ENGINEERING (B.E.)
2021 SCHEME

SCHEME & SYLLABUS
THIRD YEAR B.E. PROGRAMS

INDUSTRIAL ENGINEERING & MANAGEMENT

ACADEMIC YEAR 2023-24

INDUSTRIAL ENGINEERING & MANAGEMENT

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

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

PROGRAM EDUCATIONAL OBJECTIVES

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

PROGRAM SPECIFIC OUTCOMES

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

LEAD SOCIETY

Institute of Industrial Engineers (IIE)

Sl. No.	Abbreviation	Meaning
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	SEE	Semester End Examination
5.	CE	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.	AI & ML	Artificial Intelligence & Machine Learning
21.	PY	Physics
22.	CY	Chemistry
23.	MA	Mathematics
24.	AEC	Ability Enhancement Courses

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Bachelor of Engineering in

INDUSTRIAL ENGINEERING AND MANAGEMENT

V SEMESTER

Sl. No.	Course Code	Course Title	Credit Allocation				BoS	Category	CIE Duration (H)	Max Marks CIE		SEE Duration (H)	Max Marks SEE	
			L	T	P	Total				Theory	Lab		Theory	Lab
1	21HS51B	Principles of Management & Economics	3	0	0	3	HS	Theory	1.5	**100**	********	**3**	**100**	********
2	21IM52	Digital Metrology	3	0	1	4	IM	Theory + Lab	1.5	100	50	3	100	50
3	21IM53	Operations Management	3	0	1	4	IM	Theory + Lab	1.5	100	50	3	100	50
4	21IM54	Operations Research	3	1	0	4	IM	Theory	1.5	100	********	3	100	********
5	21IM55BX	Professional Core Elective I- Group B	3	0	0	3	IM	Theory	1.5	**100**	********	**3**	**100**	********
6	21XX56CX	Professional Core Elective- II Group C	2	0	0	2	IM/ ME/ EE	NPTEL	1	**50**	********	**2**	**50**	********
7	21IMI57	Summer Internship - II	0	0	2	2	IM	Internship	1	********	50	2	********	50
						22								

*** For Circuit Branches -Intellectual Property Rights & Entrepreneurship / For Non-Circuit Branches - principles of Management & Economics**

*** In the 6th Semester both the courses will be interchanged between the Circuits & Non circuits branches**

Professional Elective I- Group B			
Sl. No.	**Course Code**	**Course Title**	**Credits**
1.	21IM55B1	Discrete Event System Simulation	03
2.	21IM55B2	Enterprise Information Systems	03
3.	21IM55B3	Non-Conventional Manufacturing Processes	03
4.	21IM55B4	Advanced Decision Modelling	03
5.	21IM55B5	Theory of Machines	03

Professional Elective II – Group C (NPTEL elective)			
Sl. No.	**Course Code**	**Course Title**	**Credits**
1.	21IM56C1	Data Science for Engineers	02
2.	21ME56C2	Design, Technology and Innovation	02
3.	21EE56C3	Introduction To Machine Learning	02
4.	21IM56C4	Manufacturing Guidelines for Product Design	02
5.	21IM56C5	Foundation Course in Managerial Economics	02

Bachelor of Engineering in

INDUSTRIAL ENGINEERING AND MANAGEMENT

VI SEMESTER

Sl. No.	Course Code	Course Title	Credit Allocation				BoS	Category	CIE Duration (H)	Max Marks CIE		SEE Duration (H)	Max Marks SEE	
			L	T	P	Total				Theory	Lab		Theory	Lab
1	21HS61A	Intellectual Property Rights & Entrepreneurship	3	0	0	3	HS	Theory	1.5	100	****	3	100	****
2	21IM62	Global Supply Chain Management	3	0	1	4	IM	Theory + Lab	1.5	100	50	3	100	50
3	21IM63	Quality Assurance	3	0	1	4	IM	Theory + Lab	1.5	100	50	3	100	50
4	21IM64DX	Professional Core Elective III-Group D (Local Elective, Domain Specialization)	3	0	0	3	IM	Theory	1.5	100	****	3	100	****
5	21XX65EX	Professional Core Elective IV-Group E (Cluster elective)	3	0	0	3	IM/ME/AS	Theory	1.5	100	****	3	100	****
6	21IE6FX	Institutional Electives – I-(Group F)	3	0	0	3	Respective BOS	Theory	1.5	100	****	3	100	****
7	21IM67	Human Resource Management	2	0	0	2	IM	Theory	1	50	****	2	50	****
						22								

* Industry Internship / Research Internship will be done after the VI sem

Professional Elective III- Group D (Local Elective Domain Specialization)			
Sl. No.	**Course Code**	**Course Title**	**Credits**
1.	21IM64D1	Applied Ergonomics	03
2.	21IM64D2	Service Operations Management	03
3.	21IM64D3	Additive Manufacturing	03
4.	21IM64D4	Design of Experiments	03
5.	21IM64D5	Fluid Mechanics & Thermodynamics	03

Professional Elective IV- Group E (Cluster Elective)- Common to IM, AS, ME			
Sl. No.	**Course Code**	**Course Title**	**Credits**
1.	21IM65E1	Lean Manufacturing Systems	03
2.	21IM65E2	Total Quality management	03
3.	21ME65E1	Hydraulics and Pneumatics	03
4.	21ME65E2	Turbomachinery	03
5.	21AS65E1	Airport engineering	03
6.	21AS65E2	Space vehicle design	03

Institutional Electives – I (Group F)				
Sl. No.	**Course Code**	**BoS**	**Course Title**	**Credits**
1.	21IE6F1	CH	Industrial Safety and Risk Management	03
2.	21IE6F2	EE	Renewable Energy Systems	03
3.	21IE6F3	IM	Systems Engineering	03
4.	21IE6F4	ME	Mechatronics	03
5.	21IE6F5	MA	Mathematical Modelling	03
6.	21IE6F6	ME	Industry 4.0 – Smart Manufacturing for The Future	03
7.	21IE6F7	HS	Industrial Psychology for Engineers	03
8.	21IE6F8	IM	Elements of Financial Management	03
9.	21IE6F9	HS	Universal Human Values-II	03
10.	21IE6F10	EC	Human Machine Interface	03

Semester: V						
PRINCIPLES OF MANAGEMENT & ECONOMICS (Theory)						
Course Code	**:**	21HS51B		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	45L		**SEE Duration**	**:**	**3.00Hours**

Unit-I	**06 Hrs**
Introduction to Management: Management Functions – POSDCORB – an overview, Management levels & Skills, Management History - **Classical Approach:** Scientific Management, Administrative Theory, **Quantitative Approach:** Operations Research, **Behavioral Approach:** Hawthorne Studies, **Contemporary Approach:** Systems Theory, Contingency Theory. **Caselets / Case studies**	
Unit – II	**10 Hrs**
Foundations of Planning: Types of Goals & Plans, Approaches to Setting Goals & Plans, Strategic Management Process, Corporate strategies – types of corporate strategies, BCG matrix, Competitive Strategies – Porters Five force Model, types of Competitive Strategies. **Caselets / Case studies Organizational Structure & Design:** Overview of Designing Organizational Structure - Work Specialization, Departmentalization, Chain of Command, Span of Control, Centralization & Decentralization, Formalization, Mechanistic & Organic Structures. **Caselets / Case studies**	
Unit –III	**10 Hrs**
Motivation: *Early Theories of Motivation* - Maslow's Hierarchy of Needs Theory, McGregor's Theory X & Theory Y, Herzberg's Two Factor Theory. *Contemporary Theories of Motivation:* Adam's Equity theory, Vroom's Expectancy Theory. **Caselets / Case studies** **Leadership:** *Behavioral Theories*: Blake & Mouton's Managerial Grid, *Contingency Theories of Leadership:* Hersey & Blanchard's Situational Leadership, *Contemporary Views of Leadership*: Transactional & Transformational Leadership. **Caselets / Case studies**	
Unit –IV	**10 Hrs**
Introduction to Economics: Microeconomics and Macroeconomics, Circular flow model of economics, An Overview of Economic Systems. **Macroeconomic models**- The classical growth theory, Keynesian cross model, IS-LM-model, The AS-AD model, The complete Keynesian model, The neo-classical synthesis. National Budgeting process in India. **Macroeconomic Indicators:** Prices and inflation, Consumer Price Index, Exchange rate, Labor Market, Money and banks, Interest rate. Gross Domestic product (GDP) - components of GDP, Measures of GDP: Outcome Method, Income method and Expenditure method, Numericals on GDP Calculations.	
Unit –V	**09 Hrs**
Essentials of Microeconomics: Demand, Supply, and Equilibrium in Markets for Goods and Services, Price Elasticity of Demand and Price Elasticity of Supply, Elasticity and Pricing, Numericals on determining price elasticity of demand and supply. Changes in Income and Prices Affecting Consumption Choices, Monopolistic Competition, Oligopoly.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Elucidate the principles of management theory & recognize the characteristics of an organization.
CO2	Demonstrate the importance of key performance areas in strategic management and design appropriate organizational structures and possess an ability to conceive various organizational dynamics.
CO3	Compare and contrast early and contemporary theories of motivation and select and implement the right leadership practices in organizations that would enable systems orientation.
CO4	Demonstrate an understanding on the usage and application of basic economic principles.
CO5	Appreciate the various measures of macro-economic performance and interpret the prevailing economic health of the nation.

Reference Books	
1.	Management, Stephen Robbins, Mary Coulter & NeharikaVohra, 15th Edition, 2021, Pearson Education Publications, ISBN: 13: 978-0-13-558185-8
2.	Management, James Stoner, Edward Freeman & Daniel Gilbert Jr, 6th Edition, 2009, PHI, ISBN: 81-203-0981-2.
3.	Principles of Microeconomics, Steven A. Greenlaw, David Shapiro, 2nd Edition, 2017, ISBN:978-1-947172-34-0
4.	Macroeconomics: Theory and Policy, Dwivedi D.N, 5th Edition, 2021, McGraw Hill Education; ISBN : 9789353163334

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only; wherein one sub division will be a caselet in the related topics)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: V						
DIGITAL METROLOGY (Theory and Practice)						
Course Code	**:**	**21IM52**		**CIE**	**:**	**100 + 50 Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100 + 50 Marks**
Total Hours	**:**	**45L+ 30P**		**SEE Duration**	**:**	**3.00 + 3.00 hours**

Unit-I	**09 Hrs**
Concept of Measurements: General concept – Generalised measurement system, Static and dynamic characteristics – Errors in measurement – Statistical evaluation of measurement data – Standards and calibration. Classification of transducers, Selection of transducers, Resistive, capacitive & inductive transducers, Piezoelectric, Hall effect, optical and digital transducers,	
Unit – II	**09 Hrs**
Classification of sensors: Sensors, Specifications of sensors, classification of sensors - Displacement, position and proximity sensors – Potentiometers, Velocity and motion sensors – Tacho generator, Pyro electric sensors, Force - Strain gauge load cell. Fluid pressure - Piezoelectric sensors and Tactile sensor, Elements of data acquisition system, A/D, D/A converters.	
Unit –III	**09 Hrs**
Limits, Fits & Tolerance: System of Limits, Fits, Tolerance and Gauging: Definition of tolerance, Specification in assembly, Principle of interchangeability and selective assembly, limits of size, Indian standards, concept of limits of size and tolerances, definition of fits, hole basis system, shaft basis system, types of fits and their designation (IS 919-1963), geometric tolerance, position-tolerances. Introduction to GD&T.	
Unit –IV	**09 Hrs**
Optical Interferometer and Form Measurements: Interferometry - optical flats, Tool Makers microscope. Measurement of screw threads - Thread gauges, floating carriage micrometer – Measurement of gears tooth thickness - Gear tooth vernier method, Measurement of surface finish – analysis of surface traces - Ten-Point Height Average Value, Root Mean Square Value, Tomlinson Surface Meter. Measurement of straightness – Autocollimator, measurement of flatness and roundness.	
Unit –V	**09 Hrs**
Advances in Metrology: Coordinate measuring machine (CMM)- Constructional features – types, applications – digital devices- computer aided inspection. **Laser metrology** - Precision instruments based on laser principles, Uses of Laser, Michelson Interferometer, interferometric measurement of angle, Geometrical Checks on Machine Tools.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Discuss the principles and practices of metrology in manufacturing environment and analyze uncertainty in an appropriate manner
CO2	Describe the operating principles of range of widely used instrumentation techniques and illustrate how to use them in the design of measurement systems.
CO3	Compare the production process, the product function and the product design, and to select appropriate measurement quantities and tools for these purposes.
CO4	Evaluate and respond to the need for rigorous and formal metrology concepts in designing and using measurement systems

Reference Books	
1	Engineering Metrology, Jain R.K., 18th edition, 2006, Khanna Publishers, ISBN: 71-7409-024-x
2	Mechanical Measurements, Beckwith T.G, and N. Lewis Buck, 5th Edition, 1991, Addison Wesley, ISBN: 81-7808-055-9
3	Electrical and Electronic Measurements and Instrumentation, A.K.Sawhney, 18th Edition, 2008, Dhanpat Rai and Sons, ISBN 8177000160
4	MEMS Mechanical Sensors, Stephen Beeby, 2004, Artech House, ISBN 1-58053-536-4

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20)ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (20 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (20 Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50 MARKS	**50**
	MAXIMUM MARKS FOR THE CIE (THEORY & PRACTICE)	**150**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

RUBRIC FOR SEMESTER END EXAMINATION (LAB)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	**10**
2	Conduction of the Experiments	**30**
3	Viva	**10**
	TOTAL	**50**

Semester: V						
OPERATIONS MANAGEMENT (THEORY AND PRACTICE)						
Course Code	**:**	**21IM53**		**CIE**	**:**	**100 + 50 Marks**
Credits: L: T:P	**:**	**3:0:1**		**SEE**	**:**	**100 + 50 Marks**
Total Hours	**:**	**45L + 30P**		**SEE Duration**	**:**	**3.00 + 3.00 hours**

UNIT-I — **09 Hrs**

Using operations to create value: Role of operations in an organization, a process view, a supply chain view, operations strategy, competitive priorities and capabilities, fourth Industrial revolution, decision making models.

UNIT-II — **09 Hrs**

Process strategy: Process structure in services, process structure in manufacturing, process strategy decisions, strategic fit, strategies for change.

Planning capacity: Planning long term capacity, planning timing and sizing strategies, a systematic approach to long term capacity decisions.

UNIT-III — **09 Hrs**

Forecasting Demand: The role of forecasting, characteristics of forecasts, components of a forecast and forecasting methods, basic approach to demand forecasting, time series, measures of forecast error, selecting the best smoothing constant, role of IT in forecasting, risk management in forecasting, big data and the forecasting process.

UNIT-IV — **09 Hrs**

Managing process constraints: the theory of constraints, managing bottlenecks in service and manufacturing processes, applying the theory of constraints to product mix decisions, managing constraints in line processes

Efficient resource planning: Material requirements planning, master production scheduling, MRP explosion, enterprise resource planning, resource planning for service providers.

UNIT-V — **09 Hrs**

Scheduling: Introduction, **Single machine Scheduling**, Shortest Processing time (SPT), Rule to minimize mean flow time, earlier due date (EDD), Rule to minimize, Maximum lateness. Minimizing makespan,

Flow shop scheduling: Johnson's Rule, CDS Heuristic.

Job shop scheduling: Types of schedules, schedule generation. Two jobs and M machines scheduling, bottleneck scheduling.

OPERATIONS MANAGEMENT LABORATORY

- Break-Even Analysis
- Demand Forecasting
- Capacity planning
- Aggregate Planning using Linear Programming
- Production planning and scheduling
- Analyzing dependent demand inventory situations and generating reports using MRP Module.
- Preparation of Bill of Materials.
- MRP Run- Generation of planned order release report.
- Creation of Purchase order for the item.
- Creation of Production order for the item

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

Reference Books	
1.	Lee J Karjewski and Larry P Ritzman, Manoj Malhotra, Operations Management – Processes and Supply Chain, Pearson Education Asia, 30T^{h}Edn, 2021, ISBN 10: 1-292-40986-X, ISBN 13: 978-1-292-40986-3
2.	R. Paneerselvam, Production and Operations Management, PHI, 2ndEdn, 2006, ISBN:81-203-2767-5
3.	B. Mahadevan, Operations Management – Theory and Practice, PHI, 2010, 2ndEdn, ISBN: 978 8131730706
4.	Sunil Chopra & Peter Meindl, "Supply Chain Management - Strategy, Planning & Operation" Pearson Education Asia, 2006, 3rd Edition. ISBN: 81-317-0401-7.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20)ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (20 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (20 Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50 MARKS	**50**
	MAXIMUM MARKS FOR THE CIE (THEORY & PRACTICE)	**150**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

RUBRIC FOR SEMESTER END EXAMINATION (LAB)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	**10**
2	Conduction of the Experiments	**30**
3	Viva	**10**
	TOTAL	**50**

Semester: V						
OPERATIONS RESEARCH (THEORY)						
Course Code	**:**	**21IM54**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:1:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L + 30T**		**SEE Duration**	**:**	**3.00 hours**

Unit-I	**09 Hrs**
Introduction to Model Building: An Introduction to Modeling, Prescriptive or Optimization Models – Objective function, Decision Variable & Constraints, The Seven-Step Model-Building Process. **Introduction to Operations Research:** Definition of OR, Application of OR to Engineering and Managerial problems, Features of OR models, Limitations of OR. **Linear Programming:** Definition, Mathematical Formulation, Standard Form, Proportionality and Additivity Assumptions, Divisibility Assumption, Certainty Assumption, Feasible Region and Optimal Solution, Degenerate, A Diet Problem, A Work-Scheduling Problem, A Capital Budgeting Problem, Blending Problems, Production Process Models, The Graphical Solution of Two-Variable Linear Programming Problems.	
Unit – II	**09 Hrs**
Simplex Algorithm: How to Convert an LP to Standard Form, Preview of the Simplex Algorithm, Direction of Unboundedness, Why Does an LP Have an Optimal basic feasible solution, The Simplex Algorithm, Using the Simplex Algorithm to Solve Minimization Problems, Alternative Optimal Solutions, Degeneracy and the Convergence of the Simplex Algorithm, The Big M Method, The Two-Phase Simplex Method. **Sensitivity Analysis and Duality:** A Graphical Introduction to Sensitivity Analysis, Some Important Formulas, Sensitivity Analysis, Finding the Dual of an Linear Programming, Economic Interpretation of the Dual Problem, The Dual Simplex Method	
Unit –III	**09 Hrs**
Transportation Problem: Formulating a transportation problem, General Description of a Transportation Problem, Basic feasible solution using different methods, Optimality Methods, Unbalanced transportation problem, Degeneracy in transportation problems, Variants in Transportation Problems, Applications of Transportation problems. **Assignment Problem:** Formulation of the Assignment problem, Solution method of assignment problem – Hungarian Method, Solution method of assignment problem – Hungarian Method, Variants in assignment problem, Traveling Salesman Problem. Usage of software tools to demonstrate Transportation and Assignment problems	
Unit –IV	**09 Hrs**
Project Management Using Network Analysis: Network construction, CPM & PERT, Determination of critical path and duration, floats. Crashing of Network. Usage of software tools to demonstrate N/W flow problems	
Unit –V	**09 Hrs**
Game Theory: Introduction, Two-person Zero Sum game, Pure strategies – Games with saddle point, Graphical Method, The rules of dominance, solution method of games without saddle point, Arithmetic method.	

Tutorial Work
• Introduction to Operations Research Packages - using MAT Lab, GAMS Excel, TORA and LINGO • Exercise on application of Operations Research Models to various sector of economy including Manufacturing, Health Care, Infrastructure, Insurance, Banking, Retail, Agriculture and Governance

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the characteristics of different types of decision – making environments and the appropriate decision-making approaches and tools to be used in each type.
CO2:	Build and solve Transportation Models and Assignment Models.
CO3:	Design new simple models, like: CPM, PERT to improve decision –making and develop critical thinking and objective analysis of decision problems.
CO4:	Implement practical cases by using tools such as TORA, WinQSB, Excel, GAMS.

Reference Books	
1.	Operations Research: Applications & Algorithms, Wayne L. Winston, 4th Edition, 2004, Thomson Books, ISBN 0-534-52020-0.
2.	Operation Research An Introduction, Taha H A, 8th Edition, 2004, PHI, ISBN: 0130488089.
3.	Operations Research: Principles and Practice, Ravindran, Phillips, Solberg, 2nd Edition, 2007, John Wiley & Sons, ISBN8126512563
4.	Operations Research Theory and Application, J K Sharma, 2nd Edition, 2003, Pearson Education Pvt Ltd, ISBN: 0333-92394-4.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20)ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

V Semester						
DISCRETE EVENT SYSTEM SIMULATION (THEORY)						
Course Code	**:**	**21IM55B1**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**03.00 hours**

UNIT-I	**09 Hrs**
Introduction to Simulation: Simulation, Advantages, Disadvantages, Areas of application, System environment, components of a system, Model of a system, types of models, steps in a simulation study. **Simulation Examples:** Simulation of Queuing systems, Simulation of Inventory System, Other simulation examples. **Analysis of Simulation Data** **Input Modelling**: Data collection, Identification and distribution with data, parameter estimation, Goodness of fit tests, Selection of input models without data, Multivariate and time series analysis.	
UNIT – II	**09 Hrs**
Random Numbers: Properties, Generations methods, Tests for Random number- Frequency test, Runs test, Autocorrelation test. **Random Variate Generation:** Generating approximate normal variates, acceptance –rejection technique for Poisson distribution, gamma distribution.	
UNIT –III	**09 Hrs**
Inversion transforms technique-exponential distribution. Uniform distribution, weibull distribution, continuous distribution, – Erlang distribution. **Empirical Discrete Distribution:** Discrete uniform distribution, poisson distribution, **Optimisation Via Simulation:** Meaning, difficulty, Robust Heuristics, Random Search.	
UNIT –IV	**09 Hrs**
Output Analysis – Types of Simulations with Respect to Output Analysis, Stochastic Nature of output data, Measures of Performance and their estimation, Output analysis of terminating simulation, Output analysis of steady state simulations.	
UNIT –V	**09 Hrs**
Verification and Validation of Model – Model Building, Verification, Calibration and Validation of Models. **Simulation Software:** Selection of Simulation Software, Simulation packages, Trend in Simulation Software.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Describe the role of important elements of discrete event simulation and modeling paradigm
CO2:	Conceptualize real world situations related to systems development decisions, originating from source requirements and goals
CO3:	Develop skills to apply simulation to construct and execute goal-driven system models
CO4:	Interpret the model and apply the results to resolve critical issues in a realworld environment

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

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20)ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester V						
ENTERPRISE INFORMATION SYSTEMS (THEORY)						
Course Code	**:**	**21IM55B2**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**03.00 hours**

Unit-I	**09 Hrs**
Enterprise Information System: Historical background, The manufacturing Roots of ERP, comparative coverage between MRP, ERP, EIS. Concepts of EIS, EIS Characteristics, EIS As per Garter View.	
Unit-II	**09 Hrs**
Business Process Reengineering and Best Practices- Business process, Typical Business process. Reengineering, Business Process Reengineering, Business Process management, BPR with respect to EIS.	
Unit-III	**09 Hrs**
Enterprise Information Systems Development – Data storage systems, Data warehousing, Data marts, Online analytical processing, Data mining, Customer relationship Management, Business intelligent system.	
Unit-IV	**09 Hrs**
Enterprise Information Systems and Supply chain: Magnitude of EIS in SCM, Web enable EIS/ERP and its impact on SCM, EIS Vs SCM, product Life cycle management.	
Unit- V	**09 Hrs**
Trends in Enterprise Systems-MRP III (Money Resource Planning), Next Generation Of Enterprise software, Expenditure trends, Reduction In implementation time.	

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

Reference Books	
1.	Enterprise Information Systems: Contemporary Trends and Issues, David L. Olson and Subodh Kesharwani, 2009 Retrieved 20 August 20, New York: World Scientific, ISBN 9814273163.
2.	Enterprise Information Systems: Concepts, Methodologies, Tools and Applications, Information Resources Management Association (USA), 1st Edition, 2011, Idea Group Inc. ISBN 978-1-61692852-0.
3.	Enterprise Information Systems: A Pattern - Based Approach, Cheryl L. Dunn, 3rd Edition, 2005, McGraw-Hill, ISBN: 9780071111201
4.	Software Project Management, Hughes, B. and Mike Cotterell, M. 5th Edition, 2009, McGraw-Hill, ISBN:1070-1389

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: V						
NON-CONVENTIONAL MANUFACTURING PROCESSES (THEORY)						
Course Code	**:**	**21IM55B3**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3.00 Hours**

UNIT-I	**08 Hrs**
Mechanical Machining Processes: Abrasive Jet Machining (AJM), Ultrasonic Machining (USM), Abrasive Finishing Processes – Abrasive Flow Finishing (AFF), Magnetic Abrasive Finishing (MAF), Water Jet Machining (WJM), Abrasive Water Jet Machining (AWJM).	
UNIT-II	**08 Hrs**
Thermoelectric Machining Processes: Electric Discharge Machining (EDM), Electric Discharge Grinding and Electric Discharge Diamond Grinding, Wire Electric Discharge Machining, Laser Beam Machining (LBM), Plasma Arc Machining (PAM), Electron Beam Machining (EBM).	
UNIT-III	**07 Hrs**
Electrochemical and Chemical Manufacturing Processes: Electrochemical Machining (ECM), Electromechanical Grinding (ECG), Electrochemical Drilling (ECD), Electrochemical Deburring (ECDe), Chemical Machining (ChM)	
UNIT-IV	**07 Hrs**
Introduction: Definition of Prototype, Types of prototype, Need for the compression in product development, History of RP systems, classification of RP systems, Process Chain of RP. Liquid Based Rapid Prototyping System: Stereo lithography Systems - Principle, process specification & materials, advantages and disadvantages.	
UNIT-V	**08Hrs**
Solid Based Rapid Prototyping System: Fused Deposition Modeling (FDM): Principle, advantages and disadvantages. Laminated Object Manufacturing (LOM): Principle, advantages and disadvantages. Powder Based Rapid Prototyping System: Selective Laser Sintering (SLS): Principle of operation, process parameters, advantages and disadvantages. Laser Engineering Net Shaping (LENS): Principle of operation, process parameters, advantages and disadvantages.	

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

Reference Books	
1.	Advanced Machining Processes, V.K.Jain, 1st Edition, 2007, Allied Publishers Pvt. Limited, ISBN: 8177642944
2.	Modern Machining Process, Pandey P C and Shah H S, 1st Edition, 2007, TMH Publication, ISBN – 9780070965539
3.	Rapid Prototyping Principles and Applications, C.K.Chua,K.F.Leong C.S Lim, 3rd Edition, 2010, Cambridge University Press India Pvt. Ltd., ISBN:13:978-81-7596-778-6
4.	Fundamental of Modern Manufacturing: Materials, Processes and Systems, Mikell P.Groover, 2 nd Edition, 2002, Willey India, ISBN-10 81-265-1266-0

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20)ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: V						
ADVANCED DECISION MODELLING (THEORY)						
Course Code	**:**	**21IM55B4**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3.00 hours**

UNIT – I	**09 Hrs**
Introduction: Decision making and structured decision making, Necessity of structured Decision making **Single Objective Decision Making:** Traditional techniques - linear, non-linear and dynamic; non-traditional techniques - Genetic algorithms, Simulated Annealing (Numerical problems only in linear and non-linear programming only. Problems based on solver outputs and its interpretation to be emphasized) (other topics stress on the mathematical structure based on conceptual treatment) Use of programming languages and commercial/ open source software tools for solution of single objective decision making problems as part of experiential learning component.	
UNIT – II	**09 Hrs**
Multi-objective Optimization: Plan generation - weightage method, constraint method, multi-objective genetic algorithms, multi-objective differential evolution; Plan generation and selection - Fuzzy programming, Goal Programming, compromise programming (Numerical problems on weightage method limited to 2 variable case only). All other topics the emphasis is on exercises related to formulation and only the conceptual treatment to be emphasized. Use of programming constructs and working on commercial/open-source software tools as part of experiential learning only, Goal Programming and Utility Programming (Concept of Pareto Optimality)	
UNIT – III	**09 Hrs**
Discrete multi-criterion decision making: Introduction, Steps in MCDM methodology, Distance-based methods, Outranking-based methods, Utility-based methods. Numerical problems on all the methods. Emphasis on the usage of open source software tools and exposure to commercially software tools to be covered as part of experiential learning only. (Preferably numerical problems to be based on 4 * 4 and upto 6*6 input matrix only)	
UNIT – IV	**09 Hrs**
Fuzzy logic-based discrete MCDM: Introduction, Triangular and trapezoidal membership functions, Distance-based methods - Fuzzy TOPSIS, Utility-based methods - Fuzzy AHP. Numerical problems on all the methods. Emphasis on the usage of open source software tools and exposure to commercially software tools to be covered as part of experiential learning only.	
UNIT – V	**09 Hrs**
Advanced Topics: Data Envelopment Analysis, Taguchi methodology, Ant colony optimization, Particle swarm optimization, (Conceptual treatment only) **Additional MDCM Methods:** VIKOR, SIR, MOORA, WASPAS, SAW, WSM, WPM (Emphasis only on methodological aspects with conceptual treatment underlying the methods) **Case studies on usage of MCDM techniques.**	

Course Outcomes: After going through this course the student will be able to:	
CO1:	Select and explain the appropriate traditional and nontraditional techniques to analyze situations with multiple criteria for optimizing.
CO2:	Analyze and interpret information in a manner that can be communicated effectively to non-specialists.
CO3:	Recommend alternatives and carry out analyses of situations involving multiple criteria OR problems using computer packages
CO4:	Evaluate real world situations based on qualitative as well as quantitative criteria in order to derive a set of optimum decisions

Reference Books:	
1.	Multicriterion Analysis in Engineering and Management, K Srinivasa Raju, D Nagesh Kumar, 2010, PHI Learning Pvt Ltd, ISBN-978-81-203-3976-7
2.	New Methods and Applications in Multiple Attribute Decision Making (MADM), Alireza Alinezhad JavadKhalili, International Series in Operations Research & Management Science - Volume 277, Springer, ISBN 978-3-030-15008-2, 2019
3.	Multiple Criteria Decision Aid, Methods, Examples and Python Implementations, Jason Papathanasiou – Nikolaos Ploskas, Springer, ISBN - 978-3-030-06272-9, 1st Edn, 2018.
4.	Neural Networks, Fuzzy Logic, and Genetic Algorithms Synthesis and Applications, S Rajasekaran, G A VijayalakshmiPai, 2008, PHI Pvt Ltd, ISBN-978-81-203-2186-1

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20)ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: V						
THEORY OF MACHINES (THEORY)						
Course Code	**:**	**21IM55B5**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3.00 hours**

UNIT – I	**09 Hrs**
Introduction: Kinematic Link, Kinematic pair, Types of Kinematic pair, Kinematic chain, Kinematic representation of a machine. Expansion of pairs, Inversions of mechanism, Four bar chain, Slider crank mechanism, Double slider crank chain. Concepts of binary, ternary and quaternary links.	
UNIT – II	**09 Hrs**
Velocity and Acceleration Analysis of Mechanisms (Graphical Method): Velocity and acceleration analysis of four bar mechanism, slider crank mechanism. Angular velocity and angular acceleration of links, velocity of rubbing. Velocity Analysis by Instantaneous Center Method: Definition, Kennedy's theorem, Determination of linear and angular velocity using instantaneous center method.	
UNIT – III	**09 Hrs**
Governors: Types of governors; force analysis of Porter and Hartnell governors. Controlling force, stability, sensitiveness, isochronism, effort and power. Gyroscope: Vectorial representation of angular motion, gyroscopic couple. Effect of gyroscopic couple on ship, plane disc, aero plane, stability of two wheelers	
UNIT – IV	**09 Hrs**
Cams: Types of Cams, Types of Followers. Displacement, Velocity & Acceleration Time Curves for Cam Profiles. Disc Cam with Reciprocating Follower Having Knife- Edge, Roller & Flat-Face Follower, Disc Cam With Oscillating Roller Follower. Follower Motions including, SHM, Uniform Velocity, Uniform Acceleration & Retardation and Cycloidal Motion.	
UNIT – V	**09 Hrs**
Gears: Gear terminology, classification of gears, law of gearing, velocities of sliding in the mating teeth of the gear wheels, forms of teeth, effect of center distance variation on the velocity ratio for involute profile tooth gears, properties of involute profile toothed gears in mesh. Numerical Problems.	

Course Outcomes: After going through this course, the student will be able to:	
CO1:	To identify mechanisms with basic understanding of motion.
CO2:	To choose the gear trains for a different speed and torque transmission.
CO3:	Assimilate friction and its use in power transmission.
CO4:	Design and evaluate the performance of different cams and followers.

Reference Books:	
1.	Sadhu Singh, Theory of Machines, Pearson Education (Singapore) Ptd. Ltd., Indian Branch, New Delhi, 2019, ISBN: 0-07–460320–5
2.	Shigley, J.V. and Uicker, J.J., Theory of Machines & Mechanisms, McGraw Hill International, 2nd Edition, 1995, ISBN: 9780195155983.
3.	Rattan S.S, Theory of Machines, Tata McGraw-Hill Publishing Company, 2014
4.	Ballaney, Theory of Machines & Mechanisms, Khanna Publishers, 23rd Edition, 2003, ISBN: 817409122-X

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20)ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: V						
SUMMER INTERNSHIP - II (Practical)						
Course Code	:	21IMI57		**CIE**	:	50 Marks
Credits: L: T: P	:	0:0:2		**SEE**	:	50 Marks
Total Hours	:	4 Weeks		**SEE Duration**	:	02.00 hours
Students can opt the internship with the below options						4 Weeks

A. Within the respective department at RVCE (Inhouse) Departments may offer internship opportunities to the students through the available tools so that the students come out with the solutions to the relevant societal problems that could be completed within THREE WEEKS.

B. At RVCE Center of Excellence/Competence

RVCE hosts around 16 CENTER OP EXCELLENCE in various domains and around 05 CENTER OP COMPETENCE. The details of these could be obtained by visiting the website https:/ /rvce.edu.in / rvce-center-excellence. Each centre would be providing the students relevant training/internship that could be completed in three weeks.

C. At InternShala

Intern Shala is India's no.1 internship and training platform with 40000+ paid internships in Engineering. Students can opt any internship for the duration of three weeks by enrolling on to the platform through https: / /internshala.com

D. At Engineering Colleges nearby their hometown

Students who are residing out of Bangalore, should take permission from the nearing Engineering College of their hometown to do the internship. The nearby college should agree to give the certificate and the letter/email stating the name of the student along with the title of the internship held with the duration of the internship in their official letter head.

E. At Industry or Research Organizations

Students can opt for interning at the industry or research organizations like BEL, DRDO, ISRO, BHEL, etc.. through personal contacts. However, the institute/industry should provide the letter of acceptance through hard copy/email with clear mention of the title of the work assigned along with the duration and the name of the student.

Procedures for the Internship:

1. Request letter/Email from the office of respective departments should go to Places where internships are intended to be carried out with a clear mention of the duration of Three Weeks. Colleges/Industry/ CoEs/CoCswill confirm the training slots and the number of seats allotted for the internship via confirmation letter/ Email.
2. Students should submit a synopsis of the proposed work to be done during internship program. Internship synopsis should be assessed or evaluated by the concerned Colleges/Industry/CoEs/CoC. Students on joining internship at the concerned Colleges/Industry/ CoEs/CoCs submit the Daily log of student's dairy from the joining date.
3. Students will submit the digital poster of the training module/project after completion of internship.
4. Training certificate to be obtained from industry.

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

CO1	Develop interpersonal, critical skills, work habits and attitudes necessary for employment.
CO2	Assess interests, abilities in their field of study, integrate theory and practice and explore career opportunities prior to graduation.
CO3	Explore and use state of art modern engineering tools to solve the societal problems with affinity towards environment and involve in ethical professional practice.
CO4	Compile, document and communicate effectively on the internship activities with the engineering community.

RUBRICS FOR THE CONTINUOUS INTERNAL EVALUATION		
#	**COMPONENTS**	**MARKS**
1.	**REVIEW I:** Explanation of the application of engineering knowledge in industries, ability to comprehend the functioning of the organization/ departments, exhibiting professional and ethical practice, communication skills (oral and body language).	**20**
2.	**REVIEW II**: Presentation in the form digital poster, report writing, exhibiting ethics in report writing, oral presentation.	**30**
MAXIMUM MARKS FOR THE CIE THEORY		**50**

RUBRICS FOR SEMESTER END EXAMINATION		
The SEE examination shall be conducted by an external examiner (domain expert) and an internal examiner.		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	**10**
2	Conduction of the Experiments	**20**
3	Viva	**20**
	TOTAL	**50**

Semester: VI

INTELLECTUAL PROPERTY RIGHTS AND ENTREPRENEURSHIP

(Common to all Programs)

(Theory)

Course Code	**:**	21HS61A		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	40L		**SEE Duration**	**:**	**3.00 Hours**

Unit-I — **09 Hrs**

Introduction: Types of Intellectual Property

Patents: Introduction, Scope and salient features of patent; patentable and non-patentable inventions, Patent Procedure - Overview, Transfer of Patent Rights; protection of traditional knowledge, Infringement of patents and remedy, Case studies

Patent Search and Patent Drafting, Commercialization and Valuation of IP. Case examples.

Unit – II — **08 Hrs**

Trade Secrets: Definition, Significance, Tools to protect Trade secrets in India.

Trade Marks: Concept, function and different kinds and forms of Trade marks, Registrable and non- registrable marks. Registration of Trade Mark; Deceptive similarity; Transfer of Trade Mark, ECO Label, Passing off, Infringement of Trade Mark with Case studies and Remedies. Case Examples.

Unit –III — **08 Hrs**

Industrial Design: Introduction of Industrial Designs Features of Industrial, Design. Procedure for obtaining Design Protection, Revocation, Infringement and Remedies, Case studies.

Copy Right: Introduction, Nature and scope, Rights conferred by copy right, Copy right protection, transfer of copy rights, right of broad casting organizations and performer's rights, Exceptions of Copy Right, Infringement of Copy Right with case studies.

Introduction to Cyber law: Information Technology Act, cybercrime and e-commerce, data security, confidentiality, privacy, international aspects of computer and online crime.

Unit –IV — **09 Hrs**

Entrepreneurship: Introduction, Evolution of the Entrepreneurship, Importance of Entrepreneurship, Concept of Entrepreneurship, Characteristics of a successful Entrepreneur, Classification of Entrepreneur, Myths of Entrepreneurship, Entrepreneurial Development Models, Problems Faced by Entrepreneurs and Capacity Building for Entrepreneurship. Women Entrepreneurship in Asia, Women Entrepreneurship in India, Challenges Faced by Women Entrepreneurs. Case studies.

Entrepreneurship in the New Age: Getting to know your Business, it's Eco-system and Environment, Passion and Values driving, building and growing Family businesses, Challenges and suggested management approaches.

Unit –V — **11 Hrs**

Business Plans: Introduction, Purpose of a Business Plan, Contents of a Business Plan, Business Concept, Business Strategy, Marketing Plan, Operations Plan, Financial Plan, Presenting a Business Plan, Oral and Visual Presentation, Why Do Some Business Plans Fail? Procedure for Setting Up an Enterprise, Business Models and Business Model Innovation Creating a Business Plan. Case lets/Case studies.

Preparation of project: Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of. Business Opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study. Use of standard templates for preparation of project report.

Reference Books	
2.	Intellectual Property Rights: Unleashing Knowledge Economy, Prabuddha Ganguly, 1st Edition, 2001, Tata McGraw Hill Publishing Company Ltd., New Delhi, ISBN: 0074638602.
2.	Intellectual Property and the Internet, Rodney Ryder, 2002, Lexis Nexis U.K., ISBN: 8180380025, 9788180380020.
3.	Poornima M. Charantimath "Entrepreneurship Development and Small Business Enterprise", Pearson Education, 2005, ISBN: 9788177582604
4.	Dynamics of Entrepreneurial Development & Management-Vasant Desai, Himalaya Publishing House, 6th Edition, 2018, ISBN - 978-93-5299-133-4
5	Entrepreneurial development, Khanka, Shobhan Singh, S. Chand Publishing, 2006, ISBN - 8121918014, 9788121918015

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

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
PART B (Maximum of TWO Sub-divisions only)* (Small case lets and case example in one subdivision)		
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI

GLOBAL SUPPLY CHAIN MANAGEMENT
(THEORY & PRACTICE)

Course Code	**:**	**21IM62**	**CIE**	**:**	**100 + 50 Marks**
Credits: L:T:P	**:**	**3:0:1**	**SEE**	**:**	**100 + 50 Marks**
Total Hours	**:**	**45L + 30P**	**SEE Duration**	**:**	**3.00 + 3.00 hours**

UNIT-I — **09 Hrs**

Building a Strategic Frame Work to Analyse Supply Chains: Definition and Objective of Supply Chain, The importance of Supply Chain Decisions, Decision Phases in a Supply Chain, Process View of Supply Chains. Competitive and Supply Chain Strategies, Achieving Strategic fit, Expanding Strategic Scope. Drivers of Supply Chain Performance, Frame work for Structuring Drivers, Facilities, Inventory, Transportation, Information, Sourcing, Pricing, Infrastructure, International Logistics.

UNIT – II — **09Hrs**

Designing The Supply Chain Network: The Role of Distribution in the Supply Chains, Factors influencing Distribution Network design, Design Options for a Distribution Network, Online sales and the Distribution network, Distribution Networks in practice. Factors influencing network design decisions, Framework for Network design decisions, The impact of uncertainty on network design, The impact of Globalization on Supply Chain networks, Risk Management in Global Supply Chains, Discounted cash flow analysis, Evaluating Network Design Decisions **Problems**.

UNIT –III — **09Hrs**

Planning and Managing Inventories in a Supply Chain: The Role of Cycle inventory in a Supply Chain, Economies of Scale to Exploit Fixed costs, Managing Multi-echelon Cycle Inventory. The Role of Safety Inventory in a Supply Chain, Determining appropriate level of Safety inventory, Impact of supply Uncertainty on Safety inventory, Impact of aggregation on safety inventory, impact of replenishment policies on safety inventory, Managing Safety Inventory in a Multi-echelon Supply Chain, The Role of IT in inventory management. **Problems**

Unit –IV — **09Hrs**

Designing And Planning Transportation Networks: The role of transportation in a Supply chain, Modes of transportation and their performance characteristics, Transportation infrastructure and policies, Design options for a transportation network, Trade-offs in transportation design, Tailored transportation, The role of IT in transportation, **Problems.**

Sourcing Decisions In A Supply Chain: The role of sourcing in a supply chain, in-house or outsource, Third-and Fourth-party logistics providers, Total cost of Ownership, Supplier selection-Auctions and Negotiations, Sharing Risk and Reward in the Supply chain.

UNIT –V — **09 Hrs**

Digital Supply Chain: The role of IT in a supply chain, The supply chain IT framework, The supply chain macro processes, Lack of Supply Chain co-ordination and the Bullwhip effect, managerial levers to achieve coordination, continuous replenishment and vendor-managed inventories, collaborative planning, forecasting and replenishment (CPFR).

SUPPLY CHAIN AND LOGISTICS MANAGEMENT LABORATORY

Part – I

1.	Exercises on designing supply chain networks: Facility location models, Network optimization models.
2.	Planning supply chain inventory and sensitivity analysis: Cycle inventory, Safety inventory and Product availability, Inventory aggregation.

Part – II

3.	Exercises on transportation design: Transportation cost and inventory cost trade off, Customer response and transportation cost trade off, Routing and scheduling.
4.	Exercises on Designing Marketing Campaign, Customer Service and Customer Order Processing.
5.	Demonstration Exercises on the beer game, illustrating bullwhip effect; Risk Pool Game; Auctions

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

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

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20)ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (20 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (20 Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50 MARKS	**50**
	MAXIMUM MARKS FOR THE CIE (THEORY & PRACTICE)	**150**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

RUBRIC FOR SEMESTER END EXAMINATION (LAB)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	**10**
2	Conduction of the Experiments	**30**
3	Viva	**10**
	TOTAL	**50**

Semester: VI						
QUALITY ASSURANCE (THEORY & PRACTICE)						
Course Code	**:**	**21IM63**		**CIE**	**:**	**100 + 50 Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100 + 50 Marks**
Total Hours	**:**	**45L + 30P**		**SEE Duration**	**:**	**3.00 + 3.00 hours**

Unit-I	**09 Hrs**
Introduction: Dimensions of Quality, Statistical Methods for Quality, Quality costs, Seven QC tools. Quality assurance, departmental assurance activities, ISO 9000, 14000 standards, Quality audit. Statistical Process Control: Chance and assignable causes of variation. Statistical basis of control charts, Basic principles of control charts, choice of control limits, sample size and sampling frequency, rational sub groups, statistical basis of control charts. Analysis of patterns of control charts.	
Unit – II	**09 Hrs**
Control Charts for Variable and Attribute Data: Controls charts for mean and Range, Control charts for mean and standard deviation. Controls chart for fraction non- conforming (p, np charts), Control chart for non- conformities (c and u charts). Process capability – methods of estimating process capability, Process capability indices- $CP$and CPK.	
Unit –III	**09 Hrs**
Advanced Control Charts: Control charts for Individual measurements, Cumulative sum, Exponentially weighted moving average, Group control charts. **Acceptance Sampling:** Concept of acceptance sampling, economics of inspection, Acceptance sampling plans – Single, Double and Multiple Sampling. Operating Characteristic curves – construction and use. Determination of Average Outgoing Quality (AOQ), Average Outgoing Quality Level, Average Total Inspection, Production Risk and Consumer Risk, Published Sampling Plans.	
Unit –IV	**09 Hrs**
Experimental Design for Process Improvement: General model of a process, Examples of designed experiments in process improvement, Principles of experimentation, Guidelines for designing experiments, Completely randomized designs (CRD), Randomized block designs (RBD), Factorial experiments – 2^2 design.	
Unit –V	**09 Hrs**
Reliability And Life Testing: Failure models of components, definition of reliability, MTBF, Failure rate, common failure rate curve, types of failure, reliability evaluation in simple cases of exponential failures in series, parallel and series-parallel device configurations.	

Unit – VI (Laboratory Work) Part – I	
1.	To test the Goodness of fit for the given quality characteristic using Uniform & Binomial distribution
2.	To test the Goodness of fit for the given quality characteristic using Poisson distribution
3.	To test the Goodness of fit for the given quality characteristic using Normal distribution
4.	Experiments on correlation and Simple regression
5.	Conduction of Repeatability and Reproducibility studies for the given measurement system
6.	Estimation of process variability using Deming's funnel Experiment / Quincunx Apparatus (Demonstration)
7.	Developing Quality Function Deployment Matrix for a Product / Service (Open ended)
8.	Performing Quality Audit of a System (Open ended)
9.	Construction of control chart for variable quality characteristics (manual & using MS Excel / SYSTAT / SQC PC IV software)

Part – II	
1.	Construction of control chart for attribute quality characteristics (manual & using MS Excel / SYSTAT / SQC PC IV software)
2.	Advanced control charting techniques, Multivariate SPC (using MS Excel / SYSTAT / SQC PC IV software)
3.	Assessing Process Capability of the given manufacturing process using Normal probability paper method and process capability indices
4.	Exercises on Attribute Sampling Plans-Single, Double and Multiple sampling plans
5.	Conduction of Design of Experiments-Full Fractional approach for the given quality characteristics for machining operation.
6.	Exercises to demonstrate Taguchi's orthogonal Array technique through Catapult
7.	Performing Failure Modes and Effects Analysis for a system (Open ended)
8.	Estimation of System Reliability using Reliability Software Package
9.	Performing Quality Audit of a System (Open ended)
Recommended Software Packages: SPC-IV, DOE-IV, Rel Tec, Systat, Minitab, Rational Rose, M S Excel	

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

Reference Books	
1.	Statistical Quality Control: A Modern Introduction, D C Montgomery, 6th Edition, 2009, John Wiley and Sons, ISBN- 978-81-265-2506-5.
2.	Statistical Quality Control, Grant and Leavenworth, 7th Edition, 2008, McGraw Hill, ISBN– 0-07-043555-3.
3.	Quality Planning & Analysis - J M Juran, Frank M Gryna – Tata McGraw Hill - 3rd edition
4.	The QS9000 Documentation Toolkit -Janet L Novak and Kathleen C Bosheers - Prenctice Hall PTR - 2nd Edition.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20)ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (20 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (20 Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50 MARKS	**50**
	MAXIMUM MARKS FOR THE CIE (THEORY & PRACTICE)	**150**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

RUBRIC FOR SEMESTER END EXAMINATION (LAB)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	**10**
2	Conduction of the Experiments	**30**
3	Viva	**10**
	TOTAL	**50**

Semester: VI						
APPLIED ERGONOMICS (Theory)						
Course Code	**:**	**21IM64D1**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3.00 hours**

Unit-I	**09 Hrs**
Introduction: Human Factors Engineering, Goals and Process of Human Factors Engineering, Scope of Human Factors Engineering, Systems Thinking, Scientific Base of Human Factors Engineering **Design Methods:** Human factors in design and evaluation, Understanding users, context and tasks, How to perform task, Iterative design an refinement, Evaluation.	
Unit – II	**09 Hrs**
Engineering Anthropometry and workspace design: Human variability and statistics**,** Anthropometric data, Principles of work space design, Design for standing and sitting work. **Biomechanics of work:** The musculoskeletal system, Biomechanical model, Low back problems, NIOSH lifting guide, Cumulative Trauma disorder.	
Unit –III	**09 Hrs**
Displays and Controls: Types of displays and tasks, fifteen principles of display design, labels and icons, monitoring displays and integrative displays, Navigation displays and maps**,** Types of controls and tasks, Information theory, fifteen principles of discrete control, discrete and continuous controls.	
Unit –IV	**09 Hrs**
Design for individual differences: design for people with functional limitations, design for aging, design for children, design for all	
Unit –V	**09 Hrs**
Cognitive Ergonomics: Cognitive environment, Information processing model of cognition, selective attention and perception, working memory, long term memory, Divided attention and time sharing **Human Computer Interaction:** Matching interaction style to users and tasks, Interaction styles, Theories of interface and interaction, Fifteen principles of HCI design,	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Know about ergonomic principles to design workplaces
CO2	Improve human performance
CO3	Judge the environmental conditions in the work place.
CO4	Know about bio thermodynamics and bioenergetics
CO5	Implement latest occupational health and safety to the work place.

Reference Books	
1.	Mark S. Sanders and Ernest J Mc McCormick; Human Factors in Engineering and Design; McGraw-Hill and Co. Singapore, 7th Edition, 1992, ISBN: 0-07-112826-3.
2	R S Bridger, Introduction to Ergonomics, Taylor & Francis, 2nd Edition, 2003, ISBN: 0415273781.
3	Gavriel. Salvendy-Editor, Handbook of Human Factors and Ergonomics, Wiley, Hoboken, New Jersey, USA, 3rd Edition, 2006, ISBN: 0471116904.
4	Chandler Allen Phillips, Human Factors Engineering, John Wiley and Sons, New York, 2000

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20)ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
SERVICE OPERATIONS MANAGEMENT (Theory)						
Course Code	**:**	**21IM64D2**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3.0 Hours**

Unit-I	**09 Hrs**
Introduction to service operations management: Introduction, what is service operations management?, The challenges facing service operations managers, different types of services, different types of service processes, judging the success of a service operation	
Unit – II	**09 Hrs**
The service concept: the service concept, the service concept defined, the service concept as a strategic tool, focused and unfocussed service operations **Customers and relationships:** customers and customer segmentation, customer retention, managing customer relationships	
Unit –III	**09 Hrs**
Customer expectations and satisfaction: customer satisfaction, service quality and confidence, customer expectations, defining expectations-service quality factors, finding expectations and assessing satisfaction, managing perceptions **Managing supply relationships:** types of supply relationships, managing service supply chains, managing through intermediaries, supply partnerships, service level agreements	
Unit –IV	**09 Hrs**
Service processes: service processes and their importance, understanding the nature of service processes, engineering service processes, controlling service processes, repositioning service processes **Service people:** understanding the pressures on service providers, managing and motivating service providers, managing customers	
Unit –V	**09 Hrs**
Resource utilization: capacity management, operations planning and control, managing bottlenecks and queues, managing the coping zone, improving resource utilization **Performance measurement:** the purpose of Performance measurement, a balance of measures, Interlinking, targets and rewards, benchmarking	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Develop an understanding of the terminology and responsibilities that relate to Service Operations Management.
CO2	Formulate and describe the function of the Service Operations Management discipline in various sectors of the economy through case study.
CO3	Obtain a set of basic tools and skills used in solving problems traditionally associated with operating the service operations system.
CO4	Explore the interface of Service Operations Management with the other management functions, such as marketing, procurement & sourcing, outsourced good & services and customers.
CO5	Deploy technology in the improvement of service, customer relationships and globalization.

Reference Books	
1.	Service Operations Management, Improving Service Delivery, Robert Johnston, Graham Clark, 2nd Edition, 2008, Pearson, ISBN:*8131715205*
2	Service Operations Management, Richard Metters, King-Metters, Steve Walton, 13th Edition, 2002, South-Western, ISBN: 978-0324135565
3	Service Operations Management: The Total Experience, David W. Parker, 13th Edition, 2012, Edward Elgar Pub, ISBN-978-1781007860
4	Chandler Allen Phillips, Human Factors Engineering, John Wiley and Sons, New York, 2000

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20)ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI

ADDITIVE MANUFACTURING
(Theory)

Course Code	**:**	**21IM64D3**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3.0 Hours**

Unit-I — 09 Hrs

Introduction and Basic Principles: What Is Additive Manufacturing?, What Are AM Parts Used for?, The Generic AM Process, Why Use the Term Additive Manufacturing?, The Benefits of AM, Distinction Between AM and CNC Machining, Example AM Parts, Other Related Technologies

Development of Additive Manufacturing Technology: Introduction, Computers, Computer-Aided Design Technology, Other Associated Technologies, The Use of Layers, Classification of AM Processes, Metal Systems, Hybrid Systems, Milestones in AM Development, AM Around the World, The Future? Rapid Prototyping Develops into Direct Digital Manufacturing.

Overview of Stereolithography 3D printing, 4D printing.

Unit – II — 09 Hrs

Vat Photopolymerization Processes: Introduction, Vat Photopolymerization Materials, Reaction Rates, Laser Scan Vat Photopolymerization, Photopolymerization Process Modeling, Vector Scan VP Machines, Scan Patterns, Vector Scan Micro-Vat Photopolymerization, Mask Projection VP Technologies and Processes, Two-Photon Vat Photopolymerization, Process Benefits and Drawbacks

Powder Bed Fusion Processes: Introduction, Materials, Powder Fusion Mechanisms, Process Parameters and Modeling, Powder Handling, PBF Process Variants and Commercial Machines, Process Benefits and Drawbacks

Unit –III — 09 Hrs

Extrusion-Based Systems: Introduction, Basic Principles, Plotting and Path Control, Fused Deposition Modeling from Stratasys, Materials, Limitations of FDM, Bioextrusion, Other Systems

Material Jetting: Evolution of Printing as an Additive Manufacturing Process, Materials for Material Jetting, Material Processing Fundamentals, MJ Process Modeling, Material Jetting Machines, Process Benefits and Drawbacks

Unit –IV — 09 Hrs

Sheet Lamination Processes: Introduction, Materials, Material Processing Fundamentals, Ultrasonic Additive Manufacturing,

Directed Energy Deposition Processes: Introduction, General DED Process Description, Material Delivery, DED Systems, Process Parameters, Typical Materials and Microstructure, Processing–Structure–Properties Relationships, DED Benefits and Drawbacks

Guidelines for Process Selection: Introduction, Selection Methods for a Part, Challenges of Selection, Example System for Preliminary Selection, Production Planning and Control

Unit –V — 09 Hrs

Post-processing: Introduction, Support Material Removal, Surface Texture Improvements, Accuracy Improvements, Aesthetic Improvements, Preparation for Use as a Pattern, Property Enhancements Using Non-thermal Techniques, Property Enhancements Using Thermal Techniques

Direct Digital Manufacturing: Align Technology, Siemens and Phonak, Custom Footwear and Other DDM Examples, DDM Drivers, Manufacturing Versus Prototyping, Cost Estimation, Life-Cycle Costing, Future of DDM

Course Outcomes: After completing the course, the students will be able to:	
CO1	Understand the working principles and process parameters of additive manufacturing processes
CO2	Explore different additive manufacturing processes and suggest suitable methods for building a particular component
CO3	Perform suitable post processing operation based on product repair requirement
CO4	Design and develop a working model using additive manufacturing Processes

Reference Books	
1.	Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Ian Gibson, David W Rosen, Brent Stucker, Springer, ISBN 978-1-4939-2112-6, 2015, 2nd Edition.
2	3D Printing and Additive Manufacturing: Principles & Applications, Chua Chee Kai, Leong Kah Fai, World Scientific, 2015, 4th Edition.
3	Additive Manufacturing, Second Edition, Amit Bandyopadhyay,Susmita Bose, CRC Press Taylor & Francis Group, 2020.
4	Additive Manufacturing: Principles, Technologies and Applications, C.P Paul, A.N Junoop, McGrawHill, 2021.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20)ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
DESIGN OF EXPERIMENTS (Theory)						
Course Code	**:**	**21IM64D4**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3.00 hours**

Unit-I	**09 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	**09 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	**09 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	**09 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 forconstructing an orthogonal array. Problems.	
Unit –V	**09 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

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20)ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
FLUID MECHANICS & THERMODYNAMICS (Theory)						
Course Code	**:**	**21IM64D5**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3.00 hours**

Unit-I	**09 Hrs**
Introduction, Basic Concepts & Properties of Fluid: Definition of fluid, density, Specific weight, specific volume, specific gravity, viscosity, surface tension, capillarity compressibility, bulk modulus, vapour pressure, cavitation, classification of fluids, No-slip condition, definition of fluid pressure, pascal's law, hydrostatic law, pressure measurements using simple and u-tube differential manometers. Simple numerical	
Unit – II	**09 Hrs**
Dynamics of Fluid Flow: Derivation of Euler's equation of motion, Bernoulli equation for real fluids, applications of Bernoulli equation-venturimeter, orifice meter, pitot-tube. Simple numerical Flow through Pipes: Introduction, loss of energy in pipes, Darcy-weisbach formula, minor energy losses due to sudden enlargement, sudden contraction (No derivation), entrance to a pipe and exit of a pipe, concept of hydraulic gradient and total energy line. Simple numerical	
Unit –III	**09 Hrs**
Basic Concepts of Thermodynamics: System, control volume, properties, processes, cycles, thermodynamic equilibrium, Quasi-static process, temperature, zeroth law of thermodynamics, thermometers and thermometric properties, temperature scales, Numerical. **First Law of Thermodynamics:** Closed system undergoing a cycle, change of state, energy –a property of system, enthalpy and specific heats, PMMM1, Flow processes- energy analysis of steady flow systems. Examples- Turbine, compressor, nozzle-Numerical.	
Unit –IV	**09 Hrs**
Second law of thermodynamics: Thermal energy reservoirs, heat engine-thermal efficiency, pump- coefficient of performance, statements, equivalence of two statements, PMMM2, carnot cycle, reversible and irreversible processes, Numerical.	
Unit –V	**09 Hrs**
Work and Heat Transfer: Work transfer, pdv-work or displacement work, path and point functions, pdv-work in various Quasi-static processes, Other types of work transfers- electrical work, shaft work, paddle wheel work or stirring work, flow work, heat transfer, similarities and dissimilarities between heat and work transfers. Simple numericals.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Explain the properties of fluid in engineering design.
CO2	Evaluate measures resulting from the first law of thermodynamics on closed systems.
CO3	Apply the second law of thermodynamics for control volumes undergoing steady state flow processes.

Reference Books	
1.	Fluid Mechanics – Fundamentals & Application, Yunus A Cencgal and John M Cimbala, 2nd Edition, 2006, Tata McGraw Hill publications, ISBN: 978-0-07-070034-5.
2	A Textbook of Fluid Mechanics, Dr. R.K.Bansal, 1st Edition, 2008, Laxmi Publications, ISBN8131802949, 9788131802946
3	Thermodynamics - An Engineering Approach, Yunus A Cencgal and Michael A. Boles, 5th Edition, 2006, Tata McGraw Hill publications, ISBN: 0072884959.
4	Engineering Thermodynamics, Nag P K, Tata McGraw Hill, 4th Edition, 2011,ISBN-13:978-0- 07-026062-7: ISBN-10:0-07-026062-1

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20)ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

VI Semester

LEAN MANUFACTURING SYSTEMS
(Group E: Cluster Elective)
(Theory)

Course Code	**:**	**21IM65E1**		**CIE**	**:**	**100 Marks**
Credits: L: T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3.00 hours**

UNIT – I — 09 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 — 09 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 — 09 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 — 09 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.

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.

UNIT – V — 09 Hrs

Lean 4.0: Dimensions of lean manufacturing, Industry 4.0, Integration of Lean Manufacturing and Industry 4.0, Summary of lean dimensions, challenges and solutions.

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.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: (Internal Choice)	16
5 & 6	Unit 3: (Internal Choice)	16
7 & 8	Unit 4: (Internal Choice)	16
9 & 10	Unit 5: (Internal Choice)	16
	TOTAL	**100**

TOTAL QUALITY MANAGEMENT (Group E: Professional Core Elective) (Theory)						
Course Code	**:**	**21IM65E2**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3.00 hours**

UNIT-I	**09 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	**09 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	**09 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.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: (Internal Choice)	16
5 & 6	Unit 3: (Internal Choice)	16
7 & 8	Unit 4: (Internal Choice)	16
9 & 10	Unit 5: (Internal Choice)	16
	TOTAL	**100**

Semester: VI

HYDRAULICS AND PNEUMATICS
Category: Professional Cluster Elective
Stream: Common to ME, AS, IEM
(Theory)

Course Code	**:**	**21ME65E1**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 Hrs**		**SEE Duration**	**:**	**3.00 hours**

Unit-I — **07 Hrs**

Introduction to hydraulic power: Pascal's law and its application, components of a fluid power system, applications of fluid power, positive displacement hydraulic pump , construction and working of gear, vane and piston pumps(all types) Classification, parts and working of hydraulic cylinders – single acting, double acting, tandem, telescopic, cushioned. Basic motor principle. Numerical Problems on Pump and Motor volumetric displacement, theoretical and actual flow rate, power and efficiency, Hydrostatic Transmission, Cylinder Thrust, Power, capacity, speed, Mechanics of Hydraulic Cylinder loading

Unit – II — **09 Hrs**

Introduction to Pneumatic power: Production of compressed air – compressors- vane, piston, diaphragm type, preparation of compressed air- driers, filters, regulators, FRL unit, lubricators, distribution of compressed air, pneumatic double pilot valve, cushioned cylinder, shuttle valve, dual pressure valve, pressure sequence valve and time delay valve – constructional features.

Control components and accessories: Symbolic representation and constructional features of Directional control valve (spool type) valves, method of actuation – manual, solenoid, pilot. pressure relief valve(direct and pilot), pressure reducing valve, unloading valve, counterbalance valve, pressure sequence valves, Flow control valves- one way and pressure compensated. Hydraulic fluids (properties and types), reservoir construction, sealing devices, filters and strainers, accumulators.

Unit –III — **09 Hrs**

Hydraulic Circuit Design: Control of single acting and double acting cylinder and motors, Pump unloading circuit, Counterbalance Valve Application, Hydraulic Cylinder Sequencing circuit, locked, Cylinder using Pilot Check Valve, pressure reducing valve circuit, accumulator circuits.

Analysis of Hydraulic circuits: Regenerative Circuit**,** Cylinder Synchronizing circuits, Double Pump Hydraulic System, Meter in and meter out flow control, (numerical), Analysis of open-ended hydraulic circuits of industrial machine tools using various hydraulic valves and accessories.

Unit –IV — **08 Hrs**

Design of pneumatic circuits: ISO 5599 symbolic representations, structure of pneumatic circuits, component designations – lettering and numbering type, Circuit diagrams on Direct and Indirect control of pneumatic cylinders, control of pneumatic motor, use of memory valve, supply air throttling and exhaust air throttling, auto return motion, quick exhaust valve.

Logic control and Multicylinder applications: Moving Part Logic Control of Circuits, Practical examples involving the use of AND and OR gates. Applications of pressure dependent control and time delay valve, cascading principle, displacement step and timing diagram, coordinated motion control, Signal elimination using reversing valves (two cylinders).

Unit-V — **07 Hrs**

Electro Pneumatics: Electrical switching devices, symbolic representation, direct and indirect control of single acting and double acting cylinders, relay control circuit, latching circuit, auto return using proximity sensors, control of double acting cylinder using electrical timer.

Applications of Fluid power systems: Cyclic operation of double acting cylinder, automatic gate, dual cylinder sequence, box sorting system, electrical control of regenerative circuit, circuit for stamping device.

Course Outcomes: After completing the course, the students will be able to:	
CO1	Explain the basic components of hydraulic and pneumatic power pack and structure of circuits.
CO2	Identify the hydraulic and pneumatic power symbolic representations and troubleshoot the problems.
CO3	Determine the performance parameters of hydraulic pumps, actuators, filters and valves.
CO4	Design an efficient hydraulic and pneumatic circuit diagrams for industrial applications

Reference Books	
3.	S. Ilango, V. Soundararajan, 'Introduction to Hydraulics and Pneumatics', PHI learning, 2nd Edition, 2011, ISBN: 978812034406–8.
2.	Andrew Parr, 'Hydraulics and Pneumatics', Elsevier, 3rd Edition, 2011, ISBN: 978008096674–8.
3.	Anthony Esposito, 'Fluid Power with Applications', 7th Edition, 2013, ISBN – 13; 978–9332518544.
4.	R. Srinivasan, 'Hydraulic and Pneumatic controls', McGraw Hill Education, 2nd Edition, 2010, ISBN: 978818209138–2.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: (Internal Choice)	16
5 & 6	Unit 3: (Internal Choice)	16
7 & 8	Unit 4: (Internal Choice)	16
9 & 10	Unit 5: (Internal Choice)	16
	TOTAL	**100**

Semester: VI						
TURBOMACHINERY **Category: Professional Cluster Elective** **Stream: Common to ME, AS, IEM** **(Theory)**						
Course Code	**:**	21ME65D2		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	45L		**SEE Duration**	**:**	**3.00 hours**

Unit-I	**09 Hrs**
Introduction: Fluid machines, Classification, Comparison with positive displacement machines, Dimensional analysis, Dimensionless parameters and their physical significance; Specific speed; dimensional analysis and model studies. Basic Euler turbine equation and its alternate forms, Components of energy transfer, General expression of degree of reaction, Relation between degree of reaction and utilization factor, concept of velocity triangles.	
Unit – II	**10 Hrs**
Compression Process: Overall isentropic efficiency of compression, Stage efficiency, Comparison and relation between overall efficiency and stage efficiency; Polytropic efficiency and pre-heat factor **Expansion Process:**Overall isentropic efficiency for a turbine, Stage efficiency for a turbine, Comparison and relation between stage efficiency and overall efficiency for expansion process; Polytropic efficiency for expansion process and reheat factor for expansion process.	
Unit –III	**10 Hrs**
Centrifugal Pumps: Definition of terms used in the design of centrifugal pumps like manometric head, suction head, delivery head, Efficiencies of pump, multi-stage centrifugal pumps. **Centrifugal Compressors:** Expression for overall pressure ratio, Slip factor and power input factor, Surging and its control.	
Unit –IV	**08 Hrs**
Axial Flow Compressors: Classification, expression for stage pressure ratio, work done factor, analysis of air compressors**.** **Steam Turbines:** Impulse and reaction turbines, velocity and pressure compounding; condition for maximum utilization factor for multistage turbine with equiangular blades, effect of blade and nozzle losses	
Unit –V	**08 Hrs**
Hydraulic Turbines: Pelton wheel, Bucket dimensions, turbine efficiency; Francis and Kaplan Turbines, Velocity triangles, Draft tubes and their function, Types of draft tube.	

Course Outcomes: After completing the course, the students will be able to:	
CO1	Explain working principles of turbines and compressors.
CO2	Analyse the characteristics of power absorbing and power generating turbo machines.
CO3	Evaluate performance of turbo machines.
CO4	Discuss selection of turbo machine for industrial application.

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

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding up to 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: (Internal Choice)	16
5 & 6	Unit 3: (Internal Choice)	16
7 & 8	Unit 4: (Internal Choice)	16
9 & 10	Unit 5: (Internal Choice)	16
	TOTAL	**100**

Semester: VI						
AIRPORT ENGINEERING **CATEGORY: PROFESSIONAL CORE ELECTIVE (CLUSTER ELECTIVE) (GROUP- E)** **(Theory)**						
Course Code	**:**	**21AS65E1**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3.00 hours**

Unit-I	**09 Hrs**
Aviation logistics solutions: Introduction: Environment, transport and mobility. Systematic description and current challenges. Development of aircraft design driver-speed and range. Development of Airport, Airlines, ICAO, Regulatory Framework and Market Aspects.	
Unit – II	**09 Hrs**
Aircraft traits and manufacturing sources: Classification of flight vehicles, cabin design, basics of flight physics- structures, mass and balance. Flight performance and mission. Aircraft manufacturers, development process, production process, supply chain.	
Unit –III	**09 Hrs**
Airline operations, airports, and associated infrastructure: Airline types, Network management. Flight strategy and aircraft selection, flight operations, MRO. Role of Airport, Regulatory Issues, Airport operation and services. Airport planning – Infrastructure.	
Unit –IV	**09 Hrs**
Aerial Navigation Networks and Environmental Monitoring: Principle of operation- Role of Air Navigation services. Air space structures, Airspace and Airport capacity, Aircraft separation. Flight guidance system. Communication system. Integrated air traffic management and working system. Environmental aspects- emission, noise, and sound.	
Unit –V	**09 Hrs**
Managerial Practices and Strategies in Aviation: Airline passenger marketing, forecasting methods, pricing and demand. Air cargo-market for air freight. Principles of airline scheduling. Fleet planning.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Develop a holistic understanding of the air transportation system, encompassing its various components and functions.
CO2	Illustrate the intricate structure of the aviation industry, covering airlines, airports, and their associated infrastructure, while also addressing key managerial aspects
CO3	Explore the various air navigation and environmental systems utilized to enhance the efficiency and sustainability of the air transportation system.
CO4	Summarize essential information about aircraft, including their basic characteristics and major manufacturers

Reference Books	
1	Dieter Shmitt, and Valker Gollnick, Air Transport System, Springer, 2016.
2	John G Wensveen, Air Transportation-A Management Prospective, Ashgate Publishing Ltd 2011
3	Mike Hirst, The Air Transportation System, Wood head publishing Ltd, England, 2008

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**. Some sample topics are a)Demonstration of working principle of various aircraft systems through physical models. b) Crash investigation of various aircraft system failures	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	**20**
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1: (Compulsory)	**16**
3 & 4	Unit 2: Question 3 or 4	**16**
5 & 6	Unit 3: Question 5 or 6	**16**
7 & 8	Unit 4: Question 7 or 8	**16**
9 & 10	Unit 5: Question 9 or 10	**16**
	TOTAL	**100**

Semester: VI						
SPACE VEHICLE DESIGN **Category: PROFESSIONAL CORE ELECTIVE (CLUSTER ELECTIVE) (GROUP- E)** **(Theory)**						
Course Code	**:**	21AS65E2		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	45L		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**10 Hrs**
History of rocketry & launch vehicles , Ascent Mission Basics, Force and Geometry Models 1 & 2, Idealized Performance, Current & future launch vehicles. Orbit/trajectory requirements and missions.	
Unit – II	**10 Hrs**
Idealized Performance, Trajectory Under Gravity, Impact of Gravity, Impact of Drag, Δv & initial sizing, inboard profile & layout. Engine selection. Preliminary mass estimation	
Unit –III	**10 Hrs**
Ascent Mission Design, Multi-stage Rocket Concept, Multi-stage Design Basics, Multi-stage Formulation, Optimal Staging Concept, Lagrange's Solution, Approximate Staging Solution	
Unit –IV	**08 Hrs**
Concept of Rocket Variant , Variant Design Solution, Parallel Staging Concept, Relativistic and SSTO Rocket Concepts, Air-breathing Rockets and Ballistic Missiles	
Unit –V	**07 Hrs**
Jet Damping and Spin in Rockets and Missiles, Basics of Rocket Launching, Fundamentals of Re-entry, Typical Re-entry Techniques	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understand the fundamental concepts of development of various launch vehicle
CO2	Demonstrate the working principles of different types of space vehicle
CO3	Identify and Classify the required systems, trajectory and orbit employed based on the mission requirements
CO4	Compute and Evaluate the fundamental parameters involved in the stage design and vehicle sizing for specific missions

Reference Books	
1	Space Vehicle Design, Griffin and French, AIAA, 2004, ISBN 1563475391
2	Spacecraft Systems Engineering P. Fortescue, J. stark, and G. Swinerd Wiley-Blackwell 4th revised edition,2011
3	Manned Spacecraft Design Principles, Sforza, Elsevier, 2016, ISBN 9780128044254.
4	Elements of Space Technology, R. Meyer, Academic Press, 1999, ISBN 0124929400
5	Astronautics, U. Walter, WILEY-VCH, 2008, ISBN 9783527406852

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	**20**
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1: (Compulsory)	**16**
3 & 4	Unit 2: Question 3 or 4	**16**
5 & 6	Unit 3: Question 5 or 6	**16**
7 & 8	Unit 4: Question 7 or 8	**16**
9 & 10	Unit 5: Question 9 or 10	**16**
	TOTAL	**100**

Semester: VI						
INDUSTRIAL SAFETY AND RISK MANAGEMENT **Category: Institutional elective** **Stream: Chemical Engineering** **(Theory)**						
Course Code	**:**	**21IE6F1**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**40L**		**SEE Duration**	**:**	**3Hours**

Unit-I	**08 Hrs**
Introduction Safety: 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), Fault tree and Event tree analyses.	
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, heat exchanger, system breakdown structure, Accident paths, HAZOP application, risk adjusted discounted rate method, probability distribution, Hiller's model	
Unit –V	**08 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	
2.	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.	ndustrial Safety, Health and Environment Management Systems, R K Jain, Sunil S Rao, 4th Edition, 2005, Khanna Publishers, New Delhi, ISBN: 8174092102.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
RENEWABLE ENERGY SYSTEMS **Category: Institutional Elective** **(Theory)**						
Course Code	**:**	21IE6F2		**CIE**	**:**	100Marks
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	40L		**SEE Duration**	**:**	3.00 hours

Unit-I	**08 Hrs**
Introduction: Energy systems model causes of Energy Scarcity, Solution to Energy Scarcity, Factors Affecting Energy Resource Development, Energy Resources and Classification, Renewable Energy – Worldwide Renewable Energy Availability, Renewable Energy in India. **Basics of Solar Energy:** Sun- earth Geometric Relationship, Layer of the Sun, Earth – Sun Angles and their Relationships, Solar Energy Reaching the Earth's Surface, Solar Thermal Energy Application. Block diagram of solar energy conversion.	
Unit – II	**08 Hrs**
Solar PV Systems: Basic Principle of SPV conversion – Types of PV Systems (Standalone, Grid connected, Hybrid system)- Types of Solar Cells, Photovoltaic cell concepts: Cell, module, array, PV Module I-V Characteristics, Array design (different methodologies), peak-power operation, system components. Efficiency & Quality of the Cell, series and parallel connections, maximum power point tracking, Applications.	
Unit –III	**08 Hrs**
Wind Power Systems: **Wind speed and energy:** Introduction, history of wind energy, scenario- world and India. Basic principle of Wind energy conversion system (WECS), Classifications of WECS, part of a WECS. Derivation of power in the wind, electrical power output and capacity of WECS, wind site selection consideration, advantages and disadvantages of WECS. Maximum energy capture, maximum power operation, , environmental aspects.	
Unit –IV	**08 Hrs**
Geothermal and ocean energy systems: Geothermal well drilling, advantages and disadvantages, Comparison of flashed steam and total flow concept (T-S diagram). Associated Problems, environmental Effects. **Energy from ocean:** OTEC power generation, OPEN and CLOSED cycle OTEC. Estimate of Energy and power in simple single basin tidal and double basin tidal system. Issues Faced in Exploiting Tidal Energy	
Unit –V	**08 Hrs**
Hydrogen Energy: Benefits of Hydrogen Energy, Hydrogen Production through block diagram, Use of Hydrogen Energy, Merits and Demerits, Problems Associated with Hydrogen Energy. **Biomass Energy:** Introduction-Biomass resources –Energy from Biomass: conversion processes-Biomass Cogeneration-Environmental Benefits. Biomass products – ethanol, biodiesel, biogas Electricity and heat production by biomass.	

Course Outcomes: After completing the course, the students will be able to: -	
CO 1	Understand the working principle and operation of various renewable energy sources and systems.
CO 2	Analyze the performance and characteristics of renewable energy sources and systems.
CO 3	Evaluate the parameters of wind and solar energy systems.
CO 4	Design and demonstrate the applications of renewable energy sources in a typical systems.

Reference Books	
1.	Non conventional energy sources, by G.D Rai, Khanna publishes, 19th Edition, 2017, ISBN: 978-81-7409-073-8
2.	Solar photo voltaic Technology and systems, by Chetan Singh Solanki, 3rd Edition, PHI, Learning private limited New Delhi, 2013, 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.	Renewable energy: Technology, Economics and Environment, Martin Kaltschmitt, Wolfgang Streicher Andreas Wiese, Springer Publication, 2007, ISBN 978-3-540-70947- 3

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
SYSTEMS ENGINEERING (Theory)						
Course Code	**:**	**21IE6F3**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 Hrs**		**SEE Duration**	**:**	**3.00 hours**

Unit-I	**06 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 Systems:** System building blocks and interfaces, Hierarchy of Complex systems, System building blocks, The system environment, Interfaces and Interactions. **The System Development Process:** Systems Engineering through the system Life Cycle, Evolutionary Characteristics of the development process, The system engineering method, Testing throughout system development, problems.	
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, Requirements analysis, Functional Analysis and Design, Prototype development, Development testing, Risk reduction, problems.	
Unit –IV	**10 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	**09 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	Understand the Life Cycle of Systems.
CO2	Explain the role of Stake holders and their needs in organizational systems.
CO3	Develop and Document the knowledge base for effective systems engineering processes.
CO4	Apply available tools, methods and technologies to support complex high technology systems.

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

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only; wherein one sub division will be a caselet in the related topics)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
MECHATRONICS **Category: Institutional Elective** **(Theory)**						
Course Code	**:**	21IE6F4		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	45 Hrs		**SEE Duration**	**:**	**3.00 hours**

Unit-I	**09 Hrs**
Overview of Mechatronic Systems: Traditional and mechatronic design, automatic washing machine, automatic door, dishwasher, compact disc drive copy machine, camera, and temperature control. Principle and working of hall sensor, displacement sensor, absolute and incremental encoders, photoelectric sensors, inductive and capacitive proximity sensors, Relays and solenoids, Brushless DC, AC and servo motors, pulse width modulation by basic transistor circuit, H bridge circuit, Stepper motor: variable reluctance and permanent magnet, stepper motor control circuits, selection of motors.	
Unit – II	**10 Hrs**
Signal Conditioning: Operational Amplifiers - circuit diagrams and derivation - Numerical, filtering, multiplexers, 4:1 MUX, time division multiplexing -seven segment display, data acquisition, Analog and digital signals, analog to digital converters. Introduction to Digital signal processing – difference equation (Numericals). **Programmable logic controllers:** Components, principle of operation, modifying the operation, basic PLC instructions, and concepts of ladder diagram, latching, timer instructions, counter instructions.	
Unit –III	**10 Hrs**
Ladder Diagram for PLCs: Examples with ladder logic programs, simple programs using Boolean logic, word level logic instructions. Relay to ladder conversion examples., **Industrial applications of PLCs:** Central heating system, valve sequencing, traffic light control in one direction, water level control, overhead garage door, sequential process, continuous filling operation, Fluid pumping with timers, parking garage counter, can counting in assembly line.	
Unit –IV	**08 Hrs**
Microcontrollers: Components of a full featured microcontroller, Memory, I/O Ports, Bus, Read & Write Cycle Architecture of Intel 8051 microcontroller, Pin diagram, simple instructions for a microcontroller. – Data transfer arithmetic functions, logical operations, Jump and branching operation. **Digital circuits:** Digital representations, Combinational logic - Case studies: BCD to 7 segment decoder, calenda subsystem in a smartwatch., timing diagrams, Karnough maps – 3 variable and 4 variable, design of logic networks, flip-flops, Counters.	
Unit –V	**08 Hrs**
Dynamic Responses of Systems Closed loop system, Terminology, transfer functions, step response of first order and second order systems, performance measures for first and second order systems, - Numerical **Mechanical Actuation Systems** Four bar chain, slider crank mechanism, Cams and followers, gear trains - Numerical	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Select appropriate sensors and transducers and devise an instrumentation system for collecting information about processes
CO2	Apply the electrical and logic concepts and inspect the functioning of mechatronic systems.
CO3	Evaluate a control system for effective functioning of Mechatronics systems using digital electronics, microprocessors, microcontrollers and programmable logic controllers
CO4	Develop conceptual design for Mechatronics products based on potential customer requirements

Reference Books	
1.	Nitaigour Premchand, 'Mechatronics-Principles, Concepts & Applications', TMH 1st Edition, 2009, ISBN: 9780070483743
2.	Bolton W., 'Mechatronics-Electronic Control System in Mechanical and Electrical Engineering', Pearson Education, 4th Edition, 2012; ISBN:9788131732533
3.	Tilak Thakur 'Mechatronics', Oxford University Press, I Edition, 2016, ISBN: 9780199459329
4.	Petruzella, Frank D, Programmable logic controllers, McGraw-Hill, 4th Edition, 2013, ISBN-13: 978-0-07-351088-0

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: (Internal Choice)	16
5 & 6	Unit 3: (Internal Choice)	16
7 & 8	Unit 4: (Internal Choice)	16
9 & 10	Unit 5: (Internal Choice)	16
	TOTAL	**100**

Semester: VI						
MATHEMATICAL MODELLING (Theory) (Group E: Global Elective)						
Course Code	**:**	21IE6F5		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	45L		**SEE Duration**	**:**	**3.00 hours**

Unit-I	**09 Hrs**
Continuous Models Using Ordinary Differential Equations: Basic concepts, real world problems (Science and Engineering), approximation of the problem, steps involved in modelling, formation of various continuous models.	
Unit – II	**09 Hrs**
Mathematically Modelling Discrete Processes: Difference equations - first and second order, introduction to difference equations, introduction to discrete models-simple examples, mathematical modelling through difference equations in economics, finance, population dynamics, genetics and other real-world problems.	
Unit –III	**09 Hrs**
Markov modelling: Mathematical foundations of Markov chain, applications of Markov modelling.	
Unit –IV	**09 Hrs**
Modelling through graphs: Graph theory concepts, modelling situations through different types of graphs.	
Unit –V	**09 Hrs**
Variational Problem and Dynamic Programming: Optimization principles and techniques, mathematical models of variational problem and dynamic programming and applications.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Explore the fundamental concepts of mathematical models arising in various fields of engineering.
CO2:	Apply the knowledge and skills of discrete and continuous models.
CO3:	Analyze the appropriate mathematical model to solve the real-world problem and optimize the solution
CO4:	Distinguish the overall knowledge gained to demonstrate the problems arising in many practical situations.

Reference Books	
1	Mathematical Modeling, J. N. Kapur, 1st Edition, 1998, New Age International, New Delhi, ISBN: 81-224-0006-X.
2	Mathematical Modeling: Models, Analysis and Applications, Sandip Banerjee, 2014, Chapman and Hall/CRC Textbook, ISBN 9781439854518.
3	Case Studies in Mathematical Modeling, D. J. G. James and J. J. Mcdonald, 1981, Stanly Thames, Cheltonham, ISBN: 0470271779, 9780470271773.
4	Modeling with Difference Equations, D. N. Burghes, M. S. Borrie, Ellis Harwood, 1981, ISBN 13: 9780853122869.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (05), Program specific requirements (05), Video based seminar/presentation/demonstration (10), MATLAB (20). **ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
INDUSTRY 4.0 - SMART MANUFACTURING FOR THE FUTURE **Category: Institutional Elective** **(Theory)**						
Course Code	**:**	21IE6F6		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	42 Hrs		**SEE Duration**	**:**	**3.00 hours**

Unit-I	**07 Hrs**
Introduction: The Various Industrial Revolutions, Need – Reason for Adopting Industry 4.0, Definition, Goals and Design Principles – Interoperability, Virtualization, Decentralization, Real-time Capability, Service Orientation, Modularity. Individualization, Volatility, Energy and resource efficiency. Road to Industry 4.0 - Internet of Things (IoT), Architecture of IoT, Technologies for IoT & Industrial Internet of Things (IIoT), Internet of Services, Standardization, Cyber-Physical Systems, Smart Manufacturing, Network via Ethernet/ Wi-Fi for high-speed data transmission, Mobile technologies	
Unit – II	**10 Hrs**
Opportunities and Challenges Lack of resources, Availability of skilled workers, Broadband infrastructure, Policies, Future of Works and Skills in the Industry 4.0 Era, Disruption as manufacturing's greatest modern challenge **Robotics in Industry 4.0** Robotic Automation and Collaborative Robots, Human-Machine Interaction **Big Data** Evolution**,** Essential of Big Data in Industry 4.0, Big Data Merits, Data transparency, Business Intelligence, Production planning, Quality, Acquisition of Automation Data, Digital Traceability, Radio-Frequency Identification (RFID), GPS, Data transformation, Big Data Characteristics, Data as a new resource for organizations, Data driven applications, Harnessing and sharing knowledge in organizations, Data analytics - Descriptive Analytics, Diagnostic analytics, Predictive Analytics, Prescriptive analytics	
Unit –III	**10 Hrs**
Cloud Computing Fundamentals, Cloud/Edge Computing and Industry 4.0, The IT/OT convergence, Cyber Security **Horizontal and Vertical integration** End-to-end engineering of the overall value chain, Digital integration platforms, Role of machine sensors, Sensing classification according to measuring variables, Machine-to-Machine communication **Artificial Intelligence/Machine Learning in Industry 4.0** Fundamentals, Case Studies, Technology paradigms in production logistics - Intelligent conveyor system, Intelligent commissioning system, Intelligent production machine, Intelligent load carrier, Application-specific demand on Intelligent Objects (user-oriented functions), Technological realization of Intelligent Objects (product-oriented functions)	
Unit –IV	**08 Hrs**
Augmented Worker Augmented and Virtual Reality, softwares, Industrial Applications – Maintenance, Assembly, Collaborative operations, Training **Digital-to-Physical** Additive Manufacturing technologies, Advantages, impact on environment, Applications – Automotive, Aerospace, Electronics and Medical	
Unit –V	**07 Hrs**
Digital twin, Virtual factory, Total Productive Maintenance, Industry 4.0 case studies, Understanding I 4.0 in MSMEs, What's Next: Industry 5.0/Society 5.0	

Course Outcomes: After completing the course, the students will be able to:	
CO1	Identify the basic components of Industry 4.0
CO2	Analyse the role of Big data for modern manufacturing
CO3	Create AR/VR models for industrial scenario
CO4	Create simple Additive manufactured parts

Reference Books	
1.	Industry 4.0: Managing the Digital Transformation, Alp Ustundag, Emre Cevikcan, 2017, Springer, ISBN: 978-3-319-57869-9, ISBN: 978-3-319-57870-5
2.	The Concept Industry 4.0 - An Empirical Analysis of Technologies and Applications in Production Logistics, Christoph Jan Bartodziej, 2017, Springer Gabler, ISBN 978-3-658-16501-7 ISBN 978-3-658-16502-4
3.	Industry 4.0 - The Industrial Internet of Things, Alasdair Gilchrist, 2016, APRESS, ISBN-13 978-1-4842-2046-7 ISBN-13: 978-1-4842-2047-4
4.	Digitizing the Industry – Internet of Things connecting the Physical, Digital and Virtual Worlds, Ovidiu Vermesan, 2016, River Publishers, ISBN 978-87-93379-81-7 ISBN 978-87-93379-82-4

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: (Internal Choice)	16
5 & 6	Unit 3: (Internal Choice)	16
7 & 8	Unit 4: (Internal Choice)	16
9 & 10	Unit 5: (Internal Choice)	16
	TOTAL	**100**

Semester: VI						
Industrial Psychology for Engineers (Theory - Institutional Electives – I))						
Course Code	**:**	21IE6F7		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	45 Hrs		**SEE Duration**	**:**	**3.00 hours**

Unit-I	**08 Hrs**
Introduction to Psychology: Definition and goals of Psychology: Role of a Psychologist in the Society: Today's Perspectives (Branches of psychology- Clinical, Industrial). Psychodynamic, Behavioristic, Cognitive, Humanistic, Psychological Research and Methods to study Human Behavior: Experimental, Observation, Questionnaire and Clinical Method.	
Unit – II	**08 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	**10 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.	
Unit –IV	**10 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.	
Unit –V	**09 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. **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. Type A and Type B.**Psychological Counseling** - Need for Counseling, Types – Directed, Non- Directed, Participative Counseling.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Describe the basic theories, principles, and concepts of applied psychology as they relate to behaviors and mental processes.
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.
CO5	Understand the application of psychology in engineering and technology and develop a route to accomplish goals in their work environment.

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.	Organizational Behaviour , Stephen P Robbins Pearson Education Publications, 13th Edition, ISBN – 81-317 – 1132 – 3
4.	Organisational Behaviour : Human Behaviour at Work ,John W.Newstrem and Keith Davis. Tata McGraw Hill India, 10th Edition, ISBN 0-07-046504-5
5	Psychology-themes and variations , Wayne Weiten, IV edition, Brooks / Cole Publishing Co.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only; wherein one sub division will be a caselet in the related topics)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
ELEMENTS OF FINANCIAL MANAGEMENT (Theory)						
Course Code	**:**	**21IE6F8**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	45 Hrs		**SEE Duration**	**:**	**3.00 hours**

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	**10 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	**09 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)	

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.

Reference Books:	
2.	Fundamentals of Financial Management, Prasanna Chandra, 6th Edition, 2018, McGraw Hill
2.	Education(India) Pvt. Ltd, ISBN: 978-93-392-0313-9, 93-392-0313-5
3.	Financial Management-Text, Problems and Cases, Khan M Y & Jain P K, 8th Edition, 2018,
4.	McGraw Hill Education(India) Pvt. Ltd, ISBN: 9353162181 , 9789353162184

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only; wherein one sub division will be a caselet in the related topics)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
Universal Human Values - II (Institutional Electives – I)						
Course Code	**:**	**21IE6F9**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**10 Hrs**
Introduction-Basic Human Aspiration, its fulfillment through All-encompassing Resolution. The basic human aspirations and their fulfillment through Right understanding and Resolution, Right understanding and Resolution are the activities of the Self, Self is central to Human Existence; All-encompassing Resolution for a Human Being, its details and solution of problems in the light of Resolution.	
Unit – II	**10 Hrs**
Right Understanding (Knowing)- Knower, Known & the Process. The domain of right understanding starts from understanding the human being (the knower, the experiencer and the doer); and extends up to understanding nature/existence – its interconnectedness and co-existence; and finally understanding the role of human being in existence (human conduct).	
Unit –III	**08 Hrs**
Understanding Existence (including Nature). A comprehensive understanding (knowledge) about the existence, which certainly includes the Nature. The need and the process of inner evolution (through self-exploration, self-awareness and self-evaluation)- particularly awakening to activities of the Self: Realization, Understanding and Contemplation in the Self (Realization of Co-Existence, Understanding of Harmony in Nature and Contemplation of Participation of Human in this harmony/ order leading to comprehensive knowledge about the existence).	
Unit –IV	**08 Hrs**
Understanding Human Being. Understanding the human being comprehensively is the first step and the core theme of this course; human being as co-existence of the self and the body, the activities and potentialities of the self, Reasons for harmony/contradiction in the self.	
Unit –V	**08 Hrs**
Understanding Human Conduct, All-encompassing Resolution & Holistic Way of Living. Understanding Human Conduct, Understanding different aspects of All-encompassing Resolution (understanding, wisdom, science etc.), Holistic way of living for Human Being with All-encompassing Resolution covering all four dimensions of human endeavour viz., realization, thought, behavior and work (participation in the larger order) leading to harmony at all levels from self to Nature and entire Existence.	

Course Outcomes: After completion of the course the students will be able to	
CO1	Understand the basic human aspiration with program of its fulfilment and meaning of resolution in the complete expanse of human living.
CO2	Understand human being in depth and see how self is central to human being
CO3	Understand existence in depth and see how coexistence is central to existence
CO4	Understand human conduct and the holistic way of living leading to human tradition

Reference Books	
1	A foundation course in human values and professional ethics, R. R. Gaur, R Asthana, G P Bagaria, 2nd revised Edition, excel books, New Delhi – 2019, ISN 978-93-87034-47-1
2	Avartansheel Arthshastra, A Nagraj, Divya Path Sansthan, Amarkantak, India, ISBN 978-8-174-46781-2
3	Economy of Performance- a quest for social order based on non – violence, J C Kumarappa, 2010, Sarva-Seva-Sangh-Prakashan, Varanasi, India
4	Energy and Equity, Ivan Illich, 1974, The Trinity Press, Worcester & Harper Collins, USA, ISBN, 0060803274, 9780060803278

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
Human Machine Interface (HMI) **Institutional Elective** **Industry Assisted Elective-BOSCH**						
Course Code	:	21IE6F10		**CIE**	:	100 Marks
Credits: L:T:P	:	3:0:0		**SEE**	:	100 Marks
Total Hours	:	45L		**SEE Duration**	:	3Hours

Unit-I	**09 Hrs**
FOUNDATIONS OF HMI: The Human: History of User Interface Designing, I/O channels, Hardware, Software and Operating environments, The Psychopathology of everyday Things, Psychology of everyday actions, Reasoning and problem solving. The computer: Devices, Memory, processing and networks. Interaction: Models, frameworks, Ergonomics, styles, elements, interactivity, Paradigms. **Introduction to HMI and domains**: Automotive, Industrial, CE, Medical, ECUs within car and their functionalities. Interaction between ECUs. Communication protocols for ECUs(CAN, LIN, Most, FlexRay, Ethernet etc)	
Unit – II	**09 Hrs**
Automotive Human-Machine Interfaces: Automotive infotainment system - Evolution road map, Feature sets, System architecture, Trends, Human factors and ergonomics in automotive design, Automotive User Experience (UX) Design Principles, In-Vehicle Information Systems (IVIS), Driver-Assistance Systems (DAS) Interfaces, HMI design for adaptive cruise control, Voice and Gesture Recognition in Automotive HMIs, Touchscreen Interfaces and Controls, Usability Testing and Evaluation in Automotive HMIs, Safety Considerations and Regulations in Automotive HMIs, Emerging Technologies in Automotive HMIs, Human-Machine Interfaces for Autonomous Vehicles	
Unit –III	**09 Hrs**
UX and Guidelines: Introduction to UX design - stages, theory, Design thinking, UX Study, Interaction concepts, Graphic design tools - Adobe Photoshop, Adobe XD, Blender, GIMP, Asset Design - Overview , Guidelines and norms, 2D/3D rendering, OpenGL, OSG.	
Unit –IV	**09 Hrs**
HMI User Interface: User-centered HMI development process, Basics of Web-Server. Web-based HMI: Basics of TwinCAT and HTML, CSS, JavaScript. **HMI on Mobile**: Four Principles of Mobile UI Design, Benefits of Mobile HMIs, Mobile HMI Development Suites.	
Unit –V	**09 Hrs**
HMI Control Systems: Introduction to Voice-Based HMI, Gesture-Based HMI, Sensor-Based UI controls. **Haptics in Automotive HMI**: Kinesthetic Feedback Systems, Tactile Feedback Systems, Haptics in Multimodal HMI, Automotive Use-Cases **HMI Testing**: Limitations of Traditional Test Solutions, Case - Study: Bosch's HMI validation tool - Graphics Test Systems (GTS). **UI analytics**: Usage patterns, Debugging, Performance Profiling, Use Cases.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understanding the application of HMIs in various domain
CO2	Comparison of various communication protocols used in HMI development.
CO3	Apply and Analyse the car multimedia system free software and hardware evolution
CO4	Design and Evaluate the graphic tools and advanced techniques for creating car dashboard multimedia systems
Reference Books	
1	Shuo gao, Shuo Yan, Hang Zhao, Arokia Nathan " Touch based HMI; Principles and Applications" Springer Nature Switzerland AG, 1st Edition.
2	Robert Wells, " Unity 2020 by Example: A Project based guide to building 2D, 3D augumented reality and Virtual reality games from sratch" Packt Publishing ltd , edition 2020
3	Ryan Cohen, Tao Wang, "GUI Design and Android Apps" Apress, Berkley, CA,2014

ASSESSMENT AND EVALUATION PATTERN		
	CIE	**SEE**
WEIGHTAGE	**50%**	**50%**
QUIZZES		
Quiz-I	Each quiz is evaluated for 10 marks adding up to **20 MARKS**	
Quiz-II		
THEORY COURSE (Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating)		
Test – I	Each test will be conducted for 50 Marks adding upto 100 marks. Final test marks will be reduced to **40 MARKS**	
Test – II		
EXPERIENTIAL LEARNING	**40**	
MATLAB	**20**	
Model presentation/ case study/ video preparation	**20**	
MAXIMUM MARKS FOR THE THEORY	**100 MARKS**	**100 MARKS**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
PART A		
1	Objective type questions covering entire syllabus	20
PART B (Maximum of TWO Sub-divisions only)		
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
HUMAN RESOURCE MANAGEMENT (Theory)						
Course Code	**:**	**21IM67**		**CIE**	**:**	**50 Marks**
Credits: L:T:P	**:**	**2:0:0**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**30L**		**SEE Duration**	**:**	**2 Hours**

UNIT-I	**10 Hrs**
Introduction to Human Resource Management: Objectives of HRM, Importance of HRM, Line & Staff aspects of HRM, Duties & Responsibilities of HRM and Competencies of HRM. **Job Analysis & Talent Management:** Talent Management Process, Basics of Job Analysis, Methods for collecting Job Analysis Information and Writing Job Descriptions & Specifications.	
UNIT-II	**10 Hrs**
Personnel Planning & Recruiting: Workforce Planning & Forecasting, Recruitment Process and Internal & External Sources of Candidates. **Employee Testing, Selection & Interviewing:** Basics of Testing & Selecting Employees, Types of Tests, Work Samples & Simulations, Background Investigation & Other Selection Methods, Basic Types of Interviews.	
UNIT-III	**10 Hrs**
Training & Development: Orienting & Onboarding New Employees, Training Process, Implementing Training Program, Implementing Management Development Programs and Evaluating Training Process. **Performance Management & Appraisal:** Basics of Performance Management & Appraisal, Techniques for Appraising Performance, Managing Appraisal Interview, Talent Management & Employee Appraisal	

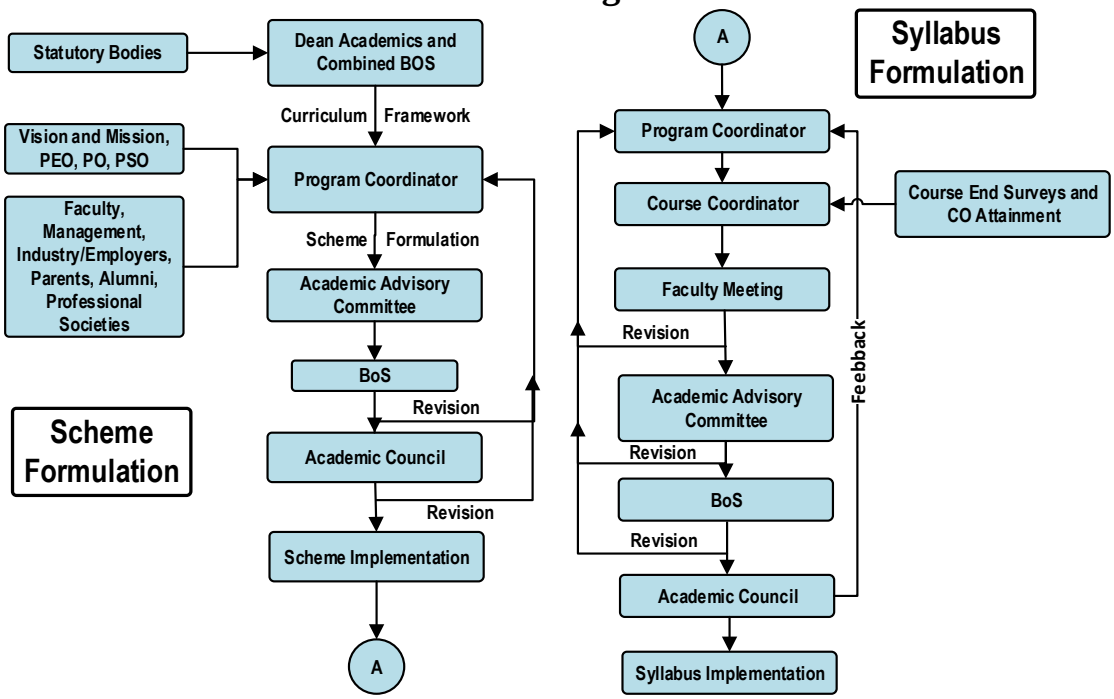
Course Outcomes: After completing the course, the students will be able to	
CO1:	Recognize the basic functions, strategy & practices of human resource management.
CO2:	Understand the processes of planning & recruitment of employees in organizations.
CO3:	Demonstrate the employee selection & interviewing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

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

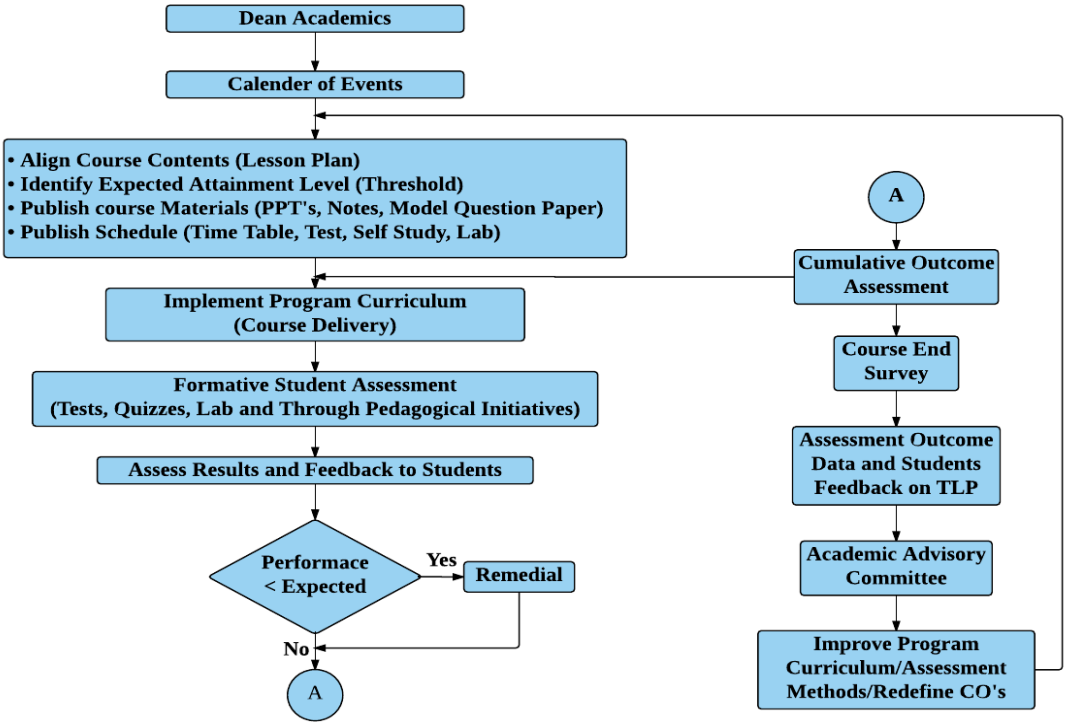
RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each quiz will be evaluated for 5 Marks adding up to 10 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS THE FINAL QUIZ MARKS.**	**10**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 25 Marks, adding up to 50 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 20 MARKS.**	**20**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (10) & Phase II (10)ADDING UPTO 20 MARKS**.	**20**
	MAXIMUM MARKS FOR THE CIE THEORY	**50**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	10
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	12
3 & 4	Unit 2 : Question 3 or 4	14
5 & 6	Unit 3 : Question 5 or 6	14
	TOTAL	**50**

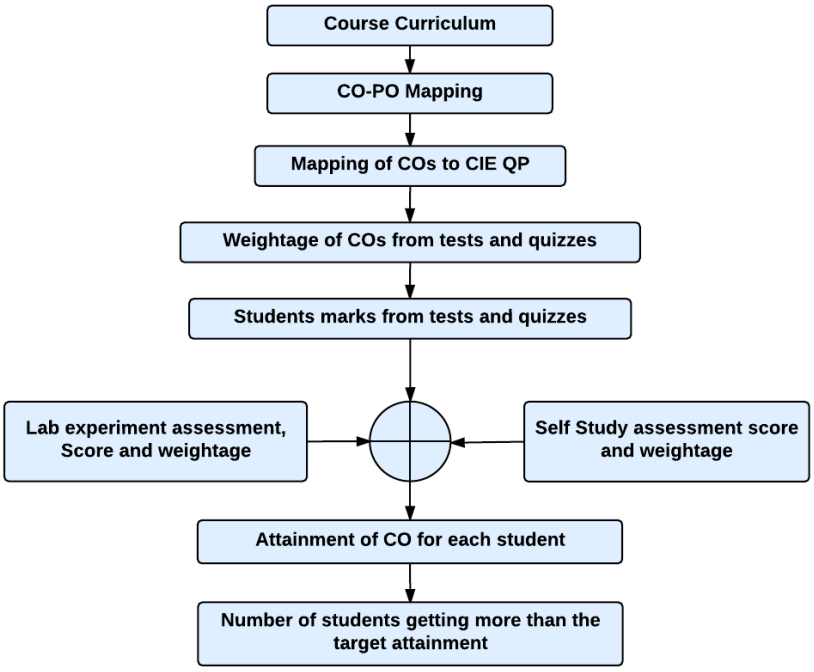
Curriculum Design Process



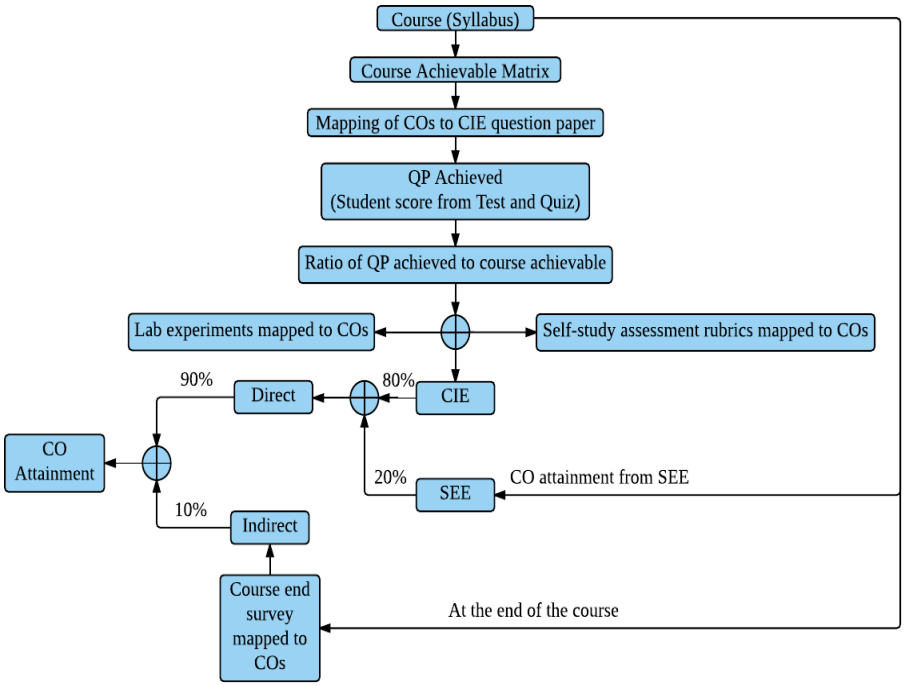
Academic Planning and Implementation



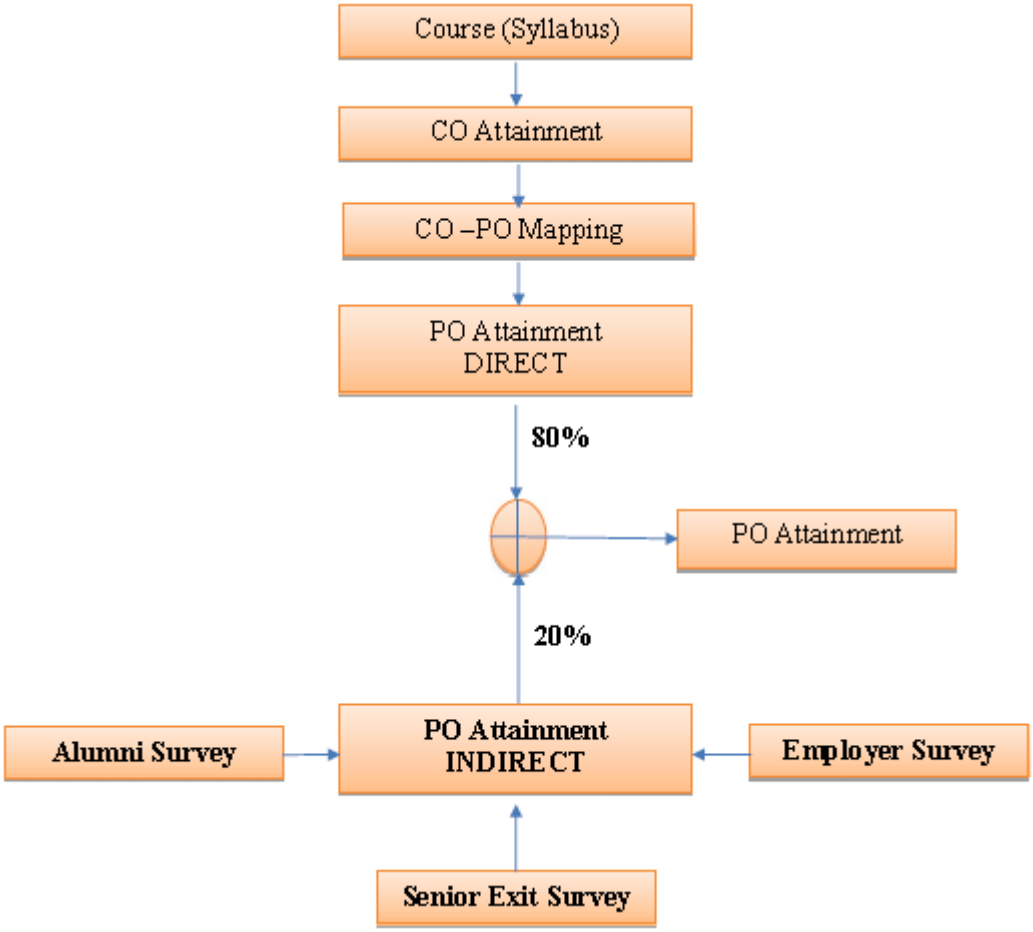
Process For Course Outcome Attainment



Final CO Attainment Process



Program Outcome Attainment Process



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PROGRAM OUTCOMES (POs)

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

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

3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet 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.