RV College of Engineering®


# Bachelor of Engineering (B.E)

Scheme And Syllabus Of V & VI Semesters
(2022 Scheme)

B.E. Programs : AS, BT, CH, CS, CS - AI, CS - CD, CS - CY, CV, EC, EE, ET, IM, IS, ME.
M. Tech (13) MCA, M.Sc. (Engg.)
Ph.D. Programs : All Departments are recognized as Research Centres by VTU Except AI & AS

2024

**99TH**
NIRF RANKING IN ENGINEERING (2024)

THE HIGHER EDUCATION WORLD UNIVERSITY RANKINGS-2022

**1501+**

THE HIGHER EDUCATION WORLD UNIVERSITY RANKINGS-2023 (ASIA)

**501-600**

EDUPUTURE EXCELLENCE AWARD
BEST PRIVATE ENGINEERING UNIVERSITY (SOUTH)
BY ZEE DIGITAL

**1001+**
SUBJECT RANKING (ENGINEERING)

**801+**
SUBJECT RANKING (COMPUTER SCIENCE)

**IIRF 2023**
ENGINEERING RANKING INDIA
NATIONAL RANK-10
STATE RANK - 2
ZONE RANK - 5

QS-IGUAGE DIAMOND UNIVERSITY RATING (2021-2024)

## CURRICULUM STRUCTURE

**61** CREDITS PROFESSIONAL CORES (PC)

**23** CREDITS BASIC SCIENCE

**22** CREDITS ENGINEERING SCIENCE

**18** CREDITS PROJECT WORK / INTERNSHIP

**12** CREDITS* OTHER ELECTIVES & AEC

**12** CREDITS PROFESSIONAL ELECTIVES

**12** CREDITS HUMANITIES & SOCIAL SCIENCE

**160** CREDITS TOTAL

*ABILITY ENHANCEMENT COURSES (AEC), UNIVERSAL HUMAN VALUES (UHV), INDIAN KNOWLEDGE SYSTEM (IKS), YOGA.

**17**
Centers of Excellence

**11**
Centers of Competence

**212**
Publications On Web Of Science

**669**
Publications Scopus (2023 - 24)

**1093**
Citations

**70**
Patents Filed

**39**
Patents Granted

**61**
Published Patents

**11**
Skill Based Laboratories Across Four Semesters

MOUS: 90+WITH INSDUSTRIES / ACADEMIC INSTITUTIONS IN INDIA & ABROAD

EXECUTED MORE THAN RS.40 CRORES WORTH SPONSORED RESEARCH PROJECTS & CONSULTANCY WORKS SINCE 3 YEARS

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# Bachelor of Engineering (B.E)

Scheme And Syllabus Of V & VI Semesters
(2022 Scheme)

B.E. Programs : AS, BT, CH, CS, CS - AI, CS - CD, CS - CY, CV, EC, EE, ET, IM, IS, ME.
M. Tech (13) MCA, M.Sc. (Engg.)
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2024

# MECHANICAL ENGINEERING

## DEPARTMENT VISION

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

## DEPARTMENT MISSION

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

## PROGRAM EDUCATIONAL OBJECTIVES

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

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

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

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

# PROGRAM SPECIFIC OUTCOMES

PSO1 Project Innovation: Competency, creativity and innovativeness in Mechanical Engineering with Multidisciplinary approach.

PSO2 Research Innovation: Analytical, research and communication skills for placement in industries, research organizations and for pursuing higher education.

PSO3 Special Labs: Knowledge in cutting edge technologies and skills in modern simulation tools.

# LEAD SOCIETY

## American Society of Mechanical Engineers - ASME

| 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. | PY | Physics |
| 21. | CY | Chemistry |
| 22. | MA | Mathematics |
| 23. | AEC | Ability Enhancement Courses |

## Bachelor of Engineering in

# MECHANICAL ENGINEERING

## 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 | HS351TA | Entrepreneurship and Intellectual Property Rights | 3 | 0 | 0 | 3 | HS | Theory | 1.5 | **100** | **** | **3** | **100** | **** |
| 2 | ME252IA | Flexible Manufacturing Systems | 3 | 0 | 1 | 4 | ME | Theory + Lab | 1.5 | **100** | **50** | **3** | **100** | **50** |
| 3 | ME353IA | Heat Transfer | 3 | 0 | 1 | 4 | ME | Theory + Lab | 1.5 | **100** | **50** | **3** | **100** | **50** |
| 4 | ME354TA | Design of Machine Elements - I | 3 | 1 | 0 | 4 | ME | Theory | 1.5 | **100** | **** | **3** | **100** | **** |
| 5 | ME355TBX | Professional Core Elective-I (Group-B) | 3 | 0 | 0 | 3 | ME | Theory | 1.5 | **100** | **** | **3** | **100** | **** |
| 6 | ME256TCX | Professional Core Elective-II (Group C) | 0 | 0 | 2 | 2 | ME | NPTEL | **** | **** | **** | **3** | **100** | **** |
| | | | | | | **20** | | | | | | | | |

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RV College of Engineering®
Mysore Road, RV Vidyaniketan Post,
Bengaluru - 560059, Karnataka, India

*Go, change the world*

## Bachelor of Engineering in
# MECHANICAL ENGINEERING

## 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 | HS261TA | Principles of Management and Economics | 3 | 0 | 0 | 3 | HS | Theory | 1.5 | **100** | **** | **3** | **100** | **** |
| 2 | ME362IA | Design of Machine Elements - II | 3 | 0 | 1 | 4 | ME | Theory + Practice | 1.5 | **100** | **50** | **3** | **100** | **50** |
| 3 | ME363IA | Finite Element Analysis | 3 | 0 | 1 | 4 | ME | Theory + Practice | 1.5 | **100** | **50** | **3** | **100** | **50** |
| 4 | ME364TA | Control Engineering | 3 | 1 | 0 | 4 | ME | Theory | 1.5 | **100** | **** | **3** | **100** | **** |
| 5 | ME365TDX | Professional Core Elective **(Group- D)** | 3 | 0 | 0 | 3 | XX | Theory | 1.5 | **100** | **** | **3** | **100** | **** |
| 6 | XX366TEX | Institutional Electives – I **(Group E)** | 3 | 0 | 0 | 3 | XX | Theory | **** | **** | **** | **3** | **100** | **** |
| 7 | ME367P | Interdisciplinary Project | 0 | 0 | 3 | 3 | ME | Project | 2 | **** | **50** | **3** | **** | **50** |
| | | | | | | **24** | | | | | | | | |

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**Professional Core Elective (Group- D)**



**Institutional Electives – I (Group E)**

| Semester: V | | | | | | |
|---|---|---|---|---|---|---|
| **ENTREPRENEURSHIP & INTELLECTUAL PROPERTY RIGHTS (Theory)** | | | | | | |
| **Course Code** | **:** | HS351TA | | **CIE** | **:** | **100 Marks** |
| **Credits: L: T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 42 L | | **SEE Duration** | **:** | **3 Hours** |

| **Unit-I** | **08 Hrs** |
|---|---|
| **Introduction to Entrepreneurship**: Definition and Scope of Entrepreneurship, Importance of Entrepreneurship in Engineering Innovation and Economic Growth, Techniques for Identifying Entrepreneurial Opportunities, Types of Entrepreneurs: Innovative, Imitative, Fabian, Characteristics and Traits of Successful Entrepreneurs.<br>**Role in economic development**- Emerging Trends in Entrepreneurship, Entrepreneur and Entrepreneurship, characteristics of Entrepreneur, Myths about Entrepreneurship, Entrepreneur vs Intrapreneur, Role of Entrepreneurial Teams<br>**Activities**: Case study on Entrepreneurship in Indian Scenario, Ideation Workshops and Hackathons, | |
| **Unit – II** | **08 Hrs** |
| **Entrepreneurial Opportunity Evaluation**: Identifying Market Opportunities and Trends, Integration of Engineering Principles in Ideation Process, Cross-Disciplinary Collaboration for Technological Innovation, Assessing Market Feasibility and Demand Analysis, Evaluating Technical Feasibility: Prototype Development, Proof of Concept, Financial Feasibility Analysis: Cost Estimation, Revenue Projection, Break-Even Analysis**.**<br>**Business Planning and Strategy Development**: Elements of a Business Plan, Executive Summary, Company Description, Market Analysis, writing a Business Plan: Structure and Components, Strategic Planning: Vision, Mission, Goals, Objectives, SWOC Analysis, Competitive Strategy: Porter's Generic Strategies, Differentiation, Cost Leadership, Focus Strategy, Growth Strategies: Organic Growth, Mergers and Acquisitions, Strategic Alliances<br>**Activities**: Writing a Business Plan on given templates, Developing Business Models and Prototypes Based on Generated Ideas | |
| **Unit –III** | **08Hrs** |
| **Entrepreneurial Marketing and Sales:** Basics of Marketing: Product, Price, Place, Promotion (4Ps), Market Segmentation, Targeting, and Positioning (STP), Branding and Product Development Strategies, Creating a Unique Value Proposition (UVP) Digital Marketing: Social Media Marketing, Content Marketing, SEO, SEM, Sales Techniques and Customer Relationship Management (CRM).<br>Entrepreneurial Finance and Resource Management: Sources of Financing: Equity Financing, Debt Financing, Venture Capital, Angel Investors, Crowdfunding, Financial Management: Budgeting, Cash Flow Management, Financial Statements Analysis, Risk Management and Insurance, Human Resource Management: Recruitment, Training, Performance Evaluation, Legal and Ethical Issues in Entrepreneurship: Intellectual Property Rights, Contracts, Corporate Governance<br>Activities:Case Studies and Practical Applications | |
| **Unit -IV** | **09Hrs** |
| **Introduction to IP :** Types of Intellectual Property<br>**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.<br>**Trade Marks:** Concept, function and different kinds and forms of Trademarks, 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. | |
| **Unit –V** | **09 Hrs** |
| **Trade Secrets:** Definition, Significance, Tools to protect Trade secrets in India.<br>**Industrial Design:** Introduction of Industrial Designs Features of Industrial, Design. Procedure for obtaining Design Protection, Revocation, Infringement and Remedies, Case studies.<br>**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. | |

| **Course Outcomes:** After going through this course, the student will be able to; | |
|---|---|
| **CO1** | Understand the concepts of entrepreneurship and cultivate essential attributes to become an entrepreneur or Intrapreneur and demonstrate skills such as problem solving, team building, creativity and leadership. |
| **CO2** | Comprehend the process of opportunity identification of market potential and customers while developing a compelling value proposition solutions. |
| **CO3** | Analyse and refine business models to ensure sustainability and profitability and build a validated MVP of their practice venture idea and prepare business plan, conduct financial analysis and feasibility analysis to assess the financial viability of a venture. |
| **CO4** | Apply insights into the strategies and methods employed to attain a range of benefits from these IPs and deliver an investible pitch deck of their practice venture to attract stakeholders |
| **CO5** | Knowledge and competence related exposure to the various Legal issues pertaining to Intellectual Property Rights with the utility in engineering perspectives. |

| **Reference Books** | |
|---|---|
| **1.** | Donald F. Kuratko ,"Entrepreneurship: Theory, Process, and Practice", South-Western Pub publishers, 10th edition, 2016,978-ISBN-13: 1305576247 |
| **2.** | Eric Ries, "The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses", Crown Currency Publishers,1st Edition, 2011, ISBN-13: 978-0307887894. |
| **3.** | Dr B L Wadehra, Law Relating to Intellectual Property, universa Law publishers 05th edition, ISBN : 9789350350300 . |
| **4** | Intellectual Property Rights: Unleashing Knowledge Economy, Prabuddha Ganguly, 1st Edition, 2001, Tata McGraw Hill Publishing Company Ltd., New Delhi, ISBN: 0074638602. |

| **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 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. 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** | **100** |

| **RUBRIC FOR SEMESTER END EXAMINATION (THEORY)** | | |
|---|---|---|
| **Q.NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B**<br>(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 | | | | | | |
|---|---|---|---|---|---|---|
| **FLEXIBLE MANUFACTURING SYSTEMS**<br>**Category: Professional Core**<br>**(Theory & Practice)** | | | | | | |
| **Course Code** | **:** | ME252IA | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:1 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 45 L+30 P | | **SEE Duration** | **:** | **3.00 Hours** |

| **Unit-I** | **06 Hrs** |
|---|---|
| **Introduction to Flexible manufacturing systems**<br>Manufacturing flexibility and tests, types, benefits and components of flexible manufacturing systems, typical layouts, operational elements of a flexible machining cell, types of automated guided vehicle systems and conveyors, vehicle guidance, management and safety, components and working of Automated storage/Retrieval and carousal systems, Coordinate measuring machines and computer aided inspection, machine vision, optimization of FMS. | |
| **Unit – II** | **10 Hrs** |
| **Manufacturing Metrics:** Cycle time and production rate for job shop, batch and mass production, workload and production capacity, manufacturing lead time and work in process, robot accuracy and repeatability, bottleneck model in FMS. (Numerical Problems)<br>**Analysis of Material handling and storage systems:** Analysis of vehicle-based systems, AGVS routing, Conveyor analysis – Single direction, continuous loop, recirculating, Sizing the rack structure, throughput, storage capacity and through put analysis for AS/RS and carousal storage systems (Numerical problems) | |
| **Unit –III** | **10 Hrs** |
| **Automated production lines and assembly systems:** General configuration of transfer line/assembly line, Work Part Transport, Storage Buffers, hardware components of part delivery, cycle time analysis and performance measures, analysis of production lines without storage buffer and with storage buffer. quantitative analysis of parts delivery system, single and multi-station assembly machines. (Numerical Problems)<br>**Scheduling in FMS:** Gantt chart, flow shop scheduling, Johnson's rule, branch and bound technique, CDS heuristic, palmers' heuristic, job shop scheduling – non delay schedule generation heuristic, graphical method, n jobs and m- machines scheduling, 2 jobs and M machines scheduling. | |
| **Unit –IV** | **10 Hrs** |
| **Computer numerical control and Direct numerical control:** Fundamentals of NC, classification of NC controls, NC coordinate systems, CNC structure, DNC, Types of CNC turning centers and machining centers with axis designations., tool presetting, ISO coding of CNC tool, Automatic Pallet Changer (APC) and Automatic Tool Changer (ATC).<br>**CNC programming for turning centers:** G and M codes, Single pass canned cycles (G90, G92, G94), positive and negative taper, Multipass canned cycles (G70, G71, G72, G73, G74, G75, G76), M codes for turning centers, tool turret, Programming exercises on combination of all turning operations. | |
| **Unit –V** | **09 Hrs** |
| **CNC programming for machining centers:** Multipass canned cycles for drilling (G80, G81, G82, G83, G84, G85, G86), tool length compensation G43, end milling with cutter radius compensation G41 and G42, Sub programming. Programming exercises for machining centers with milling and drilling combinations.<br>**Macros and Robot Programming:** MACRO variables, functions and branching. Programming exercises on drilling and machining elliptical slots, rectangular pocket with Macros. VAL/VAL II Programming instructions – Monitor commands, Motion control commands, Interlock commands, program control and Subroutine commands, sensor commands. Simple exercises on palletizing, depalletizing, weld curve. | |

| PART – B – Flexible Manufacturing System | 30 Hrs |
|---|---|
| 1. Introduction to CNC Programming: Basic Turning Operations – Box turning and taper turning<br>2. Exploring CNC Turning: Facing, Profile Turning, peck drilling and Grooving/Parting off.<br>3. Advanced CNC Turning: Threading, Negative/Positive taper, Arc Profiling<br>4. CNC Milling Fundamentals: Programming 2D Profile Contouring with subroutines<br>5. Mastering CRC : 2D Slab milling , End milling with Drilling combinations.<br>6. Transformations with CNC Milling: Mirroring, Scaling, and Rotation<br>7. CNC Programming for Pitch circle Dia drilling, Drilling and milling integration<br>8. Programming for circular and rectangular pocketing<br>**Lab EL**<br>9. CNC Turning and Milling Integration:<br>10. CNC Programming for Thread Milling and Helical Interpolation. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Illustrate the basic elements in an automated manufacturing work cell layout, production line system and robots. |
| **CO2:** | Analyse the kinematics of robot structure and programming concepts for computer integrated turning and machining centres. |
| **CO3:** | Apply the concepts of speed, feed, depth of cut for the purpose of selection of appropriate machining parameters and cutting tools for CNC milling and turning. |
| **CO4:** | Develop Manual part programs and Robot VAL II programs and validate manual NC part program data using standard commercial CAM package/Robo simulator. |

| **Reference Books** | |
|---|---|
| **1** | Automation, production systems and computer integrated manufacturing, Mikell P Groover, 4th edition, 2016. Pearson education –ISBN: 978-9332572492 |
| **2** | Chennakesava R. Alavala, CAD/CAM: Concepts and Applications, Published by PHI, 2008, ISBN 10: 8120333403 / ISBN 13: 9788120333406 |
| **3** | Computer-integrated Manufacturing: Automation in Manufacturing, R. Panneerselvam, P. Senthilkumar, P. Sivasankaran, 1st edition, 2020 Cengage Learning India Pvt. Ltd. ISBN: 978-9353503208 |
| **4** | Mikell P Groover, Emory W. Zimmers Jr, CAD/CAM, 2nd Edition, 2003, Pearson Education Inc., ISBN:81-7758-416-2. |

| RUBRICFOR 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. Each quiz is evaluated for 10 marks adding up to 20 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 **50Marks**, 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 (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**. | **40** |
| 4. | **LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (30 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (10 Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50 MARKS | **50** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **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: (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** |

| RUBRIC FOR SEMESTER END EXAMINATION (LAB) | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| 1 | Write Up | **10** |
| 2 | Conduction of the Experiments | **20** |
| 3 | Viva | **20** |
| | **TOTAL** | **50** |

| Semester: V | | | | | | |
|---|---|---|---|---|---|---|
| **HEAT TRANSFER**<br>**Category: Professional Core**<br>**(Theory & Practice)** | | | | | | |
| **Course Code** | **:** | ME353IA | | **CIE** | **:** | **100 Marks + 50 Marks** |
| **Credits: L:T:P** | **:** | 3:0:1 | | **SEE** | **:** | **100 Marks + 50 Marks** |
| **Total Hours** | **:** | 45 L+ 30 P | | **SEE Duration** | **:** | **3 Hours + 3 Hours** |

| **Unit-I** | **08 Hrs** |
|---|---|
| **Steady state heat conduction:** Modes of heat transfer: Basic laws governing conduction, convection and radiation heat transfer, Thermal conductivity; Convective heat transfer co-efficient; Boundary conditions - I, II and III kind, General 3 – dimensional heat conduction equation in Cartesian co-ordinates Steady state heat conduction in plane wall and multilayer walls, Thermal contact resistance, discussion on 3-D conduction in cylindrical and spherical coordinate systems (No derivation), plane and multilayer Cylinders, plane and multilayer Spheres, Overall heat transfer coefficient, Critical radius of insulation | |
| **Unit – II** | **10 Hrs** |
| **Heat transfer from finned surfaces:** Governing equations, solutions for different boundary conditions, fin efficiency and effectiveness, Selection of fins. problems<br>**Transient Heat Conduction:** Lumped system analysis, transient heat conduction in large plane walls, long cylinders, use of charts for Transient heat conduction in semi-infinite and infinite solids. Numerical problems | |
| **Unit –III** | **12 Hrs** |
| **Forced Convection:**<br>Dimensional analysis, Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers. External forced convection: Dimensional analysis, flow over flat plates, and flow across cylinders, Spheres; Internal forced convection: Laminar and turbulent flow in tubes with entry length concepts. Problems<br>**Natural Convection:**<br>Physical mechanism of convection, classification of fluid flow, concepts of velocity boundary layer; General expressions for drag coefficient and drag force; thermal boundary layer, general expression for local heat transfer coefficient, Average heat transfer coefficient Physical mechanism of natural convection, dimensional analysis, natural convection over surfaces - Vertical plates, cylinders, horizontal and inclined plates. Numerical problems | |
| **Unit –IV** | **07 Hrs** |
| **Boiling and Condensation:** Film and Drop wise Condensation, Boiling regimes, Heat pipe, Problems.<br>**Radiation Heat Transfer:**<br>Thermal radiation, Laws of radiation, Black body radiation, Radiation intensity, View factor and its relations, Black Surfaces and grey surfaces, Radiation shields and the radiation effect, Problems | |
| **Unit-V** | **08 Hrs** |
| **Heat Exchangers:**<br>Types of heat exchangers, overall heat transfer co-efficient, Log Mean Temperature Difference; Analysis of heat exchangers (parallel, counter, cross and shell and tube), fouling and fouling factor, effectiveness, NTU method, Problems | |

| PART – B – HEAT TRANSFER LABORATORY | 30 Hrs |
|---|---|

**Section – I**

1. Determination of thermal conductivity of metal rod
2. Determination of thermal conductivity of insulating powder
3. Determination of Stefan Boltzmann constant
4. Determination of Emissivity of a surface

**Section – II**

1. Determination of heat transfer co-efficient in free convection for Vertical cylinder and Horizontal cyclinder
2. Determination of heat transfer co-efficient in forced convection flow through a circular pipe
3. Determination of heat transfer co-efficient in forced and free convection for pin –fin equipment.
4. Determination of overall heat transfer co-efficient and effectiveness in parallel flow, counter flow, and Cross flow heat exchanger.

| **Course Outcomes: After completing the course, the students will be able to:** | |
|---|---|
| **CO1** | Explain the process of conductive, convective and radiation heat transfer. (L1 & L2) |
| **CO2** | Formulate and solve conduction problems. (L3 & L4) |
| **CO3** | Identify and analyse flow regime and use correlation for solving heat transfer. (L5) |
| **CO4** | Design and analyse performance of heat exchangers. (L5) |

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

| **RUBRICFOR 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. Each quiz is evaluated for 10 marks adding up to 20 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 **50Marks**, 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 (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**. | **40** |
| 4. | **LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (30 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (10 Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50 MARKS | **50** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **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: (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** |

| RUBRIC FOR SEMESTER END EXAMINATION (LAB) | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| 1 | Write Up | **10** |
| 2 | Conduction of the Experiments | **20** |
| 3 | Viva | **20** |
| | **TOTAL** | **50** |

| Semester: V | | | | | | |
|---|---|---|---|---|---|---|
| **DESIGN OF MACHINE ELEMENTS - I**<br>**Category: Professional Core**<br>**Stream: Mechanical Engineering**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | ME354TA | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:1:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 45 Hrs + 30 Hrs | | **SEE Duration** | **:** | **3 Hours** |

| **Unit-I** | **09 Hrs** |
|---|---|
| **Fundamentals of Machine Design:**<br>Machine Design, Basic Procedure of Machine Design, Basic requirements of machine elements, Use of standards in design, Types of design, Standards and Codes, Factor of safety, Material selection – weighted point method, manufacturing considerations in design of castings, forging & machined parts.<br>**Static Stresses**: Static loads. Normal, Bending, Shear and Combined stresses. Stress concentration and determination of stress concentration factor. | |
| **Unit – II** | **10 Hrs** |
| **Design for Impact and Fatigue Loads:**<br>**Impact Loading:** Impact stress due to Axial, Bending and Torsional loads. Impact Factor, Numerical<br>**Fatigue failure**: Endurance limit, S-N Diagram, Low cycle fatigue, High cycle fatigue, modifying factors: size effect, surface effect. Stress concentration effects, Notch sensitivity, fluctuating stresses, Goodman and Soderberg relationship, stresses due to combined loading, cumulative fatigue damage. | |
| **Unit –III** | **10 Hrs** |
| **Design of Shafts, Joints, and Couplings and Keys:**<br>**Shafts**, design for strength and rigidity with steady loading, ASME codes for power transmission shafting, shafts under combined loads.<br>**Design of Cotter and Knuckle joints**, Rigid and flexible couplings, Flange coupling, Bush and Pin type coupling and Oldham's coupling. Design of keys - rectangular/square sections | |
| **Unit –IV** | **08 Hrs** |
| **Riveted Joints and Welded Joints:**<br>**Riveted Joints:** Rivet types, rivet materials, failures of riveted joints, Joint Efficiency, Boiler Joints<br>**Welded Joints:** Types of welded joints, Strength of butt and fillet welds, welded brackets with transverse and parallel fillet weld. | |
| **Unit –V** | **08 Hrs** |
| **Threaded Fasteners and Power Screws:**<br>**Threaded Fasteners**: Stresses in threaded fasteners, Effect of initial tension, Design of threaded fasteners under static loads.<br>**Power Screws:** Types of power screws, Torque required to raise/lower the loads, efficiency and self-locking, Design of power screws for C-clamps, Machine vice, sluice gates, etc. | |

| **Course Outcomes: After completing the course, the students will be able to: -** | |
|---|---|
| **CO1** | Demonstrate the ability to apply the fundamentals of stress analysis, theories of failure and material science in the design of machine component (L1, L2) |
| **CO2** | Design specific mechanical elements based on required specifications (L3) |
| **CO3** | Analyse different types of forces and its influence on the component design (L4, L5) |
| **CO4** | Examine and relate importance of component design to complete system. (L6) |

| **Reference Books** | |
|---|---|
| 1. | Bhandari.V.B. 'Design of Machine Elements', Tata McGraw Hill Publishing Company Ltd., Second Edition; ISBN: 9780070611412. |
| 2. | K Raghavendra, 'Design of Machine Elements – I, CBS Publishers, First Edition, ISBN:978-93-890-1718-2 |
| 3. | Shigley J.E, Mischke.C.R., 'Mechanical Engineering Design', McGraw Hill International, 6th Edition, ISBN: 0070494620 |
| 4. | Spotts. M F, Shoup T E, Hornberger L E, Jayram S R, Venkatesh C V, 'Design of Machine Elements', Pearson Education, 8th Edition; ISBN – 10: 9788177584219 |
| 5 | K L Narayana, P Kannaiah, K Venkata Reddy, "Machine Drawing" New Age International, 3rd Edition. ISBN-13: 978-81-224-2518-5 |

| **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: V | | | | | | |
|---|---|---|---|---|---|---|
| **MECHANISM DESIGN**<br>**Category: Professional Core Elective**<br>**Stream: Mechanical Engineering**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | ME355TBA | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 45L | | **SEE Duration** | **:** | **3 Hours** |

| **Unit-I** | **08 Hrs** |
|---|---|
| **Introduction:**<br>Introduction to kinematics and mechanisms, motion, The Four-Bar Linkages, The Science of Relative Motion, Kinematics diagram, Degrees of freedom, Degree of Freedom, planar, Spherical and Spatial Mechanism, Kinetic inversion, Grashof's Law, Mechanical Advantage. Equivalent mechanism, Analysis Versus Syntheses, Problems | |
| **Unit – II** | **10 Hrs** |
| **Synthesis of Mechanisms- Analytical Method:** Type, Number and Dimensional Synthesis, Function Generation, path Generation and Body Guidance, Design of a slider-crank mechanism, Four-bar crack rocker mechanism, Crank-Rocker mechanism with optimum Transmission Angle,<br>**Precision points** for Function Generation, Structural Error, Chebychev Spacing, Frudenstein's Equation for both four bar and slider-crank mechanism, Bloch's Method of Synthesis Analytic Complex Number Modeling in Kinematic Synthesis, Problems | |
| **Unit –III** | **12 Hrs** |
| **Synthesis of Mechanisms**:<br>Graphical Method: Dead Centre problems (Slider-crank and Crack-Rocker mechanisms), Synthesis of a Quick-Return Mechanisms, Crank-Rocker Mechanisms with optimum Transmission Angle, Three-position Synthesis, Four-Position Synthesis (Point-Position Reduction)<br>The Overlay Method, Motion Generation Mechanism coupler as the output (two positions, three position), Coupler-Curve Synthesis (two position, Four positions, Five position), Rober-Chevschev synthesis, Pole, Relative pole, Synthesis of Four bar and slider crank mechanism (Two position and Three position), Problems | |
| **Unit –IV** | **08 Hrs** |
| **Synthesis of Spatial Mechanism:** Introduction, Exceptions in the Mobility of Mechanisms, The Position-Analysis Problem, The Eulerian Angles, introduction to Robotics, Topology arrangements of robotic arms, Forward Kinematics, Invrse Position Analysis, Inverse Velocity and Acceleration Analyses. | |
| **Unit-V** | **07 Hrs** |
| **Curvature Theory:** Introduction, Fixed and Moving Centrodes, Velocities, Accelerations, Inflection Points and the Inflection Circle, The Euler-Savary Equation | |

| Experiential Learning- LAB | | |
|---|---|---|
| **#** | **Student Must do Four exercises from the following (each Carries 10 Marks)** | **MARKS** |
| | 1. 1. Freely falling body - To Simulate and plot a freefalling body (point mass) of certain mass and inertial properties in the y-axis with simulation time of 2secs.<br>2. Inclined Plane – Simulation of rate at which the object slides down the surface is depending upon how tilted the surface is; the greater the tilt of the surface, the faster the rate at which the object will slide down it.<br>3. Lift Mechanism – Geometry - implementation of general multibody system dynamics on Scissor lift Mechanism (i.e., four bar parallel mechanism) within a bond graph modeling framework.<br>4. Lift Mechanism – Simulation with geometry design and functional parameters.<br>5. One-degree-of-freedom Pendulum – Motion study of the center of mass and to get the natural frequency of the pendulum and along with angle measurement.<br>6. Projectile - Explore projectile motion by changing the initial conditions and watching the resulting changes in the projectile's motion.<br>7. Spring Damper - Part 1 - This simulation shows a single mass on a spring, which is connected to a wall. This is an example of a simple linear oscillator. Change mass, spring stiffness, and friction (damping).<br>8. Spring Damper - Part 2 – The simulation for the spring damper considering single mass will be repeated considering different conditions.<br>9. Suspension System 1 – Simulation of suspension model with variable stiffness mechanism and study its displacement characteristics with geometrical and boundary conditions 1.<br>10. Suspension System 2 - Simulation of suspension model with variable stiffness mechanism and study its displacement characteristics with geometrical and boundary conditions 2. | **40** |

| **Course Outcomes: After completing the course, the students will be able to:-** | |
|---|---|
| **CO1** | Explain forces and links in mechanisms using design criteria |
| **CO2** | Analyse mechanisms graphically and analytically |
| **CO3** | Synthesize and design links and mechanisms |
| **CO4** | Analyse kinematics of spatial mechanisms in Robotics |

| **Reference Books** | |
|---|---|
| 2. | George N Sandoor / Arthur G. Erdman, Advanced Mechansim Design Analysis and Synthesis (Vol.2), (2010), ISBN 0-13-011437-5 |
| 2. | John J Uicker Jr. Gordon R. Pennock, Joseph E. Shigley, Theory of Machines and Mechanisms, 3rd Edition, Oxford University Press. (2003) |
| 3. | Kinematics and Dynamics of Machines, R.L.Nortron, Mc Graw Hill, 2017, Edition, ISBN:9789351340201 |
| 4. | N.G.Sandorand, G.A.Erdman, Advanced Mechanism Design,Vol.2, Prentice Hall, 1984, 3rd Edition,ISBN-13: 978-0130408723ISBN-10: 0130408727 |
| 5. | A Ghoshand A K Mallik, Theory of Mechanism and Machines, EWLP, Delhi, 2008, Edition, ISBN:9788185938936 |
| 6. | C E Wilson, Kinematics and Dynamics of Machinery, Pearson Publications, Year, 3rd Edition, ISBN:0201350998 |

| 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: V | | | | | | |
|---|---|---|---|---|---|---|
| **TURBOMACHINERY**<br>**Category: Professional Elective**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | ME355TBB | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 45L | | **SEE Duration** | **:** | **3 Hours** |

| **Unit-I** | **09 Hrs** |
|---|---|
| **Introduction**:<br>Fluid machines, Classification, Comparison with positive displacement machines, Dimensional analysis, Dimensionless parameters and their physical significance; Specific speed; dimensional analysis and model studies.<br>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:**<br>Overall isentropic efficiency of compression, Stage efficiency, Comparison and relation between overall efficiency and stage efficiency; Polytropic efficiency and pre-heat factor<br>**Expansion Process:**<br>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:**<br>Definition of terms used in the design of centrifugal pumps like manometric head, suction head, delivery head, Efficiencies of pump, multi-stage centrifugal pumps.<br>**Centrifugal Compressors**<br>Expression for overall pressure ratio, Slip factor and power input factor, Surging and its control. | |
| **Unit –IV** | **08 Hrs** |
| **Axial Flow Compressors:**<br>Classification, expression for stage pressure ratio, work done factor, analysis of air compressors**.**<br>**Steam Turbines:**<br>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:**<br>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** | |
|---|---|
| 3. | 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: V | | | | | | |
|---|---|---|---|---|---|---|
| **MECHATRONIC SYSTEMS**<br>**Category: Professional Elective**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | ME355TBC | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 45 L | | **SEE Duration** | **:** | **3 Hours** |

| **Unit-I** | **09 Hrs** |
|---|---|
| **Overview of Mechatronic Systems:** Basic elements, mechatronic design concept – coupled design, design coefficient, design evolution, evolution of mechatronics, measurement systems, concept of feedback contro with examples, Traditional and mechatronic design comparision of washing machine, components and working of automatic door, dishwasher, compact disc drive, copy machine, and temperature control. Sensors and Transducers - Basic elements, Classification, Principle, working and applications of hall sensor, LVDT absolute and incremental encoders, photoelectric sensors, inductive, capacitive and pneumatic proximity sensors. | |
| **Unit – II** | **10 Hrs** |
| **Electrical actuation systems:** 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, feed and speed control drives for CNC machines.<br>**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 (Numerical) | |
| **Unit –III** | **10 Hrs** |
| **Digital circuits:** Karnaugh maps – 3 variable and 4 variables with don't care conditions, Combinationa logic - Case studies: BCD to 7 segment decoder, calendar subsystem in a smartwatch., timing diagrams, design of logic networks, flip-flops – SR, JK, T and D type, Binary Counters.<br>**Programmable logic controllers:**<br>Components, principle of operation, modifying the operation, basic PLC instructions, and concepts of ladder diagram, latching, timer instructions, counter instructions. | |
| **Unit –IV** | **08 Hrs** |
| **Ladder Diagram for PLCs:** Examples with ladder logic programs, simple programs using Boolean logic and narrative descriptions., Relay to ladder conversion examples.<br>**Industrial applications of PLCs (Allen Bradley addressing):** 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 –V** | **08 Hrs** |
| **Microcontroller Interfacing:** Input/output addressing, interface requirements, central heating system, peripheral interface adapters, MC6821 PIA, interfacing a stepper, serial communication interface, interfacing a seven-segment display, interfacing motors, windshield wiper motion, bathroom scales.<br>**Dynamic Responses of Systems**<br>Closed loop system, Terminology, transfer functions, step response of first order and second order systems, steady state errors and error constants, performance measures for first and second order systems, - Numerical | |

| Experiential Learning- LAB | | |
|---|---|---|
| # | **Student Must do Four exercises from the following (each Carries 10 Marks)** | **MARKS** |
| | 1. "Design and Implementation of a Small-Scale Mechatronic Robotic Arm"<br>2. "Development of a Miniature Mechatronic System for Automated Object Sorting"<br>3. "Creating a Compact Mechatronic Conveyor Belt System for Material Handling"<br>4. "Prototyping a Mechatronic Gripper Mechanism for Pick-and-Place Applications"<br>5. "Designing a Miniature Mechatronic Crane System for Load Lifting"<br>6. "Building a Small-Scale Mechatronic Vehicle with Obstacle Avoidance Capabilities"<br>7. "Development of a Pocket-Sized Mechatronic Surveillance Robot"<br>8. "Prototyping a Miniature Mechatronic Weather Monitoring Station"<br>9. "Creating a Small Prototype Model of a Mechatronic 3D Printer"<br>10. "Design and Implementation of a Portable Mechatronic Home Automation System" | **40** |

| **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**<br>(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: V | | | | | | |
|---|---|---|---|---|---|---|
| **Operations Management Systems**<br>**Category: Professional Core Elective**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | ME355TBD | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 45 L | | **SEE Duration** | **:** | **3 Hours** |

| **Unit - I** | **09 Hrs** |
|---|---|
| **Linear programming and Assignment problem**<br>Operations research as a production improvement tool, Process planning and design, value analysis, Linear programming methods – Simplex method, Big M method, dual simplex method graphical method, Assignment problem – Hungarian method, Branch and bound method. | |
| **Unit – II** | **09 Hrs** |
| **Forecasting**<br>Simple Moving Average Method, Weighted Moving Average Method, Double Moving Average Method, Simple (Single) Exponential Smoothing Method, Adjusted Exponential Smoothing Method Linear Regression, Semi-average Method, Delphi Method.<br>**Queuing theory**<br>Notation for queues, examples of queuing in manufacturing, performance measures, little's result, M/M/1 queue, M/M/1/N queue, M/M/m queue, M/G/1, M/D/1 queues (Numerical) | |
| **Unit – III** | **09 Hrs** |
| **Facilities planning**<br>Factor Rating Analysis and Forced Decision Matrix, Break even analysis, single facility location problem.<br>**Assembly line balancing**<br>Objectives, concept of mass production, line balancing algorithms –largest candidate rule, Kilbridge and wester, ranked positional weights (Numericals). | |
| **Unit – IV** | **09 Hrs** |
| **Material requirement planning**<br>MRP System Structure, Bill of Materials, MRP Procedure, MRP calculations, EOQ method, minimum cost per period method, period order quantity method, least unit cost method, part period balancing method, capacity requirement planning.<br>**Aggregate planning and Master production scheduling**<br>Strategies, graphical method, Heuristic method, Linear programming model for aggregate planning. Goal programming formulations of production scheduling, Linear decision rule. | |
| **Unit – V** | **09 Hrs** |
| **Project Management**<br>PERT and CPM, Calculations on Earliest Start TimesCalculations on Latest Allowable Completion Time Activity Slacks, Resource analysis, Use of Heuristics, Precedence networking<br>**Inventory Management and Just in Time**<br>Inventory models on economic order quantity (EOQ), manufacturing models without shortages, purchase model with shortages, manufacturing model with shortages, implementation of purchase inventory model, elements and benefits of Just in Time (JIT) | |

| Experiential Learning- LAB | | |
|---|---|---|
| # | **Student Must do Four exercises from the following (each Carries 10 Marks)** | **MARKS** |
| | 1. "Optimizing Resource Allocation: Linear Programming and Assignment Problem Analysis in software tools "<br>2. "Enhancing Production Efficiency: Excel-Based Operations Research for Process Planning, Design, and Assignment Problem Solving"<br>3. "Forecasting Techniques and Queuing Theory: Applications and Analysis in Excel"<br>4. "Optimizing Operations: Forecasting and Queuing Theory in Practice with Real-World Examples"<br>5. "Strategic Facility Planning: Utilizing Factor Rating Analysis, Forced Decision Matrix, and Break-Even Analysis"<br>6. "Efficient Assembly Line Balancing: Strategies, Algorithms, and Numerical Implementations for Mass Production Optimization"<br>7. "Efficient Material Requirement Planning: Procedures, Calculations, and Capacity Requirement Planning"<br>8. "Optimizing Production: Aggregate Planning and Master Production Scheduling with Linear Programming and Heuristic Methods"<br>9. "Optimizing Single Machine Scheduling: Performance Metrics and Strategies for Tardy Job Minimization"<br>10. "Efficient network management: Techniques, Heuristics, and Graphical Methods for Production Optimization" | **40** |

| **Course Outcomes: After completing the course, the students will be able to:** | |
|---|---|
| **CO1** | Illustrate the basic concepts of operations research and management in manufacturing systems. |
| **CO2** | Solve linear programming problems using appropriate techniques and optimization solvers, interpret the results obtained |
| **CO3** | Apply the concepts of purchase, stores and inventory management and analyse and evaluate material requirement decisions |
| **CO4** | Evaluate the concepts of analytical modeling paradigms for automation using queueing theory and scheduling algorithms. |

| **Reference Books** | |
|---|---|
| 1 | Panneerselvam, R. Production and Operations Management, 3rd Edition, 2012, ISBN: 978-812034-555-3 |
| 2 | R.B Khanna, Production and Operations Management, 2nd Edition, 2015, ISBN: 9788120351219 |
| 3 | Panneerselvam, R. Operations Research, 3rd Edition, PHI, 2015, ISBN: 978-93-5443-789-2 |

| 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**<br>(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: V | | | | | | |
|---|---|---|---|---|---|---|
| **ELECTRIC VEHICLE TECHNOLOGY**<br>**Category: Professional Core Elective**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | ME255TBE | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 45 L | | **SEE Duration** | **:** | **3 Hours** |

| **Unit-I** | **06 Hrs** |
|---|---|
| **Overview:**<br>Electric and Hybrid Electric Vehicles: Definition, Efficiencies of EV's and ICE's, classification of Hybrid vehicles and power train. Energy source for charging, advantages and challenges.<br>EV architecture and principle: Energy source, Pollution, BMS, on-board charger, inverter, motor, Efficiency, energy analysis and comparison. | |
| **Unit – II** | **09 Hrs** |
| **Energy Analysis**: Range and energy calculation of 2 and 4 wheeler, energy analysis & comparison, carbon emissions and inference.<br>**Cells for EV applications**: Battery chemistry, energy & volumetric density, Cell vs battery, types of cells, cell behaviour, cell terminologies, | |
| **Unit –III** | **09 Hrs** |
| **High voltage Battery Control System and Super capacitors**: Battery Control Module, System Main Relays, Current & temperature sensors, HV Disconnect, BMS, and Super capacitors.<br>**Fuel Cells**: Back ground, parts and operation, Fuel Cell types, PEM fuel cell operation, Fuel cell cooling system, Hydrogen Storage, Advantages and dis-advantages. | |
| **Unit –IV** | **08 Hrs** |
| **Motors for traction applications:** Nomenclature, classification & operation principle - interaction & reluctance, DC motor characteristics, Synchronous & Asynchronous, BLDC, Induction, Duty period, motor requirements & characteristics for EV, Torque Vs Speed, Motor losses.<br>**Types of Chargers: A**C and DC chargers, On board and off - board charger - Type of Mode of charger, Combined Charger Socket, charging time calculation, selection and sizing of fast and slow charger (AC & DC). | |
| **Unit-V** | **08 Hrs** |
| **EV Driver Assist Systems**: Adaptive Cruise Control, Blind Spot Monitor, Parking Assist Systems, Lane keep Assist, Cross Traffic Warning System, Pre-Collision system, Lidar Systems, Autonomous Vehicle Operation: SAE definitions, levels of autonomous, Artificial Intelligence and Dedicated Short-Range Communication (DSRC).<br>**Regenerative Brakes and HV safety in EV's**: Basics of regeneration, types of regenerative brake systems, Integrated starter generator, Advantages. HV - constructional & functional safety. | |

| **Course Outcomes: After completing the course, the students will be able to:** | |
|---|---|
| **CO1** | Understand the basics of electric and hybrid electric vehicles, their architecture and technologies. |
| **CO2** | Explain energy storage technologies of electric vehicles and energy management system |
| **CO3** | Apply the concepts of electric drive systems suitable for electric vehicles. |
| **CO4** | Analyse the different charging methods for Performance Characteristics. |

| Experience Learning- LAB | | |
|---|---|---|
| # | **Student Must do Four exercises from the following (each Carries 10 Marks)** | **MARKS** |
| | 1. "Advanced Battery Technologies for Electric Vehicles: Materials, Designs, and Performance"<br>2. "Electric Motor Drive Systems: Components, Control Strategies, and Efficiency Optimization"<br>3. "Charging Infrastructure for Electric Vehicles: Standards, Protocols, and Grid Integration"<br>4. "Power Electronics in Electric Vehicles: Converters, Inverters, and Onboard Chargers"<br>5. "Energy Storage Systems for Electric Vehicles: Batteries, Supercapacitors, and Hybrid Solutions"<br>6. "Electric Vehicle Thermal Management: Cooling Systems, Heating Systems, and Energy Efficiency"<br>7. "Vehicle-to-Grid (V2G) Integration: Smart Charging, Grid Support, and Energy Management"<br>8. "Safety Systems in Electric Vehicles: High-Voltage Systems, Fault Detection, and Emergency Response"<br>9. "Wireless Charging Technologies for Electric Vehicles: Inductive Charging, Resonant Charging, and Future Prospects"<br>10. "Electric Vehicle Powertrain Design and Optimization: Motors, Transmissions, and Control Strategies" | **40** |

| **Reference Books** | |
|---|---|
| 4. | James D Halderman, Curt Ward, "Electric and Hybrid Electric Vehicles", Pearson Publisher, 1st Impression, Edition, 2023, ISBN: 978-93-560-6628-1 |
| 2. | Iqbal Hussain, "Electric & Hybrid Vehicles – Design Fundamentals", Second Edition, CRC Press, 2011, ISBN: 0-8493-1466-5 |
| 3. | Davide Andrea," Battery Management system for large Lithium Battery Packs", ARTECH HOUSE 4th Edition, 2010, ISBN-13 978-1-60807-104-3 |
| 4. | F. BADIN, Hybrid Vehicles from Components to System", Editions Technip, Paris, 2013, 3rd Edition, ISBN: 978-2-7108-0994-4 |

| **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**<br>(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: V | | | | | | |
|---|---|---|---|---|---|---|
| **Design of Jigs and Fixtures**<br>**Category: Professional Core Elective**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | ME355TBF | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 45 L | | **SEE Duration** | **:** | **3 Hours** |

| **Unit - I** | **09 Hrs** |
|---|---|
| **Introduction**: Introduction to modern day production, Definition of Jigs and Fixtures, Difference between jigs and fixtures, Advantages, guidelines for design of Jigs and fixtures.<br>**Location:** Degree of freedom, 3-2-1 principles, Choice of location, redundant location, Diamond pin calculation, Locating methods and chip control. | |
| **Unit – II** | **09 Hrs** |
| **Locating Devices:** Surface location, Rest blocks, pins, V-blocks, Equalizers, Profile locators.<br>**Clamping:** Basic principles, cutting forces, Rigid clamping, wedge clamping, Cam clamping, quick action clamps, Toggle clamps, simultaneously acting clamps. | |
| **Unit – III** | **09 Hrs** |
| **Component of Jig:** Drill bushes, Fasteners, Jig body and base frame**, Indexing Devices:** Linear indexing, rotary indexing, indexing plate, rotary indexing table.<br>**Drilling Jig:** Plate jig, Box type jig, Inclined jig, Turnover jig, Pot jig, Post jig | |
| **Unit – IV** | **09 Hrs** |
| **Milling fixture:** Essentials of milling fixture, facing fixture, indexing milling, rotary milling, reciprocating milling, slotting fixture<br>**Turning Fixture:** Standard chucks, Face plate fixture, Mandrels, turning fixture | |
| **Unit – V** | **09 Hrs** |
| **Other types of Fixtures:** Grinding fixtures, Broaching fixture, welding fixture, Assembly Fixtures, Inspection fixture Modular fixture. | |

| **Experience Learning- LAB** | | |
|---|---|---|
| **#** | **Student Must do Four exercises from the following (each Carries 10 Marks)** | **MARKS** |
| | **Design a jig/fixture for the given component. You need to draw: Front sectional view of the assembly, Side view of the assembly, Important locating and guiding elements, and bill of materials (manual and CAED)**<br>1. Design a clamping fixture for holding a specific workpiece securely during machining operations. Consider factors like material handling, accessibility for tools, and ease of loading/unloading.<br>2. Create a drilling jig for precise hole placement on a workpiece. Ensure accurate alignment and drill guide placements.<br>3. Design a fixture for welding components together. Focus on positioning accuracy, accessibility for welding torches, and joint accessibility.<br>4. Develop an assembly fixture to aid in the assembly of complex parts or assemblies. Include features for part alignment, fastening, and checking assembly correctness.<br>5. Create an inspection fixture for inspecting critical dimensions or features of a workpiece. Ensure repeatability and ease of measuring key dimensions.<br>6. Design a fixture for milling operations that allows multiple sides of a workpiece to be machined in one setup. Consider clamping mechanisms, clearance for tools, and chip evacuation. | **40** |

| | | |
|---|---|---|
| | 7. Develop a fixture for turning operations that enhances rigidity and accuracy during machining. Incorporate features for tool clearance and part orientation.<br>8. Design a fixture for a specific, non-standard machining or assembly operation. Consider unique requirements such as part orientation, tool access, and ergonomic considerations.<br>9. Create a modular fixture system that allows flexibility for various workpieces or operations. Include interchangeable components and standardized interfaces.<br>10. Design a fixture utilizing hydraulic or pneumatic systems for clamping or positioning. Ensure stability, control, and safety of operation. | |

| **Course Outcomes: After completing the course, the students will be able to:** | |
|---|---|
| **CO1** | Categorize and justify the requirements of Jigs and Fixtures for Manufacturing, Testing and Assembly |
| **CO2** | Describe and implement various Mechanisms in fixture manufacturing. |
| **CO3** | Analyze problems related to Jigs and fixtures in Manufacturing, Testing and Assembly. |
| **CO4** | Design and drafting various Jigs and Fixtures. |

| **Reference Books:** | |
|---|---|
| 1 | Joshi P.H, "Jigs& Fixtures", Tata McGraw-Hill Pub.Co.Ltd.,11$^{th}$Ed., 2010, ISBN: 0070680736, 9780070680739 |
| 2. | William E Boyes, "Jigs. & Fixtures & Gauge", Michigan SME 1$^{st}$Ed., 1986, ISBN: 0872633659 |
| 3. | Kempster M. H. A, "An Introduction to Jig and Tool Design", Butterworth-Heinemann Ltd. 3rdEd.1974, ISBN-13: 9780340182215. |
| 4 | Edward G. Hoffman, "Jig and Fixture Design", Delmar, Cengage Learning, Fifth Ed., 2004 ISBN-13: 9781401811075. |

| **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**<br>(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 V | | | | | | |
|---|---|---|---|---|---|---|
| **Ethics in Engineering Practice**<br>**Category: Professional Core Elective**<br>**(NPTEL course)** | | | | | | |
| **Course Code** | **:** | ME256TCA | | **CIE Marks** | : | **** |
| **Credits: L:T:P** | **:** | 2:0:0 | | **SEE Marks** | : | 100 Marks |
| **Total Hours** | **:** | 30 Hrs | | **SEE Duration** | : | 3 Hours |

| **Unit - I** | **10 Hrs** |
|---|---|
| Introduction to Ethical Reasoning and Engineer Ethics, Professional Practice in Engineering, Ethics as Design - Doing Justice to Moral Problems. | |
| **Unit - II** | **10 Hrs** |
| Central Professional Responsibilities of Engineers, Computers, Software, and Digital Information. | |
| **Unit - III** | **10 Hrs** |
| Rights and Responsibilities Regarding Intellectual Property, Workplace Rights and Responsibilities, Responsibility for the Environment. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Understand the basic principles of Ethics in Engineering Practice. |
| **CO2:** | Analyse Ethics as design and implementing justice to moral problems. |
| **CO3:** | Understand responsibilities of engineers and digital information. |
| **CO4:** | Understanding the rights and responsibilities with respect to IP, workplace and environment. |

| **References Books:** | |
|---|---|
| 1 | NPTEL Resources Link: https://nptel.ac.in/courses/110105097 |
| 2 | Ethics in Engineering practice and Research (2nd Edition) by Caroline Whitbeck Cambridge |
| 3 | Ethics in Engineering MW Martin and R Schinzinger MC Graw Hill |
| 4 | Engineering Ethics and Environment P a Vesilind and AS Gunn Cambridge |

| Semester V | | | | | | |
|---|---|---|---|---|---|---|
| **Laser Based Manufacturing**<br>**Category: Professional Core Elective**<br>**(NPTEL course)** | | | | | | |
| **Course Code** | **:** | ME256TCB | | **CIE Marks** | : | **** |
| **Credits: L:T:P** | **:** | 2:0:0 | | **SEE Marks** | : | 100 Marks |
| **Total Hours** | **:** | 30 Hrs | | **SEE Duration** | : | 3 Hours |

| **Unit - I** | **10 Hrs** |
|---|---|
| Introduction, Laser cutting (machining), Laser welding. | |
| **Unit - II** | **10 Hrs** |
| Laser Bending or Forming, Laser surface treatment, Additive manufacturing. | |
| **Unit - III** | **10 Hrs** |
| Lasers for automation and sensing and advanced applications. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Understand the fundamentals of Laser cutting and welding. |
| **CO2:** | Analyse the Laser forming, surface heat treatment. |
| **CO3:** | Understand various methods of additive manufacturing systems. |
| **CO4:** | Implement Laser for automation, sensing and advanced applications. |

| **References Books:** | |
|---|---|
| **1** | NPTEL Resources Link: https://nptel.ac.in/courses/112103312 |
| **2** | Steen, W. M., Laser Material Processing, Springer-Verlag, London, 2005. |
| **3** | Dahotre, N. and Samant, A., Laser Machining of Advanced Materials, CRC Press, London, 2015. |
| **4** | Joshi, S. N. and Dixit, U. S., Laser Based Manufacturing, Springer India, 2015. |
| **5** | Sugioka, K., Meunier, M., and Piqué, A., Laser Precision Microfabrication, Springer-Verlag, Berlin, Heidelberg, 2010. |
| **6** | Ion, J. C., Laser Processing of Engineering Materials, Elsevier, 2005 |

| Semester V | | | | | | |
|---|---|---|---|---|---|---|
| **Biomechanics of Joints and Orthopaedic Implants**<br>**Category: Professional Core Elective**<br>**(NPTEL course)** | | | | | | |
| **Course Code** | **:** | ME256TCC | | **CIE Marks** | : | **** |
| **Credits: L:T:P** | **:** | 2:0:0 | | **SEE Marks** | : | 100 Marks |
| **Total Hours** | **:** | 30 Hrs | | **SEE Duration** | : | 3 Hours |

| **Unit - I** | **10 Hrs** |
|---|---|
| Introduction Musculoskeletal system: Bone, Muscle, Ligament, Tendon, Cartilage and Meniscus – structure and function Anatomy of Synovial Joints – Hip, Knee, Shoulder, Elbow; Biomechanics of Human Joints: (a) Hip Joint; (b) Knee Joint; (c) Shoulder Joint; (d) Elbow Joint; Biomechanics of Gait cycle Gait Analysis, Measurement techniques 3-D Motion analysis system – markers, cameras and force platform, Lower extremity – hip musculoskeletal forces. | |
| **Unit - II** | **10 Hrs** |
| Joint Kinematics Principle of Forward and Inverse Dynamics Calculations on joint forces and moments Calculations on muscle forces, Model-based estimation of musculoskeletal forces during movements; Concepts of Stresses and Strain Bone structure - Cancellous and Cortical Bone Mechanical Behaviour of Bone, Adaptation and Viscoelasticity Bone Anisotropy; Biomechanics of Joint Replacement – Hip, Knee, Shoulder, Spine Cemented and Cementless fixation, Failure mechanisms of implants, Implant Design Considerations. | |
| **Unit - III** | **10 Hrs** |
| Biomechanical modelling techniques and analysis, Finite Element Analysis of bone and implant Bone Remodelling – formulation, algorithm, simulation Experimental validation of numerical models; Bone Fracture Healing Tissue Differentiation, Mechanoregulatory principle Mechanobiology based simulation of bone ingrowth around implants – acetabular and femoral components. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Understand the fundamentals of Musculoskeletal system. |
| **CO2:** | Analyse the Biomechanics of Gait cycle and hip musculoskeletal forces. |
| **CO3:** | Estimate Joint Kinematics Principle of Forward and Inverse Dynamics Calculations on joint forces and moments |
| **CO4:** | Understand the Biomechanical modelling techniques and analysis. |

| **References Books:** | |
|---|---|
| **1** | NPTEL Resources Link: https://nptel.ac.in/courses/112105305 |
| **2** | Basic Biomechanics of the Musculoskeletal System by Margareta Nordin and Victor H. Frankel |
| **3** | Biomechanics and Motor Control of Human Movement by David A. Winter |
| **4** | Orthopaedic Biomechanics by D.L. Bartel, D.T. Davy and T.M. Keaveny |

| Semester V | | | | | | |
|---|---|---|---|---|---|---|
| **Toyota Production System**<br>**Category: Professional Core Elective**<br>**(NPTEL course)** | | | | | | |
| **Course Code** | **:** | ME256TCD | | **CIE Marks** | : | **** |
| **Credits: L:T:P** | **:** | 2:0:0 | | **SEE Marks** | : | 100 Marks |
| **Total Hours** | **:** | 30 Hrs | | **SEE Duration** | : | 3 Hours |

| **Unit - I** | **10 Hrs** |
|---|---|
| Manufacturing Excellence, Global Environment, Production System, Operations Strategy, The Heart of the TPS: Eliminating Waste; Principles of Toyota Way, Culture Behind Toyota Way, Toyota Way in Action, Long Term Philosophy, Create Continuous Flow; Pull System, Leveling Workload, Get Quality Right the first time, Standardization of Task, Use of Visual Control. | |
| **Unit - II** | **10 Hrs** |
| Use of Reliable Technology, Role of Leaders in Manufacturing Philosophy, Developing Exceptional Teams, Challenge & Respect Extended Networks, See yourself to understand the situation; Developing decisions with Consensus, Becoming Learning Organization, Becoming a Learning Organization: Continuous Improvement, Using Toyota Way for other Organization (Service & Technical), Lean Manufacturing. | |
| **Unit - III** | **10 Hrs** |
| Lean Vs Agile Manufacturing, Sustainable Manufacturing-I & II, Flexible Manufacturing System, Benchmarking; KANBAN Approach, KANBAN Calculation-I & II, Theory of Constraints, Different Business Excellence Models. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Understand the fundamentals of Toyota Production System |
| **CO2:** | Understand the Role of Leaders in Manufacturing Philosophy. |
| **CO3:** | Understand various aspects of Lean and Agile Manufacturing. |
| **CO4:** | Implement the Bench marking and KANBAN approaches. |

| **References Books:** | |
|---|---|
| **1** | NPTEL Resources Link: https://nptel.ac.in/courses/110107130 |
| **2** | The Toyota Way, Jeffrey K. Liker, Tata McGraw Hill |
| **3** | How to implement lean manufacturing, Lonnie Wilson, McGraw Hill |

| Semester V | | | | | | |
|---|---|---|---|---|---|---|
| **Principles of Casting Technology**<br>**Category: Professional Core Elective**<br>**(NPTEL course)** | | | | | | |
| **Course Code** | **:** | ME256TCE | | **CIE Marks** | : | **** |
| **Credits: L:T:P** | **:** | 2:0:0 | | **SEE Marks** | : | 100 Marks |
| **Total Hours** | **:** | 30 Hrs | | **SEE Duration** | : | 3 Hours |

| **Unit - I** | **10 Hrs** |
|---|---|
| Introduction to Casting Technology, Solidification analysis for metals and alloys; Technology of patternmaking, study of moulding sands and their testing methods. | |
| **Unit - II** | **10 Hrs** |
| Technology of mould making and core making, Special sand moulding processes; Principles of gating design for castings; Principles of risering design for castings. | |
| **Unit - III** | **10 Hrs** |
| Special casting methods, Melting furnaces; Melting and pouring practices for production of cast iron family, steel and non-ferrous metals and alloys; Fettling and Heat treatment of castings, Casting defect and its diagnostic methods. | |

| Course Outcomes: After completing the course, the students will be able to | |
|---|---|
| CO1: | Understand the basic principles of casting technology. |
| CO2: | Identify and implement pattern and core making technologies. |
| CO3: | Understand the design the gating and risering systems. |
| CO4: | Understand various types of casting defects and implement its diagnostic methods. |

| References Books: | |
|---|---|
| 1 | Heine, R.W., Loper, C.R., and Rosenthal, P.C., “Principles of Metal Casting”, TMH. |
| 2 | Ghosh, A., and Mallik, A.K., “Manufacturing Science”, Affiliated East-West Press Pvt. Ltd. |
| 3 | Jain P.L., “Principles of Foundry Technology”, TMH. |
| 4 | Chakrabarti, A.K., “Casting Technology and Cast Alloys”, PHI. |

| Semester V | | | | | | |
|---|---|---|---|---|---|---|
| **Design Practice**<br>**Category: Professional Core Elective**<br>**(NPTEL course)** | | | | | | |
| **Course Code** | **:** | ME256TCF | | **CIE Marks** | : | **** |
| **Credits: L:T:P** | **:** | 2:0:0 | | **SEE Marks** | : | 100 Marks |
| **Total Hours** | **:** | 30 Hrs | | **SEE Duration** | : | 3 Hours |

| **Unit - I** | **10 Hrs** |
|---|---|
| Introduction to Design/Product design; Stanford model of Design thinking/ Stages of engineering design of products/Introduction to Concurrent engineering. | |
| **Unit - II** | **10 Hrs** |
| Concurrent engineering Approaches: Benefits, influencing factors; Product Development Methodology: Concurrent engineering in Practice; Product embodiment design (robustness of design/Average Quality loss). | |
| **Unit - III** | **10 Hrs** |
| Material selection process in design; House of quality, Specifications (Fits and Tolerances), Axiomatic Design; Introduction to Group Technology, Creating forms and shapes, Introduction to electronics. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Understand fundamentals of design/product design, models of design thinking. |
| **CO2:** | Understand various concurrent engineering approaches. |
| **CO3:** | Evaluate the robustness of design/Average quality loss. |
| **CO4:** | Implement the Axiomatic Design, Group Technology to create forms and shapes. |

| **References Books:** | |
|---|---|
| **1** | NPTEL Resources Link: https://nptel.ac.in/courses/112104228 |
| **2** | Nanua Singh, “Systems approach to computer integrated design and manufacturing”, Wiley India Pvt. Ltd., 4435-36/7, Ansari Road, Daryaganj, New Delhi-110002. |
| **3** | Karl T. Ulrich, Steven. D. Eppinger, “Product design and development”, McGraw hill publications. |

| Semester V | | | | | | |
|---|---|---|---|---|---|---|
| **Waste to Energy Conversion**<br>**Category: Professional Core Elective**<br>**(NPTEL course)** | | | | | | |
| **Course Code** | **:** | ME256TCG | | **CIE Marks** | : | **** |
| **Credits: L:T:P** | **:** | 2:0:0 | | **SEE Marks** | : | 100 Marks |
| **Total Hours** | **:** | 30 Hrs | | **SEE Duration** | : | 3 Hours |

| **Unit - I** | **10 Hrs** |
|---|---|
| Introduction, characterization of wastes; Energy production form wastes through incineration, energy production through gasification of wastes. | |
| **Unit - II** | **10 Hrs** |
| Energy production through pyrolysis and gasification of wastes, syngas utilization; Densification of solids, efficiency improvement of power plant and energy production from waste plastics; Energy production from waste plastics, gas clean-up. | |
| **Unit - III** | **10 Hrs** |
| Energy production from organic wastes through anaerobic digestion and fermentation, introduction to microbial fuel cells; Energy production from wastes through fermentation and transesterification; Cultivation of algal biomass from wastewater and energy production from algae. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Understand various methods of energy production from wastes. |
| **CO2:** | Understand the efficiency improvement of power plant and energy production from waste plastics. |
| **CO3:** | Understand the energy production from organic wastes through anaerobic digestion and fermentation. |
| **CO4:** | Understand the cultivation of algal biomass from wastewater and energy production from algae. |

| **References Books:** | |
|---|---|
| **1** | NPTEL Online Resources Link: https://nptel.ac.in/courses/103107125 |
| **2** | Rogoff, M.J. and Screve, F., "Waste-to-Energy: Technologies and Project Implementation", Elsevier Store. |
| **3** | Young G.C., "Municipal Solid Waste to Energy Conversion processes", John Wiley and Sons. |
| **4** | Harker, J.H. and Backhusrt, J.R., "Fuel and Energy", Academic Press Inc. |
| **5** | EL-Halwagi, M.M., "Biogas Technology- Transfer and Diffusion", Elsevier Applied Science. |
| **6** | Hall, D.O. and Overeed, R.P.," Biomass - Renewable Energy", John Willy and Sons. |
| **7** | Mondal, P. and Dalai, A.K. eds., 2017. *Sustainable Utilization of Natural Resources*. CRC Press. |

| Semester: VI | | | | | | |
|---|---|---|---|---|---|---|
| **PRINCIPLES OF MANAGEMENT & ECONOMICS (Theory)** | | | | | | |
| **Course Code** | **:** | HS261TA | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 45Hrs | | **SEE Duration** | **:** | **3.00 Hours** |

| **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**<br>**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 Equitytheory, Vroom's Expectancy Theory. **Caselets / Case studies**<br>**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.<br>**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. | |
| **Unit –V** | **09 Hrs** |
| **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, ESG an overview.<br>**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 | |

| **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:** | |
|---|---|
| 5. | 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 up to 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Some of the Experiential learning topics may include Reading Leadership books and summarizing, Analysis and interpretation of various economic reports, Visit to various organizations to understand organizational mechanics. 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**<br>(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 | | | | | | |
|---|---|---|---|---|---|---|
| **DESIGN OF MACHINE ELEMENTS - II**<br>**Category: Professional Core**<br>**(Theory and Practice)** | | | | | | |
| **Course Code** | **:** | ME362IA | | **CIE** | **:** | **100 + 50 Marks** |
| **Credits: L:T:P** | **:** | 3:0:1 | | **SEE** | **:** | **100 + 50 Marks** |
| **Total Hours** | **:** | 40L + 36 P | | **SEE Duration** | **:** | **3 Hours + 3 Hours** |

| **Unit-I** | **06 Hrs** |
|---|---|
| **Design of Curved Beams:**<br>Difference between straight beam and curved beams, stresses in straight beam and curved beam, derivation of bending stress equation for curved beam, problems on crane hook, punching presses, clamps (symmetric and unsymmetrical sections), closed rings. | |
| **Unit – II** | **10 Hrs** |
| **Design of Clutches and Brakes**<br>**Clutches:** Torque transmitting capacity, Types, uniform wear and pressure theory, friction, bearing pressure, single and multi-plate clutches.<br>**Brakes:** Energy absorbed by brake, materials of brake, pivoted block or shoe brake, simple and differential band brake.<br>**Design of Springs:** Introduction to springs; Types of Springs; Stresses in helical compression springs subjected to steady loads. Deflection in helical springs – Circular & Non-circular spring. Leaf springs – full length leaves, graduated leaves, stresses & deflection. Semi-elliptical springs; Equalization of springs (Nipping). Problems on semi-elliptical springs; automobile leaf springs | |
| **Unit –III** | **10 Hrs** |
| **Design of Spur & Helical Gears:**<br>**Spur Gears**:<br>Definition, Stresses in Gear Tooth, Lewis Equation, Form Factor, Design for Strength, Dynamic Load and wear load, material selection for different velocity ratios, types of tooth systems<br>**Helical Gears:**<br>Number of teeth, design based on strength, dynamics and wear loads, normal and transverse pitch, module, Herringbone gears, different forces on helical gear teeth | |
| **Unit –IV** | **06 Hrs** |
| **Design of Bevel & Worm Gears:**<br>**Bevel Gear**: Definition, Formative Number of Teeth, Design based on Strength, Dynamics and Wear Loads, Cone Pitch Angle, Back Cone Radius, Acute, Obtuse and right-angle bevel gears<br>**Worm Gears**: Definition, design based on strength, dynamic wear load and efficiency of gear drives, self-locking of worm gear drives. | |
| **Unit –V** | **08 Hrs** |
| **Lubrication & Bearings:**<br>Basic modes of lubrication, viscosity, properties of lubricant, Petroff's equation, bearing materials, Sommerfeld number, bearing modulus, coefficient of friction, minimum oil film thickness, heat generated and dissipated.<br>Anti-friction Bearings: Materials, types, ball and roller bearings, static and dynamic capacity, equivalent load, selection based on rated life and application. | |

| Section II – Design Laboratory |
|---|
| **SECTION – I**: |
| Determination of Principal Stresses & Strains using strain rosette analysis |
| Determination of Fringe Constant – Circular and Rectangular Specimens |
| Determination of Stress Concentration Factor in a photo-elastic plate with hole |
| Determination of pressure distribution in a Journal Bearing |
| **SECTION – II:** |
| Determination of Natural Frequency, Damping Ratio, Damping co-efficient for single degree freedom systems (Spring-Mass system) |
| Balancing of rotating masses using force and coupling polygons |
| Determination of critical speed of rotating shaft |
| Determination of Equilibrium speed of governors |
| Experiments with gyroscope |

| **Reference Books** | |
|---|---|
| 1. | Bhandari.V. B, 'Design of Machine Elements', Tata McGraw Hill Publishing Company Ltd., Ed.2nd; ISBN: 9780070611412 |
| 2. | K Raghavendra 'Design of Machine Elements II, CBS Publishers Pvt Ltd., First Edition, 2015, ISBN: 978-81-239-2633-9 |
| 3. | Shigley J.E, Mischke.C.R., 'Mechanical Engineering Design', McGraw Hill International, 6th Edition, ISBN: 0070494620 |
| 4. | Spotts. M F, Shoup T E, Hornberger L E, Jayram S R, Venkatesh C V, 'Design of Machine Elements', Pearson Education, 8th Edition; ISBN – 10: 9788177584219 |
| **Design Data Hand Book**: Design Data Handbook for Mechanical Engineers by K. Mahadevan and K. Balaveera Reddy, CBS Publishers & Distributors Pvt Ltd., Fourth Edition, ISBN: 978–81–239–2315–4 | |

| **Course Outcomes: After completing the course, the students will be able to:-** | |
|---|---|
| **CO1** | Understand basic procedure to design a system component, or process to meet desired needs within realistic constraints. (L1 & L2) |
| **CO2** | Select suitable material and size for design of components in machines. (L3 & L4) |
| **CO3** | Identify, explain, formulate, and solve design engineering problems (L5) |
| **CO4** | Analyse and evaluate forces and stresses within a mechanical system (L6) |

| RUBRICFOR 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. Each quiz is evaluated for 10 marks adding up to 20 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 **50Marks**, 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 (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**. | **40** |
| 4. | **LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (30 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (10Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50 MARKS | **50** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **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: (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** |

| RUBRIC FOR SEMESTER END EXAMINATION (LAB) | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| **1** | Write Up | **10** |
| **2** | Conduction of the Experiments | **20** |
| **3** | Viva | **20** |
| | **TOTAL** | **50** |

| Semester: VI | | | | | | |
|---|---|---|---|---|---|---|
| **FINITE ELEMENT ANALYSIS**<br>**Category: Professional Core**<br>**(Theory and Practice)** | | | | | | |
| **Course Code** | **:** | ME363IA | | **CIE** | **:** | **100 + 50 Marks** |
| **Credits: L:T:P** | **:** | 3:0:1 | | **SEE** | **:** | **100 + 50 Marks** |
| **Total Hours** | **:** | 40L + 36 Hrs | | **SEE Duration** | **:** | **3 Hours + 3 Hours** |

| **Unit-I** | **06 Hrs** |
|---|---|
| **Introduction** to FEM, Basic steps in FEM, Advantages and limitations, Basic Equations of Elasticity: Stress-strain relationship, Differential equations of equilibrium, Strain displacement relations, Rayleigh Ritz Method, Galerkin ‘s Method, Element types, Node numbering scheme (Numerical on Rayleigh Ritz and Galerkin ‘s method only) | |
| **Unit – II** | **10 Hrs** |
| **One Dimensional Finite Elements - Bar and Truss elements**<br>Linear element, Shape function, stiffness matrix, strain matrix, Gauss-Elimination method, Penalty method, boundary conditions and assemblage load vector, Convergence and Compatibility conditions, stiffness matrix for Truss elements, Numerical | |
| **Unit –III** | **10 Hrs** |
| **Analysis of Beam Elements:** Hermitian shape functions, formulations of element stiffness matrices, load vectors, Analysis of bending moment and shear force, Numerical<br>**Two Dimensional CST Elements:** Iso, super and sub-parametric representation, Shape functions, Jacobian matrix, B-matrix, element stiffness and load vectors, Numerical | |
| **Unit –IV** | **06 Hrs** |
| **Dynamic Analysis:** Equations of motion, mass and stiffness matrices, distributed and consistent mass matrices, Eigen values and Eigen vectors. Numerical | |
| **Unit-V** | **08 Hrs** |
| **Analysis of Heat Transfer 1-D element:** Steady State Heat Transfer, Galerkin‘s Formulation of Element Equations for Heat Transfer, Heat flux boundary condition, Analysis of composite slabs<br>**Analysis of thin fin:** Numerical for Heat transfer through fins, Heat flux boundary condition, Circular and rectangular fins. | |

| **Part B** | |
|---|---|
| Experiments executed using ANSYS-Work Bench software tool. | **36 Hrs** |
| 1. Introduction to design modeler and problems related to 1D and 2D elements. | |
| 2. Static structural analysis of plate with a hole. | |
| 3. Static structural analysis of connecting rod (import from SolidWorks). | |
| 4. Fatigue analysis of beam with rectangular cross section subjected to completely reversed cycles. | |
| 5. Buckling analysis for a column with square cross section. | |
| 6. Analyse contact stresses for a plate subjected to contact load by a sphere. | |
| 7. Impact analysis of a plate subjected to speeding bullet. | |
| 8. Analyse the mode shapes and modal frequencies for a free-free condition. | |
| 9. Analysis of heat transfer through the composite wall and fins. | |

| **Course Outcomes: After completing the course, the students will be able to: -** | |
|---|---|
| **CO1** | Define the fundamentals of finite element methods. |
| **CO2** | Develop the knowledge to analyse structures in static, dynamic and thermal conditions |
| **CO3** | Assess numerical techniques for solving engineering problems. |
| **CO4** | Formulate finite element model to implement industrial projects. |

| **Reference Books** | |
|---|---|
| 1. | Introduction to Finite Elements in Engineering, T.R. Chandrapatla, A D Belegundu, Pearson Publications, 4th Edition, 2011, ISBN: 13-978-0132162746 |
| 2. | Fundamentals of Finite Element Analysis, David Hutton, Tata McGraw Hill Education, 4th Edition, 2017, ISBN: 13-978-0070601222 |
| 3. | The Finite Element Method in Engineering, Rao S S, Butterworth-Heinemann, 5th Edition, 2017, ISBN: 13-978-1856176613 |
| 4. | A First Course in Finite Element Methods, Daryl L Logon, Thomson Brooks, 5th Edition, 2012, ISBN: 13-978-8131517307 |

| **RUBRICFOR 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. Each quiz is evaluated for 10 marks adding up to 20 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 **50Marks**, 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 (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**. | **40** |
| 4. | **LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (30 Marks),lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (10Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50 MARKS | **50** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **150** |

| **RUBRIC FOR SEMESTER END EXAMINATION (THEORY)** | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B**<br>(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** |

| **RUBRIC FOR SEMESTER END EXAMINATION (LAB)** | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| **1** | Write Up | **10** |
| **2** | Conduction of the Experiments | **20** |
| **3** | Viva | **20** |
| | **TOTAL** | **50** |

| Semester: VI | | | | | | |
|---|---|---|---|---|---|---|
| **Control Engineering**<br>**Category: Professional Core**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | ME364TA | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:1:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 45 L + 30 T | | **SEE Duration** | **:** | **3 Hrs** |

| **Unit-I** | **09 Hrs** |
|---|---|
| **Introduction to Control Systems:** Elements of Open-loop and closed-loop systems, dynamic response of a closed loop system, Applications of Control Systems across engineering, automation, aerospace, and robotics. Differential Equation Model for describing system dynamics. Electrical Circuits representation and analysis in control systems. F-V and F-I Analogy application in control system design. Translational and Rotational Mechanical Systems modeling for control applications. Problem Solving exercises | |
| **Unit – II** | **09 Hrs** |
| **Block Diagram Algebra and Signal Flow Graphs**: Fundamental concepts of block diagram representation, including techniques for constructing block diagrams to model various systems. Applications of block diagrams in representing complex systems or processes and analysing system interactions. Signal flow graphs as an alternative system representation and their analysis to understand signal paths. Problem-solving exercises.<br>**Control System Components and Stability**: DC and AC servomotors, tachometers, amplidynes, hydraulic and pneumatic systems, and stepper motors, BIBO stability, necessary conditions for stability, Routh stability (RH) criterion, difficulties and special cases of RH criterion, applications to linear feedback systems. | |
| **Unit –III** | **09 Hrs** |
| **Root Locus:** Angle and magnitude criterion, Properties of Root Loci, Drawing Root Locus Diagrams, Determination of Damping Ratio, Gain Margin, and Phase Margin from Root Locus, stability analysis. Simple problems<br>**Frequency Response: Nyquist and Bode Diagrams**: Nyquist criteria, sketching and obtaining gain and phase margin through Nyquist diagram, Bode plots: Magnitude vs Phase plots, understanding the relationship between magnitude and phase in logarithmic scale plots. Simple problems | |
| **Unit –IV** | **09 Hrs** |
| **State Space Analysis of Control Systems**:<br>Introduction to State Space Analysis covering the transition from classical to modern control theory. Understanding the Generalized State Equation as a fundamental representation of dynamic systems. Techniques for Deriving System State-Space Equations from differential equations or transfer functions. Conversion of State Equations to Transfer Functions for analysis and design. State Transition Matrix using laplace transformation and cayley hamilton theorom. Exploring Controllability and Observability concepts. | |
| **Unit –V** | **09 Hrs** |
| **Types of Controllers**:<br>On-Off control, Overview of control actions including Proportional (P) with controller amplification and error, Integral (I), and Derivative (D) pneumatic controllers. Understanding the combination of these pneumatic controllers in PD, PI, and PID configurations for various control applications.<br>**MATLAB in Control System Design**: Utilizing MATLAB's Control System Toolbox for system analysis, design, and tuning. Hands-on experience in control system design and tuning processes. Exploration of automated PID tuning techniques and Graphical Bode Design methods. Practical application through solving simple control system problems using MATLAB. | |

| Experience Learning- LAB | | |
|---|---|---|
| # | **Student Must do Four exercises from the following (each Carries 10 Marks)** | **MARKS** |
| | 1. Programmable Logic Controller (PLC) Based Level Control System"<br>2. Flow Control Characteristics Investigation using Flow Control Trainer<br>3. PID Controller Tuning and Response Evaluation on PID Controller Trainer<br>4. Dynamic Response Study of DC Position Servo Mechanism using Demo Unit<br>5. Characterization of Inductive Transducer for Position Sensing Applications<br>6. Characterization of Step, Ramp, and Impulse Responses of First and Second Order Systems<br>7. Time Domain Specification Analysis of Under-Damped Second Order System<br>8. Stability Analysis of Control Systems using Routh-Hurwitz and Root Locus Methods<br>9. Frequency Response Analysis of Control Systems using Bode and Nyquist Plots<br>10. Frequency Response Analysis of Control Systems using Nichols Plot | **40** |

| **Course Outcomes: After completing the course, the students will be able to:** | |
|---|---|
| **CO1** | Understand fundamental principles of control engineering, including concepts of feedback, stability, and control system design methodologies |
| **CO2** | Apply mathematical modeling techniques to analyze and design control systems for various engineering applications |
| **CO3** | Demonstrate proficiency in utilizing control system tools and software for simulation, analysis, and implementation of control strategies. |
| **CO4** | Develop the ability to evaluate and optimize control systems' performance through analysis of system dynamics, controller design, and tuning methodologies |

| **Reference Books** | |
|---|---|
| 1. | Modern Control Engineering", Katsuhiko Ogata, Pearson Education, 2010, ISBN: 978-0136156734 |
| 2. | **Feedback Control of Dynamic Systems", Gene F. Franklin, J. Da Powell, and Abbas Emami-Naeini, Pearson Education, 2019, ISBN: 978-0133496598** |
| 3. | Automatic Control Systems", Benjamin C. Kuo and Farid Golnaraghi, Wiley, 2008, ISBN: 978-0470048962 |

| 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. Each quiz is evaluated for 10 marks adding up to 20 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 **50Marks**, 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 (10) Designing & Modeling (10) **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 | | | | | | |
|---|---|---|---|---|---|---|
| **Press Tool Design**<br>**Category: Professional Elective**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | ME365TDA | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 45 L | | **SEE Duration** | **:** | **3 Hours** |

| **Unit - I** | **09 Hrs** |
|---|---|
| **Introduction:** Elements of press tools, classification of press, shearing theory, centre of pressure, strip Layout. Clearance between punch and die, Types working and applications of stock stop, pilots, strippers and knockout. Cutting Dies and applications. | |
| **Unit – II** | **09 Hrs** |
| **Bending and Forming Dies:** Theory of bending, development of bend, spring back, correcting spring back, bending force calculation, working and applications of bending dies - U bending, V bending and forming tools.<br>**Drawing:** Theory of drawing, blank development, calculation of number of stages of drawing, circular draw, draw force calculation, lubrication, Defects and remedies. | |
| **Unit – III** | **09 Hrs** |
| **Die lay out:** Top view, Sectioned Front view, Partial Enlarged Views, die openings & Holes Projections, Die block Length, width & Thickness, Dimensioning, Geometrical Symbols, Sub Title Block, Calculations of Plate Thickness.<br>Calculation of size of tool elements, Economical Strip Layout, Assembly Plan view, Assembly Sectioned Front View, Assembly Side view, Bill of Material and Detail Part Drawings of **Single stage tool:** single row blanking tool (open tool construction), single row angular layout blanking tool (with diagonal pillar die set) front feeding and double row blanking tool (with rear pillar die set) side feeding. | |
| **Unit – IV** | **09 Hrs** |
| Calculation of size of tool elements, Economical Strip Layout, Assembly Plan view, Assembly Sectioned Front View, Assembly Side view, Bill of Material and Detail Part Drawings of **Progressive tool:** Two stage progressive cutting tool with stage stopper (with rear pillar die set), Three/ Four stage progressive cutting tool with pitch punch and pilots on a rear pillar die set and Progressive cutting tool with cut-off / Part-off arrangement. | |
| **Unit – V** | **09 Hrs** |
| Calculation of size of tool elements, Economical Strip Layout, Assembly Plan view, Assembly Sectioned Front View, Assembly Side view, Bill of Material and Detail Part Drawings of **Compound tool:** For washer component and non-circular component. | |

| **Experience Learning- LAB** | |
|---|---|
| **Student Must do Four exercises from the following (each Carries 10 Marks)** | **MARKS** |
| Preparation and presentation of standard designs, taking into account the following factors:<br>➢ Economical Strip Layout<br>➢ Die Layout<br>➢ Tool Elements Layout<br>➢ Assembly Plan<br>➢ Assembly Sectional Front View<br>➢ Assembly Full/Partial Side View<br>➢ Bill of Materials<br>➢ Detailed Part Drawings<br>**1. Single Stage**<br>**a)** Single Row (Open Tool Construction)<br>**b)** Single Row Angular Layout Blanking Tool (Diagonal Pillar Die Set)<br>**c)** Double Row Blanking Tool (Rear Pillar Die Set)<br>**d)** Secondary Operational Tools with Die Nesting, Piercing Tool<br>**e)** Bending tool | **40** |

| | |
|---|---|
| **2 Progressive Tool:**<br>**a)** Two Stages Progressive Cutting Tool with Stage Stopper (Rear Pillar Die Set)<br>**b)** Three / Four Stages Progressive Cutting Tool with Pitch Punch & Pilots on a Rear Pillar Die Set<br>**c)** Progressive Cutting Tool with Cut-off<br>**d)** Progressive Cutting Tool with Part-off<br>**3. Compound tool**<br>**a)** Compound Tool for Washer<br>**b)** Compound Tool for Non-Circular Components<br>**4. Combination tool** | |

| **Course Outcomes: After completing the course, the students will be able to:** | |
|---|---|
| **CO1** | Explain the necessity of fundamental principles and theories underlying press tool design |
| **CO2** | Analyse the design constraints in the given problem |
| **CO3** | Apply the design rule for designing and manufacturing of press tools |
| **CO4** | Design and drafting customized press tools tailored to specific manufacturing requirements |

| **Reference Books** | |
|---|---|
| 1 | "Design of Jigs, Fixtures and Press Tools" by K. Venkataraman, Springer: 2nd Edition, 2022; ISBN 978-3-030-76532-3 |
| 2 | "Die Design Fundamentals" by Paquin JR & Crowley, Industrial Press Inc. 3rdEd. 2006, ISBN: 9780831131197 |
| 3 | "Handbook of Die Design" by Ivana Suchy, New York-Mc GRAW-HILL: 2nd Edition, 2006, **ISBN:**9780071462716 |
| 4 | "Advanced Die Design" by Eugene Ostergard, Natl Tooling & Machining Assn, 1993, ISBN 13: 9780070460935 |

| **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** |
| 1 | **PART A** 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 3/4/5: (Internal Choice) | 48 |
| | **TOTAL** | **100** |

| Semester: VI | | | | | | |
|---|---|---|---|---|---|---|
| **CRYOGENIC ENGINEERING**<br>**Category: Professional Core Elective**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | ME365TDB | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 45L | | **SEE Duration** | **:** | **3 Hours** |

| **Unit-I** | **09 Hrs** |
|---|---|
| **Introduction:**<br>Applications areas of Cryogenic Engineering, Low temperature properties of engineering materials – Mechanical properties, Thermal properties, Electrical properties. Introduction thermodynamically ideal system, Production of low temperatures – Joule Thompson Effect, Adiabatic expansion. Second law of Thermodynamics, Carnot refrigerator, Vapor Compression Refrigeration Cycle, components, Properties of Refrigerants | |
| **Unit – II** | **09 Hrs** |
| **Gas Liquefaction and refrigeration systems:** Liquification systems for Air Simple Linde –Hampson System, Claude System, Heylndt System, Dual pressure, Claude Liquefaction cycle Kapitza System.<br>**Liquefaction:** Comparison of Liquefaction Cycles, liquefication cycle for hydrogen, helium and Neon, Critical components of liquefaction systems. | |
| **Unit –III** | **09 Hrs** |
| **Gas Cycle Cryogenic Refrigeration Systems:** Classification of Cryo coolers Stirling cycle Cryo – refrigerators, Ideal cycle – working principle. Schmidt's analysis of Stirling cycle Various configurations of Stirling cycle refrigerators Integral piston Stirling cryo-cooler, Free displacer split type Stirling Cryo coolers, Gifford Mcmahon Cryo- refrigerator, Pulse tube refrigerator, Solvay cycle refrigerator, Vuillimier refrigerator, Cryogenic regenerators.<br>**Gas Separation and Gas Purification Systems:** Thermodynamic ideal separation system, Properties of mixtures, Principles of gas separation, Linde single column air separation. Linde double column air separation, Argon and Neon separation systems. Adsorption Process, PSA systems. | |
| **Unit –IV** | **09 Hrs** |
| **Vacuum Technology:** Fundamental principles. Production of high vacuum, Mechanical vacuum pumps, Diffusion pumps, Cryo-pumping, Measurement of high vacuum level. Cryogenic Insulation: Heat transfer due to conduction, Evacuated porous insulation Powder & Fibers Opacified powder insulation, Gas filled powders & Fibrous materials Multilayer super-insulation, Composite insulation.<br>**Low Temperature Insulation:** Reflective insulation, Evacuated powders, Rigid foams, Super insulation. Cooling by adiabatic de-magnetization, Storage and handling of cryogenic liquids, Dewars and other types of containers. | |
| **Unit 5** | **09 Hrs** |
| **Application Of Cryogenic Systems:** Cryogenic application for food preservation – Instant Quick-Freezing techniques, Super conductive devices, Cryogenic applications for space technology, Expansion fitting, cryobiology, cryosurgery, computers, underground power lines.<br>**Safety in Cryogenics:**<br>Need for safety, basic hazards, protection from hazards | |

| **Experience Learning- LAB** | |
|---|---|
| **Student Must do Four exercises from the following (each Carries 10 Marks)** | **MARKS** |
| 1. "Optimizing Cryogenic Engineering in Biomedical Applications: Case Studies in Tissue Preservation and Cryosurgery"<br>2. "Enhancing Material Selection for Low-Temperature Environments: Case Studies in Aerospace and Energy Industries"<br>3. "Case Study: Optimization of Gas Liquefaction Systems for Industrial Applications"<br>4. "Analyzing Critical Components in Gas Liquefaction Systems: Case Studies on Hydrogen, Helium, and Neon Liquefaction Cycles"<br>5. "Case Study: Performance Analysis of Gas Cycle Cryogenic Refrigeration Systems"<br>6. "Optimizing Gas Separation and Purification Systems: Case Studies on Thermodynamic Ideal Separation, Adsorption Processes, and PSA Systems"<br>7. "Case Study: Advancements in Vacuum Technology for High Vacuum Production and Measurement"<br>8. "Analyzing Cryogenic Insulation Methods: Comparative Study of Heat Transfer and Efficiency in Various Insulation Materials"<br>9. "Case Study: Enhancing Food Preservation with Cryogenic Systems: Analysis of Instant Quick-Freezing Techniques"<br>10. "Exploring Cryogenic Applications in Space Technology: Case Studies on Propulsion Systems and Thermal Control" | **40** |

| **Course Outcomes: After completing the course, the students will be able to:** | |
|---|---|
| **CO1** | Understand the principles of cryogenics and its applications. |
| **CO2** | Apply the different techniques for producing cryogenic fluids. |
| **CO3** | Analyse different Cryogenic Refrigeration and purification systems. |
| **CO4** | Selection of materials and equipment for cryogenic systems adhering to safety norms. |

| **Reference Books** | |
|---|---|
| 1. | Cryogenic Systems by R.F Barron, Oxford University Press, 1985 |
| 2. | Randall F. Barron, "Cryogenics Systems", Second Edition Oxford Univesity Press New York, Clarendon Press, Oxford, 1985. |
| 3. | Timmerhaus, Flynn, "Cryogenics Process Engineering", Plenum Press, New York. |
| 4. | Pipkov, "Fundamentals of Vacuum Engineering", Meer Publication. |
| 5. | G.M Walker. "Cryocooler-Part 1 Fundamentals" Plenum Press, New York and London. |
| 6. | G.M Walker. "Cryocooler-Part 2" Plenum Press, New York and London. |

| 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**<br>(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 | | | | | | |
|---|---|---|---|---|---|---|
| **MODELLING AND SIMULATION OF MANUFACTURING PROCESSES**<br>**Category: Professional Elective (Theory)** | | | | | | |
| **Course Code** | **:** | ME365TDC | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 45 L | | **SEE Duration** | **:** | **3 Hours** |

| **Unit-I** | **07 Hrs** |
|---|---|
| **Mathematical Modeling and Engineering Problem Solving** – A Simple Mathematical Model and the engineering problem solving process, mathematical modelling process, Hierarchical vs. Concurrent approach, multi-scale models.<br>**Modelling of Sand-Casting:** Mechanism of solidification – Rate of solidification, Solidification of large casting in an insulating mould (Numerical problems); Solidification with predominant interface resistance; Solidification with constant casting surface temperature; Solidification with predominant resistance in mould and solidified metal. (No Numerical problems). | |
| **Unit – II** | **09 Hrs** |
| **Modelling of Forming Processes**: Engineering and true stress-strain, Flow stress, Yield criteria; **Slab method: Forging –** Analysis of forging pressure for rectangular and circular disc. (Numerical problems). **Wire Drawing –** Analysis of drawing force (stress) & power and maximum allowable reduction; **Extrusion (Round bar/wire) –** Extrusion workload & Stress analysis; **Deep Drawing:** Blank holding and drawing force analysis. (Numerical problems). | |
| **Unit –III** | **09 Hrs** |
| **Modelling of Machining Processes**: Review on Orthogonal cutting; **Oblique Cutting:** Direction of chip flow, Rake angles, Cutting ratios, Velocity relationship, Shear angle; **Mechanics of Turning Process:** Analysis of chip flow direction, Effective rake angle, Power and forces, Specific cutting resistance. (Numerical problems).<br>**Ultrasonic Machining:** Grain throwing and grain hammering models, parametric analysis and process Parameters (No Numerical Problems); **Electric Discharge Machining:** Analysis of R-C circuits, Condition for maximum power generation, Material removal rate, Surface finish, Process parameters. (Numerical problems). | |
| **Unit –IV** | **07 Hrs** |
| **Introduction to Fuzzy Logic:** Crisp and Fuzzy sets operations and properties, Representation of a fuzzy set, Membership functions, Definitions in fuzzy sets, Standard operations in fuzzy sets and relations. (Numerical Problems).<br>Measures of fuzziness and inaccuracy of fuzzy sets; **Fuzzy Logic Controller:** Mamdani approach, Takagi and Sugeno's approach. (Numerical Problems). | |
| **Unit –V** | **07 Hrs** |
| **Fundamentals of Neural Networks:** Artificial neuron, Transfer functions; **Multi-Layer Feed-Forward Neural Network:** Training of network using back-propagation algorithm, Types of training methods. (No Numerical Problems)<br>**Neuro-Fuzzy System:** Mamdani Approach – Tuning of the Neuro-Fuzzy System using a Back-Propagation algorithm; **Adaptive Neuro-Fuzzy Inference System:** Takagi and Sugeno's approach. (No Numerical Problems) | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Analyse models for metal sand casting process. |
| **CO2:** | Apply models to evaluate the forces in forming processes. |
| **CO3:** | Analyse models for traditional and non-traditional machining processes. |
| **CO4:** | Apply the principles of soft computing tools to create models for the manufacturing process inputs and outputs. |

| **Reference Books** | |
|---|---|
| **1** | **"Soft Computing – Fundamentals and Applications",** Dilip K. Pratihar, Narosa Publishing House Pvt. Ltd. Revised Edition, 2015, ISBN-13: 978-81-8487-495-2. |
| **2** | **"Manufacturing Science"**, Amitabha Ghosh, East-West Press Pvt Ltd, 2nd ed., 2010, ISBN-13: 978-81-767-1063-3. |
| **3** | **"Fundamentals of Metal Cutting and Machine Tools"**, B.L Juneja, G.S. Sekhon & Nitin Seth, New Age International (P) Limited, 2003, 2nd Revised ed., 2003, ISBN-13: 978-81-224-1467-7. |
| **4** | **"Unconventional Machining Processes"**, Jagadeesha T, Dreamtech Press, Wiley India Pvt Ltd. 2021, ISBN-13: 978-9-389-97605-2. |

| **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**<br>(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: V | | | | | | |
|---|---|---|---|---|---|---|
| **FUNDAMENTALS OF COMBUSTION**<br>**Category: Professional Core Elective**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | ME365TDD | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 45 Hrs | | **SEE Duration** | **:** | **3 Hours** |

| **Unit-I** | **09 Hrs** |
|---|---|
| **Introduction:**<br>Introduction to fuels, properties of gaseous and liquid fuels, liquid and solid fuels, Review of basic thermodynamics of ideal gas mixtures, First and Second Laws of Thermodynamics applied to combustion; Heat, temperature and composition of products in equilibrium. | |
| **Unit – II** | **09 Hrs** |
| **Thermodynamics of Combustion:** Stoichiometric air/fuel ratio for combustion of fuels-excess air, exhaust gas analysis, (conversion of mass analysis to volumetric analysis and vice versa). Calorific value, Combustion efficiency. Thermo-Chemistry, Basic reactor Kinetics, Elementary Reactions, Chain Reactions, Multi-Step Reaction Combustion Reactions, Enthalpy of formation, Entropy of formation, Internal energy of combustion. Adiabatic flame temperature, simple problems | |
| **Unit –III** | **09 Hrs** |
| **Physics of Combustion:**<br>Laws of transport mechanism, premixed flames, ignition and flame stabilization and extinction, combustion control, co-ordinate master control, Combustion and Emission, Atmosphere, Chemical Emission from Combustion, Quantification of Combustion, Control of Emission & environment | |
| **Unit –IV** | **09 Hrs** |
| **Chemistry of Combustion:**<br>Basics of reaction kinetics, fundamentals of elementary reactions, chain reactions, multi-step chain reactions, concept of pre-mixed and diffusion flame. | |
| **Unit-V** | **09 Hrs** |
| **Combustion and Environment:**<br>Atmosphere, chemicals from combustion, quantification of emission, emission control methods. | |

| **Course Outcomes: After completing the course, the students will be able to:** | |
|---|---|
| **CO1** | Understand the basics of combustion. |
| **CO2** | Apply combustion concepts to solve engineering problems. |
| **CO3** | Analyse the thermodynamic properties of fuels for combustion applications. |
| **CO4** | Quantify the effects of combustion on environmental and society. |

| **Experience Learning- LAB** | |
|---|---|
| **Student Must do Four exercises from the following (each Carries 10 Marks)** | **MARKS** |
| 1. "Experimental Study: Combustion Characteristics of Gaseous vs. Liquid Fuels under Varying Conditions"<br>2. "Exploring Thermodynamic Principles: Experimental Investigation of Heat Release and Product Composition in Fuel Combustion Reactions" | **40** |

| | |
|---|---|
| 3. "Experimental Investigation: Analysis of Combustion Efficiency and Stoichiometric Air/Fuel Ratios in Fuel Combustion"<br>4. "Thermochemical Analysis: Determination of Calorific Value, Enthalpy of Formation, and Adiabatic Flame Temperature in Combustion Reactions"<br>5. "Experimental Study: Investigating Transport Mechanisms and Premixed Flames in Combustion Systems"<br>6. "Analysis of Combustion Control and Emission Reduction Strategies: Coordinated Master Control and Environmental Impact Assessment"<br>7. "Experimental Exploration of Reaction Kinetics and Elementary Reactions in Combustion Chemistry"<br>8. "Investigating Chain Reactions and Flame Types: Understanding Pre-mixed and Diffusion Flames through Experimental Analysis"<br>9. "Analyzing the Impact of Combustion on the Environment: Atmospheric Effects and Chemical Emissions"<br>10. "Quantifying Emissions from Combustion Processes and Exploring Methods for Emission Control" | |

| **Reference Books** | |
|---|---|
| 1. | D P Mishra, Fundamentals of Combustion, Revised Edition, PHI, 2013, ISBN: 9788120333482 |
| 2. | Holman B K, Heat Transfer, McGraw Hill, 9th Edition, 2022, ISBN: 978-0078447853 |
| 3. | Kuo K K, Principles of Combution, John Wiely and Sons, 2005, ISBN: 978-0471046899 |
| 4. | Strehlow R A, Fundamentals of Combustion, McGraw Hill, 1984, ISBN: 978-0882755397 |

| **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**<br>(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**<br>**Category: Professional Core Elective**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | ME365TDE | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 40 Hrs | | **SEE Duration** | **:** | **3 Hours** |

| **Unit-I** | **07 Hrs** |
|---|---|
| **Introduction to hydraulic power**<br>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**<br>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.<br>**Control components and accessories**<br>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**<br>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.<br>**Analysis of Hydraulic circuits**<br>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:**<br>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.<br>**Logic control and Multicylinder applications:**<br>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:**<br>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, multi cylinder sequence.<br>**Applications of Fluid power systems:**<br>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** | |
|---|---|
| 1. | 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**<br>(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 | | | | | | |
|---|---|---|---|---|---|---|
| **FUNDAMENTALS OF AEROSPACE ENGINEERING**<br>**Category: Institutional Electives-I GROUP-E**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | AS266TEA | | **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** |
|---|---|
| **Basics of Flight Vehicles:** History of aviation, International Standard atmosphere (ISA), Temperature, pressure and altitude relationships, Simple Problems on Standard Atmospheric Properties, Classification of aircrafts, Anatomy of an aircraft & Helicopters, Basic components and their functions. | |
| **Unit – II** | **10 Hrs** |
| **Aircraft Aerodynamics:** Bernoulli's theorem, Centre of Pressure, Lift and Drag, Types of Drag, Aerodynamic Coefficients, Aerodynamic Centre, Wing Planform Geometry, Airfoil Nomenclature, Basic Aerodynamic characteristics of Airfoil, Simple Numericals on Lift and Drag. | |
| **Unit –III** | **12 Hrs** |
| **Aerospace Propulsion:** Introduction, Turbine Engines: Brayton Cycle, Operation of Turbojet, Turboprop, Turbofan, Turboshaft, RAMJET and SCRAMJET Engines, Rocket Engines: Principles of operation of Solid, Liquid, Hybrid, Nuclear and Electric Rockets.<br>**Introduction to Space Mechanics:** Basic Orbital Mechanics-Types of Trajectories, Escape and Orbital Velocities, Kepler's Laws of Planetary Motion, Simple Numericals. | |
| **Unit –IV** | **06 Hrs** |
| **Aerospace Structures and Materials:** General types of construction-Monocoque, Semi-Monocoque & Geodesic, Structure of Wing and Fuselage, Metallic and Composite Materials. | |
| **Unit –V** | **08 Hrs** |
| **Aircraft Systems & Instruments:** Instrument Displays, Basic Air data systems & Pitot Probes- Mach meter, Air speed indicator, Vertical speed indicator, Altimeter.<br>**Basics of Aircraft Systems:** Hydraulic and pneumatic systems, Electrical System, Aircraft Fuel System, Environmental Control System. | |

| **Course Outcomes:** At the end of this course the student will be able to: | |
|---|---|
| **CO1** | Identify the fundamental nuances of Aerospace Engineering and appreciate their significance on the Flight Vehicles design and performance |
| **CO2** | Interpret the design parameters that influence the design of the Aerospace Vehicles systems and its sub-systems |
| **CO3** | Evaluate critically the design strategy involved in the development of Aerospace vehicles |
| **CO4** | Categorically appraise the operation of the Aerospace Vehicles for different operating conditions |

| **Reference Books** | |
|---|---|
| **1** | Introduction to Flight, John D. Anderson, 7th Edition, 2011, McGraw-Hill Education, ISBN 9780071086059. |
| **2** | Fundamentals of Aerodynamics, Anderson J .D, 5th Edition, 2011, McGraw-Hill International Edition, New York ISBN:9780073398105. |
| **3** | Rocket Propulsion Elements, Sutton G.P., 8th Edition, 2011, John Wiley, New York, ISBN: 1118174208, 9781118174203. |
| **4** | Aircraft structural Analysis, T.H.G Megson, 2010, Butterworth-Heinemann Publications, ISBN: 978-1-85617-932-4 |
| **5** | Ian Moir, Allan Seabridge, "Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration", John Wiley & Sons, 3rd edition, 2011, ISBN: 9781119965206 |

| 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**<br>(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 | | | | | | |
|---|---|---|---|---|---|---|
| **Bioinformatics**<br>**Category: Institutional Electives -I**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **BT266TEB** | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **45 Hrs** | | **SEE Duration** | **:** | **3Hours** |

| **Unit-I** | **09 Hrs** |
|---|---|
| **Introduction to tools and databases:** Introduction to Bioinformatics, Goals, Scope, Applications, Sequence databases, Structure databases, Special databases – genome and microarray, Applications of these databases, examples, Database similarity search: Unique requirements of database searching, Heuristic Database Searching, Basic Local Alignment Search Tool (BLAST), FASTA, Comparison of FASTA and BLAST, Database Searching with Smith-Waterman Method | |
| **Unit – II** | **09 Hrs** |
| **Sequence Analysis:** Types of Sequence alignment -Pairwise and Multiple sequence alignment, Alignment algorithms, Scoring matrices, Statistical significance of sequence alignment. Multiple Sequence Alignment: Scoring function, Exhaustive algorithms, Heuristic algorithms, Profiles and Hidden Markov Models: Position-Specific scoring matrices, Profiles, Markov Model and Hidden Markov Model, Scoring matrices – BLOSSUM and PAM<br>**Molecular Phylogenetics:** Introduction, Terminology, Forms of Tree Representation. Phylogenetic Tree Construction Methods - Distance-Based, Character-Based Methods and Phylogenetic Tree evaluation. | |
| **Unit –III** | **09 Hrs** |
| **Introduction to Next-Generation Sequencing (NGS) analysis**: Sanger sequencing principles - history and landmarks, of Sequencing Technology Platforms, A survey of next-generation sequencing technologies, A review of DNA enrichment technologies, Base calling algorithms, Base quality, phred values, Reads quality checks, Interpretations from quality checks. Adapter and primer contamination. Processing reads using clipping of reads-Advantages and disadvantages of processing of reads, automation in NGS analysis and advantages (shell scripting) | |
| **Unit –IV** | **09 Hrs** |
| **Structural analysis & Systems Biology:** Gene prediction programs – ab initio and homology-based approaches. ORFs for gene prediction. Detection of functional sites and codon bias in the DNA. Predicting RNA secondary structure, Protein structure basics, structure visualization, comparison and classification. Protein structure predictive methods using protein sequence, Protein identity based on composition. Structure prediction - Prediction of secondary structure, tertiary structure prediction methods, Scope, Applications. Concepts, implementation of systems biology, Mass spectrometry and Systems biology, Flux Balance analysis. | |
| **Unit –V** | **09 Hrs** |
| **Drug Screening:** Introduction to Computer-aided drug discovery, target selection, ligand preparation and enumeration, molecular docking, post-docking processing, molecular dynamics simulations, applications and test cases, AI/ML in Drug discovery | |

| **Course Outcomes: After completing the course, the students will be able to:** | |
|---|---|
| **CO1** | Gain proficiency in utilizing a range of bioinformatics tools and databases for comprehensive sequence and structural analysis. |
| **CO2** | Investigate and apply innovative sequencing technologies and analytical methods to solve complex biological questions and advance research in genomics and molecular biology. |
| **CO3** | Demonstrate expertise in NGS technologies, including performing data quality assessments, read processing, and managing large-scale data. |
| **CO4** | Apply bioinformatics tools for modeling and simulating biological processes, with a focus on gene prediction using both ab initio and homology-based approaches. |

| **Reference Books** | |
|---|---|
| 1. | Xiong J. Essential bioinformatics. Cambridge University Press; 2006 Mar 13. |
| 2. | Buehler LK, Rashidi HH, editors. Bioinformatics basics: applications in biological science and medicine. CRC Press; 2005 Jun 23. |
| 3. | Ghosh Z, Mallick BM. Bioinformatics principles and Applications. Oxford University Press; 2018 Jun 13. |
| 4. | Low L, Tammi MT. Introduction to next generation sequencing technologies. Bioinformatics. WORLD SCIENTIFIC. 2017 Jul 26:1-21. |
| 5. | Bioinformatics: Sequence and Genome Analysis; D W Mount; 2014; CSHL Press; 2nd edn; ISBN: 9780879697129. |
| 6. | Computational Systems Biology; A Kriete and R Eils; 2006; Academic Press; Illustrated edn; ISBN: 978-01-208-87866. |

| **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**) 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**<br>(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 | | | | | | |
|---|---|---|---|---|---|---|
| **INDUSTRIAL SAFETY ENGINEERING**<br>**Category: Institutional Electives-I**<br>**(Theory)** | | | | | | |
| Course Code | : | CH266TEC | | 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:**<br>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, problems on OSHA | |
| **Unit – II** | 08 Hrs |
| **Risk assessment and control:** Risk assessment, Risk perception, acceptable risk, problems on net present value, internal rate of return, payback period concepts including real life examples.<br>**Hazard Identification Methods:** Preliminary Hazard List (PHL), worksheets, case study. Preliminary Hazard Analysis (PHA), Fault tree and Event tree analysis. Design and development of fault tree and event tree for high pressure reactor system. | |
| **Unit –III** | 08 Hrs |
| **Hazard analysis:** Hazard and Operability Study (HAZOP): Guide words, HAZOP matrix, Procedure, HAZOP studies on reactors, heat exchanger, design of HAZOP table, Failure Modes and Effects Analysis (FMEA) concept, methodology, problems of FMEA, examples. | |
| **Unit –IV** | 08 Hrs |
| **Risk analysis on capital budgeting:** Risk adjusted discount rate (RADAR) method, certainty equivalent approach, scenario analysis, probability distribution, quantification of risk using statistical parameters and associated problems. | |
| **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 | Understand the risk assessment techniques used in process industry |
| CO2 | Interpret the various risk assessment tools. |
| CO3 | Use hazard identification tools for safety management. |
| CO4 | Analyze tools and safety procedures for protection in process industries. |

| **Reference Books** | |
|---|---|
| 1. | Functional Safety in the Process Industry: A Handbook of practical Guidance in the application of IEC61511 and ANSI/ISA-84, Kirkcaldy K.J.D Chauhan, 2012, North corolina, Lulu publication, ISBN:1291187235. |
| 2. | Safety Instrumented Systems Verification Practical probabilistic calculations, Goble and William M., 2005, Pensulvania ISA publication, ISBN:155617909X. |
| 3. | Industrial safety and risk Management, Laird Wilson and Doug Mc Cutche, 1st Edition, 2003, The University of alberta press, Canada, ISBN: 0888643942. |
| 4. | 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). 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**<br>(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 | | | | | | |
|---|---|---|---|---|---|---|
| **Robotic Process Automation (Institutional electives-I) (Theory)** | | | | | | |
| **Course Code** | **:** | **CS266TED** | | **CIE** | **:** | **100** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100** |
| **Total Duration** | **:** | **36** | | **SEE Duration** | **:** | **3 Hrs** |

| **Unit – I** | **8 Hrs** |
|---|---|
| **RPA Concepts**: RPA Basics, History of Automation, what is RPA? RPA vs Automation, Processes & Flowcharts, Programming Constructs in RPA, What Processes can be Automated? Types of Bots, Workloads that can be automated.<br>**RPA Advanced Concepts**: Standardization of processes, Setting up the Centre of Excellence, RPA Development methodologies, Difference from SDLC, RPA journey, RPA business case, RPA Team, Process Design Document/Solution Design Document, Industries best suited for RPA, Risks & Challenges with RPA, RPA and emerging ecosystem. | |
| **Unit – II** | **7 Hrs** |
| **RPA Tool Introduction:** Introduction to UiPath - the User Interface, Types of Variables, Variables in UiPath, Managing Arguments, The Arguments Panel, Namespaces; Control flow statements in UiPath, Sequences and Flowcharts, Control Flow Activities<br>Data Manipulation Introduction, Data Manipulation Operations, Types of data storing variables, Text Manipulation, main string methods.<br>**UiPath Recording:** Basic, Desktop and Web Recording, Image and Native Citrix Recording, Input/output methods, Types of OCR, Data Scraping, Advanced Scraping techniques. | |
| **Unit – III** | **7 Hrs** |
| **Advanced Automation Concepts:** Selectors, Types of Selectors (Full, partial, dynamic), Defining and Assessing Selectors, Customization, Debugging.<br>**Image, Text & Advanced Citrix Automation** – Introduction, Keyboard based automation, Information Retrieval, Best Practices<br>Excel Data Tables & PDF, Data Tables in RPA, Excel and Data Table, Extracting Data from Data Table, Anchors, Using anchors in PDF | |
| | |
| **Unit – IV** | **7 Hrs** |
| **Email Automation, Exceptions and Deploying Bots:** Introduction to Email Automation, Key concepts of email, email protocols, email automation in UiPath, email as input and output.<br>Debugging and Exception Handling, Types of exception, Debugging Tools, Strategies for solving issues, Catching errors.<br>Overview of orchestration Server, orchestrator functionalities, Connecting Bot to orchestrator | |
| **Unit – V** | **7 Hrs** |
| **Hyperautomation**: Components and application ofHyperautomation, Automation versus hyperautomation, Benefits and challenges of hyperautomation, use cases, Phases (Integration, Discover, Orchestration and Governance), Trends in Hyperautomation (low-code/no-code platform, HaaS) | |

| | **Course Outcomes: After completing the course, the students will be able to** |
|---|---|
| **CO1** | Understand RPA principles, its features and applications |
| **CO2** | Demonstrate proficiency in handling variables and decision making inside a workflow and data manipulation techniques |
| **CO3** | Gain insights into recording, Email Automation and exception handling and orchestrator. |
| **CO4** | Analyze the trends in automation and chose business strategy to design a real-world automation workflow. |

| **Reference Books:** | |
|---|---|
| **1.** | Alok Mani Tripathi, "Learning Robotic Process Automation, Publisher: Packt Publishing, Release Date: March 2018 ISBN: 9781788470940 |
| **2.** | PASCAL BORNET, Intelligent automation: Welcome to the world of hyperautomation, World Scientific Publishing Company, ISBN-13: 978-9811235481, December 2020 |
| **3.** | UiPath pdf manuals |
| **4.** | https://www.uipath.com/rpa/robotic-process-automation |
| **5.** | https://www.ibm.com/topics/hyperautomation |
| **6.** | https://www.pega.com/hyperautomation |

| **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** |
| 1 | **PART A:** 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 | | | | | | |
|---|---|---|---|---|---|---|
| **INTELLIGENT TRANSPORTATION SYSTEMS**<br>**Category: Institutional Electives-I**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | CV266TEE | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 40L | | **SEE Duration** | **:** | **3Hours** |

| **Unit-I** | **08 Hrs** |
|---|---|
| Introduction to Intelligent Transportation Systems **(**ITS): Historical background, Urbanisation, Motorisation, Transport system characteristics, Transport problems and issues, Challenges and opportunities in ITS: ITS-Today and tomorrow, ITS training and education needs, Role and importance of ITS in context of Indian Transport system and opportunity for sector growth of ITS. | |
| **Unit – II** | **08 Hrs** |
| ITS Architecture: introduction, Functionalities required for User service, Logical architecture, Physical architecture, Equipment and Market packages, Need of ITS Architecture to solve problems in Urban area.<br>Technology building blocks for ITS: Introduction, Data acquisition, Communication tools, Data analysis and Traveller information. Various detection, Identification and collection methods for ITS. | |
| **Unit –III** | **08 Hrs** |
| Traffic management system components and ITS: Introduction, objectives, traffic management measures, ITS for traffic management, Development of traffic management system, Traffic Management Centre, Advance Traffic Management System, Advanced Traveller Information System, Advance Vehicle Control Systems, Advance Public Transport System, Commercial Vehicle Operations, ITS For Intermodal Freight Transport. | |
| **Unit –IV** | **08 Hrs** |
| ITS Evaluation – Project selection at the planning level, Deployment Tracking, Impact Assessment, Benefits by ITS components, Evaluation Guidelines. ITS for Law Enforcement: Introduction, Enhance and support the enforcement traffic rules and regulations, ITS Funding options. | |
| **Unit –V** | **08 Hrs** |
| ITS Standards-Standard development process, National ITS architecture and standards, ITS standards application areas, National Transportation Communications for ITS Protocol, Standards testing. ITS for smart cities and Case studies. | |

| **Course Outcomes: After completing the course, the students will be able to:-** | |
|---|---|
| **CO1** | Identify and apply ITS applications at different levels |
| **CO2** | Illustrate ITS architecture for planning process |
| **CO3** | Examine the significance of ITS for various levels |
| **CO4** | Compose the importance of ITS in implementations |

| **Reference Books** | |
|---|---|
| 1. | Pradip Kumar Sarkar and Amit Kumar Jain, “Intelligent Transport Systems”, PHI Learning Private Limited, Delhi,2018, ISBN-9789387472068 |
| 2. | Choudury M A and Sadek A, “Fundamentals of Intelligent Transportation Systems Planning” Artech House publishers (31 March 2003); ISBN-10: 1580531601 |
| 3. | Bob Williams, “Intelligent transportation systems standards”, Artech House, London, 2008. ISBN-13: 978-1-59693-291-3 |
| 4. | Asier Perallos, Unai Hernandez-Jayo, Enrique Onieva, Ignacio Julio García Zuazola “Intelligent Transport Systems: Technologies and Applications” Wiley Publishing ©2015, ISBN:1118894782 9781118894781, |
| 5 | R.P Roess, E.S. Prassas, W.R. McShane. Traffic Engineering, Pearson Educational International, Third Edition, 2004, ISBN-13: 978-0-13-459971-7. |

| 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. **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**<br>(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 | | | | | | |
|---|---|---|---|---|---|---|
| **INTEGRATED HEALTH MONITORING OF STRUCTURES**<br>**Category: Institutional Electives - I**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | CV266TEF | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 42L | | **SEE Duration** | **:** | **3Hours** |

| **Unit-I** | **08 Hrs** |
|---|---|
| **Structural Health**: Factors affecting Health of Structures, Causes of Distress, Regular Maintenance, Importance of maintenance<br>**Structural Health Monitoring**: Concepts, Various Measures, Analysis of behavior of structures using remote structural health monitoring, Structural Safety in Alteration. | |
| **Unit – II** | **08 Hrs** |
| **Materials:** Piezo–electric materials and other smart materials, electro–mechanical impedance (EMI) technique, adaptations of EMI technique, Sensor technologies used in SHM<br>**Structural Audit**: Assessment of Health of Structure, Collapse and Investigation, Investigation Management, SHM Procedures, SHM using Artificial Intelligence | |
| **Unit –III** | **08 Hrs** |
| **Static Field Testing:** Types of Static Tests, Simulation and Loading Methods, sensor systems and hardware requirements, Static Response Measurement. | |
| **Unit –IV** | **08 Hrs** |
| **Dynamic Field Testing:** Types of Dynamic Field Test, Stress History Data, Dynamic Response Methods, Hardware for Remote Data Acquisition Systems, Remote Structural Health Monitoring. | |
| **Unit –V** | **08 Hrs** |
| **Remote Structural Health Monitoring**: Introduction, Hardware for Remote Data Acquisition Systems, Advantages, Case studies on conventional and Remote structural health monitoring<br>**Case studies:** Structural Health Monitoring of Bridges, Buildings, Dams, Applications of SHM in offshore Structures- Methods used for non-destructive evaluation (NDE) and health monitoring of structural components | |

| **Course Outcomes: After completing the course, the students will be able to:** | |
|---|---|
| **CO1** | Diagnose the distress in the structure understanding the causes and factors. |
| **CO2** | Understand safety aspects, components and materials used in Structural Health Monitoring. |
| **CO3** | Assess the health of structure using static field methods and dynamic field tests. |
| **CO4** | Analyse behavior of structures using remote structural health monitoring |

| **Reference Books** | |
|---|---|
| 1 | Structural Health Monitoring, Daniel Balageas, Claus Peter Fritzen, Alfredo Güemes,2006, John Wiley and Sons, ISBN: 978-1905209019 |
| 2 | Health Monitoring of Structural Materials and Components Methods with Applications, Douglas E Adams, 2007, John Wiley and Sons, ISBN:9780470033135 |
| 3 | Structural Health Monitoring and Intelligent Infrastructure, J. P. Ou, H. Li and Z. D. Duan, Vol1,2006, Taylor and Francis Group, London, UK. ISBN: **978-0415396523** |
| 4 | Structural Health Monitoring with Wafer Active Sensors, Victor Giurglutiu, 2007, Academic Press Inc, ISBN: 9780128101612 |

| 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** | |
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| 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 | | | | | | |
|---|---|---|---|---|---|---|
| **ADVANCED ENERGY STORAGE FOR E-MOBILITY**<br>**Category: Institutional Electives – I (Theory)** | | | | | | |
| **Course Code** | **:** | CM266TEG | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 42L | | **SEE Duration** | **:** | **3 Hours** |

**Course Learning Objectives:** The students will be able to

| | |
|---|---|
| **1** | Understand the fundamentals and technologies of energy storage in electric vehicles |
| **2** | Analyze and compare advanced battery technologies for e-mobility |
| **3** | Impart the principles of electrochemistry for analyzing issues in electric/hybrid vehicles. |
| **4** | Develop solutions for battery management systems and recycling of advanced storage devices. |

| **Unit-I** | **07 Hrs** |
|---|---|
| **Energy storage in electric vehicles:** Introduction to E-mobility, background of alternative energy sources and sustainability. Types of electric vehicles and their salient features along with their energy requirement. Fundamentals of advanced battery technology. Battery characteristics. Specification of advanced battery for e mobility. | |
| **Unit – II** | **08 Hrs** |
| **Advanced lithium-ion batteries:** Basic concepts of lithium batteries. Types of advanced cathode and anode materials employed in lithium batteries. Construction, working and future applications of lithium cobalt oxide, lithium iron phosphate, Lithium air, lithium sulfur and lithium polymer batteries with their advancement in vehicle electrification. | |
| **Unit –III** | **09 Hrs** |
| **Non lithium batteries for e mobility:** Limitations of lithium batteries. Overview of non-lithium battery technology. Construction and working of advanced non-Lithium batteries such as Lead acid, Nickel Metal Hydride, Redox flow, Zebra, Sodium and Magnesium batteries. Electrode materials and electrolyte considerations in non lithium batteries. Performance comparison with lithium-ion batteries. Battery requirement in charging infrastructure. | |
| **Unit –IV** | **09 Hrs** |
| **Chemistry of alternative storage devices:** Introduction to super capacitor. Construction, working and applications of supercapacitors along with the materials used in electrodes. Types of advanced supercapacitors. Application of supercapacitors in regenerative braking. Advancement in battery-supercapacitor hybrid, Battery-fuel cell hybrid, and Battery-solar cell hybrid electric vehicles with their advantages and limitations. | |
| **Unit –V** | **09 Hrs** |
| **Battery management and recycling:** Battery management systems (BMS): Fundamentals of battery management systems and controls, State-of-charge (SoC), state-of-health (SoH) and Cell balancing techniques. **Battery Thermal Management:** Passive and active cooling systems. Safety mechanisms, thermal runaway and thermal management. **Battery recycling:** Economic aspects, environmental safety and process of recycling of advanced batteries. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1** | Implement the fundamentals of chemistry in advanced energy storage and conversion devices. |
| **CO2** | Apply the chemistry knowledge used for hybridization of various energy storage and conversion devices. |
| **CO3** | Analyze the different battery system for achieving maximum energy storage for vehicle electrification |
| **CO4** | Evaluation of efficiency of a battery with respect to cost, environmental safety, material, energy consumption and recycling. |

| Reference Books | |
|---|---|
| 1 | Battery reference book, T. R. Crompton., 3rd edition, NEWNES Reed Educational and Professional Publishing Ltd 2000, ISBN: 07506 4625 X. |
| 2 | Batteries for Electric Vehicles, D. A. J. Rand, R. Woods, and R. M. Dell, Society of Automotive Engineers, Warrendale PA, 2003. ISBN 10: 0768001277. |
| 3 | Lithium Batteries, Science and Technology, GA. Nazri and G. Pistoa, Kluwer Academic Publisher, 2003, ISBN 978-0-387-92675-9. |
| 4 | Battery Technology Handbook, H. A. Kiehne, Marcel Dekker, NYC, 2003. ISBN: 0824742494 9780824742492. |
| 5 | Electric Vehicle Technology Explained, James Larminie and John Lowry. 2nd Edition, Wiley, ISBN-13: 978-1118505429. |
| 6 | Electric Vehicle Technology and Design, Antoni Gandia. CRC Press, ISBN-13: 978-1138551912. |
| 7 | Sustainable Transportation: Problems and Solutions. William R. Black, The Guilford Press, ISBN-13: 978-1462532072. |

| 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 |
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| 2 | Unit 1 : (Compulsory) | 16 |
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| 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)**<br>**Institutional Elective**<br>**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** | **:** | **03 Hrs** |

| **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.<br>**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,<br>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<br>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<br>norms, 2D/3D rendering, OpenGL, OSG. | |
| **Unit – IV** | **09 Hrs** |
| **HMI User Interface**:<br>User-centered HMI development process, Basics of Web-Server.Web-based HMI: Basics of TwinCAT and HTML, CSS, JavaScript.<br>**HMI on Mobile**: Four Principles of Mobile UI Design, Benefits of Mobile HMIs, Mobile HMI DevelopmentSuites. | |
| **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 MultimodalHMI, Automotive Use-Cases<br>**HMI Testing**: Limitations of Traditional Test Solutions, Case - Study: Bosch's HMI validation tool - GraphicsTest Systems (GTS).<br>**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. | Touch based HMI; Principles and Applications, Shuo gao, Shuo Yan, Hang Zhao, Arokia Nathan, Springer Nature Switzerland AG, 1st Edition. |
| 2. | Unity 2020 by Example: A Project based guide to building 2D, 3D augmented reality and Virtual reality games from sratch, Robert Wells, Packt Publishing ltd, 2020. |
| 3. | GUI Design and Android Apps, Ryan Cohen, Tao Wang, Apress, Berkley, CA,2014. |

| 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 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. 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** | **100** |

| RUBRIC FOR SEMESTER END EXAMINATION (THEORY) | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
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| 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 | | | | | | |
|---|---|---|---|---|---|---|
| **ENERGY AUDITING & STANDARDS**<br>**Category: Institutional Elective-I (Theory)** | | | | | | |
| **Course Code** | **:** | EE266TEJ | | **CIE** | **:** | 100 Marks |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | 100 Marks |
| **Total Hours** | **:** | 45 L | | **SEE Duration** | **:** | 3 Hours |

| **Unit-I** | **06 Hrs** |
|---|---|
| **Types of Energy Audit and Energy-Audit Methodology:** Definition of Energy Audit, Place of Audit, Energy – Audit Methodology, Financial Analysis, Sensitivity Analysis, Project Financing Options, Energy Monitoring and Training.<br>**Survey Instrumentation:** Electrical Measurement, Thermal Measurement, Light Measurement, Speed Measurement, Data Logger and Data Acquisition System,<br>**Energy Audit of a Power Plant:** Indian Power Plant Scenario, Benefit of Audit, Types of Power Plants, Energy Audit of Power Plant. | |
| **Unit – II** | **10 Hrs** |
| **Electrical-Load Management:** Electrical Basics, Electrical Load Management, VariableFrequency Drives, Harmonics and its Effects, Electricity Tariff, Power Factor, Transmission and Distribution Losses.<br>**Energy Audit of Motors:** Classification of Motors, Parameters related to Motors, Efficiency of a Motor, Energy Conservation in Motors, BEE Star Rating and Labelling.<br>**Energy Audit of Pumps, Blowers and Cooling Towers:** Pumps, Fans and Blowers, Cooling Towers | |
| **Unit –III** | **09 Hrs** |
| **Communication & Standards:**<br>**Wireless technologies:** WPANs, LAN, Wireless metropolitan area network, cellular network, satellite communication, Zigbee, Bluetooth, LAN, NAN<br>**Wireline communication:** Phone line technology, powerline technology, coaxial cable technology; Optical communication, TCP/IP networks | |
| **Unit –IV** | **09 Hrs** |
| **Energy Audit of Boilers:** Classification of Boilers, Parts of Boiler, Efficiency of a Boiler, Role of excess Air in Boiler Efficiency, Energy Saving Methods.<br>**Energy Audit of Furnaces:** Parts of a Furnace, classification of Furnaces, Energy saving Measures in Furnaces, Furnace Efficiency<br>**Energy Audit of Steam-Distribution Systems :** S team as Heating Fluid, Steam Basics, Requirement of Steam, Pressure, Piping, Losses in Steam Distribution Systems, Energy Conservation Methods | |
| **Unit-V** | **09 Hrs** |
| **Energy Audit of Lighting Systems:** Fundamentals of Lighting, Different Lighting Systems, Ballasts, Fixtures (Luminaries), Reflectors, Lenses and Louvres, Lighting Control Systems, Lighting System Audit, Energy Saving Opportunities.<br>**Energy Audit Applied to Buildings:** Energy – Saving Measures in New Buildings, Water Audit, Method of Audit, General Energy – Savings Tips Applicable to New as well as Existing Buildings. | |

| **Course Outcomes: After completing the course, the students will be able to: -** | |
|---|---|
| **CO 1** | Explain the need for energy audit, prepare a flow for audit and identify the instruments needed. |
| **CO 2** | Design and perform the energy audit process for electrical systems. |
| **CO 3** | Design and perform the energy audit process for mechanical systems |
| **CO 4** | Propose energy management scheme for a building |

| Reference Books | |
|---|---|
| 1. | Handbook of energy audit, Sonal Desai, Kindle Edition, 2015, McGraw Hill Education, ISBN: 9339221346, 9789339221348. |
| 2. | Energy management handbook, Wayne C Turner and Steve Doty, 6th Edition, 2015, CRC Press, ISBN: 0-88173-542-6. |
| 3. | Energy management, Sanjeev Singh and Umesh Rathore, 1st Edition, 2016, Katson Books, ISBN 10: 9350141019, ISBN 13: 9789350141014. |
| 4. | Energy audit of building systems, Moncef Krarti, 2nd Edition, 2010, CRC Press ISBN: 9781439828717 |

| 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**) ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

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| **Q. NO.** | **CONTENTS** | **MARKS** |
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| 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 | | | | | | |
|---|---|---|---|---|---|---|
| **BIOMEDICAL INSTRUMENTATION**<br>**Category: Institutional Elective-I**<br>**(Theory)** | | | | | | |
| **Course Code** | : | EI266TEK | | **CIE** | : | 100 Marks |
| **Credits: L:T:P** | : | 03:00:00 | | **SEE** | : | 100 Marks |
| **Total Hours** | : | 45L | | **SEE Duration** | : | 03 Hrs |

| **Unit-I** | **09 Hrs** |
|---|---|
| **Fundamentals:** Sources of Biomedical signals, Basic medical instrumentation system, General constraints in design of medical instrumentation systems.<br>**Bioelectric Signals and Electrodes**: Origin of bioelectric signals, Types of bioelectric signals, Recording electrodes, Electrode-tissue interface, Polarization, Skin contact impedance, Silver-silver chloride electrodes, Electrodes for ECG, EEG, EMG, Microelectrodes. | |
| **Unit – II** | **09 Hrs** |
| **Electrocardiograph:** Electrical activity of heart, Genesis and characteristics of Electrocardiograph (ECG), Block diagram description of an Electrocardiograph, ECG lead systems, Multi-channel ECG machine.<br>**Electroencephalograph:** Genesis of EEG, Block diagram description of an EEG, 10-20 Electrode system, Computerized analysis of EEG. | |
| **Unit –III** | **09 Hrs** |
| **Patient Monitoring System:** Bedside monitors, Central Monitors, Measurement of Heart Rate, Average Heart Rate meter, Instantaneous heart rate meter, Measurement of pulse rate, Blood Pressure measurement, Direct and indirect method, Automatic blood pressure measuring apparatus using Korotkoff's method.<br>**Oximeters:** Oximetry, ear oximeter, pulse oximeter, skin reflectance oximeter and intravascular oximeter | |
| **Unit –IV** | **09 Hrs** |
| **Blood Flow Meters:** Electromagnetic blood flow meter, Types of electromagnetic blood flow meters, Ultrasonic blood flow meters, NMR blood flow meters, Laser Doppler blood flow meters.<br>**Cardiac Pacemakers and Defibrillators:** Need for Cardiac pacemaker, External Pacemaker, Implantable Pacemaker, Types of Implantable Pacemaker, Ventricular Synchronous Demand Pacemaker and Programmable Pacemaker. Need for a defibrillator, DC defibrillator, Defibrillator electrodes, DC defibrillator with synchronizer. | |
| **Unit –V** | **09 Hrs** |
| **Advances in Radiological Imaging:** X-rays-principles of generation, Conventional X-ray radiography, Fluoroscopy, Angiography, Digital radiography, Digital subtraction angiography (DSA). Basic principle of computed tomography, magnetic resonance imaging system and Ultrasonic imaging system. | |

| **Course Outcomes: After completing the course, the students will be able to:-** | |
|---|---|
| CO1 | Understand the sources of biomedical signals and basic biomedical instruments. |
| CO2 | Apply concepts for the design of biomedical devices |
| CO3 | Analyze the methods of acquisition and signal conditioning to be applied to the physiological parameters. |
| CO4 | Develop instrumentation for measuring and monitoring biomedical parameters. |

| Reference Books | |
|---|---|
| 1. | Handbook of Biomedical Instrumentation, R. S. Khandpur,3rd Edition, Reprint 2016, Tata McGraw-Hill, ISBN: 9780070473553. |
| 2. | Biomedical Instrumentation and Measurements, Leslie Cromwell & others, 2nd Edition, Reprint 2015, ISBN: 9780130771315. |
| 3. | Medical instrumentation: Application and Design, J. G. Webster, 3rd Edition, Reprint 2015, Wiley Publications, ISBN: 9788126511068. |
| 4. | Principles of Medical Imaging, K. Kirk Shung, Michael B. Smith and Banjamin Tsui, Academic Press, 2016, ISBN: 978-0126409703. |

| RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY) | | |
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| **#** | **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**<br>(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 | | | | | | |
|---|---|---|---|---|---|---|
| **TELECOMMUNICATION SYSTEMS**<br>**Category: Institutional Elective-I**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **ET266TEM** | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **45 L** | | **SEE Duration** | **:** | **3 Hours** |

| **Unit-I** | **8 Hrs** |
|---|---|
| **Introduction to Electronic Communication:** The Significance of Human Communication, Communication Systems, Types of Electronic Communication, Modulation and Multiplexing, Electromagnetic Spectrum, Bandwidth, A Survey of Communication Applications.<br>**The Fundamentals of Electronics:** Gain, Attenuation, and Decibels.<br>**Radio Receivers:** Super heterodyne receiver. | |
| **Unit – II** | **10 Hrs** |
| **Modulation Schemes: Analog Modulation:** AM, FM and PM- brief review.<br>**Digital Modulation:** PCM, Line Codes, ASK, FSK, PSK & QAM (Architecture).<br>**Wideband Modulation:** Spread spectrum, FHSS, DSSS. | |
| **Unit –III** | **10 Hrs** |
| **Satellite Communication:** Satellite Orbits, Satellite Communication Systems, Satellite Subsystems,<br>Ground Stations, Satellite Applications, Global Positioning System. | |
| **Unit –IV** | **9 Hrs** |
| **Optical Communication:** Optical Principles, Optical Communication Systems, Fiber-Optic Cables, Optical Transmitters and Receivers, Wavelength-Division Multiplexing, Passive Optical Networks. | |
| **Unit –V** | **8 Hrs** |
| **Cell Phone Technologies:** Cellular concepts, Frequency allocation, Frequency reuse, Internet Telephony.<br>**Wireless Technologies:** Wireless LAN, PANs and Bluetooth, Zig Bee, Mesh Wireless Networks, | |

| **Course Outcomes: After completing the course, the students will be able to:** | |
|---|---|
| **CO1** | Describe the basics of communication systems. |
| **CO2** | Analyze the importance of modulation and multiple access schemes for communication systems. |
| **CO3** | Analyze the operational concept of cell phone and other wireless technologies. |
| **CO4** | Justify the use of different components and sub-system in advanced communication systems. |

| **Reference Books** | |
|---|---|
| 1. | Principles of Electronic Communication Systems, Louis E. Frenzel, 4th Edition, 2016, Tata McGraw Hill, ISBN: 978-0-07-337385-0. |
| 2. | Electronic Communication Systems, George Kennedy,3rd Edition, 2008, Tata McGraw Hill, ISBN: 0-02-800592-9. |
| 3. | Introduction to Telecommunications, Anu A. Gokhale, 2nd Edition, 2008, Cengage Learning ISBN: 981-240-081-8 |

| 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. **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**<br>(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 | | | | | | |
|---|---|---|---|---|---|---|
| **Mobile Communication Networks and Standards**<br>**Category: Institutional Elective -I**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **ET266TEN** | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **45 L** | | **SEE Duration** | **:** | **3 Hours** |

| **Unit-I** | **9 Hrs** |
|---|---|
| **Principle of Cellular Communication:** Cellular Terminology, Cell Structure and Cluster, Frequency Reuse Concept, Cluster size and System Capacity, Method of Locating Co-channel cells, Frequency Reuse distance, Co-channel Interference and Signal Quality, Co-channel interference Reduction Methods. | |
| **Unit – II** | **9 Hrs** |
| **Basic Cellular system:** Consideration of components of a cellular system- A basic cellular system connected to PSTN, Main parts of a basic cellular system, Operation of a Cellular system, Performance criteria- Voice quality, Trunking and Grade of Service, Spectral Efficiency of FDMA and TDMA systems | |
| **Unit –III** | **9 Hrs** |
| **Second generation Cellular Technology: GSM:** GSM Network Architecture, Identifiers used in GSM System, GSM channels, Authentication and Security in GSM, GSM Call Procedure, GSM Hand-off Procedures. | |
| **Unit –IV** | **9 Hrs** |
| **3G Digital Cellular Technology: GPRS:** GPRS technology, GPRS NetworkArchitecture, GPRS signalling, Mobility Management in GPRS. **UMTS:** UMTS Network Architecture, UMTS Interfaces, UMTS Air Interface Specifications, UMTS Channels**.** | |
| **Unit –V** | **9 Hrs** |
| **Wireless Personal Area Networks:** Network architecture, components, Bluetooth, Zigbee, Applications. **Wireless Local Area networks:** Network Architecture, Standards, Applications. Wireless Metropolitan Area Networks: IEEE 802.16 standards, advantages, WMAN Network architecture, Protocol stack | |

| **Course Outcomes: After completing the course, the students will be able to:** | |
|---|---|
| **CO1** | Describe the concepts and terminologies for Cellular Communication. |
| **CO2** | Analyze the Architecture, Hand-off and Security aspects in 2G and 3G Networks. |
| **CO3** | Compare the performance features of 2G and 3G Cellular Technologies. |
| **CO4** | Analyze and compare the architectures of various Wireless technologies and standards. |

| **Reference Books** | |
|---|---|
| 1. | Wireless Communications, T.L. Singal, 2nd Reprint 2011, Tata McGraw Hill Education Private Limited, ISBN: 978-0-07-068178-1 |
| 2. | Wireless and Mobile Networks Concepts and Protocols, Dr. Sunil Kumar SManvi, 2010, Willey India Pvt. Ltd., ISBN: 978-81-265-2069-5. |
| 3. | Wireless Communication, Upena Dalal, 1st Edition, 2009, Oxford higher Education, ISBN-13:978-0-19-806066-6. |
| 4 | Wireless Communications Principles and practice, Theodore S Rappaport, 2nd Edition, Pearson, ISBN 97881-317-3186-4 |

| 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). 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**<br>(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 | | | | | | |
|---|---|---|---|---|---|---|
| **MOBILE APPLICATION DEVELOPMENT**<br>**Category: Institutional Elective -I**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | IS266TEO | | **CIE** | **:** | 100 Marks |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | 100 Marks |
| **Total Hours** | **:** | 45L | | **SEE Duration** | **:** | 03 Hours |

**Prerequisite:** - Programming in Java.

| **Unit-I** | **09 Hrs** |
|---|---|
| **Introduction:**<br>Smart phone operating systems and smart phones applications. Introduction to Android, Installing Android Studio, creating an Android app project, deploying the app to the emulator and a device. UI Design: Building a layout with UI elements, Layouts, Views and Resources, Text and Scrolling Views.<br>Activities and Intents, The Activity Lifecycle, Managing State, Activities and Implicit Intents, The Android Studio Debugger, Testing the Android app, The Android Support Library. | |
| **Unit–II** | **09 Hrs** |
| **User experience**:<br>User interaction, User Input Controls, Menus, Screen Navigation, Recycler View, Delightful user experience, Drawables, Styles, and Themes, Material Design, Testing app UI, Testing the User Interface | |
| **Unit–III** | **09 Hrs** |
| **Working in the background:**<br>Async Task and Async Task Loader, Connect to the Internet, Broadcast Receivers and Services. Scheduling and optimizing background tasks – Notifications, Scheduling Alarms, and Transferring Data Efficiently | |
| **Unit–IV** | **09 Hrs** |
| **All about data:**<br>Preferences and Settings, Storing Data, Shared Preferences. Storing data using SQLite, SQLite Database. Sharing data with content providers.<br>Advanced Android Programming: Internet, Entertainment and Services. Displaying web pages and maps, communicating with SMS and emails, Sensors. | |
| **Unit–V** | **09 Hrs** |
| **Hardware Support & devices:**<br>Permissions and Libraries, Performance and Security. Fire base and AdMob, Publish and Polish, Multiple Form Factors, Using Google Services. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Comprehend the basic features of android platform and the application development process. Acquire familiarity with basic building blocks of Android application and its architecture. |
| **CO2:** | Apply and explore the basic framework, usage of SDK to build Android applications incorporating Android features in developing mobile applications. |
| **CO3:** | Demonstrate proficiency in coding on a mobile programming platform using advanced Android technologies, handle security issues, rich graphics interfaces, using debugging and troubleshooting tools. |
| **CO4:** | Create innovative applications, understand the economics and features of the app marketplace by offering the applications for download. |

| Reference Books | |
|---|---|
| **1** | Android Programming, Phillips, Stewart, Hardyand Marsicano, Big Nerd Ranch Guide, 2nd Edition, 2015, ISBN-13 978-0134171494 |
| **2** | AndroidStudioDevelopmentEssentials-Android6, NeilSmyth,2015, Create space Independent Publishing Platform, ISBN:9781519722089 |
| **3** | Android Programming–Pushing the limits, EricHellman,2013, Wiley, ISBN-13:978-1118717370 |
| **4** | Professional Android2ApplicationDevelopment, RetoMeier, Wiley India Pvt. Ltd, 1st Edition, 2012, ISBN-13:9788126525898 |
| **5** | BeginningAndroid3, Mark Murphy, A press Springer India Pvt Ltd,1st Edition,2011, ISBN-13:978-1-4302-3297-1 |
| **6** | AndroidDeveloperTraining-https://developers.google.com/training/android/ AndroidTestingSupportLibrary-https://google.github.io/android-testing-support-library/ |

| 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. Each quiz is evaluated for 10 marks adding up to 20 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 (10) Designing & Modeling (10) **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 | | | | | | |
|---|---|---|---|---|---|---|
| **ELEMENTS OF FINANCIAL MANAGEMENT**<br>**Institutional Elective-I (Theory)** | | | | | | |
| **Course Code** | **:** | **IM266TEQ** | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **45L** | | **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.<br>**The financial System:** Functions, Assets, Markets, Market returns, Intermediaries, regulatory framework, Growth and trends in Indian financial system. | |
| **Unit – II** | **10 Hrs** |
| **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)**<br>**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.<br>**Valuation of securities:** Basic valuation model, bond valuation, equity valuation-dividend capitalization approach and other approaches. | |
| **Unit –III** | **10 Hrs** |
| **Risk and Return:** Risk and Return of single assets and portfolios, measurement of market risk, relationship between risk and return, implications.<br>**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. **(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<br>**Securities Market:** Primary market vs Secondary market, Trading and Settlements, Stock market quotations and Indices, Govt. securities market, Corporate debt market. | |
| **Unit –V** | **09 Hrs** |
| **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<br>**(Conceptual treatment only)** | |

| **Course Outcomes: After completing the course, the students will be able to:-** | |
|---|---|
| **CO1** | Explain the features and elements of a financial system. |
| **CO2** | Recognize the relevance basic principles of financial management in decision making. |
| **CO3** | Describe the processes and techniques of capital budgeting and working capital financing by organizations. |
| **CO4** | Demonstrate an understanding of various sources of finance. |

| **Reference Books:** | |
|---|---|
| 1. | Fundamentals of Financial Management, Prasanna Chandra, 6th Edition, 2018, McGraw Hill Education(India) Pvt. Ltd, ISBN: 978-93-392-0313-9, 93-392-0313-5 |
| 2. | Financial Management ,I M Pandey, 12th edn, 2021, Pearson, ISBN-939057725X, 978-9390577255 |
| 3. | Financial Management-Text, Problems and Cases, Khan M Y & Jain P K, 8th Edition, 2018, McGraw Hill Education(India) Pvt. Ltd, ISBN: 9353162181 , 9789353162184 |
| 4. | Fundamentals of Financial Management, Eugene F Brigham, Joel F Houston, 8th Edition, 2014, Cengage Learning, ISBN : 9781285065137, 1285065131. |

| **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**<br>(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 | | | | | | |
|---|---|---|---|---|---|---|
| **OPTIMIZATION TECHNIQUES**<br>**(Institutional Elective-I)**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **IM266TER** | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **42L** | | **SEE Duration** | **:** | **03 Hours** |

| **UNIT – I** | **08 Hrs** |
|---|---|
| **Introduction:** OR Methodology, Definition of OR, Application of OR to Engineering and Managerial problems, Features of OR models, Limitations of OR.<br>**Linear Programming:** Definition, Mathematical Formulation, Standard Form, Solution Space, Types of solution – Feasible, Basic Feasible, Degenerate, Solution through Graphical Method. Problems on Product Mix, Blending, Marketing, Finance, Agriculture and Personnel.<br>**Simplex methods:** Variants of Simplex Algorithm – Use of Artificial Variables. | |
| **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. | |
| **UNIT – III** | **09 Hrs** |
| **Transportation Problem:** Formulation of Transportation Model, Basic Feasible Solution using North-West corner, Least Cost, Vogel's Approximation Method, Optimality Methods, Unbalanced Transportation Problem, Degeneracy in Transportation Problems, Variants in Transportation Problems.<br>**Assignment Problem:** Formulation of the Assignment problem, solution method of assignment problem-Hungarian Method, Variants in assignment problem, Travelling Salesman Problem (TSP). | |
| **UNIT – IV** | **08 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** | **08 Hrs** |
| **Game Theory**: Introduction, Two-person Zero Sum game, Pure strategies, Games without saddle point - Arithmetic method, Graphical Method, The rules of dominance | |

| **Course Outcomes: After going through this course the student 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 TORA, WinQSB, Excel, GAMS. |

| **Reference Books:** | |
|---|---|
| 1. | Operation Research An Introduction, Taha H A, 10th Global Edition, 2017, Pearson Education Limited, ISBN 13: 978-1-292-16554-7 |
| 2. | Principles of Operations Research – Theory and Practice, Philips, Ravindran and Solberg, 2nd Edition, 2007, John Wiley & Sons (Asia) Pvt Ltd, ISBN 13: 978-8126512560 |
| 3. | Introduction to Operation Research, Hiller, Liberman, Nag, Basu, 10th Edition, 2017, McGraw Hill Education, ISBN 13: 978-9339221850 |
| 4. | Operations Research Theory and Application, J K Sharma, 6th Edition, 2009, Trinity Press, ISBN: 978-93-85935-14-5 |

| **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 |
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| 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 | | | | | | |
|---|---|---|---|---|---|---|
| **AUTOMOTIVE MECHATRONICS**<br>**Category: Institutional Elective-I**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | ME266TES | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 45 L | | **SEE Duration** | **:** | **03 Hours** |

| **Unit-I** | **09 Hrs** |
|---|---|
| **Automobile Engines:**<br>Classifications of Internal Combustion Engines. Engine nomenclature and mechanics. Mixture formation – External, internal, quality and quantity control – homogeneous and stratified injection. Thermodynamic principles of Otto and Diesel cycle. Characteristics – pressure curve and energy yield, engine speed, torque, and power | |
| **Unit-II** | **10 Hrs** |
| **Engine Auxiliary Systems:**<br>Turbocharger, Intercooler, Exhaust manifold, 3-way catalytic convertor, Exhaust Gas Recirculation system. Common Rail Fuel Injection system- Low pressure and high-pressure fuel systems, Return line, Quantity control valve and Injectors. | |
| **Unit-III** | **10 Hrs** |
| **Vehicular Auxiliary Systems:**<br>Vehicle frame and body classification- Hatchback, Sedan, SUV, Coupe, Roadster. Adaptive Brakes - Disc and drum brakes, Antilock Braking Systems, ESP, TCS. Wheels and Tyres- Toe-In, Toe-Out, Caster and Camber angle. Classification of tyres, Radial, Tubeless.<br>**Supplemental Restraint System:** Active and passive safety, Vehicle structure, Gas generator and air bags, Belt Tensioner, Acceleration sensor, Rollover sensor, Seat occupancy recognition. | |
| **Unit-IV** | **09 Hrs** |
| **EV Technology**: Types of EV's, ICE vs EV torque output, Architecture and Working of EV's.<br>Battery Thermal Management System, Regenerative braking, Safety system and Impacts of EV on the environment. | |
| **Unit-V** | **07 Hrs** |
| **Telematics in vehicles** – Radio Transmission, Exchange of information, signal path & properties, Concept of radio waves.<br>**Sensors:** Oxygen sensors, Crankshaft/Cam shaft Sensor, Boost Pressure Sensor, Coolant Temperature Sensor, Hot Film Air Mass flow Sensor, Throttle Position Sensor, Rain/Light sensor | |

| **Course Outcomes: After completing the course, the students will be able to;** | |
|---|---|
| **CO1:** | Describe the functions of Mechatronic systems in a modern automobile |
| **CO2:** | Evaluate the performance of an engine by its parameters |
| **CO3:** | Analyse the automotive exhaust pollutants as per emission norms |
| **CO4:** | Demonstrate communication of control modules using a On-Board Diagnostic kit |

| Reference Books | |
|---|---|
| **1.** | Automotive Technology – A systems approach, Jack Erjavec, 5th Edition, Delamr Cengage Learning, ISBN-13: 978-1428311497 |
| **2.** | Automotive Engineering Fundamentals, Richard Stone and Jeffrey K. Ball, 2004, SAE International, ISBN: 0768009871 |
| **3.** | Bosch Automotive Handbook, Robert Bosch, 9th Edition, 2004, ISBN: 9780768081527 |
| **4.** | Understanding Automotive Electronics, William B Ribbens, 5th Edition, Butterworth–Heinemann, ISBN 0-7506-7008-8 |

| **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. **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**<br>(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**<br>**Category: INSTITUTIONAL ELECTIVE -I (Theory)** | | | | | | |
| **Course Code** | **:** | MA266TEU | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 45L | | **SEE Duration** | **:** | **3 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:**<br>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 chains, application of Markov Modelling to problems. | |
| **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, Problems with 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 engineering. |
| **CO2** | Apply the knowledge and skills of discrete and continuous models to understand various types of analysis. |
| **CO3** | Analyze the appropriate mathematical model to solve the real-world problem and to 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). 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**) 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**<br>(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 | | | | | | |
|---|---|---|---|---|---|---|
| **MATHEMATICS FOR QUANTUM COMPUTING**<br>**Category: INSTITUTIONAL ELECTIVE-I (Theory)** | | | | | | |
| **Course Code** | **:** | MA266TEV | | **CIE** | **:** | **100 Marks** |
| **Credits: L: T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 45L | | **SEE Duration** | **:** | **3 Hours** |

| **Unit-I** | **09 Hrs** |
|---|---|
| **Introduction to Quantum Computing:**<br>Quantum superposition, Qubits, Linear algebra for quantum computing, Inner products and Tensor products of vector spaces, Quantum states in Hilbert space, The Bloch sphere, Generalized measurements, No-cloning theorem. | |
| **Unit – II** | **09 Hrs** |
| **Quantum Gates:**<br>Universal set of gates, quantum circuits, Dirac formalism, superposition of states, entanglement Bits and Qubits. Qubit operations, Hadamard Gate, CNOT Gate, Phase Gate, Z-Y decomposition, Quantum Circuit Composition, Basic Quantum circuits. | |
| **Unit –III** | **09 Hrs** |
| **Quantum Algorithm - I:**<br>Quantum parallelism, Quantum Evolution, Deutsch Algorithm, Deutsch-Jozsa Algorithm, Simon periodicity algorithm, Phase evaluation algorithm, Quantum Fourier transform. | |
| **Unit –IV** | **09 Hrs** |
| **Quantum Algorithm - II:**<br>Bell inequalities and entanglement, Schmidt decomposition, Grover search algorithm, Shor Factoring algorithm. Application of entanglement, teleportation, Superdense coding. | |
| **Unit –V** | **09 Hrs** |
| **Applications of Quantum Computing:**<br>Quantum programming languages, Probabilistic and Quantum computations, introduction to quantum cryptography and quantum information theory. | |

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

| 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**) 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**<br>(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 | | | | | | |
|---|---|---|---|---|---|---|
| **Applied Psychology for Engineers**<br>**Theory - Institutional Electives – I (Theory)** | | | | | | |
| **Course Code** | **:** | HS266TEW | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 45 Hrs | | **SEE Duration** | **:** | **3 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** | |
|---|---|
| 2. | 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)** | | |
|---|---|---|
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| 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** | |
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| 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**<br>**Institutional Electives – I** | | | | | | |
| **Course Code** | **:** | **HS266TEY** | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **42L** | | **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** |
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| 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** |
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| | **PART B**<br>(Maximum of TWO Sub-divisions only) | |
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| 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 | | | | | | |
|---|---|---|---|---|---|---|
| **INTERDISCIPLINARY PROJECT** | | | | | | |
| **Course Code** | **:** | **ME367P** | | **CIE** | **:** | **50 Marks** |
| **Credits: L:T:P** | **:** | **0:0:3** | | **SEE** | **:** | **50 Marks** |
| **Total Hours** | **:** | **15 P** | | **SEE Duration** | **:** | **2 Hours** |

## Interdisciplinary Project Guidelines:

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

## Batch Formation:

- Students are free to choose their project partners from any other program.
- Each student in the team must contribute towards the successful completion of the project. The project may be carried out In-house only.
- ***The project work is to be carried out by a team of two to four students.***

## Project Topic Selection:

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

## Project Evaluation:

Continuous monitoring of project work will be carried out and cumulative evaluation will be done.

- The students are required to meet their guides once in a week to report their progress in project work.
- **Weekly Activity Report** (WAR) has to be maintained in the form of a diary by the project batch and the same has to be discussed with the Guide regularly.
- For CIE assessment the project groups must give a final presentation with the draft copy of the project report.
- The presentation by each group will be for 20-30 minutes and every member of the team needs to justify the contributions to the project.
- The project team is required to submit Hard copies of the detailed Project Report in the prescribed format to the department.
- For CIE 50% weightage should be given to the project guide and 50% weightage to the project evaluation committee.

| **Course Outcomes:** | |
|---|---|
| **1** | Identifying critical thinking and problem-solving abilities by analyzing and addressing interdisciplinary challenges, utilizing creative approaches and innovative solutions. |
| **2** | Exhibit proficiency in conducting comprehensive research, including literature review, data collection, modelling, simulation, and analysis, to address significant technical challenges and propose innovative solutions. |
| **3** | Demonstrate the ability to do effective teamwork, leadership, project management, and communication skills, while adhering to ethical standards and professional responsibility in delivering the project outcomes within time and budget constraints. |
| **4** | Utilize appropriate engineering tools, technologies, and software to design, test, and implement project solutions, ensuring adherence to technical specifications, safety standards, and industry best practices. |

**CIE Assessment:**

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

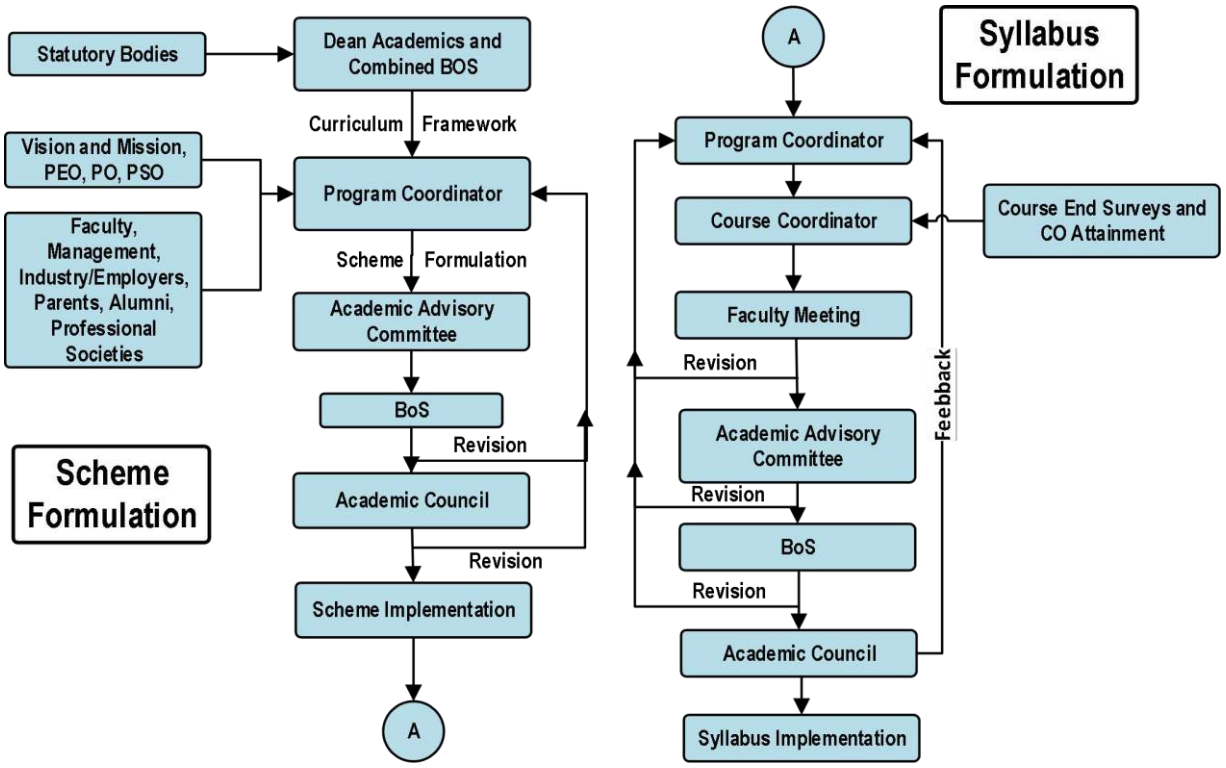
| | | |
|---|---|---|
| 1. | Selection of the topic and formulation of objectives | 10% |
| 2. | Design and Development of Project methodology | 25% |
| 3. | Execution of Project | 25% |
| 4. | Presentation, Demonstration and Results Discussion | 30% |
| 5. | Report Writing & Publication | 10% |

**SEE Assessment:**

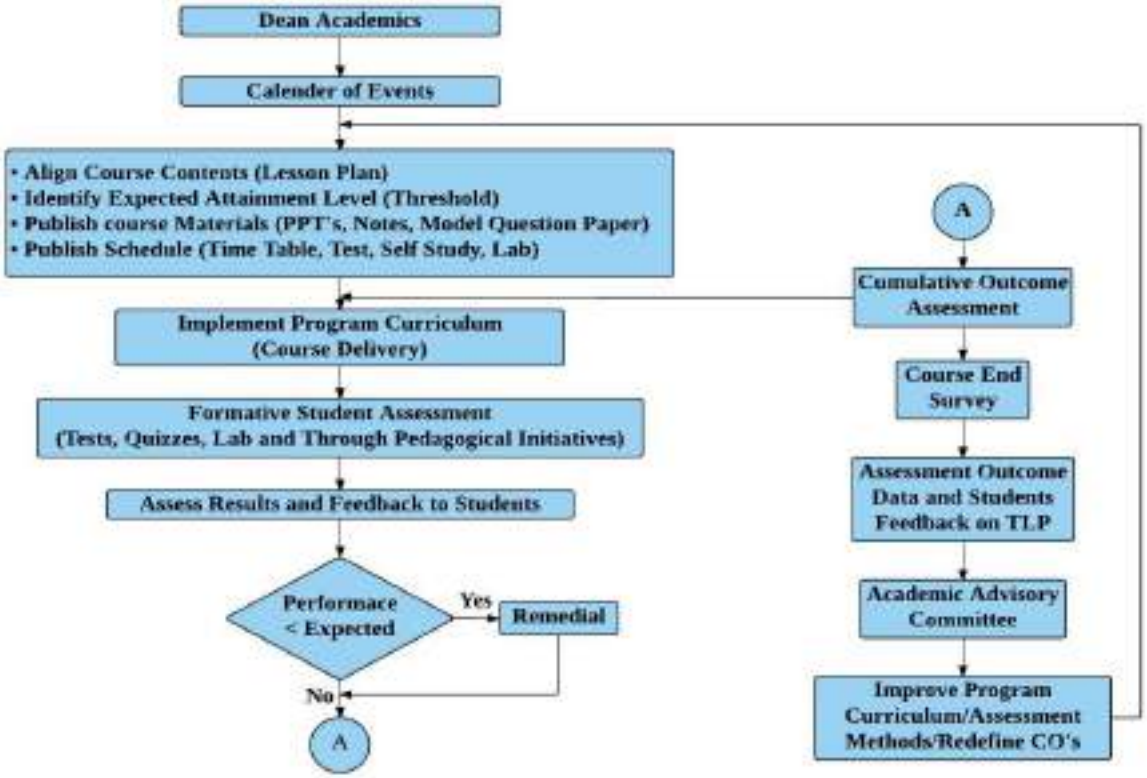
The following are the weightages given during Viva Examination.

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

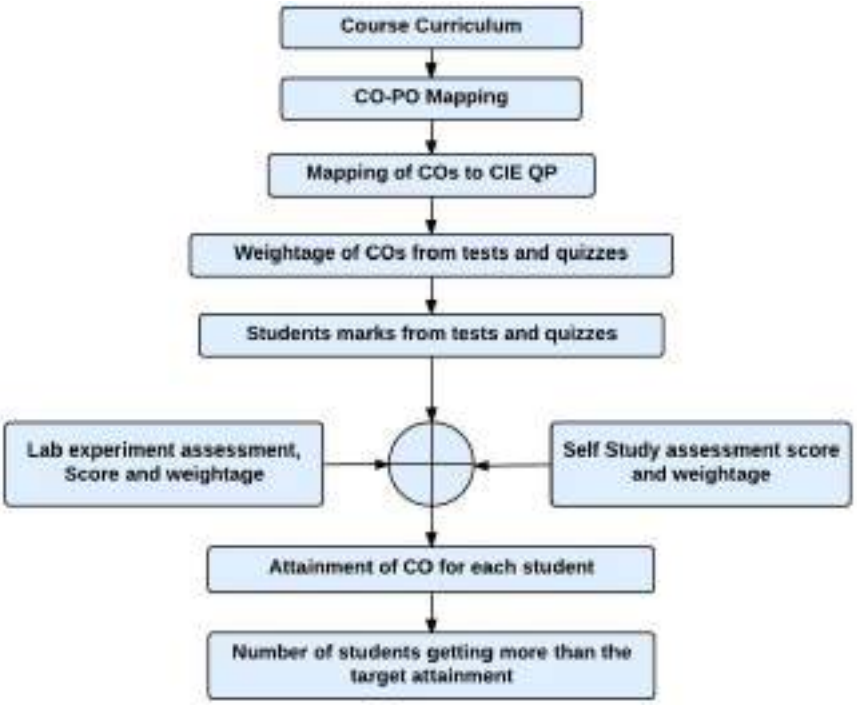
## Curriculum Design Process



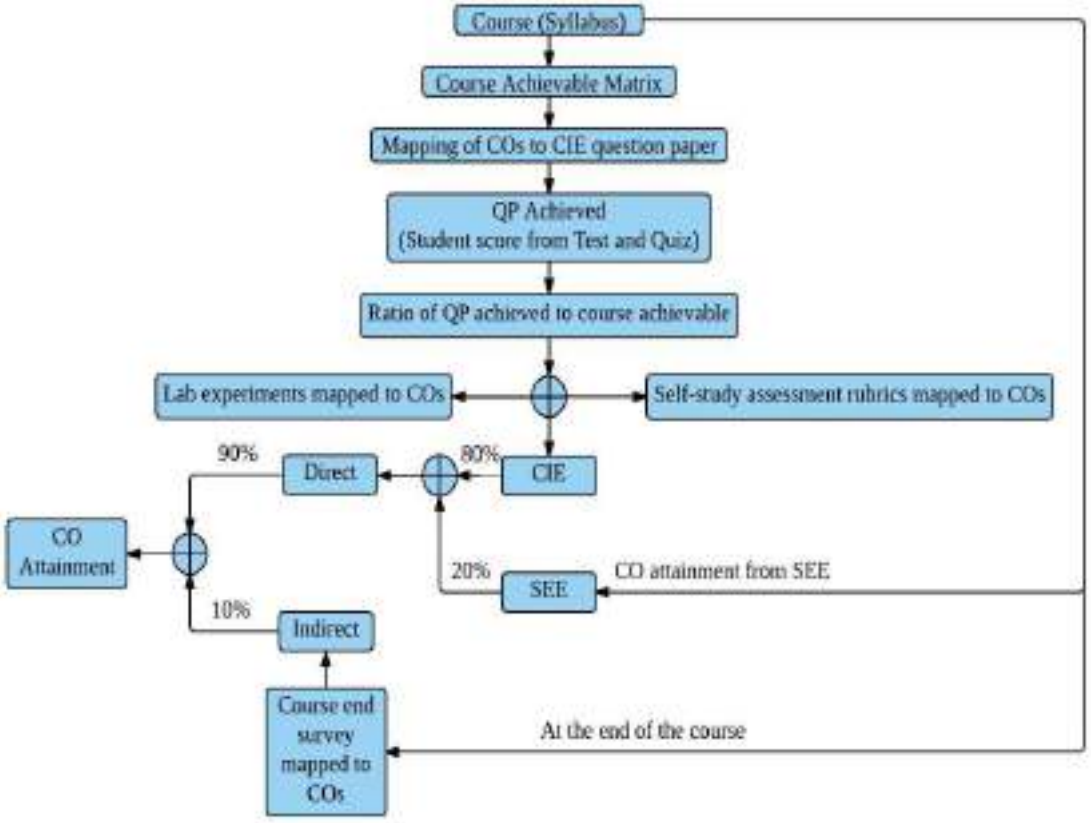

## Academic Planning and Implementation



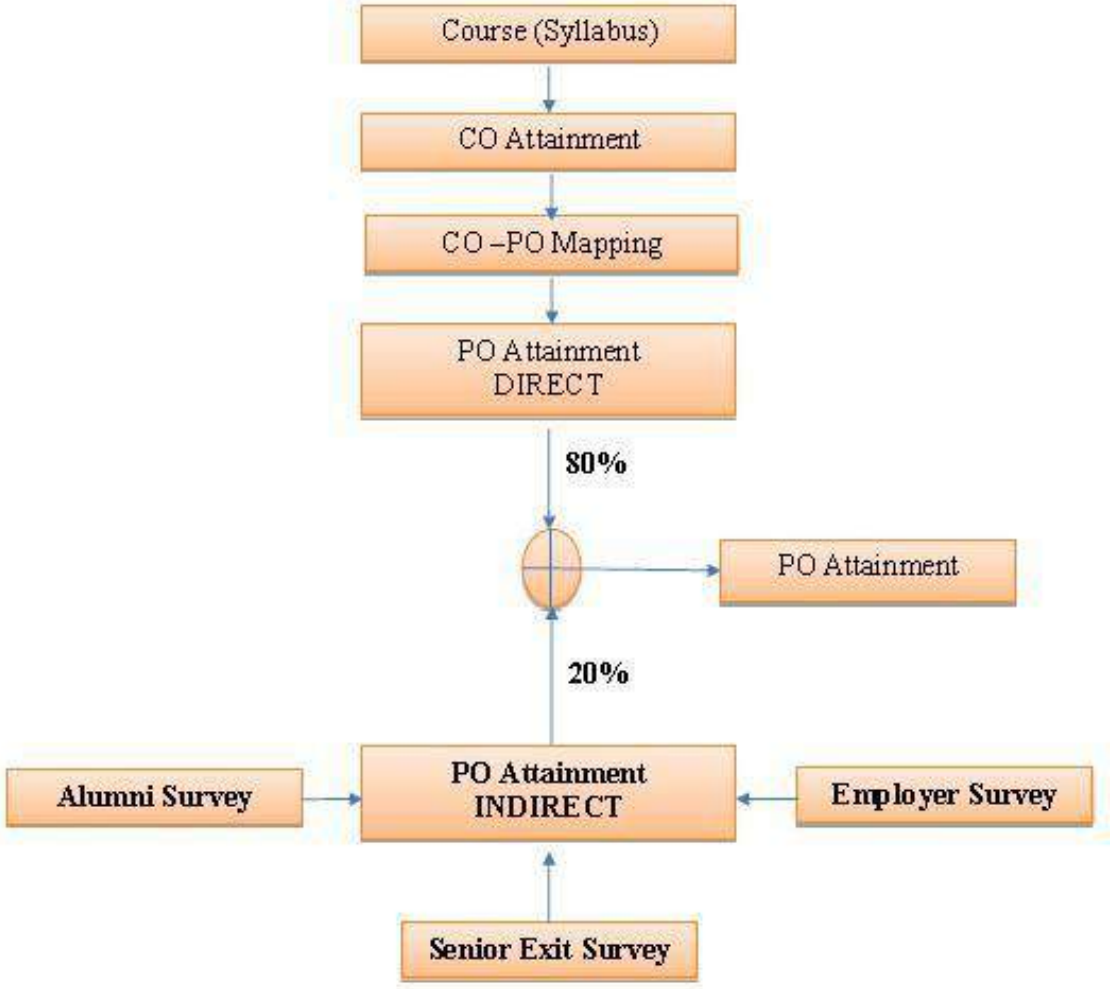
## Process For Course Outcome Attainment




## Final CO Attainment Process



## Program Outcome Attainment Process



# Knowledge and Attitude Profile (WK)

- **WK1:** A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.
- **WK2:** Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.
- **WK3:** A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.
- **WK4**: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
- **WK5:** Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.
- **WK6:** Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.
- **WK7:** Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.
- **WK8:** Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.
- **WK9:** Ethics, inclusive behaviour and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

# New Program Outcomes (PO)

- **PO1:** Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
- **PO2:** Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
- **PO3:** Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
- **PO4:** Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
- **PO5:** Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
- **PO6**: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
- **PO7:** Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
- **PO8:** Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
- **PO9:** Communication: Communicate effectively and inclusively within the community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
- **PO10:** Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
- **PO11:** Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

# INNOVATIVE TEAMS OF RVCE

**Ashwa Mobility Foundation (AMF):** Designs and fabricates Formula-themed race cars and mobility solutions to address urban transportation issues.

**Astra Robotics Team:** Focuses on designing and building application-specific robots.

**Coding Club:** Helps students gain coding skills and succeed in competitions like GSoC and ACM-ICPC.

**Entrepreneurship Development Cell (E-Cell):** Promotes entrepreneurship through workshops, speaker sessions, and mentoring for startups.

**Frequency Club Team:** Works on software and hardware, emphasizing AI and Machine Learning.

**Team Garuda:** Develops a supermileage urban concept electric car and E-mobility products.

**Team Jatayu:** Builds low-cost UAVs with autonomous capabilities for various tasks.

**Solar Car Team:** Aims to create a solar electric vehicle for sustainable transportation.

**Team Antariksh:** Focuses on space technology and the development of operational rockets.

**Team Chimera:** Builds a Formula Electric Car through R&D in E-Mobility.

**Helios Racing Team:** Designs and tests All-Terrain Vehicles, participating in SAE's BAJA competitions.

**Team Hydra:** Develops autonomous underwater vehicles for tasks like water purification.

**Team Krushi:** Creates low-cost farming equipment to assist farmers in cultivation and harvesting.

**Team Vyoma:** Designs and tests radio-controlled aircraft and UAVs.

**Team Dhruva:** Engages in astronomy-related activities and collaborates on projects with organizations like ICTS and IIA.

**Ham Club:** Promotes Amateur Radio and explores technical innovations in communications, especially for disaster response.

## Cultural Activity Teams

1. AALAP (Music club)
2. DEBSOC (Debating society)
3. CARV (Dramatics club)
4. FOOTPRINTS (Dance club)
5. QUIZCORP (Quizzing society)
6. ROTARACT (Social welfare club)
7. RAAG (Youth club)
8. EVOKE (Fashion team)
9. f/6.3 (Photography club)
10. CARV ACCESS (Film-making

NSS of RVCE

NCC of RVCE

## VISION

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

## MISSION

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

## QUALITY POLICY

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

## CORE VALUES

Professionalism, Commitment, Integrity, Team Work, Innovation