AUTONOMOUS

SYLLABUS

V & VI Semesters

B.E. in Mechanical Engineering

2023

MITE

Invent Solutions

MANGALORE INSTITUTE OF TECHNOLOGY & ENGINEERING

Institute Vision

*"To attain perfection in providing **Globally Competitive Quality Education** to all our Students and also benefit the global community by using our strength in **Research and Development**"*

Institute Mission

"*To establish world class educational institutions in their respective domains, which shall be C**enters of Excellence** in their stated and implied sense. To achieve this objective we dedicate ourselves to meet the challenges of becoming **Visionary and Realistic**, **Sensitive and Demanding**, **Innovative and Practical,** Theoretical **and Pragmatic;** ALL at the same time"*

Department Vision

To develop technically competent Mechanical Engineering Professionals, Entrepreneurs and Researchers for the benefit of the society

Department Mission

- *To provide a well-balanced program of instructions to impart concepts on basics and applied areas of Mechanical Engineering.*
- *To provide the state-of-the-art facility for learning, skill development and research in design and manufacture areas.*
- *To encourage the students to excel in the co-curricular and extra-curricular activities to impart social & ethical values and leadership quality.*

Program Educational Objectives (PEOs)

After successful completion of the program, the graduates will be

- *Professionals in design, analysis and evaluation of Mechanical components and systems using state-of-the-art modern tools.*
- *Expertise in Design, Thermal, Materials & Manufacture streams of Mechanical Engineering and carryout research and innovations.*
- *Work effectively and ethically in allied fields of Mechanical Engineering.*
- *Work in a team with good communication skills to achieve objectives with keen on lifelong learning.*

Program Specific Outcomes (PSOs)

At the end of the program, the student

- *Proficient in applying mechanical engineering principles to design, analyze and select appropriate manufacturing processes for the production of mechanical components and systems.*
- *Competence in analyzing and operating thermal and fluid systems, including HVAC, power generation and electric vehicles, with an emphasis on energy efficiency and environmental sustainability.*
- *Adept at utilizing interdisciplinary and modern IT tools in various applications.*

LIST OF COURSES

V / VI Semester Courses			
Sl. No.	**Course Code**	**Course Title**	**Sem**
HUMANITIES & SOCIAL SCIENCE COURSES			
1	23HMCC301	Entrepreneurship, Management & Finance	V
PROFESSIONAL CORE COURSES			
2	23MEPC302	Design of Machine Elements	V
3	23MEPC303	Heat Transfer	V
4	23MEPC304	Systems Engineering	V
5	23MEPC305	Heat Transfer Lab	V
6	23MEPC306	Robotics and Automation	VI
7	23MEPC307	Finite Element Analysis	VI
8	23MEPC308	Finite Element Analysis Lab	VI
SKILL ENHANCEMENT COURSE			
9	23MESE309	Project Phase -I	VI
PROFESSIONAL ELECTIVE COURSES			
10	23MEPE311	Fluid Power System	V
11	23MEPE312	Automotive Engineering	V
12	23MEPE313	Micro Devices and Smart Systems	V
13	23MEPE321	Product Design and Development	VI
14	23MEPE322	Predictive Maintenance	VI
15	23MEPE323	Sustainable Energy Sources	VI
OPEN ELECTIVE COURSES			
16	23MEOE311	Renewable Energy Resources	V
17	23MEOE312	Lean Manufacturing	V
18	23MEOE313	Product Development	V
19	23MEOE321	Fundamentals of Electric Vehicle	VI
20	23MEOE322	Supply Chain Management	VI
21	23MEOE323	Micro-Electro Mechanical Systems	VI
NON-CREDIT MANDATORY COURSES			
22	23NMCC321	Yoga-III	V
23	23NMCC322	Physical Education-III	V
24	23NMCC323	National Service Scheme -III	V
25	23NMCC324	Arts-III	V
26	23NMCC325	Yoga- IV	VI
27	23NMCC326	Physical Education- IV	VI
28	23NMCC327	National Service Scheme - IV	VI
29	23NMCC328	Arts- IV	VI

V Semester (2023 Scheme): Mechanical Engineering

Sl. No.	Course Code	Course Title	Category	Teaching Dept.	Teaching Hours /Week			Examination (Marks)			Duration of Exam (SEE) in Hrs	Credits
					L	T	P	CIE	SEE	Total		
1	23HMCC301	Entrepreneurship, Management & Finance	Humanities & Social Sciences	MBA/Any Department	3	0	0	50	50	100	3	3
2	23MEPC302	Design of Machine Elements	Professional Core Course	ME	3	2	0	50	50	100	3	4
3	23MEPC303	Heat Transfer	Professional Core Course	ME	3	0	0	50	50	100	3	3
4	23MEPC304	Systems Engineering	Professional Core Course	ME	2	0	2	50	50	100	3	3
5	23MEPC305	Heat Transfer Lab	Professional Core Course	ME	0	1	3	50	50	100	2.5	2
6	23MEPE31X	Professional Elective -I*	Discipline Specific Electives	ME	3	0	0	50	50	100	3	3
7	23MEOE31X	Open Elective -I**	Open Electives	ME	3	0	0	50	50	100	3	3
8	23NMCC32X	Yoga / Physical Education / NSS / Arts***	Non-Credit Mandatory Course	Yoga Teacher/ PED/NSS Coordinator/ Cultural Coordinator	0	0	1	100	-	100	-	-
											Total Credits	**21**

Note: MOOC Courses

MOOC Requirement:

- Students are required to register and successfully complete one MOOC (Massive Open Online Course) of 8 or 12 weeks duration, offered through the NPTEL/SWAYAM platforms, between the 6th and 7th semesters.
- The list of eligible courses shall be approved and notified by the Board of Studies (BoS) of the respective discipline at least 15 days before the

start of the semester.

- The successfully completed MOOC will be considered equivalent to a Professional Elective carrying 2 credits, which will be accounted for in the 8th semester.
- Students must submit the course completion certificate and the official scorecard issued by NPTEL as proof of completion.
- **Failure Policy:** Students who are unable to clear the MOOC in two consecutive attempts during the 6th and 7th semesters will be allowed to register for a Professional Elective course offered by the department in online mode during the 8th semester to earn the required 2 credits. SEE will be conducted by the department in the offline mode.

***Professional Elective Course -I**

Sl. No.	Course Code	Course Title
1	23MEPE311	Fluid Power System
2	23MEPE312	Automotive Engineering
3	23MEPE313	Micro Devices and Smart Systems

****Open Elective Course-I**

Sl. No.	Course Code	Course Title
1	23MEOE311	Renewable Energy Resources
2	23MEOE312	Lean Manufacturing
3	23MEOE313	Product Development

*****Yoga/ Physical Education /NSS/Arts:**

Sl. No.	Course Code	Course Title
1	23NMCC321	Yoga- III
2	23NMCC322	Physical Education-III
3	23NMCC323	National Service Scheme -III
4	23NMCC324	Arts-III

VI Semester (2023 Scheme): Mechanical Engineering

Sl. No.	Course Code	Course Title	Category	Teaching Dept.	Teaching Hours /Week			Examination (Marks)			Duration of Exam (SEE) in Hrs	Credits
					L	T	P	CIE	SEE	Total		
1	23MEPC306	Robotics and Automation	Professional Core Course	ME	3	0	2	50	50	100	3	4
2	23MEPC307	Finite Element Analysis	Professional Core Course	ME	3	0	0	50	50	100	3	3
3	23MEPC308	Finite Element Analysis Lab	Professional Core Course	ME	0	1	3	50	50	100	2.5	2
4	23MESE309	Project Phase-I	Project	ME	0	0	6	100	-	100	3	3
5	23MEPE32X	Professional Elective -II*	Discipline Specific Electives	ME	3	0	0	50	50	100	3	3
6	23MEOE32X	Open Elective-II**	Open Electives	ME	3	0	0	50	50	100	3	3
7	23NMCC32X	Yoga / Physical Education / NSS / Arts***	Non-Credit Mandatory Course	Yoga Teacher/ PED/NSS Coordinator/ Cultural Coordinator	0	0	1	100	-	100	-	-
											Total Credits	**18**

***Professional Elective Course -II**

Sl. No.	Course Code	Course Title
1	23MEPE321	Product Design and Development
2	23MEPE322	Predictive Maintenance
3	23MEPE323	Sustainable Energy Sources

****Open Elective Course-II**

Sl. No.	Course Code	Course Title
1	23MEOE321	Fundamentals of Electric Vehicle
2	23MEOE322	Supply Chain Management
3	23MEOE323	Micro-Electro Mechanical Systems

*****Yoga/ Physical Education /NSS/Arts:**

Sl. No.	Course Code	Course Title
1	23NMCC325	Yoga- IV
2	23NMCC326	Physical Education-IV
3	23NMCC327	National Service Scheme -IV
4	23NMCC328	Arts-IV

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V Semester

VI Semester

Entrepreneurship, Management & Finance			
Semester	**V**	CIE Marks	**50**
Course Code	**23HMCC301**	SEE Marks	**50**
Teaching Hours/Week (L:T: P)	**3:0:0**	Exam Hrs	**3**
Total Hours	**42**	Credits	**3**

Course Learning Objectives: This course is designed to

1. Impart key competencies, qualities, and skills of entrepreneurship
2. Provide insights into the pathways to new venture creation and concepts of management in organizations
3. Familiarize the functions of management and financial aspects of an organization

Module 1: Entrepreneur and Entrepreneurship	**No. of Hrs: 8**

Entrepreneur: Definition, Entrepreneurial competencies, Characteristics of Entrepreneurs, Qualities of an entrepreneur, Entrepreneurial skills. Developing Entrepreneurial competencies, Classification of Entrepreneurs, Entrepreneur vs Professional Managers

Entrepreneurship: Concept, Phases of Entrepreneurship Development, Fostering Entrepreneurship, Barriers to Entrepreneurship, Factors influencing Entrepreneurship

Textbook 1: Chapter 2, 3and 10

Module 2: Opportunities and pathways to Entrepreneurship	**No. of Hrs: 8**

Opportunity identification, Sources of Innovative ideas, Entrepreneurial imagination, and creativity: Concept of Creativity, Rules, Components, Process or phases of creativity, the critical thinking process
Pathways to new ventures: Creating New ventures, Acquiring an established venture, Franchising

Textbook 2: Chapter 5 and 6

Module 3: Introduction to Management	**No. of Hrs: 8**

Management: Nature, Objectives, Importance. Difference between administration and management. Levels of management, Types of managers, Managerial skills, Managerial Competencies, Scope or Functional areas of management.

Textbook 3: Chapter 1

Module 4: Management Functions	**No. of Hrs: 9**

Functions of Management: Planning, Organizing, Staffing, Directing and Controlling.

Planning: Meaning, Features, Importance, Types, and steps. Organizing: Meaning, Need, Principles, and Process. Staffing: Meaning, Nature, and Process. Directing: Meaning, Need, Elements and Techniques. Controlling: Meaning, Need, Characteristics, Steps, and Types.

Textbook 3: Chapter 3, 4, 5 and 6

Module 5: Business Organizations and Finance	**No. of Hrs: 9**

Forms of Business Organization: Sole proprietorship, Partnership, Cooperative Society, and Company. Financial decisions in a firm, Goal of Financial Management, Fundamental principle of finance, building blocks of modern finance, Risk-return tradeoff, Emerging role of financial manager in India, Cost profit volume analysis; Profit volume ratio, Break Even Analysis and Margin of safety

Textbook 4: Chapter 1- Section 1.1, 1.2,1.3, 1.4, 1.5, 1.6 and 1.11
Chapter 13 – Section 13.4

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

1. Outline the entrepreneurial skills & qualities required for business development
2. Describe the processes of opportunity identification, creativity, and pathways to establishing new ventures
3. Explain the fundamental concepts of management
4. Apply the functions of management in decision-making
5. Apply financial management principles to assess financial decisions, and determine cost-profit-volume relationship

Textbooks:

1. Vasanth Desai, "The Dynamics of Entrepreneurial Development and Management", 6th Edition, Himalaya Publishing House, 2018
2. Donald F. Kuratko and T.V. Rao, "Entrepreneurship: A South Asian Perspective", 1st Edition, Cengage Learning, 2017
3. Chandrani Singh and Aditi Khatri, "Principles and Practices of Management and Organisational Behaviour", 5th Edition, Sage Texts, 2021
4. Prasanna Chandra, "Financial Management- Theory and Practice",10th Edition, Mc Graw Hill, 2022

Reference Books:

1. Deependra Sharma, "Entrepreneurship in India",1st Edition, Routledge India, 2023
2. Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, and Sabyasachi Sinha, "Entrepreneurship", 11th Edition, McGraw Hill, 2022
3. Charanthimath Poornima M, "Entrepreneurship Development and Small Business Enterprises", 3rd Edition, Pearson, 2018

Web links:

1. Introduction to Entrepreneur: https://www.youtube.com/watch?v=rbmz5VEW90A
2. Pathways to new creations: https://www.youtube.com/watch?v=zkgbss81QKE
3. Concepts of Management: https://www.youtube.com/watch?v=GZ2dmbDmB5I
4. Functions of Management: https://www.youtube.com/watch?v=Vq8GChMK5Zg
5. Types of Business Organizations: https://www.youtube.com/watch?v=UGSlED1Jx1Y

Design of Machine Elements			
Semester	**V**	CIE Marks	**50**
Course Code	**23MEPC302**	SEE Marks	**50**
Teaching Hours/Week (L: T: P)	**3:2:0**	Exam Hrs	**3**
Total Hours	**64**	Credits	**4**

Course Learning Objectives: This course is designed to

1. Teach principles of machine element design considering strength, rigidity, failure modes, and appropriate criteria
2. Familiarize the design of shafts, Keys, couplings, welded joints, Riveted joints and epoxy based adhesive joint
3. Impart the design concepts gear drives, clutches & bearings

Module 1 : Introduction to Machine Design — **No. of Hrs: 8+4**

Introduction: Axial, bending, shear and torsion loading on machine components, combined loading

Design for static strength: Factor of safety and service factor, Failure mode: definition and types., Failure of brittle and ductile materials; even and uneven materials; Stress concentration, stress concentration factor, Theories of failure: maximum normal stress theory, maximum shear stress theory, distortion energy theory, strain energy theory, Columba –Mohr theory and modified Mohr's theory

Fatigue loading: Introduction to fatigue failure, Mechanism of fatigue failure, types of fatigue loading, S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit.

Textbook 1: Chapter 5,6, Textbook 2: Chapter 3,4,5

Module 2: Design of Shafts, Keys and Couplings — **No. of Hrs: 8+5**

Design of shafts: Torsion of shafts, solid and hollow shaft design with steady loading based on strength and rigidity, ASME and BIS codes for power transmission shafting, design of shafts subjected to combined loading

Design of keys and couplings: Keys: Types of keys and their applications, design considerations in parallel and tapered sunk keys, Couplings: Rigid and flexible coupling-types and applications, design of Flange coupling, and Bush and Pin type coupling

Textbook 1: Chapter 16, Textbook 2: Chapter 9

Module 3:Design of Riveted joints & Welded joints — **No. of Hrs: 8+5**

Riveted joints: Types of rivets, rivet materials, Caulking and fullering, analysis of riveted joints, joint efficiency, failures of riveted joints: Lap, Butt joint & Eccentric loading

Welded joints: Types, strength of butt and fillet welds, eccentrically loaded welded joint
Introduction to epoxy based adhesive joint

Textbook 1: Chapter 9, Textbook 2: Chapter 8

Module 4: Design of Gear Drives	**No. of Hrs: 8+5**

Spur Gears: Definitions, stresses in gear tooth: Lewis equation and form factor, design for strength, dynamic load and wear

Helical Gears: Definitions, transverse and normal module, formative number of teeth, design based on strength, dynamic load and wear. Fundamental Discussion on applications of various gear drives

Textbook 1: Chapter 13 &14, Textbook 2: Chapter 17,18

Module 5: Design of Clutches & Bearings	**No. of Hrs: 8+5**

Design of Clutches: Design of single plate, multi-plate based on uniform pressure and uniform wear theories

Lubrication and Bearings: Lubricants and their properties, bearing materials and properties; mechanisms of lubrication, Concept of Hydrodynamic bearings. Antifriction bearings: Types of rolling contact bearings and their applications, static and dynamic load carrying capacities, equivalent bearing load, load life relationship, selection of deep groove ball bearings from the manufacturers' catalogue; selection of bearings subjected to cyclic loads and speeds, probability of survival

Textbook 1: Chapter 12 &16, Textbook 2: Chapter 11,15 &16

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

1. Design of machine elements with static loading by appropriate failure theories and stress concentration factors
2. Design power transmission systems involving shafts, keys, and couplings for combined loading scenarios
3. Design riveted and welded joints for various loading conditions, considering joint efficiency and potential failure modes
4. Design spur and helical gear drives for power transmission requirements under dynamic and wear loads
5. Design single, multi plate clutches and journal bearings, utilizing theories of friction, wear, and lubrication principles

Textbooks:

1. Richard G. Budynas, and J. Keith Nisbett, "Shigley's Mechanical Engineering Design, 10th Edition, McGraw Hill Publication, 2015
2. V.B. Bhandari, "Design of Machine Elements", 5th Edition, McGraw Hill Publication, 2020

Reference Books:

1. Robert L. Norton, "Machine Design- An integrated Approach", 6th Edition., Pearson Education, 2021
2. H.G. Patil, S.C. Pilli, R.R. Malagi, M.S. Patil, "Elements of Machine Design", 1st Edition, IK International, 2019

Design Data Hand Book:

1. Design Data Hand Book, K. Lingaiah, McGraw Hill, 2nd Edition, 2003
2. Design Data Hand Book, K. Mahadevan and Balaveera Reddy, CBS publication

Web links:

NPTEL Course on: www.nptel.ac.in/

1. Fundamentals of Machine Design_https://archive.nptel.ac.in/courses/112/105/112105125/
2. Machine Design-2_https://archive.nptel.ac.in/courses/112/106/112106137/

List of Open Source Software/learning website:

1. http://help.autodesk.com/view/fusion360/ENU/
2. https://academy.autodesk.com/course/108871/introduction-cad-engineers
3. http://help.autodesk.com/view/fusion360/ENU/?learn=assemble
4. http://help.autodesk.com/view/fusion360/ENU/?learn=simulate
5. https://academy.autodesk.com/curriculum/introduction-cad-and-cae

Software/tools used for the design of various components.

1. http://www.mitcalc.com
2. http://www.kisssoft.ch/english/home/index.php
3. https://www.machinedesignonline.com/
4. CAD on Cloud Free software like Fusion 360

Heat Transfer			
Semester	**V**	CIE Marks	**50**
Course Code	**23MEPC303**	SEE Marks	**50**
Teaching Hours/Week (L:T:P)	**3:0:0**	Exam Hrs	**3**
Total Hours	**42**	Credits	**3**

Course Learning Objectives:

1. Teach principles of steady state conduction heat transfer its application
2. Impart the knowledge of convection heat transfer and Heat exchangers
3. Introduce the concepts of radiation heat transfer, including surface properties, emissivity, and radiation exchange between surfaces
4. Familiarize transient heat conduction and its practical applications in engineering systems

Module1: Conduction heat transfer — **No. of Hrs: 8**

Basic concepts: thermodynamics and heat transfer, applications of heat transfer, modes of heat transfer: conduction, convection, and radiation, Fourier's law of conduction, thermal conductivity and insulation

Steady-state conduction in one dimension: plane wall, cylinder, sphere, critical thickness of insulation. Applications of heat transfer in extended surfaces

Textbook 1: Chapter 1- section 1.1,
Textbook 2: Chapter 1- sections:1.2.1, 1.2.2, 1.2.3, 1.2.4
Textbook 3: Chapter 2- sections: 2.5.1, 2.5.2, 2.6.1, 2.6.2, 2.7.1, 2.8.1, 2.9.1, 2.10.1, 2.10.2 [only equations, no derivations]

Module2: Convection Heat Transfer — **No. of Hrs: 9**

Natural and Forced Convection, Flow over a flat plate Velocity boundary layer, Thermal boundary layer, Dimensionless Numbers: Reynolds, Prandtl, Nusselt, Grashoff

Forced Convection: Use of various Correlations for hydro dynamically and thermally developed flows; Use of correlations for flow over a flat plate, cylinder, sphere and flow inside the duct

Free or Natural Convection: Use of correlations for free convection in vertical, horizontal and inclined flat plates, vertical and inclined cylinder.

Textbook 3: Chapter 6-section 6.8
Textbook 2: Chapter 6- sections: 6.1.1, 6.1.2, 6.1.4, 6.2.1, 6.2.3
Textbook 3: Chapter 7- sections: 7.2 to 7.5
Textbook 3: Chapter 8- sections: 8.6

Module3: Radiation Heat Transfer — **No. of Hrs: 8**

Basic Concepts of Radiation: Emissivity, Absorptivity, and Reflectivity, Blackbody Radiation and Stefan-Boltzmann Law, Radiation View Factors, Radiation heat exchange between two parallel infinite black surfaces and between two parallel infinite gray surfaces Radiation Shielding

Textbook 3: Chapter 11
Chapter 12-12.1 o 12.3

Module4: Heat Exchangers	**No. of Hrs: 8**
Types of Heat Exchangers: Shell and Tube, Plate, Finned Tube, LMTD and NTU approaches, Phase Change Processes: Boiling and Condensation Textbook 3: Chapter 10-sections 10.1 to 10.7 Chapter 9	
Module5: Practical Applications of Unsteady State Heat Transfer	**No. of Hrs: 9**
Introduction, Lumped Capacity Analysis, Biot Number, Transient heat conduction in solids with finite conduction and convective resistances, and, Practical Applications: heat transfer in mechanical processing (casting, welding and quenching), and cooling of Electronics devices Textbook 3: Chapter 4 - section 4.1, 4.2, 4.4, 4.5	

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

1. Explain heat transfer modes and key principles of conduction, convection and radiation heat transfer
2. Apply the principles of steady state heat conduction to determine heat transfer through planes walls, cylinders & spheres and effectiveness of extended surfaces
3. Apply the principles of natural and forced convection in external and internal flows to compute heat transfer performance in engineering applications
4. Apply the principles of blackbody radiation, emissivity, and view factors to calculate radiation heat transfer between surfaces in engineering applications
5. Apply LMTD and NTU methods to design heat exchangers
6. Apply the principles of unsteady-state heat transfer to solve practical engineering problems such as casting, welding, quenching, and electronic device cooling

Textbooks:

1. Yunus A. Cengel, "Heat transfer, a practical approach", 5th Edition, Tata Mc Graw Hill, 2002
2. Incropera, F. P. and De Witt, D. P John,"Fundamentals of Heat and Mass Transfer", 5th Edition,Wiley and Sons, New York, 2006
3. R. K. Rajput, "Heat and Mass Transfer", 6th Edition, 2016

Reference Book:

1. Kurt C, "Heat and mass transfer", 2nd Edition, Rolle Cengage learning
2. M. NecatiOzisik,"Heat Transfer A Basic Approach",McGraw Hill, New York, 2005
3. Frank Kreith, Raj M. Manglik, Mark S. Bohn,"Principles of heat transfer", 7th Edition, Rolle Cengage learning, 2011
4. Holman, J. P., "Heat Transfer", 9th Edition, Tata McGraw Hill, New York, 2008

Web links and Video Lectures (e-Resources):

1. NPTEL lecture series by Prof. S.P. Sukhatme and Prof. U.N. Gaitonde, Department of Mechanical Engineering, IIT Bombay: https://youtu.be/qa-PQOjS3zA
2. Online calculator for determining the heat transfer characteristics of select cases and visualize the behaviour of heat flow through graphs: https://mech-website.onrender.com
3. Heat Transfer simulations: https://learncheme.com/simulations/heat-transfer/

Systems Engineering			
Semester	**V**	CIE Marks	**50**
Course Code	**23MEPC304**	SEE Marks	**50**
Teaching Hrs/Week (L: T: P)	**2:0:2**	Exam Hrs	**3**
Total Hrs	**50**	Credits	**3**

Course Learning Objectives: This course is designed to

1. Impart fundamental Systems Engineering principles and their application to real-world engineering problems
2. Familiarize system life cycle approach and functional & feasibility analysis
3. Teach simulation tools and techniques to explore, validate, and optimize system performance requirements
4. Familiarize with verification and validation strategies to ensure system reliability, effectiveness, and successful deployment

Module 1: Foundations of Systems Engineering (SE)	**No. of Hrs: 6 +4**

Introduction**,** systems engineering & traditional engineering, functions, examples, challenges, perspectives, systems domains, fields, approaches, activities and products

Textbook 1: Chapter 1

Practice sessions:

1. Case Study on breaking down a complex mechanical system (e.g., car engine) and map its components to Systems Engineering concepts
2. Role-playing exercises with assigned roles (e.g., systems engineer, project manager) and discuss solutions to common challenges

Module 2: System Development Process	**No. of Hrs:6+4**

Systems engineering life cycle, concept development stage, engineering development stage, post-development stage, and systems engineering methods, Systems Engineering Standards : ISO15288, IEC61508, ISO26262

Textbook 1: Chapter 4 - Sections 4.1, 4.2, 4.4

Practice sessions:

1. Life cycle Model Creation using software tools (Systems Modeling Language -SysML) to visually represent a system's life cycle (e.g., HVAC system).
2. System Lifecycle Analysis of a given system (e.g., industrial robot) and identify necessary engineering tasks at each lifecycle phase

Module 3: Concept Development	**No. of Hrs: 4+6**

Needs analysis, originating a new system, operations analysis, functional analysis, feasibility definition, needs validation, system operational requirements

Textbook 1: Chapter 6 - Section 6.1, 6.2, 6.3, 6.4, 6.5 & 6.6

Practice sessions:

1. Conduct a need analysis (by interviewing potential users, analyzing market trends, and considering technical feasibility) for a new mechanical product (e.g., an energy-efficient vehicle) and present their findings.

Develop a functional flow block diagram by breaking down a system based on functionality

Module 4: Simulation & Model-Based System Engineering	**No. of Hrs: 6+4**

Developing the system requirements, operational requirements analysis, performance requirements formulation, implementation of concept exploration, and performance requirements validation

Operational Simulation, System Effectiveness Simulation, Mission, Types of Simulation - Physical, Hardware - in - the - Loop, Engineering, Environmental & Virtual Reality; Simulation Verification and Validation

Quality of great models, stitching the models, model-based attribute tradeoffs & decision making

Textbook 1: Chapter 7 - Section 7.1, 7.2, 7.3, 7.4 & 7.5
Chapter 9 - Section 9.4

Practice sessions:

1. Use simulation software to develop a simple model of a system component (e.g., a mechanical subsystem) and experiment with different parameters and analyze the system's behavior under various conditions
2. Develop performance requirements for a new system (e.g., wind turbine) and use simulation results to validate the requirements

Module 5: Integrating, Testing, and Evaluating the Total System	**No. of Hrs: 4+6**

Integration and evaluation phase in a system life cycle, Systems Engineering Method in Integration and Evaluation, System Integration - Physical Test Configuration, Subsystem Integration, Total System Integration, Operational Test and Evaluation

Textbook 1: Chapter 13

Practice sessions:

1. Verification & Validation of a Project by developing and executing test plans for a mechanical system (e.g., a mechanical arm) and performing unit, integration, and system testing
2. Deployment strategies for a system (e.g., a factory automation line), including testing, installation, and validation phases

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

1. Explain fundamental Systems Engineering principles and their relevance to engineering challenges
2. Apply the system life cycle approach to design and evaluate engineering systems
3. Identify system needs and perform feasibility analysis to define operational requirements
4. Demonstrate the application of simulation tools to validate and optimize system performance
5. Develop verification and validation strategies for testing and deploying engineering systems

Textbooks:

1. Kossiakoff, A., Sweet, W. N., Seymour, S. J., & Biemer, S. M., "Systems engineering principles and practice", 2nd Edition, Wiley, 2011

Reference Books:

1. Dennis M. Buede, "The Engineering Design of Systems: Models and Methods", 20th Edition, Wiley-Interscience, 2011
2. Reinhard Haberfellner, Olivier de Weck, Ernst Fricke, Siegfried V, "Systems Engineering: Fundamentals and Applications", Springer Nature link, 2019
3. Wasson C. S.,"System engineering: Analysis, design, and development", 2nd Edition, Wiley, 2015

Web links:

1. Module 1: https://ocw.mit.edu/courses/16-842-fundamentals-of-systems-engineering-fall-2015/pages/lecture-notes/
2. Module 2: https://www.youtube.com/watch?v=-gmDkEHl004
3. Module 3: https://www.youtube.com/watch?v=H2WQ2qH2G3M
4. Module 4: https://www.youtube.com/watch?v=pmUkmawKrMA
5. Module 5: https://www.youtube.com/watch?v=avMnK9FpZd0
6. Design Architectures and Activity Diagram for Mobile Robot : https://in.mathworks.com/help/systemcomposer/ug/design-architectural-models.html
7. Modeling System Architecture of Keyless Entry System: https://in.mathworks.com/help/systemcomposer/ug/modeling-system-architecture-of-keyless-entry-system.html

Heat Transfer Lab			
Semester	**V**	CIE Marks	**50**
Course Code	**23MEPC305**	SEE Marks	**50**
Teaching Hrs/Week (L:T: P)	**0:1:3**	Exam Hrs	**2.5**
Total Hrs	**36**	Credits	**2**

Course Learning Objectives: This course is designed to

1. Impart the knowledge of various experimental techniques to determine heat transfer parameters under various conditions
2. Familiarize scientific principles governing heat transfer phenomena, including Fourier's Law, Newton's Law of Cooling, etc.
3. Deliver the concepts of heat transfer to select appropriate materials and design efficient heat transfer systems

Introduction to Heat Transfer — **No. of Hrs: 9**

A theoretical background of conduction heat transfer
Convection heat transfer and types
Heat transfer from extended surfaces
Concept of radiation and the laws associated with it
Relevance of boilers, heat exchangers and their general overview
Applications of transient heat conduction

Experiments — **No. of Hrs: 27**

1. Determination of thermal conductivity of a metal rod
2. Determination of overall heat transfer coefficient of a composite wall
3. Determination of effectiveness on a metallic fin
4. Determination of heat transfer coefficient in free convection
5. Determination of heat transfer coefficient in a forced convection
6. Determination of emissivity of a surface and determination of Stefan Boltzmann constant
7. Determination of LMDT and effectiveness in a parallel flow and counter flow heat exchangers
8. Determination of boiling and condensation heat transfer coefficients
9. Determine the temperature distribution in a rod under transient heat conduction

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

1. Conduct experiments on conduction, convection, boiling, condensation, and radiation heat transfer
2. Determine thermal conductivity, heat transfer coefficients and emissivity
3. Evaluate heat exchanger performance and effectiveness in parallel and counter flow arrangements

Textbooks:

1. Incropera, F.P., DeWitt, D.P., Bergman, T.L., Lavine, A.S., "Fundamentals of Heat and Mass Transfer", 9th Edition, John Wiley & Sons, 2020
2. Lienhard, J.H., Lienhard, J.H.V., "Heat Transfer", 7th Edition, Phlogiston Press, 2022

Reference Book:

1. Bejan, A., "Convection Heat Transfer", 4th Edition, John Wiley & Sons, 2013

Web links:

1. Online calculator for determining the heat transfer characteristics of select cases and visualize the behaviour of heat flow through graphs https://mech-website.onrender.com
2. Heat Transfer simulations, https://learncheme.com/simulations/heat-transfer/

Fluid Power System			
Semester	**V**	CIE Marks	**50**
Course Code	**23MEPE311**	SEE Marks	**50**
Teaching Hrs/Week (L: T: P)	**3:0:0**	Exam Hrs	**3**
Total Hrs	**42**	Credits	**3**

Course Learning Objectives: This course is designed to

1. Teach the basic concepts of hydraulic system components and working principle of hydraulic pumps, hydraulic cylinders, hydraulic motors and control values
2. Impart the knowledge of hydraulic circuit design and maintenance of hydraulic systems
3. Familiarize the components and working principle of pneumatic system
4. Impart the knowledge of logic gate applications and electro-pneumatic applications

Module 1: Introduction to Hydraulic Power — **No. of Hrs: 8**

Definition of hydraulic system, advantages, limitations, applications, Pascal's law, components of fluid power system. Pumps: Classification of pumps, theory of positive displacement pump, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps, Pump performance characteristics, pump Selection factors

Textbook1: Chapter 1-Section 1.1, 1.3, 1.4, 1.5
Chapter 5- Section 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.10

Module 2: Hydraulic Actuators and Control Valves — **No. of Hrs: 8**

Linear Hydraulic Actuators: single and double acting cylinder, mounting arrangements, cushioning
Construction and working of hydraulic rotary actuators: gear, vane, piston motors, hydraulic motor theoretical torque, power and flow rate, hydraulic motor performance
Control Valves: classification, directional control valves, solenoid and pilot operated directional control valve, shuttle valve, and check valves
Pressure control valves: types, direct operated types and pilot operated types. Flow control valves: compensated and non-compensated flow control valve, needle valve

Textbook1: Chapter 6 – Section 6.1, 6.2,6.3, 6.8
Chapter 7 – Section 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7
Chapter 8 – Section 8.1, 8.2, 8.3, 8.4

Module 3: Hydraulic Circuit Design and Maintenance — **No. of Hrs: 9**

Circuit design: Control of single acting and double acting hydraulic cylinder, regenerative circuit, pump unloading circuit, double pump hydraulic system, hydraulic cylinder sequencing circuits, maintenance of hydraulic system

Textbook1: Chapter 9- Section 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.8,
Chapter 12: Section 12.1, 12.2, 12.3

Module 4: Pneumatic System and Control Valves	**No. of Hrs: 9**
Pneumatic system, advantages, limitations, applications, choice of working medium, characteristic of compressed air. Structure of Pneumatic control System, fluid conditioners and FRL unit Direction control valves, flow control valves, pressure control valve, use of memory valve, quick exhaust valve, time delay valve, shuttle valve, twin pressure valve Simple Pneumatic Control circuits: Direct and indirect actuation, speed control, supply and Exhaust air throttling Textbook1: Chapter 13: Section 13.1, 13.2, 13.4, 13.5, Chapter 14: Section 14.1, 14.2, 14.5, Textbook 2: Chapter 6, Section-6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8, 6.9, 6.10, 6.11	
Module 5: Signal Processing Elements and Electro Pneumatic Control	**No. of Hrs: 8**
Use of Logic gates: OR and AND gates in pneumatic applications. Practical examples involving the use of logic gates, Pressure dependent controls- types - construction - practical applications, Time dependent controls principle, Construction, practical applications Principles of electro pneumatic control: signal input and output, pilot assisted solenoid control of directional control valves, Use of relay and contactors Textbook1: Chapter 16: Section 16.1, 16.2, 16.4 Chapter 15: Section 15.1, 15.2, 15.3 Textbook2: Chapter 10: Section 10.6, 10.7, 10.8	
Course Outcomes: At the end of the course, the student will be able to 1. Explain the basic concepts of hydraulic systems and working principle of hydraulic actuators 2. Compute performance characteristics of hydraulic pumps and actuators 3. Design hydraulic circuits for single and double acting cylinders 4. Explain the operation of hydraulic and pneumatic control valve and its maintenance 5. Describe the role of logic gates in pneumatic control systems and principles of electro-pneumatic control	
Text Books: 1. Anthony Esposito, "Fluid Power with Applications", 6th Edition, Pearson Education Inc. 2000 2. S. R Majumdar, "Pneumatics System: Principles and Maintenance", 1st Edition, Tata McGraw Hill India, 2011	
Reference Books: 1. S. Ilango, V. Soundararajan, "Introduction to Hydraulics and Pneumatics", 2nd Edition, PHI learning Pvt Ltd., 2011 2. Majumdar S.R, "Oil Hydraulic Systems: Principles and Maintenance", Tata McGraw-Hill, 2002 3. Andrew Parr, "Pneumatics and Hydraulics", 1st Edition, Jaico Publishing House, 1993	

Web links:

1. Oil Hydraulics and Pneumatics: https://archive.nptel.ac.in/courses/112/106/112106300/
2. Fundamentals of Industrial oil Hydraulics and Pneumatics: https://archive.nptel.ac.in/courses/112/105/112105047/

Automotive Engineering			
Semester	**V**	CIE Marks	**50**
Course Code	**23MEPE312**	SEE Marks	**50**
Teaching Hours/Week (L:T: P)	**3:0:0**	Exam Hrs	**3**
Total Hours	**42**	Credits	**3**

Course Learning Objectives: This course is designed to

1. Impart the knowledge of vehicle dynamics, control systems, engine design and advanced engine technology
2. Familiarize the concepts of transmission, drive train systems, thermal systems and automotive electronics
3. Teach the awareness of automotive safety systems

Module 1: Vehicle Dynamics and Control	**No. of Hrs: 8**

Basics of vehicle motion: longitudinal, lateral, and vertical motion, Suspension systems and their types: Macpherson strut, multi-link, Steering systems: rack and pinion, power steering and traction control

Textbook 1: Chapter 10- Section 10.3, 10.5, 10.6, 10.7, 10.13.
Chapter 11- Section 11.5, 11.9,11.10, 11.11, 11.12

Module 2: Engine Technology	**No. of Hrs: 8**

Types of engines: gasoline, diesel, hybrid, and electric, Fuel systems and fuel injection technology, Exhaust systems and emission control, Turbo charging and supercharging, Advanced engine technologies: variable valve timing, direct injection

Textbook 1: Chapter 12, &17
Textbook 2: Chapter 18

Module 3: Transmission and Drive Systems	**No. of Hrs: 9**

Manual and automatic transmission systems, Types of transmissions: CVT, dual-clutch, Clutches, gearboxes, and differential systems, All-wheel drive and four-wheel drive systems, Transaxles and driveline components

Textbook 1: Chapter 2-Section 2.1,2.2, 2.6, 2.10
Chapter 4-Section 4.3, 4.10
Chapter 5-Section 5.2

Module 4:Thermal Systems and Autotronics	**No. of Hrs: 9**

Cooling systems: radiators, water pumps, thermostats, Air conditioning and refrigeration systems, Heating and ventilation systems

Vehicle entertainment systems: audio, video, navigation, Connectivity technologies: Bluetooth, Wi-Fi, Infotainment interfaces and user experience, Advanced driver assistance systems (ADAS), Autonomous driving systems: LiDAR, radar, cameras

Textbook 1: Chapter 20-Section 20.5, 20.6
Textbook 3: Chapter 7, 8, 9 & 10

Module 5: Automotive Safety Systems	**No. of Hrs: 8**

Crashworthiness and impact analysis, Active safety systems: ABS, ESC, collision avoidance, Passive safety systems: airbags, crumple zones, seatbelts, Pedestrian safety technologies, Regulatory standards and safety testing

Textbook 4: Chapter 1, 2, 5 & 6

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

1. Explain the concepts of automotive dynamics and control, engine technologies, and transmission and drive systems
2. Apply the knowledge of vehicle dynamics and control to calculate acceleration, traction force, centripetal force, damping ratio, natural frequency, steering ratio, and slip percentage for various vehicle systems
3. Apply the concepts of transmission and drive systems to determine the torque, speed, and force transmitted through the clutch, gears, and shafts
4. Describe the principles of automotive thermal management and electronic systems
5. Explain automotive safety regulations and the methods used for safety testing

Textbooks:

1. S. Srinivasan, Automotive Mechanics, 2nd Edition, Tata McGraw- Hill, 2018
2. Kirpal Singh, Automobile Engineering, Vol I and II, 12th Edition, Standard Publishers 2012
3. Markus Maurer & Hermann Winner, Automotive Systems Engineering, Springer, 2013th edition, 2013
4. Priya Prasad & Jamel E. Belwafa, Vehicle Crashworthiness and Occupant Protection, American Iron and Steel Institute 2004

Reference Books:

1. Rajesh Rajamani, Vehicle Dynamics and Control, 2nd Edition, Springer 2012
2. R.B. Gupta, Automobile Engineering, 7th Edition, Tech India Publication, 2007
3. Nicolas Navet & François Simonot-Lion, Automotive Embedded Systems Handbook, CRC Press, 2009
4. John W. Zellner, Automotive Crashworthiness and Occupant Protection, Society of Automobile Engineers, 2006

Web link:

1. Automotive Engineering: https://archive.nptel.ac.in/courses/107/106/107106088/https://onlinecourses.nptel.ac.in/noc20_de06/previewhttps://www.digimat.in/nptel/courses/video/107106088/L01

Micro devices and Smart Systems			
Semester	**V**	CIE Marks	**50**
Course Code	**23MEPE313**	SEE Marks	**50**
Teaching Hours/Week (L:T: P)	**3:0:0**	Exam Hrs	**3**
Total Hours	**42**	Credits	**3**

Course Learning Objectives: This course is designed to

1. Impart foundational knowledge of Micro-Electro-Mechanical Systems (MEMS) and their emerging trends
2. Familiarize the micromachining and fabrication techniques used in MEMS
3. Provide the working principles of various micro sensors and actuators
4. Deliver concepts related to design considerations, constraints, and material selection for MEMS devices

Module 1: Introduction to MEMS	**No. of Hrs: 8**

Introduction, new trends in engineering and science, micro and nano scale systems, intrinsic characteristics of MEMS. Scaling laws in miniaturization: introduction to scaling and scaling in geometry, Numerical examples. Multidisciplinary nature of MEMS and the advantages and challenges of MEMS

Textbook 1: Chapter 1 – Section 1.1, 1.5, 1.6
Chapter 6 – Section 6.1, 6.2, 6.3
Textbook 3: Chapter 1 – Section 1.1, 1.2

Module 2: MEMS Materials and Micromachining Technologies	**No. of Hrs: 9**

Materials: Silicon Compounds, Quartz, Piezoelectric Crystals, and Polymers. Micromachining Technologies: photolithography, etching: wet and dry, thin-film deposition techniques, and bulk micromachining. Surface micromachining and the LIGA process. Chemical and physical considerations in MEMS fabrication

Textbook 1: Chapter 7 – Section 7.5, 7.8, 7.9, 7.10
Chapter 8 – Section 8.2, 8.6, 8.7, 8.9
Chapter 9 – Section 9.1, 9.2, 9.3, 9.4
Textbook 2: Chapter 3 – Section 3.2, 3.3, 3.4

Module 3: Micro Sensors and Actuators	**No. of Hrs: 9**

Micro sensors: Acoustic wave, biomedical, chemical, optical, pressure and thermal sensors. Micro actuators: Actuation using thermal forces, shape-memory alloys, piezoelectric crystals, and electrostatic forces. Working of microgrippers and micromotors. Numerical examples on actuators

Textbook 1: Chapter 2 – Section 2.2, 2.3, 2.4

Module 4: MEMS Design	**No. of Hrs: 8**
Design Considerations: Design constraints and selection of manufacturing processes. Process Design: Photolithography, thin-film fabrication, and geometry shaping. Design of Mechanical Systems: Thermo-mechanical loading and stress analysis. Numerical examples Textbook 1: Chapter 10 - Section 10.1, 10.2, 10.3, 10.4	
Module 5: Industrial Applications of MEMS	**No. of Hrs: 8**
MEMS case studies: Inertial sensors in Automobiles: Airbag deployment, automobile navigation, gyroscope and accelerometer. MEMS devices in commercial applications: Inkjet printers, digital micromirror devices, radio frequency MEMS switches, scanning tunneling microscopes Textbook 3: Chapter 15 – Section 15.3, 15.4	

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

1. Apply scaling laws in miniaturization and the intrinsic characteristics of MEMS
2. Describe the materials used in MEMS and micromachining technologies
3. Apply the principles of microsensors and microactuators to enhance operating performance
4. Apply the concepts of design constraints, manufacturing processes, and stress analysis to evaluate the performance of MEMS devices
5. Explain the industrial applications of MEMS with case studies

Textbooks:

1. Tai-Ran Hsu, "MEMS and Microsystems: Design and Manufacture," 1st Edition, McGraw-Hill, 2002
2. G.K. Ananthasuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat, V.K. Aatre, "Micro and Smart Systems," 1st Edition, Wiley, 2012
3. Chang Liu, "Foundations of MEMS", 2nd Edition, Pearson Education Inc., 2012

Reference Books:

1. Marc Madou, "Fundamentals of Microfabrication: The Science of Miniaturization," 2nd Edition, CRC Press, 2002
2. Mohamed Gad-el-Hak, "The MEMS Handbook," 1st Edition, CRC Press, 2005
3. Stephen D. Senturia, "Microsystem Design," 1st Edition, Springer, 2013
4. Vijay K. Varadan, K. J. Vinoy, and S. Gopalakrishnan, "Smart Material Systems and MEMS: Design and Development Methodologies," 1st Edition, Wiley, 2006

Web links:

1. MEMS and Microsystems, https://nptel.ac.in/courses/117105082, IIT Kharagpur
2. Virtual labs on "Micromachining lab", https://mm-coep.vlabs.ac.in/
3. MEMS Exchange for Fabrication Processes, https://www.mems-exchange.org/

Renewable Energy Resources			
Semester	**V**	CIE Marks	**50**
Course Code	**23MEOE311**	SEE Marks	**50**
Teaching Hrs/Week (L:T: P)	**3:0:0**	Exam Hrs	**3**
Total Hrs	**42**	Credits	**3**

Course Learning Objectives: This course is designed to

1. Impart knowledge of conventional energy sources, their extraction, utilization, and environmental impact
2. Familiarize the principles of solar radiation, photovoltaic conversion, and solar thermal systems
3. Provide the fundamental concepts of wind, biomass, tidal and ocean thermal energy conversion systems
4. Familiarize green energy technologies by exploring their production, storage, and applications

Module 1: Conventional Energy Sources — **No. of Hrs: 9**

Introduction to Energy: Forms, Sources, and Importance, Global & Indian Energy Scenario, Fossil Fuels: Coal & Oil – Extraction and Utilization, Natural Gas: LNG, CNG, and Its Applications, Nuclear Energy: Basics, Fission & Fusion, Nuclear Power Plants: Working and Safety Measures, Environmental Impact of Conventional Energy Sources, Energy Policies and Regulations. Potential of renewable energy resources and applications

Textbook 1: Chapter 1 – Section 1.1,1.4,1.5
Textbook 2: Chapter 1 – Section 1.3,1.4,1.5,1.8,1.10,1.11,1.13,1.14

Module 2: Solar Energy — **No. of Hrs: 8**

Solar Radiation, Solar Radiation geometry, Solar energy collectors: Flat Plate and Concentrating Collectors, Solar Pond, solar pond electric power plant, solar direct thermal application

Fundamentals of Solar Photovoltaic Conversion, Solar Cells, Solar PV Power Generation, Solar PV Applications

Textbook 1: Chapter 2 – Section 2.1, 2.3,2.4
Chapter 3 – Section 3.1,3.3,3.7
Chapter 4 – Section 4.3 , Chapter 5 – Section 5.5,5.6
Textbook 3: Chapter 3 – Section 3.1, 3.2,3.5
Chapter 4 – Section 4.1
Chapter 6 – Section 6.1,6.5,6.6
Chapter 8 – Section 8.1,8.2
Chapter 9 – Section 9.1

Module 3: Wind & Biomass-energy	**No. of Hrs: 9**

Wind energy- Availability of wind energy in India, problems associated with wind power, components of wind energy conversion system (WECS); Classification of WECS, Horizontal axis- single, double and multi blade system. Vertical axis- Savonius and Darrieus types

Biomass energy-Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies- Anaerobic digestion, Biogas Plant -fixed dome; Digester sizing, Urban waste to energy conversion - Biomass gasification (Downdraft & Updraft)

Textbook 1: Chapter 6 – Section 6.1,6.2,6.5,6.6,6.8,6.16
Chapter 7 – Section 7.1,7.3,7.4,7.6,7.24
Textbook 2: Chapter 7 – Section 7.1,7.7,7.8,7.12
Chapter 8 – Section 8.1,8.3,8.4,8.5,8.6,8.7,8.8

Module 4: Tidal & Ocean Thermal Energy	**No. of Hrs: 8**

Tidal Power: Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, harnessing tidal energy, advantages and limitations

Ocean Thermal Energy Conversion: Principle of working, OTEC power stations in the world, problems associated with OTEC

Textbook 1: Chapter 9 – Section 9.1,9.2,9.3
Textbook 2: Chapter 10 – Section 10.1,10.3

Module 5: Green Energy	**No. of Hrs: 8**

Green Energy: Introduction, Fuel cells: Classification, Hydrogen fuel cell; Operating principles, benefits of hydrogen energy, electrolysis method of hydrogen production, hydrogen energy storage, applications of hydrogen energy, problems associated with hydrogen energy

Textbook 1: Chapter 11 – Section 11.1,11.2,11.3,11.7
Textbook 2: Chapter 12 – Section 12.1,12.2

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

1. Explain the basic concepts of energy, energy efficiency, and sustainability, and their impact on the environment and economy
2. Apply the basic concepts of solar radiation to compute solar power generation
3. Apply the principles of wind and biomass energy conversion to find the power generation
4. Explain tidal and ocean thermal energy conversion systems mechanics, advantages, limitations, and feasibility
5. Describe the working of hydrogen fuel cells and hydrogen energy production systems

Textbooks:

1. G D Rai, "Non Conventional Energy sources", 5th Edition, Khanna Publication, 2014
2. Khan B. H., "Non-Conventional Energy Resources", 2nd Edition, Tata McGraw-Hill Education Pvt. Ltd, 2009.
3. S. P. Sukhatme and J.K. Nayak, "Solar Energy", 4th Edition, Tata McGraw-Hill, New Delhi, 2017

Reference Books:

1. G. N. Tiwari: "Solar Energy",1st Edition (revised), Narosa Publications, 2014.
2. A. W. Culp Jr, "Principles of Energy conversion", 2nd Edition, McGraw Hill, 1996
3. Shobh Nath Singh, "Non-Conventional EnergyResources", 2nd Edition, Pearson, 2018
4. Twidell, J. and Tony W., "Renewable Energy Resources", 2nd Edition, Taylor & Francis, 2006
5. Garg, Prakash, "Solar Energy, Fundamentals and Applications", 1st Edition, Tata McGraw Hill, 2000

Web links:

1. NPTEL Video Lectures – Renewable Energy Engineering: Solar, Wind, and Biomass Energy Systems. URL: https://onlinecourses.nptel.ac.in/noc22_ch27
2. NPTEL Video Lectures – Emerging Technologies in Renewable Energy Sources, URL: https://onlinecourses.swayam2.ac.in/nou25_es03
3. NPTEL Video Lectures – Renewable Energy Technology and Their Uses, URL: https://onlinecourses.swayam2.ac.in/nou25_ge15

Lean Manufacturing			
Semester	**V**	CIE Marks	**50**
Course Code	**23MEOE312**	SEE Marks	**50**
Teaching Hrs/Week (L:T: P)	**3:0:0**	Exam Hrs	**3**
Total Hrs	**42**	Credits	**3**

Course Learning Objectives: This course is designed to

1. Provide concepts of primary and secondary Lean Manufacturing, management theories Lean Manufacturing tools
2. Impart knowledge on Total Quality Management tools and techniques, Six Sigma methodologies, and their applications in manufacturing and service sectors
3. Familiarize the Quality Function Deployment and Quality in Service Sectors for product and process improvement
4. Impart knowledge on Quality Circles and its role in organizational quality improvement

Module 1: Introduction to Lean Manufacturing	**No. of Hrs: 8**

Definitions, basic concepts. Overview of historical development. Principles of lean manufacturing

Primary Tools of Lean manufacturing: 5-S technique of Eliminating the Waste, Workplace organization, Total Productive Maintenance, Process mapping, Value stream mapping, Work cell

Textbook 1: Chapter 1, Chapter 2

Module 2:Advances in Lean manufacturing	**No. of Hrs: 8**

Secondary Tools of Lean manufacturing: Objectives and benefits, Cause and Effect diagram, Pareto chart, Spider chart, Poka yoke, Kanban, Automation, Single minute exchange of die

Design for manufacturing and assembly: Just in time, Visual workplace, Overall Equipment Effectiveness

Textbook 1: Chapter 9

Module 3: TQM Tools and Benchmarking	**No. of Hrs: 10**

TQM Tools And Techniques: The seven traditional tools of quality, new management tools, and Six sigma: Concepts, methodology, applications to manufacturing, service sector including IT

Benchmarking: Concepts, Reason to bench mark, Benefits, Elements, Benchmarking process, stages and types

Textbook 2: Chapter 7 Chapter 10, Chapter 15

Module 4: Design of Experiments and Quality in Service Sectors	**No. of Hrs: 8**

Design of Experiments: Introduction, Methods, Taguchi approach, Steps in experimental design

Quality in Service Sectors: Characteristics of Service Sectors, Quality Dimensions in Service Sectors, Measuring Quality in Different Service Sectors

Textbook 3: Chapter 13,

Textbook 4: Chapter 18, Chapter 21

Module 5: Designing for Quality and Quality Circle	**No. of Hrs: 8**

Design for Quality: Introduction to quality engineering, objectives, benefits, Design Failure Mode and Effects Analysis (DFMEA), PFMEA, FFMEA severity, occurrence, and detection, Risk Priority Number

Quality Circle: Structure, its operation, Characteristics, developing quality circle in organization, Basic problem-solving techniques

Textbook 5: Chapter 13

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

1. Explain the principles of Lean Manufacturing and primary lean tools for workplace organization
2. Describe the advanced lean tools, concepts of Design for Manufacturing and Assembly for process improvement
3. Explain the Total Quality Management, Six Sigma and Benchmarking in manufacturing and service sectors
4. Apply the principles of QFD to compute service quality score, CSI and Service Quality gap
5. Apply DFMEA to compute reduction in defects, Risk Priority Number and Weighted Score for Product Design

Textbooks:

1. Masaaki Imai, "Gemba Kaizen: A Commonsense Approach to a Continuous Improvement Strategy", 2nd Edition, 2012
2. Besterfield, D H et al., "Total Quality Management", 3rd Edition, Pearson Education, 2008
3. D. C. Montgomery, "Design and Analysis of Experiments", John Wiley & Sons, 6th Edition,2004
4. Juran J.M and Frank MGryna "Quality Planning and analysis", Tata Mc Graw Hill, 2007
5. J Evans and W Linsay, The Management and Control of Quality, 6th Edition, Thomson, 2005

Reference Books:

1. P N Rao, "Manufacturing technology", McGraw Hill Education (India) Pvt. Ltd. Volume -1, 4th Edition.2013
2. Karen, Mike Osterling, "Value Stream Mapping: How to Visualize Work and Align Leadership for Organizational Transformation" 2016

Web links:

1. Foundations of Lean Manufacturing,
   URL: https://onlinecourses.swayam2.ac.in/imb24_mg119/preview
2. Toyota Production Systems,
   URL: https://archive.nptel.ac.in/courses/110/107/110107130/
3. Manufacturing Systems Technology,
   URL: https://archive.nptel.ac.in/courses/112/104/112104188/

Product Development			
Semester	**V**	CIE Marks	**50**
Course Code	**23MEOE313**	SEE Marks	**50**
Teaching Hrs/Week (L: T: P)	**3:0:0**	Exam Hrs	**3**
Total Hrs	**42**	Credits	**3**

Course Learning Objectives: This course is designed to

1. Provide knowledge of organizational structures in product development
2. Impart skills in customer need analysis, product planning, and product innovation
3. Familiarize product specifications and benchmarking techniques to enhance design effectiveness
4. Impart concept generation, testing, product architecture, industrial design, and platform planning to create market-ready products

Module 1: Product Development Processes and Organizations	**No. of Hrs: 8**

Introduction to Product Development: Importance, characteristics, challenges and opportunities

Development Processes and Organizations: Procedure, product development - process flows, organizations, and structure, case studies

Textbook 1: Chapters 1 and 2
Textbook 2 (case studies)

Module 2: Opportunity and Product Planning	**No. of Hrs: 9**

Opportunity Identification: Types of opportunities, opportunity identification process: establish, generate, screen, develop, select and reflect on the results & the process. Process of identifying customer needs, case studies

Product Planning: Types of product development projects, product planning process: identify opportunities, evaluate and prioritize projects, allocate resources & plan timing, complete pre-project planning, and reflect on the results and the process

Textbook 1: Chapters 3, 4, and 5
Textbook 2 (case studies)

Module 3: Product Specifications	**No. of Hrs: 8**

Introduction, establishing target specifications: competitive benchmarking information, ideal & marginally acceptable target values, and reflect on the results and the process. Final specifications: develop technical models, cost, refine the specifications, trade-offs, flow down the specifications, and reflect on the results and the process

Textbook 1: Chapter 6

Module 4: Concept Generation & Selection	**No. of Hrs: 9**

Concept Generation: Activity, five steps: clarify, external and internal search, systematic explore, and reflect on the solutions and the process

Concept Selection: Methodology, concept screening & scoring, limitations, case studies

Textbook 1: Chapters 7 and 8

Module 5: Concept Testing & Product Architecture	**No. of Hrs: 8**

Concept Testing: Introduction, survey population and format, concept communication, customer response, interpret the results, reflect on the results and the process

Product Architecture: Types, implications, establish, platform planning

Textbook 1: Chapters 9, 10 and 11

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

1. Explain the characteristics of product development and the challenges faced by product development organizations
2. Develop opportunity identification, product planning, and structured methods for identifying customer needs in product development
3. Describe the process of establishing target specifications and finalizing product specifications, incorporating benchmarking techniques
4. Apply the five-step concept generation method along with concept screening and scoring processes for new product development
5. Explain the purpose of concept testing and the different types of product architecture

Textbooks:

1. Karl T. Ulrich & Steven D. Eppinger, "Product Design and Development", 6th Edition, McGraw-Hill, 2020
2. Kevin Otto & Kristin Wood, "Product Design: Techniques in Reverse Engineering and New Product Development", Pearson Education, 2001

Reference Books:

1. A.K. Chitale & R.C. Gupta , "Product Design and Manufacturing", 1st Edition, PHI Learning, 2015
2. Hardi Meybaum , "The Art of Product Design: Changing How Things Get Made", 1st Edition, Wiley, 2017
3. Geoffrey Boothroyd, Peter Dewhurst, Winston A. Knight, "Product Design for Manufacture and Assembly", 3rd Edition, CRC Press, 2010

Web links:

1. Module 1: https://archive.nptel.ac.in/courses/112/107/112107217/, NPTEl, IIT.
2. Module 2: https://onlinecourses.swayam2.ac.in/imb19_mg01/preview, NPTEL, Indian Institute of Management, Bangalore
3. Module 3, 4 & 5: https://onlinecourses.nptel.ac.in/noc23_me52/preview, NPTEL, IIT Kharagpur, IIT Ropar

Yoga - III			
Semester	**V**	CIE Marks	**100**
Course Code	**23NMCC321**	SEE Marks	**-**
Teaching Hrs/Week (L:T: P)	**0:0:1**	Exam Hrs	**-**
Total Hrs	**13**	Credits	**-**

Course Learning Objectives: This course is designed to

1. Empower students to achieve and maintain good health.
2. Promote the practice of mental hygiene.
3. Facilitate students in attaining emotional stability.
4. Impart moral values and higher level of consciousness.

Contents	**No. of Hrs: 13**

- Ashtanga Yoga
  1. Asana
  2. Pranayama
  3. Pratyahara
- Suryanamaskar13 count- 3 rounds of practice
- Asana its meaning by name, technique, precautionary measures and benefits of each asana
- Different types of Asanas
  a) Sitting
     1. Ardha Ushtrasana
     2. Vakrasana
     3. Yogamudra in Padmasana
  b) Standing
     1. UrdhvaHastothanasana
     2. Hastapadasana
     3. ParivrittaTrikonasana
     4. Utkatasana
  c) Prone line
     1. Padangushtha Dhanurasana
     2. Poorna Bhujangasana
  d) Supine line
     1. Sarvangasana
     2. Chakraasana
     3. Navasana/Noukasana
     4. Pavanamuktasana
- Revision of Kapalabhati practice 30 strokes/min 3 rounds
- Meaning by name, technique, precautionary measures and benefits of each Pranayama
  1. Ujjayi
  2. Sheetali
  3. Sheektari

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

1. Describe the meaning, aim and objectives of Yoga.
2. Perform Suryanamaskar and able to analyze its benefits.
3. Exhibit the different Asanas by name, its importance, methods and benefits.
4. Perform Kapalabhati.
5. Perform the different types of Pranayama by its name, precautions, procedure and uses.

Textbooks:

1. Ajitkumar ,"YogaPravesha in Kannada" 1st Edition, Raashtroththaana Saahithya, 2017,ISBN-13: 978-8175310124
2. BKS Iyengar, "Light on Yoga", 1st Edition, Thorsons, 2017, ISBN-13: 978-0008267919
3. Dr. M L Gharote& Dr. S K Ganguly,"Teaching Methods for Yogic practices", 1st Edition, Kaivalyadhama, 2001, ISBN-13 : 978-8189485252

Reference Book:

YaminiMuthanna, "Yoga for Children step by step", 1st Edition, Om Books International, 2022, ISBN-13: 978-9394547018

Web links:

1. My Life My Yoga: https://youtu.be/KB-TYlgd1wE
2. Adiyoga: https://youtu.be/aa-TG0Wg1Ls

Scheme and Assessment:

Sl.No.	Activity	Marks
1	Quiz	20
2	Practical demonstration	50
3	Final Report	30

Physical Education - III			
Semester	**V**	CIE Marks	**100**
Course Code	**23NMCC322**	SEE Marks	**-**
Teaching Hours/Week (L: T: P)	**0:0:1**	Exam Hrs	**-**
Total Hours	**13**	Credits	**-**

Course Learning Objectives: This course is designed to

1. Impart the fundamental concepts and skills of Physical Education, Health, Nutrition and Fitness
2. Familiarization of health-related Exercises, Sports for overall growth and development
3. Build a strong foundation for the professionals in Physical Education and Sports

Contents **No. of Hrs: 13**

- Ethics in Sports & Moral Values in Sports and Games
- Sports Training Methods and its Impacts: Continuous Training, Interval Training, Circuit Training, Weight Training.
- FITT Implementing FITT principles to design personalized fitness programs. (Lectures & Practical Sessions)
- Specific Games (Students continue prior semester's game by practicing Intermediate Skills)

Basket Ball	Crossover dribble - Between-the-legs dribble - Bounce pass and no-look pass Shooting with form from mid-range - Defensive stance and footwork
Cricket	Advanced batting shots (cover drive, square drive, pull shot) - Swing and seam bowling variations - Fielding positions and strategies - Game sense and awareness
Football	Shielding the ball - Crossing the ball - Long passing and through balls - Tackling techniques (sliding & standing) - Shooting with power and accuracy - Playing different positions
Hockey	Stickhandling in tight spaces - Slapshot and sweep shot techniques - Passing with speed and accuracy - Dodging defenders - Defensive positioning and checking
Kabaddi	Advanced raiding techniques (frog jump, jump over) - Diverse raiding holds (frog kick, thigh hold) - Anticipation and countering defense - Effective raiding strategies - Advanced team defense formations
Karate	Kihon (repetition of basic techniques) - Kata (forms to practice technique and flow) - Combinations of punches and kicks - Footwork and movement - Basic kumite (sparring) techniques
Table Tennis	Looping technique (forehand and backhand) - Topspin and backspin serves - Footwork for attacking and defense - Blocking and countering techniques - Match strategy and tactics
Throwball	Long throws and bounce passes - Fake passes and deception moves - Dodging techniques to create space - Defensive positioning and guarding techniques - Team offense and set plays
Volleyball	Attack, Block, Service, Upper Hand Pass and Lower hand Pass

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

1. Develop strategies to promote ethical conduct and a positive sporting culture.
2. Understand the importance of ethics and moral values in sports and games.
3. Perform in the selected sports or athletic events

Textbooks:

1. Muller, J. P., "Health, Exercise and Fitness", 1st Edition, Sports Publication, 2018.
2. Uppal, A.K., "Physical Fitness", Friends Publication New Delhi, 1992.
3. Russell R.P., "Health & Fitness through Physical Education: Human Kinematics", Human Kinetics Publishers, 1994

Reference Books:

1. Anaika , "Play Field Manual", Friends Publication New Delhi, 2005.
2. IAAF Manual
3. Pinto John & Roshan Kumar Shetty, "Introduction to Physical Education"

Web links:

1. https://www.youtube.com/watch?v=wvlztaJYKYI
2. https://www.youtube.com/playlist?list=PLHCNPOIaj2Wc8P5xAWq9g2DUrrbixoTOK
3. https://www.youtube.com/watch?v=K9X_wB1Yu84
4. https://www.youtube.com/watch?v=HEHggOOds1w&list=PLgVaM7Baa_8myp4njEDcoYyZkBq-542S5

Scheme & Assessment of students for auditing the course & Grades

SN	Activity	Marks
1	Participation of students	20
2	Quizzes-2, each of 15 marks	30
3	Final presentation/Exhibition/Participation in Competitions (Certificate of participation in National/International)	50
	Total	**100**

National Service Scheme - III			
Semester	**V**	CIE Marks	**100**
Course Code	**23NMCC323**	SEE Marks	
Teaching Hours/Week (L:T: P)	**0:0:1**	Exam Hrs	
Total Hours	**13**	Credits	**-**

Course Learning Objectives: This course is designed to

1. Develop discipline, character, brotherhood, the spirit of adventure and ideals of selfless service amongst young citizens
2. Develop youth leadership in the students.
3. Induce social consciousness among students through various societal activities.
4. Impart knowledge in finding practical solutions to individual and community problems

NSS -Contents	**No. of Hrs: 13**

Introduction:

- Promoting a healthy lifestyle among youth
- Nutrition education, stress management and mental health activities

- **Activities:**

- Village awareness programs on women hygiene, various superstitious beliefs, avoiding self-medication, etc.
- Helping local schools to achieve good results and enhance their enrolment in Higher/technical/ vocational education

- **Note:**

- Students in individual or in a group should select any one activity in the beginning of each semester till end of that respective semester for successful completion as per the instructions of NSS officer with the consent of HOD of the department.
- At the end of every semester, activity report should be submitted for evaluation.

Course outcomes: At the end of the course, the student will be able to

1. Understand the importance of nation building and individual contribution to the betterment of the society.
2. Discover grassroots challenges of community and solve them by technological intervention.
3. Create societal impact by upholding the value of one for all and all for one.
4. Maintain discipline and team spirit.

Textbooks:

1. Ministry of Youth Affairs & Sports, Government of India (2022) "National Service Scheme Manual"
2. Rajiv Gandhi National Institute of Youth Development, Ministry of Youth Affairs & Sports, Government of India, (2017)"Introduction Training Module for National Service Scheme (NSS) Program officers",
3. Gurmeet Hans (1996), "Case material as Training Aid for field workers" TISS

Reference Books:

1. Dr. G R Bannerjee, (2012),Social service opportunities in Hospitals, TISS
2. Ram Ahuja (Third Edition) 2014, Social Problems in India, Rawat publications

Web links:

1. History of NSS https://thebetterindia.com/140/national-service-scheme-nss/
2. NSS – an introduction https://www.youtube.com/@nationalserviceschemeoffic4034/videos

Assessment details (CIE): Students will be assessed with the

Weightage	CIE
Participation of students	30 Marks
Individual contribution to success of the program	40 marks
Report preparation	30 Marks
Total marks	100 Marks

Arts - III			
Semester	**V**	CIE Marks	**100**
Course Code	**23NMCC324**	SEE Marks	-
Teaching Hours/Week (L: T: P)	**0:0:1**	Exam Hrs	-
Total Hours	**13**	Credits	-

Course Learning Objectives: This course is designed to

1. To impart an understanding of the creative process from initial concept to final execution.
2. Create and demonstrate proficiency in a chosen arts discipline through practical application.
3. Analyze and appreciate diverse art forms and styles
4. To participate in art competitions at regional, state, national, and international levels, as well as in cultural events

Contents	**No. of Hrs: 13**

Note: Student will continue the arts form selected in previous semester.

Performing Arts (Dance)	Orientation, Cinema Acting Basics, Facial Expression Exercises, Body Language, Camera Angles, Characterization demo and Practice, Individual Presentations, Evaluation.
Music	Orientation, Film Songs, Karaoke Singing, Rhythm Fusion and voice, Individual Presentation, song styles demo and practical, Evaluation.
Arts & Crafts	Orientation, Craft Forms, Paper Craft, Mask Making, Model Making, Thermocol Art, Finger Puppet Making, Group Presentation, Evaluation.
Theatre	Orientation, Introduction to Theatre Sets and properties, Practical use of properties, Set Designing, Costume Design, Headgears and Masks, Theatre Makeup, Evaluation.

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

1. To be capable of creating choreography and delivering live performances for an audience.
2. Employ a range of acting techniques and use them to create a performance.
3. Evolve into creative, effective, independent, and reflective individuals capable of making informed decisions in both process and performance.
4. Acquire knowledge and comprehension of the roles and processes used in current theatre arts practice.

Textbooks:

1. Music in Theory and Practice by Bruce Benward and Marilyn Sake, McGraw-Hill Education,2014
2. Art Fundamentals: Theory and Practice by Otto G. Ocvirk, Robert E. Stinson, Philip R. Wigg, Robert Bone, and David L. Cayton, McGraw-Hill Education,2012
3. The Viewpoints Book: A Practical Guide to Viewpoints and Composition by Anne Bogart and Tina Landau, Theatre Communications Group,2004

Reference Books:

1. Dance Composition: A practical guide to creative success in dance making, Jacqueline M. Smith
2. The Artist's handbook of method and materials by Ralph Mayer
3. Glimpses of Indian music and dance by Dr. Arun Bangre.

Web links:

https://ccrtindia.gov.in/audio-visual-catalogue/

Scheme & Assessment of students for auditing the course & Grades		
SN	**Activity**	**Marks**
1	Students Participation	20
2	Quizzes-2 (each of 15 marks)	30
3	Final presentation/Exhibition/Participation in Competitions	50
	Total	**100**

Robotics and Automation			
Semester	**VI**	CIE Marks	**50**
Course Code	**23MEPC306**	SEE Marks	**50**
Teaching Hrs/Week (L:T: P)	**3:0:2**	Exam Hrs	**3**
Total Hrs	**64**	Credits	**4**

Course Learning Objectives: This course is designed to

1. Impart the fundamental concepts of automation and robotics
2. Provide the knowledge of the working methodology of robotics and automation.
3. Familiarize robot end effectors and sensors
4. Develop basic robot programming capability
5. Familiarize the material transport and storage systems

Module 1: Introduction to Automation and Robotics	**No. of Hrs: 8**

Automated Manufacturing Systems, Computerized Manufacturing Support Systems, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automation, Fundamentals of Automated Production Lines, Analysis of Transfer Lines, Numericals, various generations of robots, degrees of freedom, Asimov's laws of robotics

Textbook 1: Chapter 1- section 1.1,
Textbook 2: Chapter 1- sections:1.2.1, 1.2.2, 1.2.3, 1.2.4

Module 2: Fundamentals of Robotics & Control Systems	**No. of Hrs: 8 + 6**

Robot anatomy, Robot configuration, Robot motions, work volume, Robot drive systems, control systems, precision of movement, end effectors, Mathematical models, Transfer Functions, Block Diagram, Controllers, Control System Analysis, Numerical

Textbook 1: Chapter 2-Sec 2.1,2.1.1,2.2,2.3,2.4,2.5,2.6, Chapter 3-3.1.1, 3.1.2, 3.1.3, 3.4

Laboratory Components:
Simulate and Control Robot Arm with MATLAB and Simulink
Transfer Function of a Mechanical and electrical systems Using Simulink

Module 3: Robot End Effectors & Sensors	**No. of Hrs: 8 + 6**

Types of End effectors, Mechanical Grippers, Types of Grippers Mechanisms, Other types of grippers, Tools and End effectors, The Robot/End effector interface: Gripper selection and Design. Transducers and sensors in robotics: tactile, proximity and range sensors, uses of sensors in robotics

Textbook 1: Chapter 5-Sec 5.1, 5.2, 5.2.2, 5.3, 5.4, 5.5, 5.6, Chapter 6-6.1,6.2,6.3,6.4,6.5
Laboratory Components:
Adding Kinematics to a Robot Model using Robcad Basics 11.0
Adding ranges to the joints of the robot model using Robcad Basics 11.0

Module 4: Robot Programming	**No. of Hrs: 8 + 6**

Methods of robot programming, Lead Through programming, requirements of robot programming language, offline programming systems, Robot Path Representation, motion interpolation, Programming Commands: wait, signal and delay, branching, capabilities and limitations of lead-through methods
Text Book 1: Chapter 8-Sec 8.1,8.2,8.5,8.7

Laboratory Components:

Robot programming for Drilling Operation

Robot programming for Point to Point using two Cubes

Module 5: Material Handling and Identification Technology	**No. of Hrs: 8 + 6**

Material Handling Systems, Principles and Design Consideration, Material Transport Systems, Storage Systems, Automatic identification methods: barcode technology, radio frequency identification, Magnetic Stripe Cards, Biometric Identification, Optical Character Recognition. Comparison and Selection of AIDC Technologies

Textbook 1: Chapter 13- Sec 13.1
Textbook 2: Chapter 10-Sec 10.1.1, 10.1.2, 10.2, Chapter 12-12.1, 12.2, 12.3, 12.4

Laboratory Components:

Robot programming for Pick and Place Operation

Robot programming using Smart Components

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

1. Explain the principles of robotics and automation, including robot anatomy, end effectors, sensors & Robot Programming
2. Determine the performance of transfer lines by calculating key metrics such as cycle time, production rate & line efficiency
3. Design mechanical gripper by considering force calculation & gripping mechanisms
4. Develop robot programming using programming commands
5. Demonstrate and simulate robot programs for pick-and-place operations using smart components

Textbooks:

1. Mikell P. Groover, Mitchel Weiss, Roger N. Nagel, Nicholas G. Odrey & Ashish Dutta, "Industrial Robotics: Technology, Programming, and Applications", 2nd Edition, McGraw-Hill, 2012
2. Mikell P. Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing", 4th Edition, Pearson Education

Reference Books:

1. Yoram Koren**,** "Robotics for Engineers", 1st Edition, McGraw-Hill International, 1985
2. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey**,** "Industrial Robotics: Technology, Programming, and Applications", 1st Edition, McGraw-Hill Education, 1986
3. Richard D. Klafter, Thomas A. Chmielewski, Michael Negin, "Robotic Engineering: An Integrated Approach", 1st Edition, Prentice Hall, 1989

Web links:

1. Introduction to Robotics**:** https://onlinecourses.nptel.ac.in/noc21_me32/preview, IIT Kanpur. NPTEL Online Courses
2. Robotics**:** https://onlinecourses.nptel.ac.in/noc21_me76/preview, IIT Madras. NPTEL Online Courses
3. Introduction to Industrial Automation and Control**:** https://nptel.ac.in/courses/108105063, IIT Kharagpur. NPTEL
4. Bulk Material Transport and Handling Systems: https://archive.nptel.ac.in/courses/113/105/113105104/, IIT Kharagpur.

Finite Element Analysis			
Semester	**VI**	CIE Marks	**50**
Course Code	**23MEPC307**	SEE Marks	**50**
Teaching Hrs/Week (L: T: P)	**3:0:0**	Exam Hrs	**3**
Total Hrs	**42**	Credits	**3**

Course Learning Objectives: This course is designed to

1. Provide the concepts of mathematical formulations in Finite Element Method (FEM)
2. Impart knowledge of interpolation models and finite element analysis of 1D bars, trusses, beams and shafts
3. Familiarize heat transfer and axisymmetric problems using FEM
4. Impart knowledge of FE analysis of dynamic systems using Eigen value and Eigen vectors

Module 1: Introduction to Finite Element Method — **No. of Hrs: 9**

General steps of the finite element method, engineering applications & advantages

Discretization process: 1D, 2D, 3D, Simplex, complex and multiplex elements. Node numbering, Location of nodes, Convergence criteria

Finite element formulation: Potential energy method, Displacement method, & Rayleigh Ritz method

Textbook 1: Chapter 1-Section 1.1, 1.4, 1.5, 1.6, Chapter 2- Section 2.6
Textbook 2: Chapter 2- Section 2.3, 2.4, Chapter 3- Section 3.3, 3.6, Chapter 5- Section 5.3, Chapter 8- Section 8.3
Textbook 3: Chapter 1- Section 1.9

Module 2: Finite Element Analysis of 1-D & 2-D Elements — **No. of Hrs: 9**

Introduction to the stiffness (Displacement) method: Linear interpolation polynomials in terms of local coordinates for1D, 2D elements. Pascal's triangle, Higher order interpolation functions for 1D quadratic and cubic elements in natural coordinates, Constant strain triangle, Numerical integration

One-Dimensional Elements: FEA of 1D bars and trusses using elimination approach and penalty approach
Textbook 1: Chapter 3- Section 3.1, 3.6
Textbook 2: Chapter 3- Section 3.1, 3.2, 3.3, 3.5, 3.7, 3.9, Chapter 4- Section 4.2, 4.3, Chapter 6- Section 6.4, Chapter 9- Section 9.2
Textbook 3: Chapter 3, Chapter 4

Module 3: Finite Element Analysis of Beams and Shafts — **No. of Hrs: 8**

Beams: Stiffness matrix based on Euler-Bernoulli beam theory, Hermite shape functions, analysis of beams – simply supported, fixed, straight and cantilever beams, propped cantilever beams with concentrated and uniformly distributed loads

Torsion of Shafts: Finite element formulation of shafts, determination of stress and twists in circular shafts

Textbook 1: Chapter 4- Section 4.1, 4.3, 4.4, Chapter 5- Section 5.4
Textbook 2: Chapter 9- Section 9.3
Textbook 3: Chapter 8, Chapter 10- Section 10.3

Module 4: Heat Transfer & Fluid Flow Problems	**No. of Hrs: 8**

Heat Transfer: Basic equations of heat transfer: Energy balance equation, Rate equation – conduction, convection, radiation, 1D finite element formulation, analysis of temperature gradient & heat fluxes in composite sections & straight fins

Fluid Flow: Flow through a porous medium, Flow through pipes of uniform and stepped sections

Textbook 1: Chapter 13- Section 13.1, 13.2, 13.4, Chapter 14- Section 14.1, 14.2
Textbook 2: Chapter 13- Section 13.1, 13.2, 13.3, Chapter 14- Section 14.2, 14.3
Textbook 3: Chapter 10

Module 5: Axisymmetric Elements & Dynamic Considerations	**No. of Hrs: 8**

Axisymmetric Solid Elements: stiffness matrix and analysis of axisymmetric bodies with triangular elements subjected to surface forces, point loads & angular velocity

Dynamic Considerations: Formulation of mass matrix for point mass and distributed mass, Consistent mass matrix for one dimensional bar element, truss element, Lumped mass matrix for one dimensional bar element & truss element. Computation of Eigen values and Eigen vectors, applications to bars, stepped bars, and beams

Textbook 1: Chapter 11- Section 11.4, Chapter 12- Section 2.1, 12.2.1, 12.2.2, 12.2.3
Textbook 3: Chapter 6, Chapter 11- Section 11.1, 11.2, 11.3, 11.4

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

1. Apply the Finite Element Method and discretization process in engineering problems
2. Solve for stresses of 1D bar and truss elements using the stiffness method
3. Calculate stresses, bending moments in beams, and angle of twist in shafts using FEM
4. Compute temperature gradient and heat flux for 1D heat transfer and fluid flow problems
5. Apply finite element formulations to axisymmetric structures and dynamic systems

Text Books:

1. Logan D. L., "A first course in the Finite Element Method", 6th Edition, Cengage Learning, 2016
2. Rao S. S., "Finite Element Method in Engineering", 5th Edition, Pergaman Int. Library of Science, 2010
3. Chandrupatla T. R, "Finite Elements in Engineering" 2nd Edition, PHI, 2013

Reference Books:

1. J.N.Reddy, "Finite Element Method", 3rd Edition, McGraw -Hill International Edition, 2006
2. Bathe K. J, "Finite Elements Procedures" 2nd Edition, PHI, 2015

Web links:

1. Finite Element Method: https://archive.nptel.ac.in/courses/112/105/112105308/, IIT Kharagpur
2. Introduction to Finite Element Method: https://nptel.ac.in/courses/112106135, IIT Madras
3. Introduction to the Finite Element Method: https://www.iitg.ac.in/mech/ documents/ 128/ introfem.pdf, G. P. Nikishkov, IIT Guwahati

Finite Element Analysis Lab			
Semester	**VI**	CIE Marks	**50**
Course Code	**23MEPC308**	SEE Marks	**50**
Teaching Hrs/Week (L: T: P)	**0:1:3**	Exam Hrs	**2.5**
Total Hrs	**48**	Credits	**2**

Course Learning Objectives: This course is designed to

1. Develop proficiency in FEA software
2. Familiarize structural behaviour by utilizing FEA software to analyze bars, trusses, and beams under various loading conditions
3. Impart the principles of dynamic analysis to determine natural frequencies and assess structural response using FEA software

Part - A	**No. of Hrs: 7+21**

1. Analysis of stresses in bars of constant cross sectional area, tapered cross sectional area and cross section varying in steps
2. Analysis of stress in Trusses
3. Analysis of bending moments and bending stresses in beams – Simply supported, cantilever, beams with point load , UDL, and beams with varying load
4. Stress analysis of a rectangular plate with a circular hole

Part - B	**No. of Hrs: 5+15**

1. Thermal Analysis of 1D & 2D problem with conduction and convection boundary conditions
2. Dynamic Analysis to find:
   a) Natural frequency of beam with fixed – fixed end condition
   b) Response of beam with fixed – fixed end conditions subjected to forcing function
   c) Response of Bar subjected to forcing functions

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

1. Apply the finite element tool to analyze structural components such as bars, trusses, and beams under various loading conditions
2. Demonstrate stress analysis of plates with openings and perform thermal analysis of 1D and 2D structures under conduction and convection boundary conditions
3. Perform dynamic analysis of beams and bars subjected to various loading conditions

Text Books

1. Logan D. L., “A first course in the Finite Element Method”, 6th Edition, Cengage Learning, 2016
2. Rao S. S., “Finite Element Method in Engineering”, 5th Edition, Pergaman Int. Library of Science, 2010

Reference Book

1. Chandrupatla T. R, “Finite Elements in Engineering” 2nd Edition, PHI, 2013

Web links:

1. Innovative Finite Element Modelling tutorials: http://www.visualfea.com/
2. Finite Element Method: https://archive.nptel.ac.in/courses/112/105/112105308/, IIT Kharagpur
3. An Introduction to MATLAB and Some Example Applications in Structural Engineering: https://youtu.be/Y8BOsDvzfXQ?si=di3O5a0by75FaARK

Project Phase -I			
Semester	**VI**	CIE Marks	**100**
Course Code	**23MESE309**	Credits	**3**
Hours/Week (L: T: P)	**0:0:6**	Mode	**Experiential**

Objectives:

1. To develop the students' ability to independently or collaboratively identify a problem, review literature, define objectives, and propose a preliminary methodology for solving an engineering problem, which will be realized in Project Phase – II.
2. The course also aims to develop leadership and interpersonal communication skills within team members.

General Guidelines:

1. A project guide (faculty member) will be allocated by the department
2. The HoD shall appoint a project coordinator who will take the responsibility of monitoring all the activities related to the project execution.
3. The HoD shall constitute project evaluation/review committee(s) & the composition shall be as follows:
    a. HoD or one of the HoDs in case of an interdisciplinary project, shall be the Chairman of the committee
    b. Project Coordinator shall be member -Convener
    c. Project guide shall be the member
    d. One/Two senior faculty members nominated by the HoD (may be from different departments in case of an interdisciplinary project jointly nominated by the HoDs)
4. Each project team shall consist of 2 to 4 students from the same department or different departments.
5. Interdisciplinary projects may be allowed with prior approval from the concerned HODs only.
6. Project teams must arrive at problem statements that address either real-world challenges or research-related issues relevant to their domain of study. Each team must formulate an appropriate project title in consultation with their project guide.
7. Each project team shall maintain a project dairy and record their project progress at regular interval of time. This shall carry signature of the students and the project guide.
8. There is no Semester End Examination (SEE) for this course and evaluation is based entirely on Continuous Internal Evaluation (CIE)
9. Marks may be equally or proportionally distributed among team members based on contribution assessed by the guide and committee.
10. A student shall obtain minimum of 40% of the total marks to pass this course
11. Plagiarism, data fabrication, or copying of work will result in stringent disciplinary action and /or penalties. (Note: Any disciplinary actions or penalties will be as per institutional policy).

Deliverables:

1. Comprehensive Project Report comprising of:
   - Abstract
   - Introduction
   - Literature Survey
   - Problem Definition
   - Proposed Methodology
   - Design
   - Summary and Work Plan for Phase-II
   - References
   - Appendices

   The project report shall be prepared in the prescribed format provided by the institute.

2. A plagiarism report shall be obtained from the Department of Library. Acceptable similarity threshold is generally below 20%, and hence, the plagiarized content shall not exceed 20%. Similarity above 20% will require resubmission after proper revisions.

Review and Evaluation:

1. There shall be two reviews and a presentation. Total of 100 CIE marks is distributed as follows:

Review - 1	
Topic approval, Problem Definition & Objectives	20 Marks
Literature Review	10 Marks
Innovation/Novelty	10 Marks
Total	**40 Marks**
Review - 2	
Methodology & Design	15 Marks
Report Quality & Formatting	15 Marks
Total	**30 Marks**
Presentation	
Presentation	20 Marks
Team work	10 Marks
Total	**30 Marks**
Grand Total	**100 Marks**

2. First review shall be conducted after one month from the start of the semester. Further, every department shall develop rubrics to assess performance of the students based on the above given parameters

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

1 Identify an engineering or research problem through a thorough review of relevant literature
2 Design an appropriate solution or methodology to address the identified problem
3 Prepare a comprehensive project report
4 Effectively present each component of the project report to a knowledgeable audience
5 Collaborate and contribute effectively as a team member, recognizing the dynamics of both individual and group work

Product Design and Development			
Semester	**VI**	CIE Marks	**50**
Course Code	**23MEPE321**	SEE Marks	**50**
Teaching Hours/Week (L: T: P)	**3:0:0**	Exam Hrs	**3**
Total Hours	**40**	Credits	**3**

Course Learning Objectives: This course is designed to

1. Provide knowledge of organizational structures in product development
2. Impart skills in customer need analysis, product planning, and product innovation
3. Familiarize product specifications and benchmarking techniques to enhance design effectiveness
4. Impart concept generation, testing, product architecture, industrial design, and platform planning to create market-ready products

Module 1: Product Development Processes and Organizations — **No. of Hrs: 8**

Introduction to Product Development: Importance of product development, characteristics of successful product development, composition of a product development team, duration and cost, challenges & opportunities, case studies

Development Processes and Organizations: Generic product development process, concept development: front-end process, adapting the generic and Tyco product development process, process flows, organizations, and organizational structure

Textbook 1: Chapters 1 and 2
Textbook 2: Case studies

Module 2: Opportunity Identification and Product Planning — **No. of Hrs: 8**

Opportunity Identification: Introduction, types, structure of opportunity identification, opportunity identification process: establish a charter, generate and opportunities, screen, develop promising opportunities, select exceptional opportunities, and reflect on the results & the Process. Five steps process of identifying customer needs, case studies

Product Planning: Product planning process, types of product development projects, product planning process: identify opportunities, evaluate and prioritize projects, allocate resources & plan timing, complete pre-project planning, and reflect on the results and the process

Textbook 1: Chapters 3, 4, and 5
Textbook 2: Case studies

Module 3: Product Specifications — **No. of Hrs: 8**

Introduction, establishing target specifications: list of metrics, competitive benchmarking information, ideal & marginally acceptable target values, and reflect on the results and the process

Setting the final specifications: Develop technical models, cost model of the product, refine the specifications, making trade-offs, flow down the appropriate specifications , and reflect on the results and the process, case studies

Textbook 1 : Chapter 6

Module 4: Concept Generation & Selection	**No. of Hrs: 8**

Concept Generation: Activity of concept generation, structured approaches, five-step concept generation method: problem definition, external and internal search, systematic exploration, and reflect on the solutions and the process, case studies

Concept Selection: Methods for choosing a concept, methodology, steps involved in the concept screening & scoring and limitations, caveats, case studies

Textbook 1 : Chapters 7 and 8

Module 5: Concept Testing & Product Architecture, Industrial Design	**No. of Hrs: 8**

Concept Testing: Define the purpose of the concept test, choose a survey population, survey format, communicate the concept, measure customer response, interpret the results, and reflect on the results & the process, case study on - estimating market sizes

Product Architecture: Introduction, types, implications and establishing the architecture, platform planning

Industrial Design: Assessing the need, impact, industrial design process, assessing the quality

Textbook 1 : Chapters 9, 10 and 11

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

1. Explain the characteristics of product development and the challenges faced by product development organizations
2. Develop opportunity identification, product planning, and structured methods for identifying customer needs in product development
3. Describe the process of establishing target specifications and finalizing product specifications, incorporating benchmarking techniques
4. Apply the five-step concept generation method along with concept screening and scoring processes for new product development
5. Explain the purpose of concept testing and the different types of product architecture

Textbooks:

1. Karl T. Ulrich & Steven D. Eppinger, "Product Design and Development", 6th Edition, McGraw-Hill, 2020
2. Kevin Otto & Kristin Wood, "Product Design: Techniques in Reverse Engineering and New Product Development", Pearson Education, 2001

Reference Books:

1. A.K. Chitale & R.C. Gupta , "Product Design and Manufacturing", 1st Edition, PHI Learning, 2015
2. Hardi Meybaum , "The Art of Product Design: Changing How Things Get Made", 1st Edition, Wiley, 2017
3. Geoffrey Boothroyd, Peter Dewhurst, Winston A. Knight, "Product Design for Manufacture and Assembly", 3rd Edition, CRC Press, 2010

Web links:

1. Module 1 : https://archive.nptel.ac.in/courses/112/107/112107217/, NPTEl, IIT.
2. Module 2: https://onlinecourses.swayam2.ac.in/imb19_mg01/preview, NPTEL, Indian Institute of Management, Bangalore
3. Module 3, 4 & 5: https://onlinecourses.nptel.ac.in/noc23_me52/preview, NPTEL, IIT Kharagpur, IIT Ropar

Predictive Maintenance			
Semester	**VI**	CIE Marks	**50**
Course Code	**23MEPE322**	SEE Marks	**50**
Teaching Hrs/Week (L:T: P)	**3:0:0**	Exam Hrs	**3**
Total Hrs	**42**	Credits	**3**

Course Learning Objectives: This course is designed to

1. Familiarize maintenance concepts, challenges, and system approaches of condition-based maintenance techniques for effective predictive maintenance
2. Impart concepts of advanced condition monitoring *and* total productive maintenance principles
3. Provide insights into the maintenance effectiveness performance evaluation

Module 1: Introduction to Maintenance	**No. of Hrs: 8**

Maintenance concept, Productivity and maintenance, challenges, levels, planning and safety, and objectives, System approach, requirements, achievements, Role of overhauling in maintenance, Preventive maintenance: Expert systems, types of maintenance system, planning and scheduling, evaluation, control, Maintainability

Module 2: Condition Based Maintenance	**No. of Hrs:9**

Signal monitoring, on-line and off-line monitoring, condition monitoring techniques, automatic visual inspection, monitoring of temperature, leakage, vibration, vibration fundamental and signature, vibration analysis, vibration measuring system, vibration transducers, machinery vibration troubleshooting, vibration severity, sources and types of contaminants

Module 3: Specialized condition monitoring techniques	**No. of Hrs: 9**

Filtergrams, Ferrography, Spectrography, Thickness monitoring, Crack monitoring, Corrosion monitoring, Noise or sound monitoring, Ultrasonic monitoring, Use and pitfall of ultrasonic monitoring, Smell or odour monitoring, Motor current signature analysis , Partial discharge monitoring

Module 4: Total Productive Maintenance	**No. of Hrs: 8**

Definition, origin of TPM, Features/Principles of TPM, Components/Pillars of TPM, Autonomous maintenance, Equipment and process improvement using KAIZEN, Planned maintenance, Early management of new equipment, Quality maintenance, Education and training, Safety and Environmental Management, TPM implementations, TPM benefits

Module 5: Maintenance Effectiveness Performance Evaluation	**No. of Hrs: 8**

Overall equipment effectiveness, Equipment availability, Maintenance effectiveness assessment, Key performance indicators, Maintenance performance analysis, Maintenance performance measuring indices, Measuring maintenance effectiveness, Maintainability index, maintenance audit, Conducting audits, Technical audits, Benefits of audits, Maintenance benchmarking and types of benchmarking

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

1. Explain the fundamental concepts, objectives of maintenance, condition monitoring techniques and their applications
2. Apply preventive maintenance principles and techniques, to improve equipment performance and minimize downtime
3. Apply specialized condition monitoring techniques to diagnose equipment faults and predict potential failures
4. Explain the total productive maintenance for equipment and process improvement
5. Explain the maintenance effectiveness performance evaluation

Textbooks:

1. Er.Sushil Kumar Srivastava, "Maintenance Engineering (Principles, Practices, and Management)", 2nd Edition, S Chand and Company ltd., 2010
2. R.C. Mishra, "Reliability and Maintenance Engineering", 1st Edition, New Age International (P) Ltd., 2006

Reference Books:

1. Alakesh Manna, " A Text Book of Reliability and Maintenance Engineering", 1st Edition, I.K International Publishing House Pvt. Ltd., 2011
2. C.L. Dunlop, "A Practical Guide to Maintenance Engineering", Butterworth International Editions, 1990
3. R.C. Mishra, K. Pathak, "Maintenance Engineering and Management", 2nd Edition, PHI Learning Pvt. Ltd., 2012

Web links:

1. Condition monitoring and Maintenance management: https://onlinecourses.swayam2.ac.in/nou21_me10/preview
2. Machinery Fault Diagnosis and Signal processing: https://onlinecourses.nptel.ac.in/noc22_me60/preview

Sustainable Energy Sources			
Semester	**VI**	CIE Marks	**50**
Course Code	**23MEPE323**	SEE Marks	**50**
Teaching Hours/Week (L:T: P)	**3:0:0**	Exam Hrs	**3**
Total Hours	**42**	Credits	**3**

Course Learning Objectives: This course is designed to

1. Impart knowledge of various energy sources of conventional and non-conventional energy resources
2. Provide the fundamentals of conversion of solar radiation and solar thermal systems to enhance the effective utilization of solar energy
3. Deliver core concepts of wind and biomass energy conversion technologies
4. Discuss tidal, ocean thermal, and geothermal energy conversion systems for sustainable energy generation
5. Familiarize concepts of green energy technologies and their potential applications

Module 1: Introduction to Sustainability & Renewable Energy Sources	**No. of Hrs: 8**

Sustainability : ESG - Environment Social & Governance, Sustainable Development Goals (SDGs), Circular economy, Carbon economy, renewable energy sources, biodiversity, carbon footprint calculation

Energy sources- Introduction, Classification of Energy Resources; Conventional Energy Resources - Availability and their limitations; Non-Conventional Energy Resources – Classification, Advantages, Limitations; Comparison of Conventional and Nonconventional Energy Resources

Textbook 1: Chapter 1 – Section 1.1,1.4,1.5
Textbook 2: Chapter 1 – Section 1.3,1.4,1.5,1.8,1.10,1.11,1.13,1.14
Textbook 3: Chapter 3 – Section 3.1,3.2,3.5,3.7

Module 2: Solar Energy	**No. of Hrs: 9**

Solar energy: Introduction, Solar Constant, Basic Sun-Earth Angles – definition, representation, Solar Radiation Geometry

Liquid flat plate collector, Effect of various parameters on the performance

Concentrating collectors – Introduction, cylindrical, parabolic collector, Compound parabolic collector, Central receiver collector

Solar thermal applications- Solar Pond, Solar Air heater, Solar Water heater, solar power generation, solar space cooling and refrigerator, solar distillation, solar drying, solar cooking Solar Photovoltaic(PV) Conversion, Solar Cells, Solar PV Power Generation, Solar PV Applications

Textbook 1: Chapter 3 – Section 3.1,3.3,3.7
Chapter 4 – Section 4.2,4.3
Chapter 5 – Section 5.2,5.3,5.4,5.5,5.6,5.8,5.9
Textbook 3: Chapter 4 – Section 4.1,4.9
Chapter 6 – Section 6.1,6.4,6.5,6.6
Chapter 8 – Section 8.1,8.2
Chapter 9 – Section 9.1

Module 3:Wind & Biomass energy	**No. of Hrs: 9**

Wind energy- Properties of wind, availability of wind energy, wind velocity, and power; major problems associated with wind power, Basic components of wind energy conversion system (WECS); Classification of WECS, Horizontal axis- single, double and multi-blade system. Vertical axis- Savonius and Darrieus types

Biomass energy-Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies, Biogas plants- fixed dome, floating dome; Urban waste to energy conversion; Biomass gasification

Textbook 1: Chapter 6 – Section 6.1,6.2,6.5,6.6,6.8,6.16
Chapter 7 – Section 7.1,7.3,7.4,7.6,7.24
Textbook 2: Chapter 7 – Section 7.1,7.7,7.8,7.12
Chapter 8 – Section 8.1,8.3,8.4,8.5,8.6,8.7,8.8

Module 4: Tidal, Ocean & Geothermal thermal energy	**No. of Hrs: 8**

Tidal Power: Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, harnessing tidal energy, advantages and limitations.
Ocean Thermal Energy Conversion: Principle of working, OTEC power stations in the world, problems associated with OTEC

Geothermal Energy- Introduction, types of geothermal resources, methods of harnessing, geothermal energy applications, environmental problems and prospects in India

Textbook 1: Chapter 8- Section 8.1,8.4,8.5,8.17,8.18
Chapter 9 – Section 9.1,9.2,9.3
Textbook 2: Chapter 9 – Section 9.1,9.2,9.3,9.6,9.7
Chapter 10 – Section 10.1,10.3

Module 5: Green Energy	**No. of Hrs: 8**

Green Energy: Introduction, Fuel cells: Classification of fuel cells – H2; Operating principles, Benefits of hydrogen energy, hydrogen production technologies (electrolysis method only), hydrogen energy storage, applications of hydrogen energy, problems associated with hydrogen fuel cell.
Textbook 1: Chapter 11 – Section 11.1,11.2,11.3,11.7
Textbook 2: Chapter 12 – Section 12.1,12.2

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

1. Apply the concepts of renewable and non-renewable energy sources to estimate their associated carbon footprints
2. Apply the principles of solar radiation conversion to understand photovoltaic conversion and solar thermal energy systems for effective solar energy utilization
3. Describe the working principles, components, and applications of wind and biomass energy conversion technologies
4. Explain the mechanics, advantages, limitations, and feasibility of tidal, ocean thermal, and geothermal energy conversion systems for sustainable energy generation
5. Describe green energy technologies, including the working of hydrogen fuel cells, hydrogen production methods, storage, and their potential applications

Textbooks:

1. G D Rai, "Nonconventional Energy sources", 5th edition, Khanna Publication, 2014
2. G.D. Rai, "Solar Energy utilization",5th edition, Khanna Publishers, 2004
3. Khan B. H., "Non-Conventional Energy Resources", 2nd Edition, Tata McGraw-Hill Education Pvt. Ltd, 2009.
4. S. P. Sukhatme and J.K. Nayak, "Solar Energy", 4th edition, Tata McGraw-Hill, New Delhi, 2017

Reference Books:

1. G. N. Tiwari: "Solar Energy",1st edition (revised) , Narosa Publications, 2014
2. A. W. Culp Jr, "Principles of Energy conversion", 2nd edition, McGraw Hill, 1996
3. Shobh Nath Singh , "Non-Convention EnergyResources" , 2nd edition, Pearson, 2018
4. Twidell, J. and Tony W., "Renewable Energy Resources" , 2nd Edition, Taylor & Francis, 2006
5. Garg, Prakash, "Solar Energy, Fundamentals and Applications" , 1st edition, Tata McGraw Hill, 2000

Web links:

1. NPTEL Video Lectures – Renewable Energy Engineering: Solar, Wind, and Biomass Energy Systems. Prof. R. Anandalakshmi, IIT Kharagpur. URL: https://onlinecourses.nptel.ac.in/noc22_ch27
2. NPTEL Video Lectures – Emerging Technologies in Renewable Energy Sources, By Prof. SanjayAgrawal, URL: https://onlinecourses.swayam2.ac.in/nou25_es03
3. NPTEL Video Lectures – Renewable Energy Technology and Their Uses, By Prof. SanjayAgrawal, URL: https://onlinecourses.swayam2.ac.in/nou25_ge15

Fundamentals of Electric Vehicle			
Semester	**VI**	CIE Marks	**50**
Course Code	**23MEOE321**	SEE Marks	**50**
Teaching Hrs/Week (L: T: P)	**3:0:0**	Exam Hrs	**3**
Total Hrs	**42**	Credits	**3**

Course Learning Objectives: This course is designed to

1. Impart the fundamental concepts of vehicle architecture and performance characteristics of EVs
2. Provide the concepts of torque and speed characteristics of motor drives and power converters
3. Impart the concepts of methods to improve battery performance through battery management systems
4. Familiarize EV Charging Infrastructure, EV Testing and Quality Assurance

Module 1: EV Architecture and Parameterization	**No. of Hrs: 8**

Vehicle Fundamentals, Basics of Electro mobility-Pure EV, Hybrid, Plug-In Hybrid, EV and IC engine- pros & cons. EV powertrain architecture, Vehicle Performance. Mechanical sub-system of an EVs - dynamics of steering system & suspension system, Thermal management, Gear and transmission Systems, Braking systems, Chassis design, Turbulence, Vibrational study, Wheel and Tyre dynamics

Textbook 1: Chapter-1, Chapter-3, Textbook 2: Chapter-9

Module 2: EV Power Drives	**No. of Hrs: 8**

EV Motors and speed control methods, Motor ratings, EV/HEV motor requirement. Types of Motors: IM, PMSM, SyRM, PMBLDC, SRM, Torque and speed characteristics. Motor drives and converters: DC/DC Converter, AC/DC Converter, AC and DC charge controller

Textbook 1: Chapter-6, Chapter-7, Textbook 2: Chapter-7

Module 3: Battery Fundamentals & BMS	**No. of Hrs: 8**

Battery modeling, advantages and disadvantages, Characteristics of battery cell, Battery sizing , Introduction to BMS Charging and discharging control methods, SOC, Cell balancing, BMS topologies, SoC estimation, Protection and battery management system logic, Development of Battery-pack Architecture, Battery thermal management system

Textbook 1: Chapter-4

Module 4: EV Charging Infrastructure	**No. of Hrs: 9**
Need of Charging Infrastructure, Battery Charging methods: CC-CV Charging, EV supply equipment (EVSE), EV battery chargers components , Charging infrastructure challenges , Classification of charging levels, modes, plug types, BHARAT DC001 communication protocols, Converters in EV chargers Reference Book 3: Chapter-2, Chapter-3, Chapter-5	
Module 5: Performance and Quality assurance of EVs	**No. of Hrs: 9**
Testing for Electric Vehicle, Testing – Penetration Testing, Thermal Testing, Non-Destructive Testing. Quality Assurance, Battery Systems, Functional and Performance Testing, Reliability and Durability, Safety Standards and Regulations	

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

1. Apply the concepts of electro-mobility to find the performance of EVs
2. Describe the characteristics and operations of motor drives & power converters
3. Apply the concepts of battery management system topologies to find battery performance and thermal management in energy storage applications
4. Describe the components, levels, and modes of EV charging infrastructure
5. Explain the testing methods, quality assurance procedures and safety standards

Textbooks:

1. Iqbal Hussain, "Electric and Hybrid Vehicles Design Fundamentals", 1st Edition, CRC Press, 2003
2. James Larminie, John Lowry "Electric Vehicle Technology Explained", 1st Edition, John Wiley and Sons, 2003

Reference Books:

1. Chris Mi, M. Abul Masrur, David Wenzhong Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", Wiley publication, 2011
2. Prof. K.C.Jain, Dr.Amit R.Patil, Dr. Arvind J. Bhosale, Dr. S.S. Raghuvanshi "Fundamentals of Hybrid and Electric Vehicles" 1st Edition, Khanna Publishers, 2024
3. Mohammed Saad Alam, Reji Kumar Pellai, N. Murugesan, "Developing charging infrastructure and technologies for Electric Vehicles" IGI Global Publishers, 2021

Web links:

1. Web course on "Introduction to Hybrid and Electric Vehicles" by Dr. Praveenkumar and Prof. S Majhi, IIT Guwahati available on NPTEL at https://nptel.ac.in/courses/108/103/108103009/
2. Video Course on "Electric Vehicles" by Prof. Amitkumar Jain, IIT Delhi available on NPTEL at https://nptel.ac.in/courses/108/102/108102121/

Supply Chain Management			
Semester	**VI**	CIE Marks	**50**
Course Code	**23MEOE322**	SEE Marks	**50**
Teaching Hrs/Week (L:T: P)	**3:0:0**	Exam Hrs	**3**
Total Hrs	**42**	Credits	**3**

Course Learning Objectives: This course is designed to

1. Impart knowledge of supply chain management in economy and organization
2. Provide the concepts of make versus buy decisions in supply chain management
3. Familiarize the inventory management techniques, associated costs for optimum utilization of the inventory. integration of internal and external supply chains
4. Impart knowledge of information technology in enhancing supply chain execution, collaboration, decision support, and performance measurement

Module 1: Introduction to Supply Chain Management	**No. of Hrs: 8**

The Role of Supply Chain Management in Economy and organization: Fundamentals of Supply Chain, evolution, decisions, importance, enablers of supply chain performance, supply chain performance in India, Supply Chain Strategy and Performance Measure: Customer service and cost trade-offs, Supply chain performance using financial data

Textbook 1: Chapter 1 & 2
Textbook 2: Chapter 1- Section 1.4, 1.5, Chapter 3- Section 3.2, 3.3

Module 2: Outsourcing: Make Versus Buy	**No. of Hrs:8**

Identifying core processes: the business process route, the product architecture route; Market versus hierarchy: economies of scale, agency cost, transaction cost, incomplete contracts, integrative framework of market versus hierarchy; The make versus buy continuum: tapered integration, collaborative relationship; Sourcing strategy portfolio approach: reconfiguration of the supply base

Textbook 1: Chapter 3
Textbook 2: Chapter 15, Section-15.1, 15.2, 15.3,15.5

Module 3: Inventory Management	**No. of Hrs: 9**

Types of inventory: cycle inventory, safety stock, decoupling stocks, anticipation inventory, pipeline inventory, dead stock; Inventory related costs: ordering cost, inventory-carrying cost, stock out costs; Managing cycle stock: cycle stock inventory model; Managing safety stock: capturing uncertainty, impact of service level on safety stock; Managing seasonal stock: planning for seasonal demand; Multiple item multiple location inventory management: selective inventory control techniques

Textbook 1: Chapter 4

Module 4: Supply Chain Integration	**No. of Hrs: 9**
Internal integration: centralized system, decentralized system, hybrid system; External integration: increase in demand volatility, impact of buyer, supplier practices, bullwhip effect, demand volatility and information distortions, remedial strategies; Building partnership and trust: steps in building relationships, effect of interdependence on relationships Textbook1: Chapter 9	
Module 5: Supply Chain Restructuring	**No. of Hrs: 8**
Chain Mapping: value-addition curve, customer entry point, point of differentiation; postpone the point of differentiation: postponement for reducing transportation cost, case studies, issues of postponement strategy Information Technology in Supply Chain Management: enabling supply chain management, IT in supply chain transaction execution, collaboration and coordination, decision support, measurement and reporting Text book1: Chapter 8&10 Text book2: Chapter 17- Section 17.1, 17.2, 17.3, 17.4	

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

1. Apply the fundamental concepts of supply chain management to find its impact on organizational performance and economic growth
2. Explain the role of make versus buy decisions in the supply chain
3. Apply inventory management principles to optimize stock levels and minimize costs
4. Describe the internal and external supply chain integration to minimize demand and supply distortion
5. Explain the concepts of supply chain mapping, postponement strategies, and the role of information technology in supply chain

Textbooks:

1. Janat Shah, "Supply Chain Management Text and Cases", 2nd Edition, Pearson Education, 2016
2. Sunil Chopra and Peter Meindl, "Supply Chain Management-Strategy Planning and Operation", 6th Edition, PHI Learning / Pearson Education, 2014

Reference Books:

1. David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi, "Designing and Managing the Supply Chain: Concepts, Strategies, and Cases", 3rd Edition, Tata McGraw-Hill, 2007
2. Ballou Ronald H, "Business Logistics and Supply Chain Management", 5th Edition, Pearson Education, 2003
3. Michael H. Hugos, "Essentials of Supply Chain Management", 1st Edition, Wiley, 2003,

Web links:

1. Modelling and Analysis for Supply Chain Management: https://onlinecourses.nptel.ac.in/noc21_mg45/preview
2. Operations and Supply Chain Management: https://nptel.ac.in/courses/110106045
3. Management of Inventory Systems: https://nptel.ac.in/courses/110105095

Micro-Electro-Mechanical Systems			
Semester	**VI**	CIE Marks	**50**
Course Code	**23MEOE323**	SEE Marks	**50**
Teaching Hours/Week (L:T:P)	**3:0:0**	Exam Hrs	**3**
Total Hours	**42**	Credits	**3**

Course Learning Objectives: This course is designed to

1. Impart the knowledge of Micro-Electro-Mechanical Systems (MEMS) and their emerging trends
2. Familiarize the micromachining and fabrication techniques used in MEMS
3. Provide the working principles of various micro sensors and actuators
4. Impart the concepts on MEMS design, material selection, manufacturing, and packaging techniques for Microelectronics and Microsystems

Module 1: Introduction to MEMS	**No. of Hrs: 8**

Introduction, new trends in engineering and science, micro and nano scale systems, intrinsic characteristics of MEMS. Scaling laws in miniaturization: introduction to scaling and scaling in geometry, Numerical examples. Multidisciplinary nature of MEMS and the advantages and challenges of MEMS

Textbook 1: Chapter 1 – Section 1.1, 1.5, 1.6
Chapter 6 – Section 6.1, 6.2, 6.3
Textbook 3: Chapter 1 – Section 1.1, 1.2

Module 2: MEMS Materials and Micromachining Technologies	**No. of Hrs: 9**

Materials: Silicon Compounds, Quartz, Piezoelectric Crystals, and Polymers. Micromachining Technologies: photolithography, etching: wet and dry, thin-film deposition techniques, and bulk micromachining. Surface micromachining and the LIGA process. Chemical and physical considerations in MEMS fabrication

Textbook 1: Chapter 7 – Section 7.5, 7.8, 7.9, 7.10
Chapter 8 – Section 8.2, 8.6, 8.7, 8.9
Chapter 9 – Section 9.1, 9.2, 9.3, 9.4
Textbook 2: Chapter 3 – Section 3.2, 3.3, 3.4

Module 3: Micro Sensors and Actuators	**No. of Hrs: 9**

Micro sensors: Acoustic wave, biomedical, chemical, optical, pressure and thermal sensors. Micro actuators: Actuation using thermal forces, shape-memory alloys, piezoelectric crystals, and electrostatic forces. Numerical examples on actuators

Textbook 1: Chapter 2 – Section 2.2, 2.3, 2.4

Module 4: MEMS Design and Packaging	**No. of Hrs: 8**
Design Considerations: Design constraints and selection of manufacturing processes. Process Design: Photolithography, thin-film fabrication, and geometry shaping. Microsystems Packaging: Mechanical packaging of microelectronics and general considerations in packaging design Textbook 1: Chapter 10 - Section 10.1, 10.2, 10.3 Chapter 11 - Section 11.1, 11.2, 11.3	

Module 5: Industrial Applications of MEMS	**No. of Hrs: 8**
MEMS Case Studies: Inertial sensors in Automobiles: Airbag deployment, automobile navigation, gyroscope and accelerometer. MEMS devices in commercial applications: Inkjet printers, digital micro-mirror devices, radio frequency MEMS switches, scanning tunneling microscopes Textbook 3: Chapter 15 – Section 15.3, 15.4	

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

1. Apply scaling laws in miniaturization and the intrinsic characteristics of MEMS
2. Describe the materials used in MEMS and micromachining technologies
3. Apply the principles of micro sensors and micro actuators to enhance operating performance
4. Explain the design considerations, material selection, and manufacturing processes, and packaging for MEMS
5. Explain the industrial applications of MEMS with case studies

Textbooks:

1. Tai-Ran Hsu, "MEMS and Microsystems: Design and Manufacture," 1st Edition, McGraw-Hill, 2002
2. G.K. Ananthasuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat, V.K. Aatre, "Micro and Smart Systems," 1st Edition, Wiley, 2012
3. Chang Liu, "Foundations of MEMS", 2nd Edition, Pearson Education Inc., 2012

Reference Books:

1. Marc Madou, "Fundamentals of Microfabrication: The Science of Miniaturization," 2nd Edition, CRC Press, 2002
2. Mohamed Gad-el-Hak, "The MEMS Handbook," 1st Edition, CRC Press, 2005
3. Stephen D. Senturia, "Microsystem Design," 1st Edition, Springer, 2013
4. Vijay K. Varadan, K. J. Vinoy, and S. Gopalakrishnan, "Smart Material Systems and MEMS: Design and Development Methodologies," 1st Edition, Wiley, 2006

Web links:

1. MEMS and Micro systems, https://nptel.ac.in/courses/117105082, IIT Kharagpur
2. Virtual labs on "Micromachining lab", https://mm-coep.vlabs.ac.in/
3. MEMS Exchange for Fabrication Processes, https://www.mems-exchange.org/

Yoga - IV			
Semester	**VI**	CIE Marks	**100**
Course Code	**23NMCC325**	SEE Marks	**-**
Teaching Hrs/Week (L:T: P)	**0:0:1**	Exam Hrs	**-**
Total Hrs	**13**	Credits	**-**

Course Learning Objectives: This course is designed to

1. Empower students to achieve and maintain good health.
2. Promote the practice of mental hygiene.
3. Facilitate students in attaining emotional stability.
4. Impart moral values and higher level of consciousness.

Contents	**No. of Hrs: 13**

- Ashtanga Yoga 1. Dharana 2. Dhyana (Meditation) 3. Samadhi
- Asana by name, technique, precautionary measures and benefits of each asana
- Suryanamaskar13 count- 4 rounds of practice
- Different types of Asanas
  a) Sitting
     1. Bakasana
     2. Hanumanasana
     3. Ekapada Rajakapotasana
     4. Yogamudra in Vajrasana
  b) Standing
     1. Vatayanasana
     2. Garudasana
  c) Balancing
     1. Veerabhadrasana
     2. Sheershasana
  d) Supine line
     1. Sarvangasana
     2. Setubandha Sarvangasana
     3. Shavasanaa (Relaxation posture).
- Revision of Kapalabhati practice 40 strokes/min - 3 rounds
- Meaning by name, technique, precautionary measures and benefits of Pranayama Bhramari.

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

1. Describe the meaning, aim and objectives of Yoga.
2. Perform Suryanamaskar and able to analyze its benefits.
3. Exhibit the different Asanas by name, its importance, methods and benefits.
4. Perform Kapalabhati.
5. Perform the different types of Pranayama by its name, precautions, procedure and uses.

Textbooks:

1. Ajitkumar ,"YogaPravesha in Kannada" 1st Edition, Raashtroththaana Saahithya, 2017,ISBN-13: 978-8175310124
2. BKS Iyengar, "Light on Yoga", 1st Edition, Thorsons, 2017, ISBN-13: 978-0008267919
3. Dr. M L Gharote& Dr. S K Ganguly,"Teaching Methods for Yogic practices", 1st Edition, Kaivalyadhama, 2001, ISBN-13 : 978-8189485252

Reference Book:

YaminiMuthanna, "Yoga for Children step by step", 1st Edition, Om Books International, 2022, ISBN-13: 978-9394547018

Web links:

1. My Life My Yoga: https://youtu.be/KB-TYlgd1wE
2. Adiyoga: https://youtu.be/aa-TG0Wg1Ls

Scheme and Assessment:

Sl.No.	Activity	Marks
1	Quiz	20
2	Practical demonstration	50
3	Final Report	30

Physical Education - IV			
Semester	**VI**	CIE Marks	**100**
Course Code	**23NMCC326**	SEE Marks	**-**
Teaching Hours/Week (L: T: P)	**0:0:1**	Exam Hrs	**-**
Total Hours	**13**	Credits	**-**

Course Learning Objectives: This course is designed to

1. Impart the fundamental concepts and skills of Physical Education, Health, Nutrition and Fitness
2. Familiarization of health-related Exercises, Sports for overall growth and development
3. Build a strong foundation for the professionals in Physical Education and Sports

Contents **No. of Hrs: 13**

- Importance of nutrition for optimal performance and healthy eating habits. (Lectures)
- Mindfulness and stress management techniques like meditation. (Practical Sessions)
- Emphasis on teamwork, communication, and sportsmanship. (Practical Sessions)
- Specific Games (Students continue prior semester's game by practicing Advanced Skills)

Basket Ball	Behind-the-back dribble - Spin moves - Alley-oop passes - Shooting off the dribble - Advanced footwork and shot creation techniques
Cricket	Reverse swing and googly bowling - Spin bowling variations (leg spin, off spin) - Captaincy skills - Advanced batting techniques (switch hitting)
Football	Advanced dribbling techniques (stepovers, fakes) - First touch passing and control - Volley control and shooting - Set pieces (free kicks, corner kicks) Advanced heading techniques - Goalkeeper diving and shot-stopping
Hockey	Deke moves and advanced stickhandling - Aerial control - Passing variations (chip pass, scoop pass) - Penalty corner techniques - Advanced defensive strategies
Kabaddi	Advanced raiding maneuvers (super raid) - Quick and deceptive raiding holds - Strategic raiding based on game situation - Strong team defense coordination - Advanced anti-raid tactics
Karate	Advanced kumite strategies and tactics - Complex combinations of attacks and counters - Throwing and takedown techniques (sweeps, trips) - Advanced conditioning and strength training
Table Tennis	Advanced footwork for quick movement - Smashing technique - Serving variations (sidespin, flick serve) - Deceptive spins and tactics - Advanced match play strategies
Throwball	Jump shot and other variations - No-look passes and behind-the-back passes - Quick throws and fast breaks - Advanced dodging techniques and footwork - Zone defense and press defense strategies
Volleyball	Offensive spiking mechanics (jumping and hitting the ball

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

1. Demonstrate an understanding of the link between nutrition, performance, and healthy eating habits
2. Demonstrate improved self-awareness, stress management skills, and effective teamwork through participation in sportsmanship-focused activities.
3. Perform in the selected sports or athletic events

Textbooks:

1. Muller, J. P., "Health, Exercise and Fitness", 1st Edition, Sports Publication, 2018.
2. Uppal, A.K., "Physical Fitness", Friends Publication New Delhi, 1992.
3. Russell R.P., "Health & Fitness through Physical Education: Human Kinematics", Human Kinetics Publishers, 1994

Reference Books:

1. Anaika , "Play Field Manual", Friends Publication New Delhi, 2005.
2. IAAF Manual
3. Pinto John & Roshan Kumar Shetty, "Introduction to Physical Education"

Web links:

1. https://www.youtube.com/watch?v=wvlztaJYKYI
2. https://www.youtube.com/watch?v=d393LzvqG3E&list=PL94CA1fTzfEd8FkpCa0WNTF7y1pFWNFKc
3. https://www.youtube.com/watch?v=m7EhWv4wgP4

Scheme & Assessment of students for auditing the course & Grades		
SN	Activity	Marks
1	Participation of students	20
2	Quizzes-2, each of 15 marks	30
3	Final presentation/Exhibition/Participation in Competitions (Certificate of participation in National/International)	50
	Total	**100**

National Service Scheme - IV			
Semester	**VI**	CIE Marks	**100**
Course Code	**23NMCC327**	SEE Marks	**-**
Teaching Hours/Week (L:T: P)	**0:0:1**	Exam Hrs	**-**
Total Hours	**13**	Credits	**-**

Course Learning Objectives: This course is designed to

1. Develop discipline, character, brotherhood, the spirit of adventure and ideals of selfless service amongst young citizens
2. Develop youth leadership in the students.
3. Induce social consciousness among students through various societal activities.
4. Impart knowledge in finding practical solutions to individual and community problems

NSS -Contents	**No. of Hrs: 13**

Introduction:

- Basic first aid skills
- Disaster preparedness, emergency evacuation
- **Activities:**
- Environment Awareness and Conservation
- Obstacle management Training, conflict management and negotiation skills
- **Note:**
- Students in individual or in a group should select any one activity in the beginning of each semester till end of that respective semester for successful completion as per the instructions of NSS officer with the consent of HOD of the department.
- At the end of every semester, activity report should be submitted for evaluation.

Course outcomes: At the end of the course, the student will be able to

1. Understand the importance of nation building and individual contribution to the betterment of the society
2. Discover grassroots challenges of community and solve them by technological intervention
3. Create societal impact by upholding the value of one for all and all for one.
4. Maintain discipline and team spirit

Textbooks:

1. Ministry of Youth Affairs & Sports, Government of India (2022) "National Service Scheme Manual"
2. Rajiv Gandhi National Institute of Youth Development, Ministry of Youth Affairs & Sports, Government of India, (2017)"Introduction Training Module for National Service Scheme (NSS) Program officers",
3. Gurmeet Hans (1996), "Case material as Training Aid for field workers" TISS

Reference Books:

1. Dr. G R Bannerjee, (2012),Social service opportunities in Hospitals, TISS
2. Ram Ahuja (Third Edition, 2014), Social Problems in India, Rawat publications

Web links:

- History of NSS
  - https://thebetterindia.com/140/national-service-scheme-nss/
- NSS – an introduction
  https://www.youtube.com/@nationalserviceschemeoffic4034/videos

Assessment details (CIE): Students will be assessed with the

Weightage	CIE
Participation of students	30 Marks
Individual contribution to success of the program	40 marks
Report preparation	30 Marks
Total marks	100 Marks

Arts - IV			
Semester	**VI**	CIE Marks	**100**
Course Code	**23NMCC328**	SEE Marks	**-**
Teaching Hours/Week (L: T: P)	**0:0:1**	Exam Hrs	**-**
Total Hours	**13**	Credits	**-**

Course Learning Objectives: This course is designed to

1. To impart an understanding of the creative process from initial concept to final execution.
2. Create and demonstrate proficiency in a chosen arts discipline through practical application.
3. Analyze and appreciate diverse art forms and styles
4. To participate in art competitions at regional, state, national, and international levels, as well as in cultural events

Contents	**No. of Hrs.: 13**

Note: Student will continue the arts form selected in previous semester.

Performing Arts (Dance)	Orientation, Cinema Script Writing, Audition Techniques, Shooting Script, Basics Direction and Camera, Group Assignments, Group Presentation, Evaluation.
Music	Orientation, Western Songs, Voice Culture, Voice Modulation, Rap Singing, Folk Song Revision, Film Song Revision, Group Presentation Evaluation
Arts & Crafts	Orientation, Puppetry: Glow Puppetry- Head Puppets -Animal Puppetry -POP Puppetry- Group Presentation- Evaluation
Theatre	Orientation, Theatre Music, Theatre Choreography, Script Writing, Group Production, Grand Rehearsals, Group Show, Evaluation.

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

1. To be capable of creating choreography and delivering live performances for an audience.
2. Employ a range of acting techniques and use them to create a performance.
3. Evolve into creative, effective, independent, and reflective individuals capable of making informed decisions in both process and performance.
4. Acquire knowledge and comprehension of the roles and processes used in current theatre arts practice.

Textbooks:

1. Music in Theory and Practice by Bruce Benward and Marilyn Sake, McGraw-Hill Education,2014
2. Art Fundamentals: Theory and Practice by Otto G. Ocvirk, Robert E. Stinson, Philip R. Wigg, Robert Bone, and David L. Cayton, McGraw-Hill Education,2012
3. The Viewpoints Book: A Practical Guide to Viewpoints and Composition by Anne Bogart and Tina Landau, Theatre Communications Group,2004

Reference Books:

1. Dance Composition: A practical guide to creative success in dance making, Jacqueline M. Smith
2. The Artist's handbook of method and materials by Ralph Mayer
3. Glimpses of Indian music and dance by Dr. Arun Bangre.

Web links:
https://ccrtindia.gov.in/audio-visual-catalogue/

Scheme & Assessment of students for auditing the course & Grades

SN	Activity	Marks
1	Students Participation	20
2	Quizzes-2 (each of 15 marks)	30
3	Final presentation/Exhibition/Participation in Competitions	50
	Total	**100**