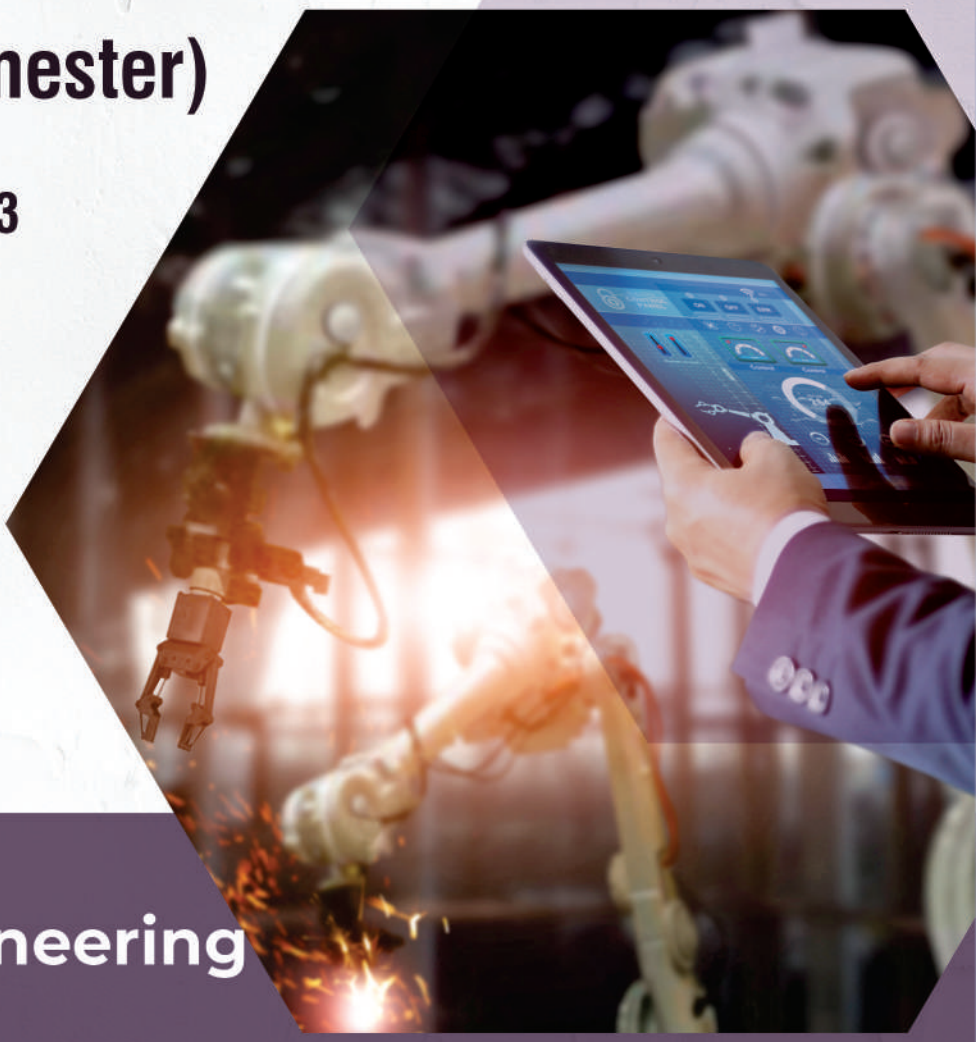
BE SCHEME & SYLLABUS

Fourth Year
(VII and VIII Semester)

With effect from 2022-23



Mechanical Engineering

ST JOSEPH ENGINEERING COLLEGE

AN AUTONOMOUS INSTITUTION

Vamanjoor, Mangaluru - 575028

MOTTO

Service & Excellence

VISION

To be a global premier Institution of professional education and research.

MISSION

- Provide opportunities to deserving students of all communities, the Christian students in particular for quality professional education.
- Design and deliver curricula to meet the national and global changing needs through student-centric learning methodologies.
- Attract, nurture and retain the best faculty and technical manpower.
- Consolidate the state-of-art infrastructure and equipment for teaching and research activities.
- Promote all round personality development of the students through interaction with alumni, academia and industry.
- Strengthen the Educational Social Responsibilities (ESR) of the institution.

ST JOSEPH ENGINEERING COLLEGE

An Autonomous Institution

Vamanjoor, Mangaluru - 575028

Affiliated to VTU – Belagavi & Recognized by AICTE New Delhi
NBA – Accredited: B.E.(ECE, EEE, ME and CIV) & PG (MBA and MCA)
NAAC – Accredited with A+

B.E. SCHEME & SYLLABUS

(With effect from 2022-23)

MECHANICAL ENGINEERING

FOURTH YEAR

(VII and VIII Semester)

AUTONOMY AND ACCREDITATION

St Joseph Engineering College (SJEC) is an Autonomous Institute under Visvesvaraya Technological University (VTU), Belagavi, Karnataka State, and is recognized by the All-India Council for Technical Education (AICTE), New Delhi. SJEC is registered under the trust "Diocese of Mangalore, Social Action Department".

The SJEC has been conferred Fresh Autonomous Status from the Academic Year 2021-22. The college was granted autonomy by the University Grants Commission (UGC) under the UGC Scheme for Autonomous Colleges 2018 and conferred by VTU. The UGC Expert Team had visited the college on 28-29 November 2021 and rigorously assessed the college on multiple parameters. The fact that only a handful of engineering colleges in the state have attained Autonomous Status adds to the college's credibility that has been on a constant upswing. Autonomy will make it convenient for the college to design curricula by recognizing the needs of the industry, offering elective courses of choice and conducting the continuous assessment of its students.

At SJEC, the Outcome-Based Education (OBE) system has been implemented since 2011. Owing to OBE practised at the college, SJEC has already been accredited by the National Board of Accreditation (NBA). Four of the UG programs, namely Mechanical Engineering, Electronics and Communication Engineering, Electrical & Electronics Engineering and Civil Engineering and two of the PG programs, namely, MBA and MCA programs, have accreditation from the NBA.

Also, SJEC has been awarded the prestigious A+ grade by the National Assessment and Accreditation Council (NAAC) for five years. With a Cumulative Grade Point Average (CGPA) of 3.39 on a 4-point scale, SJEC has joined the elite list of colleges accredited with an A+ grade by NAAC in its first cycle. The fact that only a small percentage of the Higher Education Institutions in India have bagged A+ or higher grades by NAAC adds to the college's credibility that has been on a constant upswing.

The college is committed to offering quality education to all its students, and the accreditation by NAAC and NBA reassures this fact. True to its motto of "Service and Excellence", the college's hard work has resulted in getting this recognition, which has endorsed the academic framework and policies that the college has been practicing since its inception. The college has been leveraging a flexible choice-based academic model that gives students the freedom to undergo learning in respective disciplines and a transparent and continuous evaluation process that helps in their holistic development.

CONTENTS

ABOUT THE DEPARTMENT

The Department of Mechanical Engineering was established in the year 2002 with the vision of nurturing technically competent and socially responsible Engineering Professionals. Alma mater to more than 1800 Graduate Engineers over the past 19 glorious years; the Mechanical Engineering Department, SJEC, strives to prepare students for careers across a broad range of industries such as automotive, manufacturing, materials and metallurgy, oil and gas, and aeronautical. Mechanical Engineering encompasses learning the application of physical principles of heat, force, conservation of mass and energy, design of mechanisms and machine elements, system design, manufacturing and maintenance of industrial machinery, etc. Thrust is laid on teaching CAD/CAM tools along with latest design tools, to keep the students abreast with modern technologies in the discipline of Mechanical Engineering. The Department offers Undergraduate (B.E.), Post Graduate (M.Sc. in Engineering by Research), and Doctoral (Ph.D.) programme; with an annual intake of 120 candidates for B.E. Course. The Department of Mechanical Engineering at SJEC is one of the few Departments in the region to secure NBA Accreditation since 2013 and the Department has also got permanent affiliation status from VTU Belagavi from 2019-20 to 2024-25.

DEPARTMENT VISION

To be a value-based department committed to excellence in teaching and research, nurturing technically competent and socially responsible engineering professionals

DEPARTMENT MISSION

- Providing state-of-the-art technical knowledge in Mechanical Engineering.
- Promoting research, education and training in frontier areas of Mechanical Engineering.
- Facilitating faculty development through quality improvement programmes.
- Initiating collaboration with industries, research organizations and institutes for internship, joint research and consultancy.
- Instilling social and ethical values in students, staff and faculty through personality development programmes.
- Developing innovation in engineering and technology in order to provide beneficial service to the local community.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

1. Graduates will engage in designing, manufacturing, testing, operating and/or maintaining systems in the field of Mechanical Engineering and allied industries.

2. Graduates will be able to communicate and perform effectively in both individual and team-based project environments, including multi-disciplinary settings.

3. Graduates will apply knowledge and skills considering ethical practices, societal, economic and environmental factors and/or pursue higher education and research.

4. Graduates will develop the practice of continuously updating themselves with the latest knowledge and information in their field of specialization.

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

PO1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and engineering specialization to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and the synthesis of information to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6: The Engineer and The World: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO9: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO10: Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and a leader in a team, to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOS)

Graduates of the Mechanical Engineering program are able to:

PSO1: Apply the principles of design and material characteristics to develop a mechanical system and analyze it using CAD/CAM/FEA tools.

PSO2: Apply analytical, numerical, and experimental techniques to analyze the performance of thermal systems.

PSO3: Apply advanced manufacturing principles to engineer components with appropriate considerations of productivity, quality and cost.

VII Semester (B.E. – Mechanical Engineering)													
SI. No.	**Course and Course Code**		**Course Title**	**Teaching Department**	**Paper Setting Board**	**Teaching Hours/Week**			**Examination**				**Credits**
						Theory Lecture	**Tutorial**	**Practical /Drawing**	**Duration in hours**	**CIE Marks**	**SEE Marks**	**Total Marks**	
						L	**T**	**P**					
1	IPCC	22MEC71	Finite Element Methods (Integrated)	MEC	MEC	2	2	2	03	50	50	100	4
2	IPCC	22MEC72	Hydraulics and Pneumatics (Integrated)	MEC	MEC	3	-	2	03	50	50	100	4
3	PCC	22MEC73	Automotive Engineering	MEC	MEC	3	-	-	03	50	50	100	3
4	PEC	22MEC74X	Professional Elective -III	MEC	MEC	3	-	-	03	50	50	100	3
5	PRJ	22MEC75	Major Project Phase II	MEC	MEC	-	-	6	03	50	50	100	6
					Total	**11**	**2**	**10**	**15**	**400**	**200**	**600**	**20**

22MEC74X: Professional Elective III			
22MEC741	Additive Manufacturing	22MEC743	Artificial Intelligence in Mechanical Engineering
22MEC742	Fuel Cell and its Applications	22MEC744	Tribology

VIII Semester (B.E. - Mechanical Engineering)													
SI. No.	**Course and Course Code**		**Course Title**	**Teaching Department**	**Paper Setting Board**	**Teaching Hours/Week**			**Examination**				**Credits**
						Theory Lecture	**Tutorial**	**Practical/ Drawing**	**Duration in hours**	**CIE Marks**	**SEE Marks**	**Total Marks**	
						L	**T**	**P**					
1	PEC	22MEC81	Professional Elective IV (Online Course)	Any MOOC topic (Choices are given by respective Department) with minimum 12 weeks to be completed before the end of 8th semester.								100	3
2	OEC	22MEC82	Open Elective -II (Online Course)	Any MOOC topic (Choices are given by respective Department) with minimum 12 weeks to be completed before the end of 8th semester.								100	3
3	INT	22MEC83	Research / Industry Internship (14 to 16 weeks)			-	-	-	03	50	50	100	10
			Total			**-**	**-**	**-**	**03**	**50**	**50**	**300**	**16**

Note: a. Professional Elective IV : These are ONLINE courses suggested by the Board of Studies.

b. Open Elective -II : These are ONLINE courses suggested by the Board of Studies.

c. During 4th year of the program i.e., after VII semester, students shall take up the **Research Internship /Industrial Internship for 14-16 weeks**. Research/Industrial Internship shall be carried out at an Industry, NGO, MSME, Innovation centre, Incubation centre, Start-up, Centre of Excellence (CoE), Study Centre established in the parent institute and /or at reputed research organizations/institutes.

VII Semester

FINITE ELEMENT METHODS			
Course Code	22MEC71	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Integrated	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	2:2:2	SEE	3 Hours
Total Hours	40 hours Theory + 10 Lab slots	Credits	04

Course Learning Objectives: The objective of the course is to

- Learn the basics of the finite element method.
- Learn the theory and characteristics of finite elements that represent engineering structures.
- Apply finite element solutions to structural, thermal and dynamic problems.

Module-1 Introduction to FEM (08 hours)

Basics of FEM: General steps of the finite element method. Engineering applications of finite element method, Advantages and disadvantages of the finite element method.

Potential energy method with problems on spring loaded systems, Rayleigh Ritz method with problems on bars.

Displacement method of finite element formulations: Discretization process, Types of elements: 1D, 2D and 3D, Node numbering scheme, location of nodes. Convergence criteria.

Strain- displacement relations: Stress-strain relations, Plain stress and Plain strain conditions, temperature effects (no derivations), simple problems.

Module-2 Analysis of Bars and Trusses (08 hours)

Shape functions: Definition and its properties, Derivation of shape function for 1D linear element, quadratic element, CST element in natural coordinates.

Numerical problems on bars, stepped bars – stiffness matrix, solution of displacements, reactions and stresses by using elimination approach, penalty approach. (Problems with maximum 3 elements only).

Numerical problems on trusses - stiffness matrix, solution of displacements, reactions and stresses by using elimination approach. (Problems with 2 elements only).

Module-3 Analysis of Beams and Shafts (08 hours)

Beams: Boundary conditions, Hermite shape functions (no derivations), Beam stiffness matrix, Numerical problems on simply supported and cantilever beams cantilever beams with concentrated and uniformly distributed load. (Problems with 2 elements only).

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

Module-4 Heat Transfer and Fluid Flow Analysis (08 hours)

Heat Transfer: Basic equations of heat transfer, Types of boundary conditions, 1D heat conduction governing equation. Problems with temperature gradient and heat fluxes, 1D heat transfer in straight fins and composite walls.

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

Module-5 Axi-symmetric and Dynamic Considerations (08 hours)

Axi-symmetric Solid Elements: Derivation of stiffness matrix of axisymmetric bodies with triangular elements, Numerical solution of axisymmetric triangular element subjected to surface forces, point loads, angular velocity etc.

Dynamic Considerations: Formulation for point mass and distributed masses, Consistent element mass matrix of 1D bar element. Evaluation of eigen values and eigen vectors, Numerical problems on bars and stepped bars.

PRACTICAL MODULE

PART – A

1. Introduction to finite element analysis package, pre-processing, processing and post -processing.
2. Analysis of bars of uniform cross section and stepped bars subjected to different loading conditions (minimum 3 exercises of different types).
3. Analysis of trusses (minimum 3 exercises of different types).
4. Analysis of beams – simply supported and cantilever types with point loads, UDL (minimum 4 exercises to be done).

PART – B

1. Stress analysis of a rectangular plate with a circular hole.
2. Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions (Minimum 2 exercises of different types)
3. Dynamic analysis:

a. Beam for natural frequency determination
b. Bar subjected to forcing function
c. Fixed -fixed beam subjected to forcing function

PART – C

(Demonstration)

1. Demonstration of use of graphic standards (IGES, STEP etc.) to import the model.
2. Demonstration of one example of contact analysis.

PART D

(Open Ended Problems)

1. Torsion of circular shafts: Modelling in modelling software and analysis in FEA Package.
2. Fluid flow Analysis -Potential distribution in the 2 -D bodies.

Course Outcomes: At the end of the course the student will be able to:	
22MEC71.1	Apply the basic concept of finite element formulation for different loading and boundary conditions.
22MEC71.2	Analyse the bars and trusses under different loading and geometric conditions for stress-strain analysis.
22MEC71.3	Develop finite element equations for beams and circular shafts by applying different boundary conditions and solve for unknowns.
22MEC71.4	Apply suitable boundary conditions to a global equation for heat transfer and fluid flow analysis.
22MEC71.5	Analyze the axisymmetric problems and bars under dynamic loading using finite element method.
22MEC71.6	Utilize the finite element analysis technique to model and solve the practical problems.

Sl. No.	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
Textbooks				
1	Introduction to Finite Elements in Engineering	Tirupathi K., Chandrapatla, Ashok D. Belagundu	Pearson Education Pvt. Ltd.	3rd Edition 2004
2	A First Course in the Finite Element Method	Daryl L. Logan	Cengage Learning India	5th Edition 2020

Reference Books				
1	The Finite Element Method in Engineering	S.S. Rao	Elsevier, London	5th Edition 20016
2	Finite Element Analysis	George R Buchanan	Tata McGraw Hill	2006
3	Concepts and Applications of Finite Element Analysis	Robert Cook	Wiley, New Delhi	4th Edition 2017
4	Practical Finite Element Analysis	Nitin S Gokhale	Finite to Infinite India	2008th Edition

Web links and Video Lectures (e-Resources):

- https://ocw.mit.edu/courses/2-094-finite-element-analysis-of-solids-and-fluids-ii-spring-2011/
- http://lms.vtu.ac.in/econtent/courses/ME/10ME64/index.php
- http://lms.vtu.ac.in/econtent/courses/ME/06ME63/index.php
- https://nptel.ac.in/courses/112103295
- https://nptel.ac.in/courses/112106135

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
22MEC71.1	3	2	-	1	-	-	-	-	-	-	-	-	-	-
22MEC71.2	-	3	2	-	2	-	-	-	-	-	-	2	-	-
22MEC71.3	-	2	3	-	-	-	-	-	-	-	-	2	-	-
22MEC71.4	3	2	-	-	-	-	-	-	-	-	-	-	2	-
22MEC71.5	3	2	-	-	-	-	-	-	-	-	-	1	-	-
22MEC71.6	-	-	-	2	3	1	2	-	-	-	1	2	-	-

1: Low 2: Medium 3: High

HYDRAULICS AND PNEUMATICS			
Course Code	22MEC72	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Integrated	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	3:0:2	SEE	3 Hours
Total Hours	40 hours Theory + 10 Lab slots	Credits	04

Course Learning Objectives: The objective of the course is to

- Provide the knowledge on the working principles of fluid power systems.
- Study the fluids and components used in modern industrial fluid power system.
- Develop the design, construction and operation of fluid power circuits
- Learn the working principles of pneumatic power system and its components.
- Provide the knowledge of trouble shooting methods in fluid power systems.

Module-1 Introduction to Fluid Power and Pumps (8 hours)

Introduction to Fluid power **–** Advantages and Applications – Fluid power systems – Types of fluids- Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow -Friction loss – Work, Power and Torque- Problems, Sources of Hydraulic power.

Pumping Theory-– Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of pumps – Fixed and Variable displacement pumps –Problems.

Module-2 Hydraulic Actuators and Control Components (8 hours)

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Rotary Actuators-Hydraulic motors

Control Components: Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Accessories: Reservoirs, Pressure Switches – Filters –types and selection- Applications – Fluid Power ANSI Symbols – Problems.

Module-3 Hydraulic Circuits and Systems (8 hours)

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double-Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Deceleration circuits, Sizing of hydraulic systems, Hydrostatic transmission, Electro hydraulic circuits, –Servo and Proportional valves – Applications- Mechanical, hydraulic servo systems.

Module-4 Pneumatic and Electro Pneumatic Systems (8 hours)

Properties of air –Air preparation and distribution – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – classification- single cylinder and multi cylinder circuits-Cascade method –Integration of fringe circuits, Electro Pneumatic System – Elements – Ladder diagram – timer circuits-Problems, Introduction to fluidics and pneumatic logic circuits.

Module-5 Trouble Shooting and Applications (8 hours)

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Conditioning of hydraulic fluids Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications- mobile hydraulics; Design of Pneumatic circuits for metal working, handling, clamping counter and timer circuits. – Low-cost Automation – Hydraulic and Pneumatic power packs, IOT in Hydraulics and pneumatics

Practical Module
1. Bending of Thin Brass Plates Using a Pneumatic Single-Acting Cylinder 2. Pneumatic Control of a Casting Ladle for Metal Pouring 3. Pneumatic Control of a Valve Using a Double-Acting Cylinder 4. Electro Pneumatic Control Valve Opening and Closing Device. 5. Electro Pneumatic Control of Hopper Discharge Using Memory Valve and Solenoid Valve 6. Implementation of AND Gate Logic Using a Programmable Logic Controller (PLC) 7. Implementation of OR Gate Logic Using a Programmable Logic Controller (PLC)

Course Outcomes: At the end of the course the student will be able to:	
22MEC72.1	Apply the working principles of fluid power systems and hydraulic pumps.
22MEC72.2	Apply the working principles of hydraulic actuators and control components.
22MEC72.3	Design and develop hydraulic circuits and systems.
22MEC72.4	Apply the working principles of pneumatic circuits and power system and its components.
22MEC72.5	Identify various troubles shooting methods in fluid power systems.
22MEC72.6	Identify various real life applications of fluid power systems.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Fluid Power with Applications	Anthony Esposito	Prentice Hall	7th Edition 2014
2	Fluid Power Theory and Applications	James A. Sullivan	Prentice Hall	4th Edition 1997
Reference Books				
1	Pneumatics Concepts, Design and Applications	Jagadeesha. T	Universities Press	1st Edition 2015
2	Pneumatic Control	Joji.P	Wiley India	2008
3	Hydraulic and Pneumatic Controls	Srinivasan.R.	Vijay Nicole Imprints,	3rd Edition 2019
4	Hydraulic and Pneumatic Controls	Shanmugasundaram.K.	Chand & Co	2006

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/112105046
- https://onlinecourses.nptel.ac.in/noc23_me28/preview

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
22MEC72.1	1	1	-	-	-	-	-	-	-	-	-	-	1	-
22MEC72.2	1	1	-	-	-	-	-	-	-	-	-	-	-	-
22MEC72.3	3	1	-	-	1	-	-	-	2	-	-	-	-	-
22MEC72.4	1	2	-	-	2	-	-	-	-	-	-	-	-	-
22MEC72.5	1	1	-	-	-	-	-	-	-	1	-	-	-	-
22MEC72.6	2	1	-		-	-	-	-	-	-	-	1	-	-

1: Low 2: Medium 3: High

AUTOMOTIVE ENGINEERING			
Course Code	22MEC73	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L: T: P)	3:0:0	SEE	3 Hours
Total Hours	40 hours	Credits	03

The objectives of this course are to

- Identify the different parts of an automobile and it's working
- Understand the working of transmission and braking systems
- Comprehend the working of steering and suspension systems
- Learn various types of fuels and injection systems
- Identify the cause of automobile emissions, its effects on the environment and methods to reduce the emissions.

Module-1 Engine Components and Principal Parts (8 hours)

INTRODUCTION: Spark Ignition (SI) & Compression Ignition (CI) engines, cylinder – arrangements and their relative's merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve timing diagram, Types of combustion chambers for SI. Engine and CI. Engines, methods of a Swirl generation, choice of materials for different engine components, engine positioning. Concept of HCCI engines, hybrid engines, twin spark engine.

COOLING AND LUBRICATION: Cooling requirements, types of cooling- forced circulation water cooling system, water pump, Radiator, thermostat valves. Significance of lubrication, splash and forced feed system.

Module-2 Transmission System (8 hours)

CLUTCH-types and construction, gear boxes- manual and automatic, gear shift mechanisms, over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.

BRAKES**:** Types of brakes, mechanical compressed air, vacuum and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, drum brakes, Antilock –Braking systems, purpose and operation of antilock-braking system, ABS Hydraulic Unit, Rear-wheel antilock & Numerical

Module-3 Steering and Suspension Systems (8 hours)

STEERING AND SUSPENSION SYSTEMS: Steering geometry and types of steering gear box- Power Steering, Types of Front Axle, Suspension, Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel, Air suspension system.

IGNITION SYSTEM: Battery Ignition system, Magneto Ignition system, electronic Ignition system.

Module-4 Superchargers, Turbochargers and Fuel Supply System (8 hours)

SUPERCHARGERS AND TURBOCHARGERS: Naturally aspirated engines, Forced Induction, Types of superchargers, Turbocharger construction and operation, Intercooler, Turbocharger lag.

FUELS, FUEL SUPPLY SYSTEMS FOR SI AND CI ENGINES: Conventional fuels, alternative fuels, normal and abnormal combustion, cetane and octane numbers, Fuel mixture requirements for SI engines, multi point and single point fuel injection systems, fuel transfer pumps, Fuel filters, fuel injection pumps and injectors. Electronic Injection system, Common Rail Direct Injection System.

Module-5 Automotive Emission Control Systems (8 hours)

AUTOMOTIVE EMISSION CONTROL SYSTEMS: Different air pollutants, formation of photochemical smog and causes. Automotive emission controls, controlling crankcase emissions, controlling evaporative emissions, Cleaning the exhaust gas, Controlling the air-fuel mixture, Controlling the combustion process, Exhaust gas recirculation, Treating the exhaust gas, Air-injection system, Air-aspirator system, Catalytic converter.

EMISSION STANDARDS: Euro I to Euro VI norms, Bharat Stage I to Bharat Stage VI norms, development and evolution of emission regulations, Motor Vehicle Act.

Course Outcomes: At the end of the course the student will be able to:	
22MEC73.1	Describe the construction and working of engine components, cooling and lubrication system.
22MEC73.2	Demonstrate the role and working of Clutch, gear box, transmission systems and braking system in automobile with neat sketches wherever necessary.
22MEC73.3	Illustrate the role of Steering, Suspension and functions of ignition system in automobile.
22MEC73.4	Apply superchargers and turbochargers to increase engine power by forcing more air into the engine for better combustion
22MEC73.5	Describe the combustion process and fuel supply system in SI and CI engine
22MEC73.6	Analyze various factors leading to Automotive Emissions and explain various emission control techniques and emission standards.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Automobile Engineering	Kirpal Singh	Standard Publishers	12th Edition 2017
2	Automotive Mechanics	S. Srinivasan	Tata McGraw Hill	2nd Edition 2003
Reference Books				
1	Automotive Mechanics	William H Crouse & Donald L Anglin	Tata McGraw Hill Publishing Company Ltd	10th Edition 2010
2	Automotive Mechanics Principles and Practices	Joseph Heitner	East West Press	2nd Edition 2006
3	Fundamentals of Automobile Engineering	K.K. Ramalingam	SciTech Publications (India) Pvt. Ltd.	2nd Edition 2009
4	Automobile Engineering	R. B. Gupta	Satya Prakashan	4th Edition 1984

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/107/106/107106088/
- https://www.youtube.com/watch?v=H_RgFXjg-5s&t=1s
- https://archive.nptel.ac.in/courses/107/106/107106088/
- https://www.youtube.com/watch?v=NJkU8wbjgjs&t=7s
- https://www.youtube.com/watch?v=IMqpZKMfi1Y&t=4s
- https://www.youtube.com/watch?v=qhvi7f4c3bw&t=6s

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
22MEC73.1	3	-	-	-	-	-	-	-	-	-	-	-	1	-
22MEC73.2	3	-	-	-	-	-	-	-	-	-	-	1	-	-
22MEC73.3	3	-	-	-	-	-	-	-	-	-	-	-		-
22MEC73.4	3	-	-	-	-	-	-	-	-	-	-	-	1	-
22MEC73.5	3	-	-	-	-	-	-	-	-	-	-	1	-	-
22MEC73.6	-	-	3	-	-	-	2	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

ADDITIVE MANUFACTURING			
Course Code	22MEC741	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L: T:P)	3:0:0	SEE	3 Hours
Total Hours	40 hours	Credits	03

Course Learning Objectives: The objectives of the course are

- To understand the principal methods, areas of usage, possibilities, and limitations of Additive Manufacturing.
- To familiarize with the characteristics of different materials used in Additive Manufacturing.
- To understand the principles of photo polymerization & powder fusion processes, extrusion-based systems, printing, sheet lamination & beam deposition processes, direct write technologies, and direct digital manufacturing.
- To have an exposure to process selection, software issues, and post-processing techniques

Module – 1 Introduction and Basic Principles of Additive Manufacturing (08 Hours)

Introduction and Basic Principles of AM: The need for Additive Manufacturing (Rapid Prototyping), Generic AM Processes, The Benefits of AM, Distinction between AM and CNC Machining.

Development of AM Technology: Introduction, Computer-Aided Design Technology, Use of Layers, Classification of AM Processes, Metal Systems, Hybrid Systems, Milestones in AM Development. **Additive Manufacturing Process Chain:** Introduction, The Eight Steps in AM, Design for AM, and Application Areas.

Module – 2 Photo polymerization, Powder Fusion & Extrusion Based Processes (08 Hours)

Photo polymerization processes: Stereo lithography (SLA), Materials, SLA resin curing process, Micro-stereo lithography, Process Benefits and Drawbacks, Applications of Photo Polymerization Processes. **Powder fusion processes:** Selective Laser Sintering (SLS), Materials, Powder fusion mechanism, SLS Metal and ceramic part creation, Applications of Powder Bed Fusion Processes.

Extrusion-based Systems: Fused Deposition Modeling (FDM); Principles, Materials, Routing and path control, Applications of Extrusion-Based Processes.

Module – 3 Printing, Sheet Lamination, Beam Deposition Processes & Direct Write Technologies (08 Hours)

Printing Processes: Evolution of Printing as an AM Process, Research achievements in Printing Deposition, Technical Challenges of Printing, 3-D Printing, Advantages of Binder Printing.

Sheet Lamination Processes: Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Thermal Bonding; Applications of LOM and UC.

Beam Deposition Processes: General Beam Deposition Process, Description of Material Delivery, BD Systems, Process Parameters, Typical Materials and Microstructure, BD Benefits and Drawbacks.

Direct Write Technologies: Introduction, Ink-based DWI, Laser Transfer; DW Thermal Spray, DW Deposition, DW Liquid-Phase Direct Deposition.

Module – 4 Guidelines for Process Selection (08 Hours)

Guidelines for Process Selection: Introduction, Selection Methods for different applications, Challenges of Selection, Production Planning, and Control.

Software Issues for AM: Introduction, the STL File, Problems with STL Files, STL File Manipulation. **Post-Processing:** Support material removal, Surface texture improvements, Property enhancements using Non-Thermal techniques and Thermal techniques.

Module – 5 Use of Multiple Materials in Additive Manufacturing (08 Hours)
The Use of Multiple Materials in AM: Introduction, Multiple Material Approaches, Discrete Multiple Material Processes, Porous Multiple Material Processes, Blended Multiple Material Processes, Commercial Applications Using Multiple Materials, **AM Applications:** Functional Models, Patterns for Investment and Vacuum Casting, Medical Models, Art Models, Engineering Analysis Models, Rapid Tooling, Bi-Metallic Parts, Applications: Examples for Aerospace, Defense, Automobile, Biomedical, and General Engineering Industries. **Direct Digital Manufacturing (DDM):** Eligibility Technology, Manufacturing versus Prototyping; Life-Cycle Costing, Future of Direct Digital Manufacturing.

Course Outcomes: At the end of the course the student will be able to:	
22MEC741.1	Demonstrate a comprehensive understanding of the basic AM processes, including its differences from traditional manufacturing processes (subtractive and formative).
22MEC741.2	Distinguish different AM processes such as SLA, SLS, FDM, 3DP, LOM, UC, BDP & DWT based on their working principles and type of materials used.
22MEC741.3	Assess different AM processes based on design requirements and material properties, and describe the use of multiple materials in AM.
22MEC741.4	Describe the software issues in AM like STL file manipulation and problems with STL files.
22MEC741.5	Understand the various post-processing techniques used to improve part quality after printing and learn about challenges in post-processing and how they impact the final product.
22MEC741.6	Explore real-world applications in various industries like aerospace, automotive, medical devices, and consumer products and the future of DDM

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Text Books				
1	Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing	Ian Gibson, David W. Rosen, Brent Stucker	Springer, New York / / London	2nd Edition 2015
2	Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling	D.T. Pham, S.S. Dimov	Springer	1st Edition 2001
Reference Books				
1	Rapid Prototyping: Theory & Practice	Ali K. Kamrani, Eman Abouel Nasr	Springer	1st Edition 2006
2	Additive Manufacturing Technologies	Hari Prasad, A.V. Suresh	Cengage	1st Edition 2019

Web links and Video Lectures (e-Resources):

- Manufacturing Process Technology: Part 1: https://nptel.ac.in/courses/112104195/
- Manufacturing Process Technology: Part 2: https://nptel.ac.in/courses/112104204/
- Rapid Manufacturing: https://nptel.ac.in/courses/112/104/112104265/
- Generative Design for Additive Manufacturing: https://www.coursera.org/learn/generative-design-additive-manufacturing?
- The 3D Printing Revolution: https://www.coursera.org/learn/3d-printing-revolution

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
22MEC741.1	2	-	-	-	-	2	-	-	-	-	-	-	-	1
22MEC741.2	2	-	-	-	-	2	-	-	-	-	-	-	-	-
22MEC741.3	1		2	-	-	-	-	-	-	-	-	-	-	-
22MEC741.4	3	-	-	-	2	-	-	-	-	-	-	-	-	-
22MEC741.5	2	2	-	-	-	-	-	-	-	-	-	-	-	-
22MEC741.6	2	-	-	-	-	1	-	-	-	-	-	-	-	1

1: Low 2: Medium 3: High

FUEL CELL AND ITS APPLICATION			
Course Code	22MEC742	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L: T:P)	3:0:0	SEE	3 Hours
Total Hours	40 hours	Credits	03

Course Learning Objectives: The objective of the course is

- Understand the fundamental principles and operation of fuel cell technology.
- Apply thermodynamic principles to analyze fuel cell systems.
- Comprehend the kinetics of fuel cell reactions and methods to improve kinetic performance.
- Evaluate transport phenomena in fuel cell systems, and their impact on voltage losses and
- performance.
- Apply mathematical modeling techniques to analyze fuel cell performance, optimize system
- design and operation.

Module 1 Fuel Cell Technology (8 Hours)

Introduction – Basic fuel cell operation – Fuel cell types – Fuel cell performance and losses – Fuel cell components – Fuel cell subsystem – Thermal management – Fuel delivery/processing – Power electronic system – Fuel cell advantages and disadvantages - Potential fuel cell applications and markets.

Module 2 Fuel Cell Thermodynamics (8 Hours)

Thermodynamics: Internal energy, First law, Second law, Thermodynamic potentials, Molar quantities, Standard state, Reversibility – Heat potential of a fuel –Work potential of a fuel - Relationship between Gibbs free energy and electrical work - Relationship between Gibbs free energy and voltage - Reversible voltage of a fuel cell: Variation with temperature, pressure, and concentration – Fuel cell efficiency.

Numerical problems on fuel cell efficiency, heat generation, reactant consumption and product generation, and electrical power.

Module 3 Fuel Cell Reaction Kinetics (8 Hours)

Electrode kinetics – Activation energy – Electrochemical reaction - Rate of reaction – Exchange current density – Galvani potential – Butler-Volmer equation – Tafel equation – Nernst equation – Methods to improve kinetic performance – Catalyst-electrode design and structure. Numerical problems on reaction rate, activation voltage and exchange current density.

Module 4 Transport in Fuel Cell Systems (8 Hours)

Ion transport in electrolyte: diffusion, convection and migration – Water activity and uptake – Nafion ion conductivity - Electron transport – Gas-phase mass transport – Binary gas-phase diffusion approaches – Limiting current density – Knudsen diffusion - Single-phase flow in channels and porous media – Multiphase mass transport in channels and porous media – Heat generation and transport.

Numerical problems on voltage losses, ionic conductivity in the electrolyte, water activity, water uptake, limiting current density, and diffusion.

Module 5 Fuel Cell Design and Modeling (8 Hours)

Theory and governing equation – Fuel cell mass and energy balance – Sizing of a fuel cell stack – Stack configuration – Heat removal from a fuel cell stack – Stack clamping – Basic fuel cell model – One-dimensional fuel cell model – Fuel cell model based on computational fluid dynamics (optional). Numerical problems on open circuit voltage, output voltage, and one-dimensional PEMFC model

Course Outcomes: At the end of the course the student will be able to:	
22MEC742.1	Understand the fundamental principles and operation of various types of fuel cells, including their components, performance characteristics, and subsystems.
22MEC742.2	Apply thermodynamic principles to analyze fuel cell systems, and assess their efficiency and performance.
22MEC742.3	Analyze fuel cell reaction kinetics to evaluate reaction rates and design considerations for improving fuel cell performance.
22MEC742.4	Evaluate transport phenomena in fuel cell systems to assess voltage losses and optimize system design.
22MEC742.5	Design and model fuel cell systems to optimize system performance and operation.
22MEC742.6	Apply mathematical modeling techniques to analyze fuel cell performance and solve numerical problems related to efficiency, heat generation, reactant consumption, product generation, and electrical power, to support system design and optimization efforts.

Sl. No.	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
Textbooks				
1	Fuel Cell Fundamentals	Ryan O'Hayre, Suk-Won Cha, Whitney G. Colella, Fritz B. Prinz	John Wiley & Sons, Inc., Hoboken, New Jersey	3rd Edition 2016
2	Fuel Cell Engines	Mathew M. Mench	John Wiley & Sons, Inc., Hoboken, New Jersey	2nd Edition 2008
Reference Books				
1	PEM Fuel Cells: Theory and Practice	Frano Barbir	Academic Press Inc	2nd Edition 2012
2	Fuel Cells Principles and Applications	B Viswanathan And M Aulice Scibioh,	Orient Blackswan	January 2006

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc22_ch66/preview
- https://www.youtube.com/watch?v=OTdnvk-h3cE – NPTEL video lecture

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
22MEC742.1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
22MEC742.2		2	-	1	-	-	-	-	-	-	-	-	1	-
22MEC742.3	-	1	-	2	-	-	-	-	-	-	-	-	1	-
22MEC742.4	1	-	2	-	-	-	-	-	-	-	-	-	2	-
22MEC742.5	-	2	-	1	-	-	-	-	-	-	-	1	-	-
22MEC742.6	-	-	3	-	1	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

ARTIFICIAL INTELLIGENCE IN MECHANICAL ENGINEERING			
Course Code	22MEC743	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	3:0:0	SEE	3 Hours
Total Hours	40 hours	Credits	03

Course Learning Objectives: This Course will enable students

- To introduce the fundamentals of Artificial Intelligence (AI)
- To explore Machine Learning (ML) techniques and its applications
- To examine the role of AI in robotics
- To understand Deep Learning and its engineering applications
- To apply AI techniques in mechanical manufacturing industries

Module-0 Introduction to Artificial Intelligence (3 hours)

What is data? What is a dataset? Variables, features, labels. Introduction to Python (via Google Colab, Jupyter). Importing CSVs, plotting, basic statistics.
(Delivered using curated YouTube videos / Online MOOC contents before the classes commence).

Module-1 Introduction to Artificial Intelligence (8 hours)

Introduction to AI: Definition and scope of AI. History and evolution of AI. Basic concepts: Machine Learning and Deep Learning.
Problem Formulation and Problem-Solving Methods in AI Context: Understanding problem formulation in AI. Defining problems and solutions in AI context. Problem graphs and their importance. Techniques like matching, indexing, and heuristic functions. Algorithms such as Hill Climbing, Depth First Search (DFS), and Breadth First Search (BFS).

Module-2 Machine Learning and its Applications (8 hours)

Introduction to Machine Learning: Definitions and types of machine learning: supervised, unsupervised, and reinforcement learning. Natural Language Processing (NLP) Computer Vision.
Machine Learning Algorithms: Linear Regression and Decision Trees. Probability and Bayesian learning. Case Studies.

Module-3 Artificial Intelligence in Robotics (8 hours)

Reinforcement Learning in Robotics: Concepts of Planning and Search in Robotics. Techniques for localization, tracking, mapping, and control.
Search and Optimization Algorithms: Understanding A* search and path smoothing algorithms.
Introduction to Simultaneous Localization and Mapping (SLAM) algorithms.
Applications in Robotics: AI for precision agriculture and assistance robots. Case studies demonstrating AI in robotics.

Module-4 Deep Learning and its Applications (8 hours)

Introduction to Deep Learning: Biological motivation for deep learning.
Deep Learning Algorithms: Applications of feed-forward neural networks. Recurrent neural networks (RNNs) and their applications. Convolutional neural networks (CNNs) and use cases in image and pattern recognition. Real-world applications of deep learning in various domains.

Module-5 Application of Artificial Intelligence in Mechanical Manufacturing Industries (8 hours)

Discussions & Case Studies on the following applications of AI in Mechanical Engineering.
Predictive Maintenance using AI, AI for Quality Control in Manufacturing, Energy Optimization in HVAC and Production Systems, AI in Design and Material Selection, AI-Enabled Safety Monitoring Systems

Course Outcomes**:** At the end of the course the student will be able to:	
22MEC743.1	Discuss the application of AI techniques to solve engineering problems in mechanical systems.
22MEC743.2	Evaluate machine learning models to determine the best fit for engineering applications.
22MEC743.3	Analyze AI-based robotic solutions that are used to enhance system performance and efficiency.
22MEC743.4	Discuss the deep learning methods used to solve complex mechanical engineering tasks.
22MEC743.5	Evaluate the effectiveness of AI applications in manufacturing processes.
22MEC743.6	Predict and discuss the future application of AI in mechanical engineering applications.

Sl. No.	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
Textbooks				
1	Artificial Intelligence	Saroj Kaushik	Cengage Learning India	1st Edition 1 January 2011
2	Introduction to Machine Learning	Alpaydin Ethem	PHI Learning Pvt. Ltd.	3rd Edition 25 January 2015
3	Artificial Intelligence: A Modern Approach	Stuart Russell and Peter Norvig	Pearson Education	4th Edition 31 May 2022
4	Deep Learning with Applications Using Python: Chatbots and Face, Object, and Speech Recognition With TensorFlow and Keras	Navin Kumar Manaswi	Apress	18 May 2018
5	Introduction to AI Robotics, Second Edition	Robin R. Murphy	Bradford Books	1 October 2019
Reference Books				
1	Artificial Intelligence in Mechanical and Industrial Engineering	Divya Zindani, J. Paulo Davim, Kaushik Kumar - Editors	CRC Press	1st Edition 21 June 2021
2	Soft Computing Techniques and Applications in Mechanical Engineering	Mangey Ram, J. Paulo Davim	IGI Global	1st Edition December, 2017
3	Artificial Intelligence and Machine Learning Applications in Civil, Mechanical, and Industrial Engineering (Advances in Computational Intelligence and Robotics)	Gebrail Bekda (Editor), Sinan Melih Nigdeli (Editor), Melda Yücel (Editor)	Business Science Reference	1st Edition 30 November 2019

Web links and Video Lectures (e-Resources):

- https://www.coursera.org/learn/machine-learning - Online course
- https://see.stanford.edu/Course/CS223A - Introduction to Robotics
- https://www.fast.ai/ - Deep Learning Resources
- https://www.youtube.com/watch?v=4X1KwYTBcKI - AI for Manufacturing
- https://www.youtube.com/watch?v=Xn46OkueJbA - AI for Manufacturing
- https://robotics.umich.edu/academics/courses/online-courses/ - Online Courses

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
22MEC743.1	-	3	-	-	2	-	-	-	-	-	-	-	-	-
22MEC743.2	-	-	3	-	-	2	-	-	-	-	-	-	-	-
22MEC743.3	-	-	2	-	3	-	-	-	-	-	-	-	-	-
22MEC743.4	-	3	-	-	2	-	-	-	-	-	-	-	-	-
22MEC743.5	-	2	-	-	3	-	-	-	-	-	-	-	-	-
22MEC743.6	-	-	-	-	3	-	3	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TRIBOLOGY			
Course Code	22MEC744	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	3:0:0	SEE	3 Hours
Total Hours	40 Hours Theory	Credits	03

Course Learning Objectives: The objective of the course is to

- Understand the technological significance of Tribology with relation to theories of friction, its measurement methods and material considerations.
- Learn the consequences of wear, wear mechanisms, wear theories and analysis of wear problems.
- Understand lubricants with regard to their properties, especially viscosity and its variation with pressure and temperature, along with lubricant additives, grades of lubricants and its selection.
- Learn the principles of lubrication, lubrication regimes, theories of hydrodynamic and advanced lubrication techniques.
- Understand the factors influencing the selection of bearing materials for different applications.
- To introduce the concepts of surface engineering and its importance in tribology.

Module-1 Introduction to Tribology & Lubricants (8 hours)

Introduction to Tribology: Tribology in design, Factors influencing Tribological phenomena, Properties of materials relevant to friction and wear.

Lubricants: Types, Properties of lubricants, Viscosity and its measurement, Effect of temperature and Pressure on Viscosity, Lubrication types, Lubricant Additives, Standard grades of lubricants, and Selection of Lubricants.

Module-2 Friction & Wear (8 hours)

Friction: Origin, Contact of engineering surfaces: Hertzian and Non-Hertzian contact, friction theories, measurement methods, friction of metals and non-metals.

Wear: Classification and mechanisms of wear, delamination theory, debris analysis, testing methods and standards. Related case studies.

Module-3 Hydrodynamic Journal Bearings (8 hours)

Hydrodynamic Journal Bearings: Mechanism of pressure development in an oil film and Reynold's equation in 2D. Introduction to idealized journal bearing, load carrying capacity, condition for equilibrium, Sommerfeld's number and its significance; Friction forces and power loss in a lightly loaded journal bearing, Petroff's equation, partial bearings, end leakages in journal bearing, numerical examples.

Module-4 Plane Slider bearings & Hydrostatic Lubrication (8 hours)

Plane slider bearings with fixed/pivoted shoe: Pressure distribution, Load carrying capacity, coefficient of friction, frictional resistance in a fixed/pivoted shoe bearing, center of pressure, numerical examples.

Hydrostatic Lubrication: Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing, numerical examples. Introduction to Hydrostatic journal bearings.

Module-5 Bearing Materials (8 hours)

Bearing Materials: Commonly used bearings materials, and properties of typical bearing materials. Advantages and disadvantages of different bearing materials.

Introduction to Surface Engineering: Concept and scope of surface engineering. Surface modification – transformation hardening, surface melting, thermo chemical processes. Surface Coating – plating, fusion processes, vapor phase processes. Selection of coating for wear and corrosion resistance.

Applications of lubricants in automobiles – engine lubrication, transmission systems, and other automotive components.

Course Outcomes: At the end of the course the student will be able to:	
22MEC744.1	Discuss the technological significance of Tribology with regard to friction and wear and recommend suitable lubricants for various applications based on an understanding of their grades and lubricant additives.
22MEC744.2	Analyze the fluid film bearing performance characteristics such as load carrying capacity, friction force, and power loss for different regimes of lubrication.
22MEC744.3	Evaluate the suitability of different materials for bearings with an understanding of the various tribological properties for the design of tribo pairs.
22MEC744.4	Assess the surface modifications and surface coatings of tribo-pairs with regard to friction and wear resistance.
22MEC744.5	Assess a case study and present their inferences of tribological significance in sustainable development.
22MEC744.6	Conduct a survey of local suppliers of lubricants and bearings followed by comparative study of manufacturer catalogs.

Sl. No.	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
Textbooks				
1	Engineering Tribology	Prasanta Sahoo	PHI Learning Pvt. Ltd	3rd Edition 2011
2	Engineering Tribology	John Austin Williams	Oxford University Press	2005
3	Fundamentals of Tribology	Basu, Sengupta, and Ahuja	PHI Learning Pvt. Ltd	7th Edition 2015
Reference Books				
1	Introduction to Tribology in Bearings	B. C. Majumdar	S. Chand	2nd Edition 2008
2	Engineering Tribology	Gwidon Stachowiak & Andrew Batchelor	Butterworth Heinemann.	4th Edition 2005
3	Handbook of tribology: materials, coatings, and surface treatments	B. Bhushan, B.K. Gupta	McGraw-Hill	1997
4	Tribology in Industries	Srivastava S.	S Chand and Company limited	1st Edition 2001

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/112102015
- https://pdhonline.com/courses/m427/m427_new.htm
- https://ocw.mit.edu/courses/2-800-tribology-fall-2004/pages/assignments/
- https://www.udemy.com/share/106CmO/
- https://www.youtube.com/watch?v=XAS9eG0lT_8
- https://www.youtube.com/watch?v=SBFSb_Qy6PI

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
22MEC743.1	-	-	3	-	-	-	2	-	-	-	-	-	-	-
22MEC743.2	-	-	3	-	-	-	-	-	-	-	-	-	-	-
22MEC743.3	-	-	3	-	-	-	-	-	-	-	-	-	-	1
22MEC743.4	-	3	-	-	-	-	-	-	-	-	-	-	-	-
22MEC743.5	-	-	-	-	-	2	-	-	3	-	-	-	-	-
22MEC743.6	-	-	-	-	-	-	-	2	-	-	-	1	-	-

1: Low 2: Medium 3: High

MAJOR PROJECT PHASE II			
Course Code	22MEC75	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Practical	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	(0:0:6)	SEE	3 Hrs
Total Hours	72 hours	Credits	06

Course Learning Objectives:

1. Utilize fundamental principles of engineering and interdisciplinary knowledge to identify, analyse, and solve complex problems in the project domain.
2. Develop and execute a comprehensive project plan that includes designing, prototyping, testing, and evaluating a system, component, or process to meet specific needs and constraints.
3. Conduct in-depth research, critically review literature, and integrate innovative solutions or techniques within the project framework.
4. Demonstrate effective teamwork, communication, and collaboration skills in a multidisciplinary environment to achieve project objectives.
5. Incorporate ethical considerations, societal impact, and sustainable practices in the project development, while adhering to professional engineering standards.
6. Prepare and present a well-structured project report, supported by technical documentation and visual aids, and confidently defend the work during project viva-voce or presentations.

1. Project Execution

- **Regular Meetings**: Students should meet regularly with their project-guide to discuss progress, challenges, and next steps.
- **Documentation**: Maintain detailed documentation throughout the project in a project work-dairy, including design decisions, experiments, and testing results.
- **Milestones**: Set clear milestones and deadlines to ensure steady progress. These could include design completion, initial prototype, testing, etc.

2. Mid-term Review

- **Progress Presentation**: DPEC shall conduct a mid-term review where students present their progress to a panel of faculty members.
- **Feedback**: Provide constructive feedback and guidance to help students refine their projects.

3. Final Submission

- **Report**: The project report should include an abstract, introduction, literature review, methodology, implementation, results, discussion, conclusion, and references.
- **Code and Data**: If applicable, students should submit their code, datasets, and any other relevant materials.

4. Project Presentations

- **Oral Presentation**: Students should present their projects to a panel, explaining their work, findings, and contributions.
- **Demonstration**: If possible, include a live demonstration of the project or show relevant simulations and results.
- **Q&A**: Be prepared to answer questions from the panel and justify the project's methodology and conclusions.

5. Evaluation Criteria

- **Originality and Innovation**: Assess the novelty and creativity of the project.
- **Technical Competence**: Evaluate the depth of technical knowledge and problem-solving ability demonstrated.
- **Project Execution**: Consider the effectiveness of project planning, adherence to timelines, and quality of implementation.
- **Presentation and Communication**: Judge the clarity and coherence of the final report, presentation, and the ability to answer questions.

6. Plagiarism Check
● **Academic Integrity**: Ensure that the work submitted is original and properly cites all references and sources. ● **Plagiarism Check**: Run all reports through plagiarism detection software and ensure that similarity index is less than the threshold value (25%).
7. Mentorship and Feedback
● **Feedback:** Students are required to consult with their project guide regularly throughout the project work to seek guidance and feedback. ● **Weekly Meetings:** At least one mentorship meeting every week shall be held and recorded in the project work-dairy.
8. Post Submission
● **Publication**: DPEC shall encourage students to publish their work in conferences or journals, especially if it contributes significantly to their field. ● **Project Archive**: Store all projects in the department's digital archive for future reference.

Continuous Internal Evaluation (CIE)		
Description	**Proposed Dates**	**CIE Weightage (Max 100 marks)**
1. Project Progress Evaluation -I	Beginning of the 7th Semester	20 marks
2. Project Progress Evaluation -II	Middle of the 7th Semester	30 marks
3. Project Report Evaluation (Phase II)	End of the 7th Semester	50 marks
Semester End Examinations (SEE)		
4. SEE will be conducted for 100 marks (after the last working day of the 7th semester) in the presence of the external examiner with the weightage as **Project Report: 50 marks, Project Presentation: 25 marks and Question & Answer Session: 25 marks**. Marks awarded for Project Report is same for all batch-mates.		

Course Outcomes: At the end of the course the student will be able to :	
22MEC75.1	Demonstrate the ability to identify, define, and solve complex engineering problems using appropriate methodologies and modern tools.
22MEC75.2	Successfully design, develop, and test an engineering solution that meets specified requirements, addressing technical, economic, environmental, and social constraints.
22MEC75.3	Apply research skills to review existing literature, gather and analyze data, and incorporate innovative or state-of-the-art technologies in the project
22MEC75.4	Collaborate effectively within a team, taking on leadership or supportive roles as needed, while ensuring clear communication and efficient project management.
22MEC75.5	Demonstrate awareness of professional ethics, societal impact, and sustainability in the design and implementation of engineering solutions.
22MEC75.6	Exhibit strong written and oral communication skills by preparing technical reports, project documentation, and delivering persuasive project presentations.

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
22MEC75.1	2	3	-	-	1	-	-	-	-	-	-	-	-	-
22MEC75.2	-	-	3	-	-	2	1	-	-	-	-	-	-	-
22MEC75.3	1	2	-	3	-	-	-	-	-	-	-	-	-	-
22MEC75.4	-	-	-	-	-	1	-	-	3	2	2	-	-	-
22MEC75.5	-	-	1	-	-	-	2	3	-	-	-	-	-	-
22MEC75.6	-	-	-	-	-	-	-	-	-	3	2	1	-	-

1: Low 2: Medium 3: High

VIII Semester

Professional Elective – IV (Online Course)			
Course Code	**22MEC81**	CIE Marks	50 *
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50 *
		Total Marks	100
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE	3 Hrs
Total Hours	36 hours	Credits	03

Course Learning Objectives:

1. Understand and apply foundational concepts and principles of the chosen elective domain to real-world engineering problems.
2. Develop the ability to learn independently and navigate MOOC platforms effectively to acquire domain-specific knowledge and skills.
3. Demonstrate analytical and problem-solving abilities by engaging in course assessments, simulations, case studies, or project-based activities.
4. Interpret and evaluate course content critically from multiple sources including video lectures, reading materials, and peer discussions.
5. Integrate interdisciplinary knowledge gained from the MOOC into core engineering subjects for innovative applications or design thinking.
6. Communicate technical ideas and solutions effectively, both in written and oral form, based on the knowledge acquired through the online course.

*Note: In case of MOOCs certificates submitted by the students, the marks/grade shall be awarded based on the percentage of marks/grade reflected in the certificates.

1. Selection of MOOCs

1.1 Accredited Platforms: Students shall select MOOCs from accredited platforms such as Coursera, edX, SWAYAM/NPTEL, Udacity, or any online learning platform recognized by the respective Engineering Department / Board of Studies (BoS). Engineering Departments with the approval of BoS shall publish a list of MOOCs courses in the beginning of every semester/academic session.

1.2 Prerequisites: Students shall ensure that he/she has completed any foundational courses or prerequisites required for the chosen MOOCs.

1.3 Relevant Courses: Students shall choose courses that are relevant to the Student's Engineering discipline and career goals. Students shall NOT opt for the course which is part of their curriculum (I to VIII semester B.E program) and Honors Degree/Minor Degree courses. In case of any overlapping in the contents of the MOOC Course with that in the curriculum or other courses, the maximum permitted overlapping in the course contents (syllabus) is 20-25%.

1.4 Credit Value: Students shall ensure that the selected MOOCs collectively account for 3 credits. Typically, a 3-credit MOOC will require around 35-40 hours of study, a 2-credit MOOC will require around 20-25 hours of study and a 1-credit MOOC will require 10-12 hours of study.

1.5 Duration of Course: A 4-weeks MOOCs is eligible for 1-credit. Students are advised to enroll for one 12-weeks MOOCs course to earn 3 credits. However, Students can also take one 8-weeks MOOCs + one 4-weeks MOOCs instead of one course. In each case, the number of hours of study mentioned shall be satisfied. The total performance in the MOOCs will be average of performances considering both MOOCs courses.

2. Approval Process

2.1 Pre-Approval: Students must seek pre-approval from the Department MOOCs Coordinator before enrolling in MOOCs.

2.2 Submission of Proposal: Students can submit a detailed proposal to Department MOOCs Coordinator including the name of the MOOCs, the platforms, course duration, credit value, and relevance to their field of study.

If a Student has already completed any MOOCs course/s from the beginning of the III semester B.E, that satisfies the criteria mentioned in the clause 1. Selection of MOOCs, such course/s can be considered by the Department for credit transfer, provided the student has NOT already claimed the benefit of completing the MOOCs under any assessment in any of the subject.

2.3 Evaluation: The Department will evaluate the proposal for relevance, academic rigor, and credit equivalence and will communicate the decision to the Students.
3. Registration and Enrollment
3.1 Official Enrollment: Students shall register for the approved MOOCs on the respective platforms. **3.2 Documentation:** Students shall keep documentation of registration and course details for future reference and provide the same when asked by the Department.
4. Course Completion
4.1 Active Participation: Students shall engage actively in all course activities including lectures, assignments, quizzes, and discussion forums. **4.2 Completion Certificate:** Students shall obtain a verified certificate of completion for MOOC Course. Free versions without certificates are NOT eligible for credit.
5. Assessment and Evaluation
5.1 Performance Tracking: Students shall maintain records of performance in all assessments throughout the course. **5.2 Final Assessment:** The Department may conduct a final assessment (proctored exam) to ensure that the knowledge gained aligns with the academic standards. This summative assessment (proctored exam) by the Engineering Department is mandatory in the absence of such assessment in the MOOC course/s by the online platform.
6. Credit Transfer
6.1 Submission of Certificates: Students shall submit the completion certificate/s and performance records to the Department MOOCs Coordinator. **6.2 Credit Evaluation:** The Department will evaluate the certificates and performance records to approve the credit transfer. **6.3 Grade Conversion:** College will take care to convert the grades from the MOOCs into the grading system as per established Academic Rules and Regulations.
7. Integration into Academic Record
7.1 Transcript Update: Upon approval, the credits and grades will be integrated into the student's academic transcript. **7.2 Grade Point Average (GPA) Calculation:** The MOOC grades are included in the calculation of the student's GPA.
8. Support and Resources
8.1 Academic Advising: The Department MOOCs Coordinator shall provide guidance and support to the students throughout the process. **8. 2 Technical Support:** The Department MOOCs Coordinator shall ensure that students have access to the necessary technical resources to complete MOOCs courses.
9. Feedback and Improvement
9.1 Student Feedback: Department MOOCs Coordinator shall collect feedback from students on their MOOC experiences to improve future implementations. **9.2 Continuous Improvement:** MOOCs guidelines and processes will be updated based on student feedback, Department feedback and evolving educational standards.

Course Outcomes: At the end of the course the student will be able to :	
22MEC81.1	Demonstrate comprehensive understanding of the key concepts, tools, and techniques in the chosen elective domain.
22MEC81.2	Apply the acquired knowledge to solve domain-specific engineering problems using appropriate methods and tools.
22MEC81.3	Analyze and interpret information from MOOC resources to support decision-making and problem-solving.

22MEC81.4	Exhibit self-directed learning skills and effective time management to complete the MOOC as per defined timelines.
22MEC81.5	Collaborate and communicate effectively in online learning environments through discussions, peer reviews, and group tasks (if applicable).
22MEC81.6	Integrate the knowledge gained from the MOOC into interdisciplinary engineering contexts and reflect on its professional relevance.

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
22MEC81.1	3	2	-	-	1	-	-	-	-	-	-	-	-	-
22MEC81.2	3	-	2	-	-	-	-	-	-	-	2	-	-	-
22MEC81.3	-	-	-	-	3	-	-	-	-	-	2	-	-	-
22MEC81.4	3	-	-	-	2	-	-	-	-	-	1	-	-	-
22MEC81.5	-	-	-	-	-	-	-	-	2	3	1	-	-	-
22MEC81.6	3	-	-	-	-	2	-	-	-	-	1	-	-	-

1: Low 2: Medium 3: High

Open Elective – II (Online Course)			
Course Code	**22MEC82**	CIE Marks	50*
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50*
		Total Marks	100
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE	3 Hrs
Total Hours	36 hours	Credits	03

Course Learning Objectives:

1. Gain foundational and interdisciplinary knowledge in a subject outside the core engineering specialization to promote broader intellectual development.
2. Understand key theories, models, and practices related to the open elective topic, as delivered through MOOC lectures, readings, and assessments.
3. Develop the ability to learn independently and manage learning schedules, leveraging the flexibility of the MOOC platform.
4. Apply the acquired knowledge to real-world contexts, demonstrating the relevance of interdisciplinary learning to personal, professional, or societal challenges.
5. Enhance digital learning competencies, including navigating online resources, participating in online discussions, and completing online assessments effectively.
6. Foster critical thinking, creativity, and lifelong learning mindset by exploring new domains and expanding personal and professional interests.

*Note: In case of MOOCs certificates submitted by the students, the marks/grade shall be awarded based on the percentage of marks/grade reflected in the certificates.

1. Selection of MOOCs

1.1 Accredited Platforms: Students shall select MOOCs from accredited platforms such as Coursera, edX, SWAYAM/NPTEL, Udacity, or any online learning platform recognized by the respective Engineering Department / Board of Studies (BoS). Engineering Departments with the approval of BoS shall publish a list of MOOCs courses in the beginning of every semester.

1.2 Prerequisites: Students shall ensure that he/she has completed any foundational courses or prerequisites required for the chosen MOOCs.

1.3 Relevant Courses: Students shall choose courses that are relevant to the Student's Engineering discipline and career goals. Students shall NOT opt for the course which is part of their curriculum (I to VIII semester B.E program) and Honors Degree/Minor Degree courses. In case of any overlapping in the contents of the MOOC Course with that in the curriculum or other courses, the maximum permitted overlapping in the course contents (syllabus) is 20-25%.

1.4 Credit Value: Students shall ensure that the selected MOOCs collectively account for 3 credits. Typically, a 3-credit MOOC will require around 35-40 hours of study , a 2-credit MOOC will require around 20-25 hours of study and a 1-credit MOOC will require 10-12 hours of study.

1.5 Duration of Course: A 4-weeks MOOCs is eligible for 1-credit. Students are advised to enroll for one 12-weeks MOOCs course to earn 3 credits. However, Students can also take one 8-weeks MOOCs + one 4-weeks MOOCs instead of one course. In each case, the number of hours of study mentioned shall be satisfied. The total performance in the MOOCs will be average of performances considering both MOOCs courses.

2. Approval Process

2.1 Pre-Approval: Students must seek pre-approval from the Department MOOCs Coordinator before enrolling in MOOCs.

2.2 Submission of Proposal: Students can submit a detailed proposal to Department MOOCs Coordinator including the name of the MOOCs, the platforms, course duration, credit value, and relevance to their field of study.

If a Student has already completed any MOOCs course/s from the beginning of the III semester B.E, that satisfies the criteria mentioned in the clause 1. Selection of MOOCs, such course/s can be considered by the Department for credit transfer, provided the student has NOT already claimed the benefit of completing the MOOCs under any assessment in any of the subject.

2.3 Evaluation: The Department will evaluate the proposal for relevance, academic rigor, and credit equivalence and will communicate the decision to the Students.

3. Registration and Enrollment

3.1 Official Enrollment: Students shall register for the approved MOOCs on the respective platforms.

3.2 Documentation: Students shall keep documentation of registration and course details for future reference and provide the same when asked by the Department.

4. Course Completion

4.1 Active Participation: Students shall engage actively in all course activities including lectures, assignments, quizzes, and discussion forums.

4.2 Completion Certificate: Students shall obtain a verified certificate of completion for MOOC Course. Free versions without certificates are NOT eligible for credit.

5. Assessment and Evaluation

5.1 Performance Tracking: Students shall maintain records of performance in all assessments throughout the course.

5.2 Final Assessment: The Department may conduct a final assessment (proctored exam) to ensure that the knowledge gained aligns with the academic standards. This summative assessment (proctored exam) by the Engineering Department is mandatory in the absence of such assessment in the MOOC course/s by the online platform.

6. Credit Transfer

6.1 Submission of Certificates: Students shall submit the completion certificate/s and performance records to the Department MOOCs Coordinator.

6.2 Credit Evaluation: The Department will evaluate the certificates and performance records to approve the credit transfer.

6.3 Grade Conversion: College will take care to convert the grades from the MOOCs into the grading system as per established Academic Rules and Regulations.

7. Integration into Academic Record

7.1 Transcript Update: Upon approval, the credits and grades will be integrated into the student's academic transcript.

7.2 Grade Point Average (GPA) Calculation: The MOOC grades are included in the calculation of the student's GPA.

8. Support and Resources

8.1 Academic Advising: The Department MOOCs Coordinator shall provide guidance and support to the students throughout the process.

8. 2 Technical Support: The Department MOOCs Coordinator shall ensure that students have access to the necessary technical resources to complete MOOCs courses.

9. Feedback and Improvement

9.1 Student Feedback: Department MOOCs Coordinator shall collect feedback from students on their MOOC experiences to improve future implementations.

9.2 Continuous Improvement: MOOCs guidelines and processes will be updated based on student feedback, Department feedback and evolving educational standards.

Course Outcomes: At the end of the course the student will be able to :	
22MEC82.1	Demonstrate a clear understanding of the fundamental concepts and frameworks in the selected open elective domain.
22MEC82.2	Apply interdisciplinary knowledge gained from the MOOC to analyze and address real-life or cross-domain problems.
22MEC82.3	Exhibit the ability to learn independently, manage time effectively, and complete the online course requirements within the stipulated duration.
22MEC82.4	Interpret and evaluate information from diverse MOOC resources (videos, readings, forums) to support critical analysis and decision-making.
22MEC82.5	Communicate insights, reflections, and applications of the course content effectively in written or multimedia formats.
22MEC82.6	Integrate the learning from the MOOC to enhance personal, academic, or professional development beyond the engineering curriculum.

Course Articulation Matrix

Course Outcomes (COs)	**Program Outcomes (POs)**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
22MEC82.1	3	-	-	-	1	-	-	-	-	-	2	-	-	-
22MEC82.2	3	2	-	-	-	-	-	-	-	-	1	-	-	-
22MEC82.3	-	-	-	-	3	-	-	-	-	-	2	-	-	-
22MEC82.4	3	-	-	-	2	-	-	-	-	-	1	-	-	-
22MEC82.5	-	-	-	-	-	-	-	-	2	3	1	-	-	-
22MEC82.6	3	-	-	-	-	2	-	-	-	-	1	-	-	-

1: Low 2: Medium 3: High

Research/Industry Internship			
Course Code	**22MEC83**	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Practical	SEE Marks	50
		Total Marks	100
Number of Weeks	14-16 Weeks	SEE	3 Hours
		Credits	10

Research Internship

Course Learning Objectives:

1. To equip students with the knowledge of fundamental research principles, methodologies, and techniques applicable to their engineering discipline.
2. To enable students to formulate research questions, design experiments or studies, and use appropriate data collection and analysis tools.
3. To foster the ability to think critically and innovatively while solving complex engineering problems during the research process.
4. To guide students in developing the skills necessary for writing clear and well-structured research reports, papers, and presentations.
5. To instill an understanding of ethical practices in research, including integrity, responsible data handling, and respect for intellectual property.
6. To prepare students to work effectively in research teams, communicate their ideas clearly, and present their findings to both technical and non-technical audiences.

Pre-Internship Preparation

1. **Orientation Session:** Attend an orientation session with the academic mentor (allotted from the Department) and the Research Supervisor to understand the research goals, expectations, and assessment criteria.
2. **Documentation:** Complete necessary documentation, including the approval from the Department, processing of the internship request application, research agreements and confidentiality agreements, if applicable.
3. **Research Proposal:** Develop a research proposal in consultation with the Research Supervisor and academic mentor outlining the objectives, methodology, and expected outcomes.

During the Internship

1. **Work Plan:** Follow a structured research plan provided by the supervising researcher or mentor.
2. **Literature Review:** Conduct a comprehensive literature review to understand the current state of research in the chosen area.
3. **Regular Meetings:** Participate in regular meetings with academic and research mentors to discuss progress, challenges, and next steps.
4. **Lab Work/Field Work:** Engage in experimental work, simulations, or field studies as required by the research project.
5. **Data Collection and Analysis:** Collect, analyze, and interpret data using appropriate tools and techniques.
6. **Documentation:** Maintain detailed records of research activities, experiments, and findings.

Deliverables

1. **Weekly Reports:** Submit weekly progress reports to academic and research mentors.
2. **Monthly Reports:** Submit monthly progress reports to academic and research mentors.
3. **Mid-Term Review:** Participate in a mid-term review meeting to assess progress and realign research goals if necessary.
4. **Report and Research Paper:** Prepare a draft report and a research paper detailing the research problem, methodology, results and discussions, and conclusions.
5. **Presentation:** Deliver a presentation summarizing the research work to faculty, peers, and other stakeholders upon completion of the internship.

Assessment Criteria
1. **Research Quality:** Evaluate the quality and rigor of the research conducted. 2. **Report Quality:** Assess the clarity, organization, and thoroughness of the report and the research paper. 3. **Presentation:** Evaluate the effectiveness and clarity of the final presentation. 4. **Innovation and Creativity:** Consider the originality and innovative aspects of the research. 5. **Self-Reflection:** Review the student's ability to critically reflect on their research experience and identify areas for future growth.
Post-Internship
1. **Feedback Session:** Attend a feedback session with academic mentors to discuss the research experience and areas of improvement. 2. **Publication:** Explore opportunities to publish the research findings in academic journals or conferences. 3. **Networking:** Maintain professional relationships established during the internship for future research collaborations.
Additional Tips
• **Curiosity:** Cultivate a curious mindset and a willingness to explore new ideas. • **Collaboration:** Work collaboratively with other researchers and team members. • **Adaptability:** Be open to modifying research approaches based on findings and feedback. • **Communication:** Develop strong written and oral communication skills to effectively present research findings. • **Time Management:** Prioritize tasks and manage time efficiently to meet research deadlines.

Evaluation Scheme	
Continuous Internal Evaluation (CIE): I (Only OFFLINE)	Will be conducted during the 7th semester BE. Students shall submit the Research Internship Proposal and make a presentation and answer questions raised by the Departmental Internship Evaluation Committee (DIEC). Marks split-up: Research Internship Proposal – 50 marks + Oral Presentation-25 marks + Question and Answer-25 marks.
Continuous Internal Evaluation (CIE): II (ONLINE/OFFLINE)	Will be conducted during the middle of the 8th semester BE. Students shall submit the Reports (daily/weekly/monthly reports), make a presentation on progress done so far and answer questions raised by the Departmental Internship Evaluation Committee. Marks split-up: Reports – 50 marks + Oral Presentation-25 marks + Question and Answer-25 marks.
Continuous Internal Evaluation (CIE): III (Only OFFLINE)	Will be conducted at the end of the 8th semester BE. Students shall submit the Reports (daily/weekly/monthly reports) and the final internship report, make a presentation on work completed and answer questions raised by the Departmental Internship Evaluation Committee. Marks split-up: Reports – 50 marks + Oral Presentation-25 marks + Question and Answer-25 marks.
CIE Marks (Max 100)	Average of the CIE:I , CIE-II and CIE:III marks
Semester-End-Examinations (SEE) (Only OFFLINE)	Will be conducted within a week of the last working day of the 8th semester BE. Student shall submit the internship report approved by all the concerned, make a presentation and answer the questions raised by the internal and external examiners. Marks split-up: Reports – 50 marks + Oral Presentation-25 marks + Question and Answer-25 marks.

Course Outcomes: At the end of the course the student will be able to:	
22MEC83.1	Apply appropriate research methodologies and tools to design and conduct experiments, analyze data, and draw conclusions.
22MEC83.2	Demonstrate the ability to identify and solve complex engineering problems through innovative and systematic research approaches.
22MEC83.3	Acquire proficiency in using advanced technologies, tools, and techniques relevant to their field of research.
22MEC83.4	Develop skills in writing comprehensive research reports, documentation, and effectively presenting research findings.
22MEC83.5	Understand and apply ethical standards in research, including plagiarism avoidance, proper citations, and data integrity.
22MEC83.6	Gain experience in working collaboratively within a research team and contributing effectively to the shared goals of the project.

References

1. AICTE Internship Policy : Guidelines and Procedures 2019.
Available at https://aicte-india.org/sites/default/files/AICTE%20Internship%20Policy.pdf

2. UGC Guidelines for Internship/Research Internship for Under Graduate Students 2023.
Available at https://www.ugc.gov.in/pdfnews/0063650_Draft-Guidelines-for-Internship-and-Research-Internship-for-Under-Graduate-Students.pdf

3. VTU Mandatory Internship Guidelines 2021.
Available at https://vtu.ac.in/pdf/regulations2021/anex4.pdf

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
22MEC83.1	1	-	2	3	-	-	-	-	-	-	-	-	-	-
22MEC83.2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
22MEC83.3	-	-	-	-	3	2	-	-	-	-	1	-	-	-
22MEC83.4	-	-	-	-	-	-	-	-	-	3	1	-	-	-
22MEC83.5	-	-	-	-	-	2	-	3	-	-	1	-	-	-
22MEC83.6	-	-	-	-	-	-	-	-	3	2	-	-	-	-

1: Low 2: Medium 3: High

Research/Industry Internship			
Course Code	**22MEC83**	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Practical	SEE Marks	50
		Total Marks	100
Number of Weeks	14-16 Weeks	SEE	3 Hours
		Credits	10

Industry Internship

Course Learning Objectives:

1. To develop practical engineering skills through hands-on experience in a real-world industrial environment.
2. To enhance the ability to identify, analyze, and solve complex engineering problems encountered during the internship.
3. To gain an understanding of the functioning of the industry, including exposure to its standards, practices, and emerging technologies.
4. To improve communication, collaboration, and teamwork skills by working with professionals in a multidisciplinary team setting.
5. To foster adaptability by learning to work in dynamic and fast-paced industrial environments while embracing lifelong learning.
6. To instill a sense of professional ethics, responsibility, and accountability in engineering practice by adhering to industry-specific codes of conduct.

Pre-Internship Preparation

1. **Orientation Session:** Attend an orientation session with the academic mentor (allotted from the Department) to understand the internship goals, expectations, and assessment criteria.
2. **Documentation:** Complete necessary documentation, including the approval from the Department, processing of the internship request application, internship agreements if applicable etc.
3. **Goal Setting:** Define specific, measurable, achievable, relevant, and time-bound (SMART) goals in consultation with academic and industry mentors.

During the Internship

1. **Work Plan:** Follow a structured work plan provided by the host organization.
2. **Mentorship:** Regularly meet with assigned industry and academic mentors to review progress and seek guidance.
3. **Work Diary/Daily Report/Learning Diary:** Maintain a diary/logbook documenting daily activities, learnings, challenges, and reflections.
4. **Professional Conduct:** Adhere to the professional and ethical standards of the host organization, including dress code, punctuality, and communication protocols.
5. **Skill Application:** Actively participate in projects and tasks assigned, applying theoretical knowledge to practical situations.

Deliverables

1. **Weekly Reports:** Submit the weekly progress reports to academic and industry mentors.
2. **Monthly Reports:** Submit the monthly progress reports to academic and industry mentors.
3. **Mid-Term Review/Evaluation:** Participate in a mid-term review meeting/evaluation to assess progress and realign goals if necessary.
4. **Final Report:** Prepare a comprehensive final report in the specified format detailing the projects undertaken, skills acquired, challenges faced, and overall learning experience.
5. **Presentation:** Deliver a presentation summarizing the internship experience to faculty evaluators and peers upon completion of the internship.

Assessment Criteria

1. **Performance Evaluation:** Receive feedback from the industry mentor based on work performance, technical skills, and professional behaviour.
2. **Report Quality:** Evaluate the quality, clarity, and comprehensiveness of the final report.

3. **Presentation:** Assess the effectiveness and clarity of the final presentation. 4. **Self-Reflection:** Review the student's ability to critically reflect on their learning experience and identify areas for future growth.
Post-Internship
1. **Feedback Session:** Attend a feedback session with academic mentors to discuss the internship experience and areas of improvement. 2. **Certification:** Obtain an internship completion certificate from the host organization. 3. **Networking:** Maintain professional relationships established during the internship for future opportunities.
Additional Tips
• **Professionalism:** Demonstrate a professional attitude and work ethic at all times. • **Adaptability:** Be open to learning and adapting to new environments and technologies. • **Communication:** Develop strong communication skills to effectively collaborate with colleagues and mentors. • **Time Management:** Prioritize tasks and manage time efficiently to meet deadlines.

Evaluation Scheme	
Continuous Internal Evaluation (CIE): I (ONLINE/OFFLINE)	Will be conducted during the middle of the 8th semester BE. Students shall submit the Reports (daily/weekly/monthly reports), make a presentation on work done so far and answer questions raised by the Departmental Internship Evaluation Committee. Marks split-up: Reports – 50 marks + Oral Presentation 25 marks + Question and Answer 25 marks.
Continuous Internal Evaluation (CIE): II (Only OFFLINE)	Will be conducted at the end of the 8th semester BE. Students shall submit the Reports (daily/weekly/monthly reports) and the final report, make a presentation on work completed and answer questions raised by the Departmental Internship Evaluation Committee. Marks split-up: Reports – 50 marks + Oral Presentation 25 marks + Question and Answer 25 marks.
CIE Marks (Max 100)	Average of the CIE:I and CIE:II marks
Semester-End-Examinations (SEE) (Only OFFLINE)	Will be conducted within a week of the last working day of the 8th semester BE. Student shall submit the internship report approved by all the concerned, make a presentation and answer the questions raised by the internal and external examiners. Marks split-up: Reports – 50 marks + Oral Presentation 25 marks + Question and Answer 25 marks.

Course Outcomes: At the end of the course the student will be able to:	
22MEC83.1	Apply engineering concepts and theoretical knowledge to solve real-world industry problems.
22MEC83.2	Enhance their problem-solving abilities by identifying, analyzing, and providing innovative solutions to engineering challenges in the industry.
22MEC83.3	Develop key professional skills such as teamwork, communication, and time management in a corporate or industrial environment.
22MEC83.4	Gain exposure to industry-standard tools, technologies, methodologies, and regulatory standards relevant to their field of study.
22MEC83.5	Demonstrate understanding and adherence to professional ethics, safety regulations, and responsibilities in an industrial setting.
22MEC83.6	Build a network of industry professionals and gain insights into career opportunities, preparing them for future employment in the engineering sector.

References

1. AICTE Internship Policy: Guidelines and Procedures 2019.
Available at https://aicte-india.org/sites/default/files/AICTE%20Internship%20Policy.pdf

2. UGC Guidelines for Internship/Research Internship for Under Graduate Students 2023.
Available at https://www.ugc.gov.in/pdfnews/0063650_Draft-Guidelines-for-Internship-and-Research-Internship-for-Under-Graduate-Students.pdf

3. VTU Mandatory Internship Guidelines 2021.
Available at https://vtu.ac.in/pdf/regulations2021/anex4.pdf

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
22MEC83.1	3	2	-	-	-	1	-	-	-	-	1	-	-	-
22MEC83.2	-	3	2	1	-	-	-	-	-	-	1	-	-	-
22MEC83.3	-	-	-	-	-	-	-	-	3	2	-	-	-	-
22MEC83.4	-	-	-	-	3	2	-	-	-	-	-	1	-	-
22MEC83.5	-	-	-	-	-	2	-	3	-	-	-	-	-	-
22MEC83.6	-	-	-	-	-	-	-	-	2	3	-	1	-	-

1: Low 2: Medium 3: High

***

Core Values of the Institution

SERVICE

A Josephite will keep service as the prime goal in everything that is undertaken. Meeting the needs of the stakeholders will be the prime focus of all our endeavors.

EXCELLENCE

A Josephite will not only endeavor to serve, but serve with excellence. Preparing rigorously to excel in whatever we do will be our hallmark.

ACCOUNTABILITY

Every member of the SJEC Family will be guided to deliver on assurances given within the constraints set. A Josephite will always keep budgets and deadlines in mind when delivering a service.

CONTINUOUS ADAPTATION

Every member of the SJEC Family will strive to provide reliable and continuous service by adapting to the changing environment.

COLLABORATION

A Josephite will always seek to collaborate with others and be a team-player in the service of the stakeholders.

Objectives

- Provide Quality Technical Education facilities to every student admitted to the College and facilitate the development of all round personality of the students.
- Provide most competent staff and excellent support facilities like laboratory, library and internet required for good education on a continuous basis.
- Encourage organizing and participation of staff and students in in-house and outside Training programmes, seminars, conferences and workshops on continuous basis.
- Provide incentives and encouragement to motivate staff and students to actively involve in research-innovative projects in collaboration with industry and R &D centres on continuous basis
- Invite more and more number of persons from industry from India and abroad for collaboration and promote Industry-Institute Partnership.
- Encourage consultancy and testing and respond to the needs of the immediate neighbourhood.

St Joseph Engineering College

AN AUTONOMOUS INSTITUTION

Affiliated to VTU, Belagavi | Recognised by AICTE, New Delhi
Accredited by NAAC with A+ Grade
B.E. (ECE, EEE, ME, CIV), MBA & MCA Accredited by NBA, New Delhi

Vamanjoor, Mangaluru - 575 028, Karnataka, India
Ph: 91-824-2868100 / 2263753 / 54 / 55
E-mail: sjec@sjec.ac.in| Website: www.sjec.ac.in