Third Year BE

SCHEME & SYLLABUS

Autonomous Scheme 2021-22

Mechanical Engineering

ST JOSEPH ENGINEERING COLLEGE

AN AUTONOMOUS INSTITUTION

Vamanjoor, Mangaluru - 575028

MOTTO

Service and 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.(CSE,ECE,EEE, ME and CIV) & MBA
NAAC – Accredited with A+

B.E. SCHEME & SYLLABUS

(With effect from 2021-22)

MECHANICAL ENGINEERING

THIRD YEAR

(V and VI 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). Five of the UG programs, namely Computer Science & Engineering, Mechanical Engineering, Electronics and Communication Engineering, Electrical & Electronics Engineering and Civil Engineering and MBA 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 practising 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 1700 Graduate Engineers over the past 17 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:

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

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

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

4. Conduct investigations on 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.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

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

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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

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

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

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

12. 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: Take up research programs on contemporary areas of Mechanical engineering.

PSO2: Gain competence to face various competitive examinations and succeed in seeking the best opportunities in the corporate world and higher studies.

V 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**	
						L	T	P					
1	HSMC	21MEC501	Management and Economics	ME	ME	3	-	-	03	50	50	100	3
2	PCC	21MEC502	Thermo-fluids Engineering (Integrated)	ME	ME	2	2	2	03	50	50	100	4
3	PCC	21MEC503	Theory of Machines	ME	ME	2	2	-	03	50	50	100	3
4	PCC	21MEC504	Hydraulics and Pneumatics	ME	ME	2	2	-	03	50	50	100	3
5	PCC	21MEC505	Finite Element Methods	ME	ME	2	2	-	03	50	50	100	3
6	PCC	21MEL506	Finite Element Analysis Lab	ME	ME	-	-	2	03	50	50	100	1
7	HSMC	21RMI507	Research Methodology and Intellectual Property Rights	ME	ME	3	-	-	03	50	50	100	3
8	INT	21INT508	Summer Internship - II	ME	ME	-	-	-	03	100	-	100	2
9	MNCC	21ETP509	Emerging Technologies: A Primer	COM	COM	-	-	2	02	50	-	50	-
						14	8	6	26	500	350	850	22

Note: BSC: Basic Science Courses; ESC: Engineering Science Courses; HSMC: Humanity, Social Science and Management Courses; MNCC = Mandatory Non-Credit Course. INT: Internship, PCC: Professional Core Course; PEC = Professional Elective Course; OEC = Open Elective Course; UHV: Universal Human Values SDC: Ability Enhancement (Skill Development) Course.

One-hour Lecture (L) per week per semester = 1 Credit; Two-hour Tutorial (T) per week per semester = 1 Credit; Two-hour Practical/Laboratory/Drawing (P) per week per semester = 1 Credit.

VI 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**	
						L	T	P					
1	PCC	21MEC601	Heat Transfer (Integrated)	ME	ME	3	-	2	03	50	50	100	4
2	PCC	21MEC602	Machine Design	ME	ME	2	2	-	03	50	50	100	3
3	PEC	21MEC603X	Professional Elective - 1	ME	ME	3	-	-	03	50	50	100	3
4	OEC	21XXX604X	Open Elective - 1	ME	ME	3	-	-	03	50	50	100	3
5	HSMC	21CIV605	Environmental Studies	CIV	CIV	1	-	-	02	50	50	100	1
6	PCC	21MEL606	CIM and Automation Lab	ME	ME	-	-	2	03	50	50	100	1
7	PCC	21MEC607	Operation Research	ME	ME	3	-	-	03	50	50	100	3
8	SDC	21MEC608	Mini-Project	ME	ME	-	-	2	03	100	-	100	2
9	MNCC	21IIP609	Innovation and Intellectual Property	COM	COM	-	-	2	02	50	-	50	-
10	INT	Summer Internship III: Research Internship / Industrial Internship: 24 weeks during the VI to VIII semesters On successful completion, 10 credits will be added in the VIII Semester marks card.											
						15	02	08	25	500	350	850	20

Professional Elective - I: Students can select any one of the Professional Electives offered by the Department.

Professional Elective – 1 21MEC603X					
21MEC6031	Tribology	21MEC6033	Theory of Elasticity	21MEC6035	Composite Materials Technology
21MEC6032	Refrigeration and Air-Conditioning	21MEC6034	Fuel Cell and its Application		

Open Elective I (21XXX604X)							
Course Code	**CSE**	**AIM**	**CBS**	**ECE**	**EEE**	**MEC**	**CIV**
21XXX6041	Introduction to Database Management System	Neural Networks	Neural Networks	Basics of Analog Circuits	Renewable Energy Sources	Automobile Engineering	Remote Sensing and Geographical Information System
21XXX6042	Introduction to Programming in Java	Introductionto AI and ML	Introductionto AI and ML	Fundamentals of Digital System Design	PLC & SCADA	3D modelling	Numerical Methods and Applications
21XXX6043	Dot Net Programming	ComputerVision	ComputerVision	Microcontroller	Control Systems	Entrepreneurship Development	Sustainability Concepts in Engineering
21XXX6044	Introduction to Python	Predictive Analytics	Predictive Analytics	Programming & Interfacing with Arduino	Electrical Safety Practices	Statistical Quality Control	Occupational Health and Safety
21XXX6045	-	Introduction to Data Science	Introduction to Data Science	Communication Theory	Energy Conservation and Audit	Non-Destructive Testing	-

Note: Open Elective – I: Students can select any one of the open electives offered by other Departments except those that are offered by the parent Department (Please refer to the list of open electives). Selection of an open elective shall not be allowed if, (i) the candidate has studied the same course during the previous semesters of the program. (ii) the syllabus content of open elective is similar to that of the Departmental core courses or professional electives. (iii). A similar course, under any category, is prescribed in the higher semesters of the program. Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.

Research/Industrial Internship - All the students admitted shall have to undergo a mandatory internship of minimum 24 weeks during the VI to VIII semesters. Viva-Voce examination shall be conducted during VIII semester and the prescribed credit shall be included. The internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take up/complete the internship shall be declared fail and shall have to complete during subsequent examination after satisfying the internship requirements.

Research Internship Students have to take up research internships at Centers of Excellence (CoE) / Study Centers established in the same institute and /or out of the institute at reputed research organizations / Institutes. A research internship is intended to give students the flavour of current research going on a particular topic/s. The internships serve this purpose. They help students to get familiarized with the field, the skill needed, the amount and kind of effort required for carrying out research in that field.

AICTE Activity Points to be earned by students admitted to BE/B.Tech/B. Plan day college programme (For more details refer to Chapter 6, AICTE Activity Point Programme, Model Internship Guidelines): Over and above the academic grades, every student admitted to the 4 years Degree programme and every student entering 4 years Degree programme through lateral entry, shall earn 100 and 75 Activity Points respectively for the award of degree through AICTE Activity Point Programme. Students transferred from other Universities to fifth semester are required to earn 50 Activity Points from the year of entry. The Activity Points earned shall be reflected on the student's eighth semester Grade Card. The activities can be can be spread over the years, anytime during the semester weekends and holidays, as per the liking and convenience of the student from the year of entry to the programme. However, minimum hours' requirement should be fulfilled. Activity Points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression. In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

V Semester

Management and Economics			
Course Code	**21MEC501**	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

- To help the students to understand the fundamental concepts and principles of management; the basic roles, skills, functions of management, various organizational structures and basic knowledge of marketing.
- To impart knowledge, with respect to concepts, principles and practical applications of Economics, which govern the functioning of a firm/organization under different market conditions.

Module-1 Management and Planning (8 hours)

Management: Introduction - Meaning - nature and characteristics of Management, Scope and Functional areas of management - Management as a science, art of profession - Management & Administration - Roles of Management, Levels of Management, Development of Management Thought- early management approaches – Modern management approaches.

Planning: Nature, importance and purpose of planning process Objectives - Types of plans (Meaning Only) - Decision making Importance of planning - steps in planning & planning premises - Hierarchy of plans.

Module-2 Organizing, Directing and Controlling (8 hours)

Organizing and Staffing: Nature and purpose of organization Principles of organization - Types of organization - Depart Mentation Committees Centralization Vs Decentralization of authority and responsibility - Span of control - MBO and MBE (Meaning Only) Nature and importance of staffing--Process of Selection & Recruitment (in brief).

Directing & Controlling: Meaning and nature of directing Leadership styles, Motivation Theories, Communication - Meaning and importance - coordination, meaning and importance and Techniques of Co Ordination. Meaning and steps in controlling - Essentials of a sound control system - Methods of establishing control (in brief).

Module-3 Engineering Economics (8 hours)

Introduction: Engineering and economics, Problem solving and decision making, Laws of demand and supply, Difference between Microeconomics & Macroeconomics, equilibrium between demand & supply, elasticity of demand, price elasticity, income elasticity. Law of Returns, Interest and interest factors, simple and compound interest, Cash flow diagrams, personal loans and EMI payment calculation with flexible interest rates, Discussion and problems.

Module-4 Present, Future and Annual Worth and Rate of Returns (8 hours)

Basic present worth comparisons, Present worth equivalence, Assets with unequal lives and infinites lives, future worth comparisons, payback comparisons, Equivalent annual worth comparisons, situations for annual worth comparisons. Asset life, Rate of return, minimum acceptable rate of return, IRR anomalies and misconceptions, Cost of capital, comparisons of all present future and annual worth with IRR, product costing, Discussions and problems.

Module-5 Costing and Depreciation (8 hours)

Components of costs, estimation of selling price, marginal cost, first cost, all kinds of overheads, indirect cost estimation with depreciation, mensuration and estimation of material cost, cost estimation of mechanical process, idling time. Product costing (approaches to product costing), causes of depreciation, methods of computing depreciation charges, straight line method, declining balance method, sum of years method, sinking fund method, service output methods, taxation concepts, personal income taxes and corporate taxes, Discussions and problems

Course Outcomes: At the end of the course the student will be able to:	
21MEC501.1	Discuss the situations of unethical professional conduct and propose ethical alternatives of management in the engineering arena and describe importance of planning pertains to protection of the public and public interest at global, regional and local level.
21MEC501.2	Identify deficiencies or gaps in knowledge between the theory and practice and describe the roles of management techniques for sustainable development of SMEs.
21MEC501.3	Apply the basic concepts of engineering economics to demonstrate the understanding of regulations, legislation and standards within the perspective of given syllabus
21MEC501.4	Select the best economic model from various available alternatives
21MEC501.5	Source and comprehend technical literature and other credible sources of information in costing and depreciation and ascertain the professional conduct in the area.
21MEC501.6	Discuss Decision making, Organizing, Staffing, Directing and Controlling

Sl. No.	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
Textbooks				
1	Engineering Economy	Riggs J.L	McGraw Hill	4,2004
2	Principles of Management	Tripathy and Reddy	Tata McGraw Hill	3, 2006
Reference Books				
1	Management Fundamentals Concepts, Applications, Skill Development	Robert N. Lussier	Cengage	1, 2012
2	Mechanical estimation and costing	T.R. Banga& S.C. Sharma	Khanna Publishers	17, 2015
3	Engineering Economics	R. Paneer selvam	Prentice Hall India	2, 2012

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/122106031
- https://onlinecourses.nptel.ac.in/noc22_mg104/preview

Course Articulation Matrix

Course Outcomes (COs)	**Program Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
21MEC501.1	-	-	-	-	-	3	-	-	-	-	-	-	-	-
21MEC501.2	-	-	-	-	-	-	-	-	1	-	-	-	-	-
21MEC501.3	-	-	-	-	-	3	-	-	-	-	-	-	-	-
21MEC501.4	1	-	1	-	-	-	-	-	-	-	-	-	-	-
21MEC501.5	1	-	1	-	-	-	-	-	-	-	-	-	-	-
21MEC501.6	-	-	-	-	-	3	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

Thermo-fluids Engineering			
Course Code	**21MEC502**	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

- To understand the concepts of testing of I. C. Engines and methods to estimate Indicated, Brake and Frictional Power and efficiencies.
- To understand theory and performance calculation of Reciprocating compressor and positive displacement pumps.
- To understand the concepts related to Refrigeration, refrigeration cycles and Air conditioning and get conversant with Psychrometric Charts, Psychrometric processes, human comfort conditions.
- To understand typical construction of a Turbo machine, their working principle, application and conversion of fluid energy to mechanical energy in Turbo machine with utilization factor and degree of reaction.
- To understand the working principle of hydraulic turbines and centrifugal machines.

Module-1 Performance Testing of IC Engines (08 hours)

Performance Testing of IC Engines: Two-stroke and Four-stroke I.C. engines - Measurement of speed, air flow, fuel consumption, Measurement of Brake Power and Indicated Power, Performance curves, Heat Balance sheet., Frictional power: various methods – Willan's line, Morse test, motoring etc. Simple Numerical.

Reciprocating Air Compressors: Operation of a single stage reciprocating compressors: work input through p-v diagram, effect of clearance and volumetric efficiency, adiabatic, isothermal and mechanical efficiencies. Multi-stage compressor, optimum intermediate pressure, inter-cooling, minimum work for compression.

Module-2 Refrigeration (08 hours)

Refrigeration: Vapour compression refrigeration system; description, analysis, refrigerating effect, capacity, power required, units of refrigeration, COP, reversed Carnot cycle. Use of refrigeration tables and p-h chart. Classification of Refrigerants. Desirable properties of refrigerants. Simple Numerical.

Psychrometries: Atmospheric air and Psychrometric properties: DBT, WBT, DPT, partial pressure, specific and relative humidity and relation between the enthalpy and adiabatic saturation temperatures. Construction and use of psychrometric chart. Analysis of various processes: Heating, cooling, dehumidifying and humidifying. Adiabatic mixing of stream of moist air. Simple numerical using psychrometric chart.

Module-3 Introduction to Turbo machines (08 hours)

Introduction to Turbo machines: Classification of Turbomachines, Basic constructional details, Euler's equation for a Turbo machine, Impulse & Reaction machine - Axial flow and radial flow machines, utilization factor, degree of reaction & efficiencies of Turbo machines.

Introduction to positive displacement machines: Classification, comparison with turbomachines. Construction and working of reciprocating pump, gear and vane pumps. Discussion on engineering applications.

Module-4 Hydraulic Turbines (08 hours)

Hydraulic Turbines: Classification of hydraulic turbines, Various heads and efficiencies, Significance of Specific speed and Unit quantities.

Impulse Turbine: working principle, Velocity triangles, work done, in Pelton wheel and Numerical.

Reaction turbine: working principle, Velocity triangles, work done, in Francis turbine and Kaplan turbine. Draft tubes, Cavitation in reaction turbines, Numerical.

Module-5 Centrifugal Pumps, Fans, Blowers and Compressors (08 hours)
Centrifugal Pumps: Parts of centrifugal pump, Various heads and efficiencies, work done, minimum speed for starting centrifugal pump, Cavitation in pumps and NPSH. Pumps in series and parallel, casings. Simple numerical using velocity triangles. **Centrifugal Fans, Blowers & Compressors:** types; velocity triangles, work done and degree of reaction, size & speed; vane shape & efficiency; vane shape & characteristics; actual performances characteristics; Concept of slip and slip coefficient. Discussion on engineering applications.

PRACTICALMODULE

PART – A

1. Determination of calorific value of solid/liquid fuels using Bomb Calorimeter.
2. Determination of calorific value of gaseous fuels using Boys Gas Calorimeter.
3. Performance test on single cylinder engine fourstroke diesel engine and draw Heat balance sheet.
4. Performance test on multi cylinder engine, draw Heat balance sheet and perform Morse test.
5. Performance test on Vapour compression refrigeration -test rig.
6. Performance test on Air conditioning-test rig.

PART – B

1. Performance test on single/multi stage Reciprocating compressor.
2. Performance test on single / multi-stage centrifugal pump.
3. Performance test on Pelton turbine and draw main and operating characteristics.
4. Performance test on Francis turbine and draw main and operating characteristics.
5. Performance test on Kaplan turbine and draw main and operating characteristics.

PART – C

(Demonstration)

Demonstration on Computerised IC Engine test rig for its performance and analysis.

PART D

(Open Ended Problems)

Use of modern computing tools preferred in analysis of performance and estimations

Course Outcomes: At the end of the course the student will be able to:	
21MEC502.1	Apply the concepts of testing and evaluate the performance of I. C. Engines and Reciprocating compressor.
21MEC502.2	Apply and analyse the concepts related to Refrigeration and Air conditioning, using p-h and Psychrometric Charts.
21MEC502.3	Apply the Euler's turbine equation to evaluate the energy transfer and other related parameters.
21MEC502.4	Compare and evaluate the performance of reciprocating and centrifugal pumps.
21MEC502.5	Classify and analyse the various types of hydraulic turbines.
21MEC502.6	Conduct experimental investigation of various positive displacement and turbomachines.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Engineering Thermodynamics	P.K. Nag	Tata McGraw Hill	6, 2018
2	Thermodynamics	Yunus A, Cengel, Michael A Boles	Tata McGraw Hill	7, 2012
3	Turbo machines	M. S. Govindegowda and A. M. Nagaraj	M. M. Publications	7, 2012
Reference Books				
1	Principles of Engineering Thermodynamics	Michael J, Moran, Howard N. Shapiro	Wiley	8, 2005
2	I.C. Engines	M.L. Mathur & Sharma	Dhanpat Rai & Sons- India	5, 2008
3	Turbines, Compressors & Fans	S. M. Yahya	Tata McGraw Hill Co. Ltd	2, 2002

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/112/104/112104305/
- https://archive.nptel.ac.in/courses/112/103/112103307/

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
21MEC502.1	-	2	-	3	-	-	-	-	-	-	-	-	-	-
21MEC502.2	-	-	2	3	-	-	-	-	-	-	-	-	-	-
21MEC502.3	3	3	-	2	-	-	-	-	-	-	-	-	-	-
21MEC502.4	-	3	-	2	-	-	-	-	-	-	-	-	-	-
21MEC502.5	-	3	-	2	-	-	-	-	-	-	-	-	-	-
21MEC502.6	-	-	-	3	-	-	-	-	2	-	-	-	-	-

1: Low 2: Medium 3: High

Theory of Machines			
Course Code	**21MEC503**	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	2:2:0	SEE	3 Hours
Total Hours	40 hours Theory	Credits	03

Course Learning Objectives:

- Know the principles of kinematic pairs, chains and their classification, DOF and inversions of kinematic chains
- Impart knowledge on various types of links and synthesis
- Know the necessity of balancing in high speed rotating components
- To familiarize principles of cams and its profiles, governors, gyroscope and gears

Module-1 Introduction (8 hours)

Introduction: Definitions: Link, kinematic pairs, kinematic chain, mechanism, structure, degrees of freedom, Classification links, Classification of pairs based on type of relative motion, Grubler's criterion, mobility of mechanism, Grashoff's criteria, inversions of Grashoff's chain.
Mechanisms: Quick return motion Mechanisms-Drag link mechanism, Whitworth mechanism and Crank and slotted lever Mechanism. Intermittent Motion mechanisms: Geneva wheel mechanism, Ratchet and Pawl mechanism, pantograph.

Module-2 Static Force Analysis (8 hours)

Velocity and Acceleration Analysis of Mechanisms (Graphical Method): - Motion of link in machine - Determination of Velocity and acceleration diagrams - Graphical method - Application of relative velocity method four bar chain.
Static Force Analysis: Static Equilibrium, Equilibrium of Two and Three force, Members with Two Forces and Torque, Free Body Diagrams, Static Force Analysis of Four Bar Mechanism and slider crank mechanism with and without friction.

Module-3 Balancing of Rotating Masses (8 hours)

Balancing of Rotating Masses: Static and Dynamic Balancing, Balancing of several rotating masses by balancing masses in same plane and in different planes.
Cams: Types of Cams, Disc Cam with Reciprocating follower having Knife-Edge, Roller Follower Motions including, SHM, Uniform Velocity, Uniform Acceleration & Retardation.

Module-4 Gear Trains (8 hours)

Spur Gears: Law of gearing, path of contact, arc of contact, Interference in involute gears, methods of avoiding interference, condition and expressions for minimum number of teeth to avoid interference.
Gear Trains: Epicyclic gear trains: tabular methods of finding velocity ratio of epicyclic gear trains, torque calculation in epicyclic gear trains.

Module-5 Governors and Gyroscope (8 hours)

Governors: Types of Governors; Force Analysis of Porter and Hartnell Governors. Controlling Force, Stability, Sensitiveness, Isochronism, Effort and Power.
Gyroscope: Vectoral representation of angular motion, gyroscopic couple. Effect of gyroscopic couple on ship, aero plane and stability of four wheeled vehicle.

Course Outcomes: At the end of the course the student will be able to:	
21MEC503.1	Interpret various concepts and terminologies of machines, mechanisms and calculate mobility of joints within mechanisms.
21MEC503.2	Examine and evaluate the force, velocity on links of four bar, crank slider mechanism subjected to external forces.

21MEC503.3	Solve problems concerning static and dynamic balancing of systems involving rotating masses
21MEC503.4	Analyze the effect of gyroscopic couple on rotors, ships, aero planes and automobiles
21MEC503.5	Analyze and understand concepts on cams, gear, gear trains and to become acquainted with gear standardization and design specifications.
21MEC503.6	Demonstrate the working principle of governors and force analysis of Porter & Hartnell governor.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Theory of Machines Kinematics and Dynamics	Sadhu Singh	Pearson	3,2019
2	Mechanism and Machine Theory	G. Ambekar	Prentice Hall India	2009
Reference Books				
1	Theory of Machines	Rattan S.S	Tata McGraw-Hill Publishing Company	3, 2014
2	Mechanisms and Machines-Kinematics, Dynamics and Synthesis	Michael M Stanisic	Cengage Learning	2, 2016

Web links and Video Lectures (e-Resources):

- https://www.digimat.in/nptel/courses/video/112104121/L01.html
- https://www.digimat.in/nptel/courses/video/112104114/L01.html
- https://www.digimat.in/nptel/courses/video/112103112/L01.html

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
21MEC503.1	-	-	3	-	-	-	-	-	2	-	-	2	1	-
21MEC503.2	2	-	1	-	-	-	-	-	-	-	-	-	1	-
21MEC503.3	-	2	-	-	-	-	-	-	-	-	-	-	2	-
21MEC503.4	-	-	-	2	-	-	-	-	-	-	-	-	-	-
21MEC503.5	-	-	2	-	-	-	-	-	1	-	-	-	2	-
21MEC503.6	-	-	2	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

Hydraulics and Pneumatics			
Course Code	**21MEC504**	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	2:2:0	SEE	3 Hours
Total Hours	40 hours	Credits	03

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 (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 (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 (8 hours)

Hydraulic circuits and systems: 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 (8 hours)

Pneumatic and electro pneumatic systems : 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 (8 hours)

Trouble shooting and applications: 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 Note: (Use of standard Design Data Book is permitted in the University examination)

Course Outcomes: At the end of the course the student will be able to:	
21MEC504.1	Apply the working principles of fluid power systems and hydraulic pumps.
21MEC504.2	Apply the working principles of hydraulic actuators and control components.

21MEC504.3	Design and develop hydraulic circuits and systems.
21MEC504.4	Apply the working principles of pneumatic circuits and power system and its components.
21MEC504.5	Identify various troubles shooting methods in fluid power systems.
22MEC504.6	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,	2009
2	Fluid Power Theory and Applications	James A. Sullivan,	Fourth Edition, Prentice Hall,	1997
Reference Books				
1	Pneumatics Concepts, Design and Applications	Jagadeesha. T	Universities Press,	2015
2	Pneumatic Control	Joshi.P.,	Wiley India	2008
3	Hydraulic and Pneumatic Controls 3rd edition,	Srinivasan.R.,	Vijay Nicole Imprints,	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	PO12	PSO1	PSO2
21MEC504.1	1	-	-	-	-	1	_	-	-	-	-	-	1	-
21MEC504.2	1	1	1	-	-	-	_	-	-	-	-	-	1	-
21MEC504.3	-	1	1	-	-	_	-	-	-	-	-	-	-	1
21MEC504.4	1	_	-	-	-	_	_	-	-	-	-	-	_	_
21MEC504.5	_	1	1	_	_	_	_	_	_	_	_	_	_	1
21MEC504.6	_	1	_	_	_	_	_	_	_	_	_	_	_	_

1: Low 2: Medium 3: High

Finite Element Methods			
Course Code	**21MEC505**	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	2:2:0	SEE	3 Hours
Total Hours	40 hours	Credits	03

Course Learning Objectives: The objective of the course is to

- Learn the basics of 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, Galerkin's method (brief description only).

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).

Interpolation models: Simplex, complex and multiplex elements, Pascal triangle, Linear interpolation polynomials in terms of global coordinates for 1D and 2D simplex elements.

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.

Lagrange interpolation functions – Derivation of shape functions for higher order triangular and quadrilateral element. (study purpose only).

Numerical problems on bars, stepped bars – stiffness matrix, solution of displacements, reactions and stresses by using elimination approach, penalty approach.

Numerical problems on trusses - stiffness matrix, solution of displacements, reactions and stresses by using elimination approach.

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

Beams : Boundary conditions, Hermite shape functions , Beam stiffness matrix, Numerical problems on simply supported and cantilever beams cantilever beams with concentrated and uniformly distributed load.

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 finite element formulation using variational method, Problems with temperature gradient and heat fluxes, heat transfer in straight fins and composite sections.

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 one-dimensional bar element, truss element, triangular element. Lumped mass matrix of bar element, truss element, Evaluation of eigen values and eigen vectors, Applications to bars, stepped bars.

Course Outcomes: At the end of the course the student will be able to:	
21MEC505.1	Apply basic concept of finite element formulation for different loading and boundary conditions
21MEC505.2	Identify and apply the characteristics of FEA elements such as bars, beams, truss elements for stress-strain analysis.
21MEC505.3	Develop element characteristic equation and generate global equations for bars, trusses, beams, circular shafts by applying different boundary conditions.
21MEC505.4	Apply suitable boundary conditions to a global equation for structural, fluid flow and thermal analysis and solve for unknowns.
21MEC505.5	Apply suitable boundary conditions for axi-symmetric elements and solve for unknowns.
21MEC505.6	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.	3, 2004
2	A First Course in the Finite Element Method	Daryl L. Logan	Cengage Learning India	5, 2020
Reference Books				
1	The Finite Element Method in Engineering	S.S. Rao	Elsevier, London	5, 2016
2	Finite Element Analysis	George R Buchanan	Tata McGraw Hill	2006
3	An Introduction to the Finite Element Method	J N Reddy	Tata McGraw Hill	3, 2005
4	Concepts and Applications of Finite Element Analysis	Robert Cook	Wiley, New Delhi	4, 2017
5	Practical Finite Element Analysis	Nitin S Gokhale	Finite to Infinite India	2008

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**	**PO12**	**PSO1**	**PSO2**
21MEC505.1	3	2	-	1	-	-	-	-	-	-	-	-	-	-
21MEC505.2	-	3	2	-	2	-	-	-	-	-	-	-	-	1
21MEC505.3	-	2	3	-	-	-	-	-	-	-	-	-	-	-
21MEC505.4	3	2	-	-	-	-	-	-	-	-	-	-	-	2
21MEC505.5	3	2	-	-	-	-	-	-	-	-	-	-	-	2
21MEC505.6	-	-	-	2	-	1	-	2	-	-	-	1	1	2

1: Low 2: Medium 3: High

Finite Element Analysis Lab			
Course Code	**21MEL506**	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Practical	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	0:0:2	SEE	3 Hours
Total Hours	11 Lab slots	Credits	01

Course Learning Objectives: The objective of the course is to

- Understand basic principles of Finite Element Analysis (FEA)
- Analyze the 1-D, 2-D and dynamic problems using FEA approach using the ANSYS software
- Model Beam, Bar & truss as 1-D elements to analyze the stresses and deformation at critical zones
- Model a plate as a 2-D element to evaluate the stresses and deformations under physical loads and thermal influence.

Experiments

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 2 exercises of different types).
3. Analysis of trusses (minimum 2 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:	
21MEL506.1	Apply finite element software for the purpose of replicating and analyzing real-world scenarios through computational modeling.
21MEL506.2	Cultivate proficiency in the application of Finite Element Analysis (FEA) techniques to address a diverse range of engineering challenges, with a focus on both static and dynamic analyses.
21MEL506.3	Develop models for 2D and axisymmetric finite elements on ANSYS software to evaluate the stresses and displacement in bar and beam elements
21MEL506.4	Apply FEA concepts to an in-depth examination of engineering challenges seen in the real world.

21MEL506.5	Solve problems of limited complexity in the heat transfer domain to analyze the thermal stresses and heat transfer through the material.
21MEL506.6	Identify right boundary conditions to be incorporated and select suitable elements during the analysis of static and thermal model.

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.	3, 2004
2	A First Course in the Finite Element Method	Daryl L. Logan	Cengage Learning India	5, 2020
Reference Books				
1	The Finite Element Method in Engineering	S.S. Rao	Elsevier, London	5, 2016
2	Finite Element Analysis	George R Buchanan	Tata McGraw Hill	2006
3	An Introduction to the Finite Element Method	J N Reddy	Tata McGraw Hill	3, 2005
4	Concepts and Applications of Finite Element Analysis	Robert Cook	Wiley, New Delhi	4, 2017
5	Practical Finite Element Analysis	Nitin S Gokhale	Finite to Infinite India	2008

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

Course Articulation Matrix

Course Outcomes (COs)	**Program Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
21MEL506.1	3	-	-	-	3	-	-	-	-	-	-	-	-	-
21MEL506.2	-	2	3	2	-	-	-	-	-	-	-	-	-	2
21MEL506.3	3	3	-	-	3	-	-	-	-	-	-	-	-	-
21MEL506.4	3	-	-	3	2	-	-	-	-	-	-	-	-	2
21MEL506.5	-	2	3	2	-	-	-	-	-	-	-	-	-	2
21MEL506.6	2	-	-	3	3	-	-	-	-	-	-	-	-	2

1: Low 2: Medium 3: High

Research Methodology and Intellectual Property Rights			
Course Code	**21RMI507**	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:

1. To understand the basic concepts related to research
2. To learn the concept of literature survey, review and technical writing
3. To discuss the basics of intellectual property
4. To explain the patents, copyrights, trademarks, industrial designs and geographical indications

Module-1 Research Methodology and Literature Survey (8 hours)

Research Methodology: Meaning, objectives, types, significance of research. Research approaches, method versus methodology, research process, Criteria of good research. Defining the research problem: conditions, components, selection, necessity, techniques and illustrations.

Literature Survey, Literature Review: Introduction, process, databases (Google Scholar, Web of Science, Scopus, Science Direct etc) and management tools. Author Metrics and Journal Metrics, Identifying gap areas from literature review. Ethics in research and publications. Plagiarism: Introduction, tools for detection, avoiding plagiarism. Illustrations.

Textbook 1: Ch 1 and 2, Textbook 2: Ch 7-17.

Module-2 Technical Writing and Presentations (8 hours)

Research Paper Writing: Importance, steps of writing research papers, Contents of a research article, referencing and citations, submission and post-submission. Illustrations.

Thesis Writing: Synopsis, Introduction, Literature review, Aim and objectives, Methodology, Time frame, Results and discussions, Conclusions.

Research Proposal Writing: Types of research projects, Major funding agencies in India, Preliminary requirements for proposal writing, Standard heads in research proposal. Illustrations.

Textbook 2: Ch 20-28, 35.

Module-3 Introduction to IPR and Patents (8 hours)

Introduction to Intellectual Property: Meaning, relevance, Types of IP, Role of International Institutions: The Patent Cooperation Treaty (PCT), TRIPS Agreement, WIPO, IP system in India and National IPR Policy in India.

Patents: Concept, Patents Act 1970 and its amendments, Patentable Subject Matter and Patentability Criteria, Non- Patentable Subject Matter, Procedure for Filing of Patent Application and types of Applications, Patent Search and Databases, Patent Granting Procedure, Rights of Patentee, Patent Infringement, Recent Developments: Patenting of Softwares, Inventions in Biotechnology. Illustrations.

Textbook 3: Lesson 1-10.

Module-4 Copyright and Trademarks (8 hours)

Copyright: Introduction, meaning, nature of copyright protection, Indian copyright law: Classes of work, copyright pertaining to software, Authorship and ownership and rights, Terms of copyright, Assignment, transmission and licensing, Infringement of copyrights: Exceptions and remedies, Copyright societies, Office, board, Registration of copyrights and appeals, Illustrations.

Trademark: Introduction, The Trade Marks Act 1999, Important Definitions, Trade Mark Rules 2017, Procedure of registration of trade mark in India. Duration and renewal, Opposition to registration, Grounds for refusal to registration, Rights conferred by registration, Infringement of registered Trade Mark and Remedies. Illustrations.

Textbook 3: Lesson 11 and 12.

Module-5 Industrial Designs and Geographical Indications (8 hours)
Industrial Designs: Introduction, Need for protection of industrial designs, Registrable and non-registrable designs, Registration of designs, Infringement of Industrial Designs–and Remedies, Illustrations. **Geographical Indications (GIs):** Introduction, Geographical Indications of Goods (Registration & Protection) Act, 1999, Procedure for registration of geographical indications, Infringement of GIs. **Layout – Designs of Integrated Circuits:** Introduction, Procedure for Registration of Layout design under the Semi-Conductor Integrated Circuits Layout-Design Act, 2000, Conditions and Procedures for registration. Infringement and Penalty. **Miscellaneous Topics:** The Protection of Plant Varieties and Farmers' Rights, Protection of Traditional Knowledge and Bio-diversity Act. Textbook 3: Lesson 13-16, Textbook 4: Ch 70.

Course Outcomes: At the end of the course the student will be able :	
21RMI507.1	To conduct literature survey, review and define a research problem.
21RMI507.2	To follow research ethics and develop the art of writing technical papers and reports.
21RMI507.3	To discuss the importance of Intellectual Property Rights in India.
21RMI507.4	To explain the various forms of Intellectual Property and its relevance in Indian context.
21RMI507.5	To explain the legal aspects of patents, copyrights and trademarks in India.
21RMI507.6	To explain the legal aspects of industrial designs, geographical indications and semi-conductor integrated circuits layout-designs in India.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Research Methodology: Methods and Techniques	C R Kothari and Gaurav Garg	New Age International Publishers	4th Edition 2019
2	Academic Writing	Ajay Semalty	B S Publications	2021
3	Intellectual Property Rights – Laws and Practice	The Institute of Company Secretaries of India, New Delhi	Delhi Computer Services, New Delhi	2018
4	Law Relating to Intellectual Property Rights	V K Ahuja	LexisNexis, India	3rd Edition 2017
Reference Books				
1	Research Methodology: A Step-by-Step Guide for Beginners	Ranjit Kumar	Sage Publications India Pvt Ld New Delhi	4th Edition 2014
2	Intellectual Property: A Primer for Academia	Prof. Rupinder Tewari and Ms. Mamta Bhardwaj	Publication Bureau, Panjab University, India	2021
Additional Resources: Web links/NPTEL Courses https://ipindia.gov.in/ (Official website of Intellectual Property India) https://dpiit.gov.in/policies-rules-and-acts/policies/national-ipr-policy https://www.icsi.edu/media/webmodules/FINAL_IPR&LP_BOOK_10022020.pdf				

https://corpbiz.io/learning/design-infringement-in-india/
https://nptel.ac.in/courses/121106007 (Introduction to Research (Research Methodology))
https://nptel.ac.in/courses/109105112 (Introduction on Intellectual Property to Engineers and Technologists)

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
21RMI507.1	-	**2**	-	-	**1**	-	-	-	-	-	-	**2**	-	-
21RMI507.2	-	-	-	-	**1**	-	-	**3**	-	**2**	-	-	-	-
21RMI507.3	-	-	-	-	-	**2**	-	-	-	**2**	-	-	-	-
21RMI507.4	-	-	-	-	-	**2**	-	-	-	**2**	-	-	-	-
21RMI507.5	-	-	-	-	-	**2**	-	-	-	**2**	-	-	-	-
21RMI507.6	-	-	-	-	-	**2**	-	-	-	**2**	-	-	-	-

1: Low 2: Medium 3: High

Emerging Technologies: A Primer			
Course Code	21ETP509	CIE Marks	50
Teaching Hours/Week (L:T:P)	(0:0:2)	SEE Marks	-
Credits	0	Exam Hours	02

Course Learning Objectives:

1. To develop a strong awareness of the ethical and societal implications associated with emerging technologies.
2. To instil practical skills related to AI (Artificial Intelligence), Blockchain, Digital Twins, RPA (Robotic Process Automation), and Cybersecurity.
3. To enable experiences of working on a team project, allowing students to apply their knowledge and skills to a real-world problem and present their findings effectively.

Module-1: AI and Web 3.0 (06 Hours)

Introduction to Emerging Technologies: Overview of the course, Importance of staying updated with emerging technologies, Ethical and societal considerations.

Artificial Intelligence (AI): Definition and history of AI, Machine learning and deep learning, Applications of AI in various industries, In-Class Assignment: AI in Everyday Life, Homework Assignment: Building a Simple Chatbot.

Web 3.0: Blockchain and Metaverse - Introduction to Blockchain technology, Metaverse and its potential, In-Class Assignment: Creating a Simple Smart Contract, Homework Assignment: Exploring a Metaverse Platform.

Module-2: Smart Manufacturing and Robotic Process Automation (06 Hours)

Smart Manufacturing and Digital Twins: The concept of Smart Manufacturing, Role of IoT and sensors, Digital Twins and their applications, In-Class Assignment: Explore the designs of Digital Twins, Homework Assignment: Analysing a Smart Manufacturing Case Study.

Robotic Process Automation: Understanding Robotic Process Automation (RPA), Types of robots and their applications, Human-robot collaboration, In-Class Assignment: Automating a Task with RPA, Homework Assignment: Researching Advances in Robotics.

Module-3: Cybersecurity and Quantum Computing (06 Hours)

Cybersecurity: Importance of cybersecurity in the digital age, Threats and vulnerabilities, Security best practices, In-Class Assignment: Ethical Hacking Simulation, Homework Assignment: Creating a Cybersecurity Plan.

Quantum Computing: Introduction to Quantum Mechanics, Quantum bits (qubits) and quantum gates, Quantum supremacy and real-world applications. Homework Assignment: Exploring Quantum Computing Research.

Module-4: Project Work (06 Hours)

Team Formation, Synopsis submission, Mid-Term Progress Review, Final Project Presentation.

Course Outcomes: At the end of the course the student will be able to:	
21ETP509.1	Assess the ethical and societal impacts of emerging technologies, demonstrating critical thinking skills.
21ETP509.2	Apply AI and Web 3.0 concepts to develop practical solutions and explore real-world applications.
21ETP509.3	Apply RPA principles and tools to automate common tasks to boost productivity.
21ETP509.4	Explain common cybersecurity threats and recommend best practices to safeguard digital assets.
21ETP509.5	Explain the fundamentals of quantum computing and its real-world applications.
21ETP509.6	Develop a solution using emerging technologies for a real-world problem in teams.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Artificial Intelligence: A Modern Approach	Stuart Russell, Peter Norvig	Pearson	Fourth Edition, 2020
2	Blockchain Technology	Chandramouli Subramanian, Asha A George, Abhilash K A and Meena Karthikeyan	Universities Press (India) Pvt. Ltd.	First Edition 2020
3	Metaverse and Web 3: A Beginner's Guide: A Beginner's Guide: A Digital Space Powered with Decentralized Technology	Utpal Chakraborty	BPB Publications	First Edition, 2022
4	Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool - UiPath	Alok Mani Tripathi	Packt Publishing	First Edition 2018
5	Cybersecurity: The Beginner's Guide: A comprehensive guide to getting started in cybersecurity	Dr. Erdal Ozkaya	Packt Publishing Limited	First Edition 2019
6	Quantum Computing: A Gentle Introduction	Eleanor G. Rieffel, Wolfgang H. Polak.	MIT Press	First Edition 2014
Reference Books				
1	Smart Manufacturing Technologies for Industry 4.0: Integration, Benefits, and Operational Activities	Edited By: Jayakrishna Kandasamy, Kamalakanta Muduli, V. P. Kommula, Purushottam L. Meena	CRC Press	First Edition 2022
2	The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems	Tom Taulli	Apress Berkeley, CA	2020
3	The Cyber Security Handbook: Prepare for, respond to and recover from cyber-attacks with the IT Governance Cyber Resilience Framework (CRF)	Alan Calder	IT Governance Publishing	First Edition 2020

Web links/Video Lectures:

Introduction to Emerging Technologies:

1. https://aiethics.princeton.edu/case-studies/case-study-pdfs/
2. https://research.aimultiple.com/ai-ethics/
3. https://news.harvard.edu/gazette/story/2020/10/ethical-concerns-mount-as-ai-takes-bigger-decision-making-role/
4. https://www.sciencedirect.com/science/article/pii/S0268401223000816
5. https://www.youtube.com/watch?v=G2fqAlgmoPo
6. https://www.youtube.com/watch?v=zizonToFXDs

Web 3.0: Blockchain and Metaverse

1. What is Ethereum? | ethereum.org
2. Navigating Remix — Remix - Ethereum IDE 1 documentation (remix-ide.readthedocs.io)

3. Solidity — Solidity 0.6.8 documentation (soliditylang.org)
4. https://www.youtube.com/watch?v=nalMdCI_pv8&t=765s
5. The Decentralized Autonomous Organization and Governance Issues by Usman W. Chohan :: SSRN
6. Ethereum Smart Contract Best Practices (consensys.github.io)
7. https://hackernoon.com/hack-solidity-reentrancy-attack

Smart Manufacturing and Digital Twins:

1. https://www.youtube.com/watch?v=nwFed03fS_s
2. https://www.youtube.com/watch?v=ScmK-bKJ4MI

RPA and Robotics:

1. https://www.youtube.com/watch?v=9URSbTOE4YI
2. https://www.youtube.com/watch?v=UEbw7dIOg0g
3. https://www.uipath.com/resources/automation-case-studies
4. https://www.ibm.com/products/robotic-process-automation/case-studies

Cybersecurity:

1. https://www.getastra.com/blog/security-audit/what-is-vapt/
2. https://owasp.org/www-project-top-ten/
3. https://owasp.org/www-project-mutillidae-ii/
4. https://www.youtube.com/watch?v=JAtwZoW76-I
5. Threat modelling (STRIDE framework): https://learn.microsoft.com/en-us/azure/security/develop/threat-modeling-tool-threats
6. Cyber Kill Chain:https://www.lockheedmartin.com/en-us/capabilities/cyber/cyber-kill-chain.html

Quantum Computing:

1. https://www.youtube.com/watch?v=e3fz3dqhN44
2. https://quantumai.google/

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
21ETP509.1	-	-	-	-		**3**	-	**2**	-	--	-	-
21ETP509.2	-	**2**	-	-	**3**	-	-	-		-	-	**1**
21ETP509.3	-	-	-	**3**	**2**	-	-	-	--	-	-	-
21ETP509.4	-	-	-	-	**3**	-		-	-	-	-	**1**
21ETP509.5	**2**	-	-	-	**3**	-	-	-	-	-	-	-
21ETP509.6	-	-	**2**	-	**3**	-	--	-	**2**	-	-	**1**

1: Low 2: Medium 3: High

VI Semester

Heat Transfer			
Course Code	**21MEC601**	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

- Study the modes of heat transfer.
- Learn how to formulate and solve 1-D steady and unsteady heat conduction problems.
- Apply empirical correlations for fully-developed laminar, turbulent internal flows and external boundary layer convective flow problems.
- Study the basic principles of heat exchanger analysis and thermal design.
- Understand the principles of boiling and condensation including radiation heat transfer related engineering problems.

Module-1 Steady-State One-Dimensional Heat Conduction (8 hours)

Introductory concepts and definitions: Modes of heat transfer: Basic laws governing conduction, convection, and radiation heat transfer; Types of boundary conditions. General three dimensional Heat Conduction Equation: Derivation of the equation in (i) Cartesian, coordinate only. Discussion of three dimensional Heat Conduction Equation in (ii) Polar and (iii) Spherical Co-ordinate Systems.

Steady-state one-dimensional heat conduction problems in Cartesian System: Steady-state one-dimensional heat conduction problems (i) without heat generation and (ii) constant thermal conductivity - in Cartesian system with various possible boundary conditions. Brief Introduction to variable thermal conductivity and heat generation [No numerical on variable thermal conductivity and heat generation] Thermal Resistances in Series and in Parallel. Critical Thickness of Insulation in cylinder and spheres Concept. Derivation

Module-2 Extended Surfaces and Transient (8 hours)

Extended Surfaces or Fins: Classification, Straight Rectangular and Circular Fins, Temperature Distribution and Heat Transfer Calculations, Fin Efficiency and Effectiveness, Applications

Transient [Unsteady-state] heat conduction: Definition, Different cases - Negligible internal thermal resistance, negligible surface resistance, comparable internal thermal and surface resistance, Lumped body, Infinite Body and Semi-infinite Body, Numerical Problems, Heisler and Grober charts.

Module-3 Thermal Radiation (8 hours)

Numerical Analysis of Heat Conduction: Introduction, one-dimensional steady conduction and one dimensional unsteady conduction, boundary conditions, solution methods.

Thermal Radiation: Fundamental principles - Gray, White, Opaque, Transparent and Black bodies, Spectral emissive power, Wien's displacement law, Planck's laws, Hemispherical Emissive Power, Stefan-Boltzmann law for the total emissive power of a black body, Emissivity and Kirchhoff's Laws, View factor, Net radiation exchange between parallel plates, concentric cylinders, and concentric spheres, Radiation Shield.

Module-4 Convection (8 hours)

Forced Convection: Boundary Layer Theory, Velocity and Thermal Boundary Layers, Prandtl number, Turbulent flow, Various empirical solutions, Forced convection flow over cylinders and spheres, Internal flows – laminar and turbulent flow solutions.

Free convection: Laminar and Turbulent flows, Vertical Plates, Vertical Tubes and Horizontal Tubes, Empirical solutions.

Module-5 Heat Exchanger (8 hours)
Heat Exchangers: Definition, Classification, applications, LMTD method, Effectiveness - NTU method, Analytical Methods, Fouling Factors, Chart Solution Procedures for solving Heat Exchanger problems: Correction Factor Charts and Effectiveness-NTU Charts. **Introduction to boiling:** pool boiling, Bubble Growth Mechanisms, Nucleate Pool Boiling, Critical Heat Flux in Nucleate Pool Boiling, Pool Film Boiling, Critical Heat Flux, Heat Transfer beyond the Critical Point, film wise and dropwise Condensation.

PRACTICALMODULE

A–Demonstration (offline/virtual):

A1. Analysis of steady and transient heat conduction, temperature distribution of plane wall and cylinder using Numerical approach (ANSYS/CFD package).

A2. Determination of temperature distribution along a rectangular and circular fin subjected to heat loss through convection using Numerical approach (ANSYS/CFD package).

B–Exercise (compulsorily to be conducted):

B1. Determination of Thermal Conductivity of a Metal Rod.
B2. Determination of Overall Heat Transfer Coefficient of a Composite wall.
B3. Determination of Effectiveness on a Metallic fin.
B4. Determination of Heat Transfer Coefficient in free Convection
B5. Determination of Heat Transfer Coefficient in a Forced Convention
B6. Determination of Emissivity of a Surface.

C–Structured Enquiry (compulsorily any 4 to be conducted):

C1. Determination of Stefan Boltzmann Constant.
C2. Determination of LMDT and Effectiveness in a Parallel Flow and Counter Flow Heat Exchangers.
C3. Experiments on Boiling of Liquid and Condensation of Vapour.
C4. Performance Test on a Vapour Compression Refrigeration.
C5. Performance Test on a Vapour Compression Air – Conditioner.
C6. Experiment on Transient Conduction Heat Transfer

Course Outcomes: At the end of the course the student will be able to:	
21MEC601.1	Compute temperature distribution and heat transfer rate in steady state and unsteady state heat conduction (Plane slabs, fins, critical insulation and transient conduction).
21MEC601.2	Calculate the heat transfer rate for a dimensional heat conduction problem using numerical method.
21MEC601.3	Solve the problems of radiation heat transfer
21MEC601.4	Compute the heat transfer coefficient for forced and free convection heat transfer using different empirical relations
21MEC601.5	Analyse heat exchanger performance by using LMTD and NTU methods and calculate heat transfer coefficient for boiling and condensation heat transfer.
21MEC601.6	To do analysis of one-dimensional heat conduction problems using MATLAB

Sl. No.	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
Textbooks				
1	Principals of heat transfer	Frank Kreith, Raj M. Manglik, Mark S. Bohn	Cengage learning	7, 2011.

2	Heat transfer, a practical approach	Yunus A. Cengel	Tata Mc Graw Hill	5,2015
Reference Books				
1	Heat and mass transfer	Kurt C, Rolle	Cengage learning	2,2015
2	Heat Transfer A Basic Approach	M Necati Ozisik	Mc Graw Hill, Newyork	2005
3	Fundamentals of Heat and Mass Transfer	Incropera, F. P. and De Witt, D. P	John Wiley and Sons, New York	5, 2006
4	Heat Transfer	Holman, J. P.	Tata McGraw Hill, New York	9, 2008

Web links and Video Lectures (e-Resources):

NPTEL Heat Transfer course for Mechanical Engineering

http://nptel.ac.in/courses/112101097/

https://nptel.ac.in/courses/103105140/

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
21MEC601.1	-	2	-	-	-	2	-	-	-	-	-	-	-	-
21MEC601.2	-	2	-	-	-	2	-	-	-	-	-	-	-	-
21MEC601.3	-	2	-	-	-	-	2	-	-	-	-	-	-	2
21MEC601.4	-	2	-	-	-	-	2	-	-	-	-	-	-	-
21MEC601.5	-	2	-	-	-	2	-	-	-	-	-	-	-	2
21MEC601.6	-	2	-	-	-	2	-	-	-	-	-	-	-	2

1: Low 2: Medium 3: High

Machine Design			
Course Code	**21MEC602**	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	2:2:0	SEE	3 Hours
Total Hours	40 hours Theory	Credits	03

Course Learning Objectives: The objective of the course is enable students to

- To explain the principles involved in design of machine elements, subjected to different kinds of forces, from the considerations of strength, rigidity.
- Develop the capability to design elements like shafts, springs, screwed joints and flexible machine elements.
- To learn transmission elements like gears, belts and bearings from the manufacturers' catalogue.
- To design the mechanical systems involving machine elements like clutches brakes and bearings.

Module-1 (8 hours)

Design for Static strength: Static loads and factor of safety. Theories of failure: Maximum normal stress theory, Maximum shear stress theory, Distortion energy theory; Failure of brittle materials, Failure of ductile materials. Stress concentration, Determination of stress concentration factor

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

Module-2 (8 hours)

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

Springs: Types of springs, spring materials, stresses in helical coil springs of circular cross sections. Leaf Springs: Stresses in leaf springs, equalized stresses, and nipping of leaf springs,

Module-3 (8 hours)

Riveted joints: Types of rivets, rivet materials, Caulking and fullering, analysis of riveted joints, joint efficiency, failures of riveted joints, boiler joints, riveted brackets.

Threaded Fasteners: Stresses in threaded fasteners, effect of initial tension, design of threaded fasteners under static, dynamic and impact loads, design of eccentrically loaded bolted joints,

Module-4 (8 hours)

Spur & Helical Gears: Design of Spur Gears: Definitions, stresses in gear tooth: Lewis equation and form factor, Design for strength, Dynamic load and wear load. Design of Helical Gears: Definitions, formative number of teeth; Design based on strength, dynamic and wear loads.

Design of Flexible Elements: Selection and design of flat and V-belts for different applications

Module-5 (8 hours)

Design of Clutches and Brakes: Design of single plate and multi-plate clutch based on uniform pressure and uniform wear theories. Design of band brakes and block brakes

Lubrication and Bearings: Hydrodynamic lubrication, pressure development in oil film, bearing modulus, coefficient of friction, minimum oil film thickness, heat generated, and heat dissipated.

Course Outcomes: At the end of the course the student will be able to:	
21MEC602.1	Apply codes and standards in the design of machine elements and select an element based on the Manufacturer's catalogue
21MEC602.2	Analyze the performance and failure modes of mechanical components subjected to combined loading and fatigue loading using the concepts of theories of failure.

21MEC602.3	Design springs, shafts, riveted joints and fasteners considering the applications and different nature of loading.
21MEC602.4	Assess the actuation force required to design the clutches and brakes based on power, heat generated, heat dissipated, and torque transmitted.
21MEC602.5	Inspect, select the module and material hardness for Spur and Helical gear based on strength, wear factor and dynamic load.
21MEC602.6	Decide the right V belt / Flat belt selection based on power, torque and service factors for different applications using the manufacturers catalogue.

Sl. No.	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
Textbooks				
1	Fundamentals of Machine Component Design	Juvinall R.C, and Marshek K.M	John Wiley & Sons	3,2007
2	Design of Machine Elements	V. B. Bhandari	Tata Mcgraw Hil	4,2016
Reference Books				
1	Design and Machine Elements	Spotts M.F., ShoupT.E	Pearson Education	8,2006
2	Elements of Machine Design	H.G.Patil, S.C.Pilli, R.R.Malagi, M.S.Patil	IK International	1, 2019

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/112/105/112105125/
- https://archive.nptel.ac.in/courses/112/105/112105124/
- https://www.youtube.com/watch?v=mzWMdZZaHwI&list=PL3D4EECEFAA99D9BE&index=1

Course Articulation Matrix

Course Outcomes (COs)	**Program Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
21MEC602.1	-	-	2	-	-	1	-	-	2	-	-	-	1	-
21MEC602.2	-	-	2	-	-	1	-	-	2	-	-	-	1	-
21MEC602.3	-	2	2	-	-	-	-	-	2	-	-	-	1	-
21MEC602.4	-	2	2	-	-	-	-	-	2	-	-	-	1	-
21MEC602.5	-	2	2	-	-	-	-	-	2	-	-	-	1	-
21MEC602.6		2	2		-	-	-	-	-	-	-	-	1	-

1: Low 2: Medium 3: High

Tribology			
Course Code	21MEC6031	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 objectives of the course are to

- Analyze the factors influencing tribological phenomena in engineering systems and their impact on friction and wear behavior.
- Compare and contrast different types of lubricants, their properties, and additives to select suitable lubricants for specific applications.
- Evaluate the frictional behavior of engineering surfaces and apply friction theories to real-world scenarios.
- Classify and explain the mechanisms of wear, including delamination theory and debris analysis, to assess wear processes in components.
- Analyze the principles of hydrodynamic and hydrostatic lubrication in journal bearings, understanding pressure development, load-carrying capacity, and frictional losses.
- Assess different surface engineering techniques and coatings for wear and corrosion resistance, selecting appropriate methods for specific engineering requirements.

Module-1 Introduction to Tribology (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 and 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 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.

Course Outcomes: At the end of the course the student will be able to:	
21MEC6031.1	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.
21MEC6031.2	Analyze the fluid film bearing performance characteristics such as load carrying capacity, friction force, and power loss for different regimes of lubrication.
21MEC6031.3	Evaluate the suitability of different materials for bearings with an understanding of the various tribological properties for the design of tribo pairs.
21MEC6031.4	Discuss the surface modifications and surface coatings of tribo-pairs with regard to friction and wear resistance.
21MEC6031.5	For a given case of relative motion, describe the friction and wear mechanisms and their methods of measurements.
21MEC6031.6	Select suitable fluid film bearings from common manufacturer's catalogs for different applications.

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	2005
2	Engineering Tribology	John Austin Williams	Oxford University Press	1994
3	Fundamentals of Tribology	Basu, Sengupta, and Ahuja	PHI Learning Pvt. Ltd	2015
Reference Books				
1	Introduction to Tribology in Bearings	B. C. Majumdar	S. Chand	2008
2	Engineering Tribology	Gwidon Stachowiak & Andrew Batchelor	Butterworth Heinemann.	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	2002

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**	**PO12**	**PSO1**	**PSO2**
21MEC6031.1	-	-	3	-	-	-	2	-	-	-	-	-	-	-
21MEC6031.2	-	-	3	-	-	-	-	-	-	-	-	-	-	-
21MEC6031.3	-	-	2	-	-	-	-	-	-	-	-	-	-	-
21MEC6031.4	-	-	2	-	2	-	-	-	-	-	-	-	-	-
21MEC6031.5	-	-	-	-	3	-	-	-	-	-	-	-	-	-
21MEC6031.6	-	2	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

REFRIGERATION AND AIR-CONDITIONING			
Course Code	**21MEC6032**	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

- Study the basic terms used in refrigeration.
- Identify various ASHRAE Nomenclature for refrigerating systems.
- Understand the working principles and applications of various refrigeration systems.
- Study the working of air conditioning systems and their applications.
- Identify the performance parameters and their relations of an air conditioning system.

Module-1 Introduction to Refrigeration (8 hours)

Introduction to Refrigeration:Basic Definitions, ASHRAE Nomenclature, Air Refrigeration Cycles-reversed Carnot cycle, Bell-Coleman cycle analysis, Air Refrigeration systems-merits and demerits and applications: Aircraft refrigeration cycles, Joule Thompson coefficient and Inversion Temperature.

Industrial Refrigeration:Chemical and process industries, Dairy plants, Petroleum refineries, Food processing.

Module-2 Refrigeration System-I (8 hours)

Vapour Compression Refrigeration System(VCRS)

Comparison of Vapour Compression Cycle and Gas cycle, Vapour Compression Refrigeration system Working and analysis, Limitations, Superheat horn and throttling loss for various refrigerants, efficiency, Modifications to standard cycle – liquid-suction heat exchangers, Discussion on Grindlay cycle and Lorenz cycle, Optimum suction condition for optimum COP Actual cycles with pressure drops, Complete Vapour Compression Refrigeration System.

Module-3 Refrigeration System-II (8 hours)

Vapour Absorption Refrigeration Systems:Absorbent – Refrigerant combinations, Water-Ammonia Systems, Practical problems, Lithium- Bromide System, Contrast between the two systems, Modified Version of Aqua-Ammonia System with Rectifier and Analyzer Assembly. Practical problems – crystallization and air leakage, Commercial systems

Other types of Refrigeration systems: Brief Discussion on Steam-Jet refrigeration system, Thermoelectric refrigeration, pulse tube refrigeration, thermos-acoustic refrigeration systems.

Module-4 Refrigerants (8 hours)

Introduction to Refrigerants: Primary and secondary refrigerants, Designation of Refrigerants, Desirable properties of refrigerants including solubility in water and lubricating oil, material compatibility, toxicity, flammability, leak detection, cost, environment and performance issues Thermodynamic properties of refrigerants,

Types of Refrigerants: Synthetic and natural refrigerants, Comparison between different refrigerants vis a vis applications, Special issues and practical implications Refrigerant mixtures – zeotropic and azeotropic mixtures Refrigeration systems Equipment: Compressors, Condensers, Expansion Devices and Evaporators.

Module-5 Air-Conditioning (8 hours)

Introduction to Air-Conditioning: Basic Definition, Classification, power rating, Mathematical Analysis of Air-Conditioning Loads, Related Aspects, Different Air-Conditioning Systems-Central – Station Air-Conditioning System, Unitary Air-Conditioning System, Window Air-Conditioner and Packaged Air-Conditioner, Components related to Air-Conditioning Systems.

Transport air conditioning Systems: Air conditioning systems for automobiles (cars, buses etc.), Air conditioning systems for trains, Air conditioning systems for ships.

Course Outcomes: At the end of the course the student will be able to:	
21MEC6032.1	Illustrate the principles, nomenclature and applications of refrigeration systems.
21MEC6032.2	Explain vapour compression refrigeration system and identify methods for performance improvement
21MEC6032.3	Describe the working principles of air, vapour absorption, thermoelectric and steam-jet and thermo acoustic refrigeration systems.
21MEC6032.4	Identify suitable refrigerant for various refrigerating systems.
21MEC6032.5	Estimate the performance of air-conditioning systems.
21MEC6032.6	Compute and Interpret cooling and heating loads in an air-conditioning system.

Sl. No.	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
Textbooks				
1	Refrigeration and Air conditioning	Arora C.P	Tata Mc Graw –Hill, New Delhi	2,, 2001
2	Refrigeration and Air-Conditioning	S C Arora & S Domkundwar	Dhanpat Rai Publication	7,, 2002
Reference Books				
1	Principles of Refrigeration	Roy J Dossat	Pearson	4, 2013
2	Refrigeration and Air-Conditioning	R S Khurmi and J K Gupta	S Chand	5, 2011

Web links and Video Lectures (e-Resources):

1. http://nptel.ac.in/courses/112105128/# - Lectures by Prof. R.C. Arora, Prof. M. Ramgopal, IIT Kharagpur.
2. https://nptel.ac.in/courses/112107208 - Lectures by Prof Ravi Kumar, IIT Roorkee.

Course Articulation Matrix

Course Outcomes (COs)	**Program Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
21MEC6032.1	3	-	3	-	-	-	-	-	-	-	2	-	-	-
21MEC6032.2	3	-	3	-	-	-	-	-	-	-	2	-	-	-
21MEC6032.3	3	-	3	-	-	-	-	-	-	-	2	-	-	-
21MEC6032.4	3	-	2	-	-	-	-	-	-	-	2	-	-	-
21MEC6032.5	3	-	3	-	-	-	-	-	-	-	2	-	-	-
21MEC6032.6	3	-	2	-	-	-	-	-	-	-	2	-	-	-

1: Low 2: Medium 3: High

THEORY OF ELASTICITY			
Course Code	**21MEC6033**	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

1. Gain knowledge of stresses and strains in 3D and their relations and thermal stresses.
2. Understand the 2D analysis of elastic structural members.
3. Analyze elastic members for the stresses and strains induced under direct loading conditions.
4. Analyze the stresses induced in disks and cylinders.
5. Examine behavior of non-circular shafts and thin tubes under torsion

Module-1 Analysis of Stress (8 hours)

Analysis of Stress: Definition and notation of stress, Basic concepts: Body force, Surface traction, Stresses in two and three dimension, equations of equilibrium in differential form, stress components on an arbitrary plane, equality of cross shear, stress invariants, principal stresses, planes of maximum shear, stress transformation, Numerical problems.

Module-2 Analysis of Strain (8 hours)

Analysis of Strain: Displacement field, strains in terms of displacement field, infinitesimal strain at a point, engineering shear strains, strain invariants, principal strains, octahedral strains, plane state of strain, compatibility equations, strain transformation, Numerical Problems.

Module-3 Two Dimensional Problems (8 hours)

Two Dimensional Problems: Cartesian coordinates – Airy's stress functions –Polynomial solutions, Investigation of Airy's Stress function for simple 2D problems – Bending of a narrow cantilever beam of rectangular cross section under edge load.

Module-4 General Equations in Cylindrical Coordinates (8 hours)

General Equations in Cylindrical Coordinates: 2D Equations of equilibrium, Strain – displacement relations, Thick cylinder under uniform internal and / or external pressure, shrink fit.

Stresses in rotating discs and cylinders. Stresses in an infinite plate with a circular hole subjected to uniaxial and biaxial loads, stress concentration**.**

Module-5 Torsion of Prismatic Bars (8 hours)

Torsion of Prismatic Bars: Saint venant's semi inverse method applied to circular, elliptical and triangular bars, membrane analogy, torsion of closed thin tubes

Course Outcomes: At the end of the course the student will be able to:	
21MEC6033.1	Apply principles of elasticity theory to estimate stresses and strains in isotropic materials.
21MEC6033.2	Describe the state of stress and strain in 2D and 3D elastic members subjected to direct loads and thermal loads.
21MEC6033.3	Analyze the structural members: beams and rotating discs
21MEC6033.4	Formulate and solve planar problems using Airy stress function in rectangular and polar co-ordinates
21MEC6033.5	Determine stresses and displacements in simple solids such as pressurized cylinders, shrink fitted cylinders, rotating disc and shaft, plate with hole

21MEC6033.6	Solve specific three-dimensional problems like torsion, bending of prismatic bar, membrane analogy and simple plate bending

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Theory of Elasticity	S. P. Timoshenko and J. N Goodier	Mc. Graw, Hill International	3, 2017
2	Theory of Elasticity	Dr. Sadhu Singh	Khanna Publications	4, 2004
Reference Books				
1	Advanced Mechanics of solids	L. S. Srinath	Tata Mc. Graw Hill	2009
2	Theory of Elastic stability	Stephen P. Timoshenko	Mc Graw Hill	2, 2014
3	Applied Elasticity	T.G. Seetharamuand Govindaraju	Interline Publishing	2008.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/105/105/105105177/
- Theory of Elasticity, by Prof. Amit Shaw, Prof. Biswanath Banerjee IIT https://onlinecourses.nptel.ac.in/noc20_ce42
- Mechanical Behavior of Materials, Part 1: Linear Elastic Behavior https://www.edx.org/course/mechanical-behavior-materials-part-1-mitx-3-032-1x

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
21MEC6033.1	-	2	-	--	-	-	-	-	-	-	-	-	-	-
21MEC6033.2	1	2	-	-	-	-	-	-	-	-	-	-	-	-
21MEC6033.3	1	-	2	-	-	-	-	-	-	-	-	-	-	-
21MEC6033.4	-	2	-	-	-	-	-	-	-	-	-	-	-	-
21MEC6033.5	-	2	1	-	-	-	-	-	-	-	-	-	-	-
21MEC6033.6	-	2	1	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

Fuel Cell and its Application			
Course Code	**21MEC6034**	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 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:	
21MEC6034.1	Understand the fundamental principles and operation of various types of fuel cells, including their components, performance characteristics, and subsystems.
21MEC6034.2	Apply thermodynamic principles to analyze fuel cell systems, and assess their efficiency and performance.
21MEC6034.3	Analyze fuel cell reaction kinetics to evaluate reaction rates and design considerations for improving fuel cell performance.
21MEC6034.4	Evaluate transport phenomena in fuel cell systems to assess voltage losses and optimize system design.
21MEC6034.5	Design and model fuel cell systems to optimize system performance and operation.
21MEC6034.6	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	Third Edition 2016
2	Fuel Cell Engines	Mathew M. Mench	John Wiley & Sons, Inc., Hoboken, New Jersey	2008
Reference Books				
3	PEM Fuel Cells: Theory and Practice	Frano Barbir	Academic Press Inc	Second Edition 2012

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**	**PO12**	**PSO1**	**PSO2**
21MEC6034.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
21MEC6034.2	-	3	-	1	-	-	-	-	-	-	-	-	-	1
21MEC6034.3	-	3	-	1	-	-	-	-	-	-	-	-	-	2
21MEC6034.4	1	-	3	-	-	-	-	-	-	-	-	-	-	2
21MEC6034.5	-	1	-	3	-	-	-	-	-	-	-	-	-	2
21MEC6034.6	-	-	2	-	3	-	-	-	-	-	-	-	-	2

1: Low 2: Medium 3: High

Composite Materials Technology			
Course Code	**21MEC6035**	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 to

- To know the behaviour of constituents in the composite materials.
- To enlighten on different types of reinforcement and matrices.
- To develop different manufacturing method available for composite material
- To understand the various characterization techniques
- To impart the knowledge and analysis skills in applying basic laws in mechanics to the composite materials.

Module-1 Introduction to Composite Materials (8 hours)

Introduction to Composite Materials: Definition, classification & brief history of composite materials.

Constituent of composite materials: Reinforcements, Matrix, Coupling agents, coatings and fillers.

Reinforcements: Introduction, Glass Fibers, Boron Fibers, Carbon Fibers, Organic Fibers, Ceramic Fibers, Whiskers, Other Non-Oxide Reinforcements, Comparison of Fibers.

Matrix Materials: Polymers, Metals and Ceramic Matrix Materials.

Interfaces: Wettability, Crystallographic nature of interface, types of bonding at the interface and optimum interfacial bond strength.

Module-2 Metal Matrix Composites (8 hours)

Polymer Matrix Composites (PMC): Processing of PMC's: Processing of Thermoset Matrix Composites, Thermoplastic Matrix Composites, Sheet Moulding Compound and carbon reinforced polymer composites. Interfaces in PMC's, Structure & Properties of PMCs, applications.

Metal Matrix Composites (MMC): Types of MMC's, Important Metallic Matrices, Processing, Interfaces in MMC's, Properties & Applications.

Module-3 Ceramic Matrix Composites (8 hours)

Ceramic Matrix Composites (CMC): Processing of CMC's: Cold Pressing & Sintering, Hot Pressing, Reaction Bonding Processes, Infiltration, Directed Oxidation, In Situ Chemical Reaction Technique, Sol-Gel, Polymer Infiltration & Pyrolysis, Electrophoretic Deposition, Self-Propagating High Temperature Synthesis. Interfaces, properties, and applications of CMC's.

Carbon Fiber/Carbon Matrix Composites: Processing of Carbon/Carbon Composites, Oxidation protection of carbon/carbon composites, Properties of Carbon/Carbon Composites, and application of Carbon/Carbon Composites.

Multi-filamentary Superconducting Composites: The Problem of Flux Pinning, Types of Super Conductor, Processing & structure of Multi filamentary superconducting composites, Applications of multi-filamentary superconducting composites.

Module-4 Nonconventional Composites (8 hours)

Nonconventional Composites: Introduction.

Nanocomposites: Polymer clay nanocomposites, self-healing composites, self-reinforced composites. Bio composites

Laminates: Ceramic laminates, Hybrid Composites.

Performance/Characterization of composites: Static Mechanical Properties: Tensile Properties, Compressive Properties, Flexural Properties, In-Planar Shear Properties, Interlaminar Shear Strength.

Fatigue properties: Tension-Tension Fatigue, Flexural Fatigue.

Impact Properties: Charpy, Izod and Drop-Weight Impact Test.

Module-5 (8 hours)
Micromechanics of composites: Density, Mechanical Properties; Prediction of Elastic Constants, Micromechanical Approaches, Halpin-Tsai Equation, Transverse Stresses, Thermal properties. Numerical Problems. **Macro mechanics of composites:** Introduction, Elastic constants of an isotropic material, elastic constants of a lamina, relationship between engineering constants and reduced stiffnesses and compliances.

Course Outcomes: At the end of the course the student will be able to:	
21MEC6035.1	Interpret the behaviour of constituents in the composite materials.
21MEC6035.2	Illustrate different types of manufacturing processes in the preparation of composite materials.
21MEC6035.3	Analyse the problems on micro and macro mechanical behaviour of composites.
21MEC6035.4	Determine stresses and strains relation in composites materials.
21MEC6035.5	Illustrate the effective use of properties in design of composite structures.
21MEC6035.6	Perform literature search on advanced composite materials.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Composite Material Science and Engineering	Krishna K. Chawla	Springer	3, 2015
2	Fibre-Reinforced Composites, Materials, Manufacturing, and Design	P.K. Mallick	CRC Press, Taylor & Francis Group	3,2007
3	Mechanics of Composite Materials & Structures	Madhujit Mukhopadhyay	Universities Press	2022
Reference Books				
1	Mechanics of Composite Materials	Autar K. Kaw	CRC Taylor & Francis	2, 2005
2	Stress analysis of fiber Reinforced Composites Materials	Michael W. Hyer	DEStech Publications, Inc.	2009
3	Mechanics of Composite Materials	Robert M Jones	Taylor & Francis	2, 1999

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=JBMVZpRD-Zk&ab_channel=NPTELIITGuwahati (Last accessed 17/04/2023)
- https://www.youtube.com/watch?v=KYlGXj-kI6M&list=PLXAknhr3GMjwtSFzmSEaSp14K3g4SwAOp&ab_channel=ManufacturingofComposites (Last accessed 17/04/2023)
- https://archive.nptel.ac.in/courses/112/104/112104229/ (Last accessed 17/04/2023)

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
21MEC6035.1	-	-	2	-	-	-	-	-	-	-	-	-	-	-
21MEC6035.2	-	-	2	-	-	-	-	-	-	-	-	-	-	-
21MEC6035.3	-	-	-	2	-	-	-	-	-	-	-	-	-	3
21MEC6035.4	-	-	-	-	2	-	-	-	-	-	-	-	-	-
21MEC6035.5	-	-	-	-	-	-	2	-	-	-	-	-	-	-
21MEC6035.6	-	-	-	-	-	-	-	-	-	-	-	2		3

1: Low 2: Medium 3: High

Automobile Engineering			
Course Code	**21MEC6041**	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 Objectives: The objectives of this course is 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 it's Principle Parts (8 hours)

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 and Turbochargers (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, II, III and IV norms, Bharat Stage II, III, IV norms. Motor Vehicle Act

Course Outcomes: At the end of the course the student will be able to:	
21MEC6041.1	Describe the construction and working of engine components, cooling and lubrication system.
21MEC6041.2	Demonstrate the role and working of Clutch, gear box, transmission systems and braking system in automobile with neat sketches wherever necessary.
21MEC6041.3	Illustrate the role of Steering, Suspension and functions of ignition system in automobile.
21MEC6041.4	Explain the working of Supercharger and turbocharger in power enhancement
21MEC6041.5	Describe the combustion process and fuel supply system in SI and CI engine
21MEC6041.6	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**
Text Books				
1	Automobile Engineering	Kirpal Singh	Standard Publishers	12, 2011
2	Automotive Mechanics	S. Srinivasan	Tata McGraw Hill	2, 2003
Reference Books				
1	Automotive Mechanics	William H Crouse & Donald L Anglin	Tata McGraw Hill Publishing Company Ltd	10,2007
2	Automotive Mechanics Principles and Practices	Joseph Heitner	East West Press	2,2006
3	Fundamentals of Automobile Engineering	K.K.Ramalingam	SciTech Publications (India) Pvt. Ltd.	2,2006
4	Automobile Engineering	R. B. Gupta	Satya Prakashan	4,1984.

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**	**PO12**	**PSO1**	**PSO2**
21MEC6041.1	3	-	-	-	-	-	2	-	-	-	-	-	2	2
21MEC6041.2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
21MEC6041.3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
21MEC6041.4	3	-	-	-	-	-	-	-	-	-	-	-	-	-
21MEC6041.5	3	-	-	-	-	-	2	-	-	-	-	-	-	-
21MEC6041.6	3	-	-	-	-	-	2	-	-	-	-	-	2	2

1: Low 2: Medium 3: High

3 D MODELING			
Course Code	21MEC6042	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:

- Control the screen environment through workspaces
- Gain knowledge of 3D max method of viewing 3D objects.
- Understand the creation of drawing objects in different planes
- Understand the creation of complex objects with standard and extended primitives
- Understand concept of modifiers, kinematics and modelling methods
- Recognize the properties of objects that relate to 3D imagery

Module-1 (8 hours)

Introduction to 3D-Max Interface of 3DS max, Understanding the concept of four view ports, Aligning object in the each view port in X, Y, Z axis, Hot keys, User defined hot keys, using the menus, Floating and docking. Command panel, customizing the interface, Using drag and drop feature,

Introduction to different workspaces, Geometry, Sub objects, Extruding, Welding, bridging etc.

Module-2 (8 hours)

Concept of Standard and Extended Primitives Introduction to standard and extended primitives. Introduction to creating complex objects with Standard and extended primitives, Understanding the spline tools.

Introduction to polygons. Using modifier stack, navigating the modifier stack, File navigation, Introduction to Connection (Hierarchy, Group, and Link).

Module-3 (8 hours)

Introduction to Modifiers Introduction to the 3d elevators and walk through, Introduction to modifiers and modifier gizmos, Familiarity with Modifiers like Bend, edit poly, X form, wave, lathe symmetry etc

Advanced 3DS Max, Modeling objects with lathe, loft, extrude etc, Creating 3D objects from 2D spline shapes, Organic and inorganic modeling, Introduction to texturing, Working with Diffuse, Opacity and Reflection, Basics of UV unwrapping, Creating texture maps, Bump and Displacement Mapping.

Module-4 (8 hours)

Modelling Introduction to Polygon modeling, Nurbs modelling, Modelling Props and sets (Locations), Modelling a high poly model, Technical issues related to managing high poly model. Managing the display of huge sets and models in the view port. Modelling the character using templates & view port references, Optimizing the final model, refining the mesh, basic posture, Testing the model, Difference between hi-poly & low-poly characters.

Concept of Kinematics Introduction to Bones & IK-FK, Introduction to Biped Rig-1, Introduction to Biped Rig-2 (Creating Controls and Finishing the Rig), Basic Key frame Animation.

Module-5 (8 hours)

Introduction to Maya Introduction to the interface of Maya, Menu bar, Tool bar, Hot box, Using the shelf, hot keys. Using the spacebar, manipulating a view.

Creating objects: Simple primitives, Lights, cameras. Selecting objects, types of selection, Single selection, adding and subtracting selection. Edit menu selection options, Marquee selection, Lasso selection, selection mask Using hyper shade, Relationship editor, hyper graph and outliner.

Course Outcomes: At the end of the course the student will be able to:	
21MEC6042.1	Use animation software to create geometric forms
21MEC6042.2	Create complex three dimensional (3D) forms

21MEC6042.3	Demonstrate the knowledge of spline curves
21MEC6042.4	Create 3D curvilinear forms
21MEC6042.5	Map detailed textures to complex 3D objects
21MEC6042.6	Create and render a 3D image

Sl. No.	Title of the Book	Name of Author/s	Name of the Publisher	Edition & Year
Textbooks				
1	Mastering Autodesk Maya 2011	Eric Keller Todd Palamar, Anthony Honn	Wiley Publishers	1, 2010
2	Max a step by step approach	Kurt Wendt	Lulu Publishers	1, 2005
3	3Ds Max 2010 Bible	Kelly Murdock	John Wiley & Sons	1, 2005
Reference Books				
1	Introducing Maya 20113Ds	Dariush Derakhshani	Sybex Publishers	1, 2011
2	3ds Max 2009 Architectural Visualization - Intermediate to Advanced	Brian L .Smith	C G School Publishers	1, 2008
3	3D Modelling and Animation	Michael G, Nikos Sarris	IGI Publishers	1, 2003
4	3D Modelling, Animation, and Rendering	Michael E. Mortenson	Createspace Pub	1, 2010

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/112102102
- https://nptel.ac.in/courses/112104031
- https://onlinecourses.nptel.ac.in/noc20_cs90/preview
- https://nptel.ac.in/courses/106103224
- https://nptel.ac.in/courses/112104265

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
21MEC6042.1	2	-	-	-	3	-	-	-	-	-	-	-	-	-
21MEC6042.2	2	-	-	-	3	-	-	-	-	-	-	-	-	2
21MEC6042.3	2	-	-	-	3	-	-	-	-	-	-	-	-	-
21MEC6042.4	2	-	-	-	3	-	-	-	-	-	-	-	-	2
21MEC6042.5	2	-	-	-	3	-	-	-	-	-	-	-	-	-
21MEC6042.6	2	-	-	-	3	-	-	-	-	-	-	-	-	2

1: Low 2: Medium 3: High

Entrepreneurship Development			
Course Code	**21MEC6043**	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

1. Understand the concept of Entrepreneur and Entrepreneurship and relevant roles
2. Learn creativity and entrepreneurial plan including Project Feasibility and Project Appraisal
3. Understand Corporate entrepreneurship and issues related to Corporate entrepreneurship
4. Understand Family and Non-Family Entrepreneur & Women entrepreneurs and women entrepreneurs in India
5. Understand International Entrepreneurship Opportunities and Case studies on Indian Start ups

Module-1 Entrepreneurship (8 hours)

Definition of Entrepreneur, Internal and External Factors, Functions of an Entrepreneur, Entrepreneurial motivation and Barriers, Classification of Entrepreneurship, Theory of Entrepreneurship, Concept of Entrepreneurship, Development of entrepreneurship; Concept of entrepreneur, Manager and Intrapreneur (differences in their roles, responsibilities and Career Opportunities)

Module-2 Creativity and Entrepreneurial Plan (8 hours)

The business plan as an entrepreneurial tool, Contents of a business plan, Idea Generation, Screening and Project Identification, Creative Performance, Feasibility Analysis: Economic, Marketing, Financial and Technical; Project Planning: Evaluation, Monitoring and Control segmentation. Creative Problem Solving: Heuristics, Brainstorming, Synectic's, Value Analysis, Innovation. Project Feasibility and Project Appraisal.

Module-3 Corporate Entrepreneurship (8 hours)

Introduction, Flavors of corporate entrepreneurship, Corporate venturing, Intrapreneurship, organizational transformation, Industry rule bending, Need for corporate entrepreneurship, domain of corporate entrepreneurship, conditions favorable for Corporate entrepreneurship, benefits of Corporate entrepreneurship, issues related to Corporate entrepreneurship.

Module-4 Family and Non-Family Entrepreneur and Women Entrepreneurs (8 hours)

Role of Professionals, Professionalism vs family entrepreneurs, Role of Woman entrepreneur, Factors influencing women entrepreneur, Challenges for women entrepreneurs, Growth and development of women entrepreneurs in India.

Module-5 Small Scale Industry (8 hours)

SMALL SCALE INDUSTRY: Definition; Characteristics; Objectives; Scope; role of SSI in Economic Development. Advantages of SSI, Steps to start an SSI, Impact of Liberalization, Privatization, Globalization on S.S.I, Effect of WTO/GATT. Overview of detailed project report/profile. Startup India: Benefits, Policies. Action plan- simplification and Handholding, Funding Support and incentives, Industry-Academia Partnership and Incubation. Salient features of Karnataka Startup Policy 2015-2020, Strategies encouraging entrepreneurship through NAIN. Venture capitalist, SSI funding schemes by banks and financial institutions, Government of India Initiatives on Thrust Areas, Case studies on Indian Startups.

Course Outcomes: At the end of the course the student will be able to:	
21MEC6043.1	Identify your entrepreneurial traits.
21MEC6043.2	Identify the business opportunities that suits you.
21MEC6043.3	Use the support systems to zero down to your business idea.

21MEC6043.4	Develop comprehensive business plans.
21MEC6043.5	Prepare plans to manage the enterprise effectively.
21MEC6043.6	Develop project proposals to launch small scale enterprises.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Dynamics of Entrepreneurship Development	Vasant Desai	Himalaya Publication house	6, 2011
2	Entrepreneurship, New Venture Creation	Holt, David H.	Pearson Education India	1, 2016
3	Entrepreneurial Development	S.S. Khanka	S.Chand& Company Ltd. New Delhi	2012
4	Innovation and Entrepreneurship	Peter F. Drucker	Harper &Row	2006
Reference Books				
1	Entrepreneurship – Theory, Process and Practice	Donald F Kuratko	Cengage Learning	9, 2014.
2	Entrepreneurship	Rajeev Roy	Oxford University Press	2, 2011
3	Entrepreneurship theory at cross roads: paradigms and praxis	Mathew J Manimala	Dream tech	2, 2005
4	Entrepreneurship	Hisrich R D, Peters M P	Tata McGraw-Hill	8, 2013

Web links and Video Lectures (e-Resources):

- Entrepreneur.com https://www.entrepreneur.com/lists
- GOVT. SPONSORED SCHEMES https://www.nabard.org/content1.aspx?id=23&catid=23&mid=530
- NABARD – Information Centre https://www.nabard.org/interestrate.aspx?cid=502&id=24
- NABARD – What we Do https://www.nabard.org/whats-new.aspx
- Market Review http://www.businesstoday.in/markets
- Start Up India https://www.startupindia.gov.in/
- About – Entrepreneurship Development Institute of India EDII. http://www.ediindia.org/institute.html
- EDII – Centres http://www.ediindia.org/centres.html
- EDII – Publications http://www.ediindia.org/publication.html
- Business Plans: A Step-by-Step Guide https://www.entrepreneur.com/article/247574
- The National Science and Technology Entrepreneurship Development Board NSTEDB. http://www.nstedb.com/index.htm
- NSTEDB – Training http://www.nstedb.com/training/training.htm
- Tata Exposures http://www.tatasocial-in.com/project-exposure
- Thinking of Entrepreneurship https://www.sidbi.in/en
- NSIC Schemes and Services http://www.nsic.co.in/SCHSERV.ASP

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
21MEC6043.1	-	2	-	-	-	-	-	-	-	-	2	-	-	-
21MEC6043.2	-	-	-	-	-	2	-	-	-	-	2	-	-	-
21MEC6043.3	-	2	-	-	-	-	-	2	2	-	-	-	-	-
21MEC6043.4	-	2	-	-	-	-	-	-	-	-	2	2	-	-
21MEC6043.5	-	-	-	-	-	-	-	2	2	-	2	-	-	-
21MEC6043.6	-	-	-	-	-	-	-	-	-	2	2	2	-	-

1: Low 2: Medium 3: High

Statistical Quality Control			
Course Code	**21MEC6044**	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	3

Course Learning Objectives: The objective of the course is to

- To apprehend the purpose and function of statistical quality control and its improvements.
- To acquire the Measures of Dispersion and central tendency.
- To prepare students on identifying and plotting control charts for chance variations.
- Demonstrate an understanding of key concepts of process capability & performance.
- To prepare students on identifying and plotting control charts for assignable variations.
- To acquire knowledge on acceptance sampling methods & its applications.

Module-1 Introduction (8 hours)

The Meaning of Quality and Quality Improvement; Brief History of Quality Methodology; Statistical Methods for Quality Control and Improvement; quality costs, legal aspects of quality implementing, quality improvement. Mean, Median, Mode, Standard deviation, calculating area, Normal distribution tables, Finding the Z score and Central limit theorem

Module-2 Methods and Philosophy of Statistical Process Control (8 hours)

Chance and assignable causes, Statistical Basis of the Control Charts, basic principles, choices of control limits, significance of control limits, sample size and sampling frequency, rational subgroups, analysis of pattern on control charts, warning limits, Average Run Length (ARL)

Module-3 Control Charts for Variables and Process Capability (8 hours)

Control Charts for X-Bar and R- Charts, Type I and Type II errors, the probability of Type II error. Simple Numerical Problems. The foundation of process capability, Natural Tolerance limits, Process capability index, Process performance index, summary of process measures. Numerical problems.

Module-4 Control Charts for Attributes (8 hours)

Binomial distribution, Poisson distribution (from the point of view of Quality control) Control Chart for Fraction Nonconforming, Control Chart for number Nonconforming, Control Charts for Nonconformities or Defects, Control Chart for Number of non- conformities per unit. Numerical problems.

Module-5 Lot-By-Lot Acceptance Sampling for Attributes (8 hours)

The acceptance sampling problem, single sampling plan for attributes, Double, Multiple, and Sequential sampling, AOQL, LTPD, OC curves, the Dodge-Romig sampling plans. Numerical problems.

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

21MEC6044.1	Understand the concepts of quality management and apply central limit theorem to estimate population parameters from sample data.
21MEC6044.2	Analyze and improve processes using statistical control charts and interpret patterns to identify assignable causes.
21MEC6044.3	Use statistical process control and process capability analysis to identify opportunities for process improvement and implement changes to enhance process performance.
21MEC6044.4	Understand and implement control charts, monitor and improve product/service quality, and interpret results.
21MEC6044.5	Apply binomial and Poisson distributions to quality control, and solve numerical problems related to quality control.

21MEC6044.6	Apply sampling plans, evaluate operating characteristics, and solve acceptance sampling problems.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Total Quality Management	Poornima M Charantimath	Pearson	4, 2022
2	Introduction to Statistical Quality Control	Douglas C Montogmery	John Wiley & Sons	8, 2019
Reference Books				
1	Fundamentals of Quality Control and Improvement	Amitava Mitra	John Wiley & Sons	5, 2021
2	Design and Analysis of Experiments	Douglas C Montogmery	John Wiley & Sons	10, 2019

Web links and Video Lectures (e-Resources):

- https://alison.com/course/understanding-cost-of-quality-and-tqm-tools-revised-2018
- https://www.classcentral.com/course/swayam-total-quality-management-i-17825
- https://onlinecourses.nptel.ac.in/noc20_mg34/preview
- https://archive.nptel.ac.in/courses/110/104/110104080/
- https://onlinecourses.nptel.ac.in/noc21_mg24/preview
- https://www.udemy.com/course/statistical-quality-control-sqc/

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
21MEC6044.1	-	-	-	-	-	2	-	-	-	-	-	-	1	1
21MEC6044.2	-	-	-	-	-	1	-	-	-	-	1	-	1	-
21MEC6044.3	-	-	-	-	-	2	-	-	-	-	2	-	1	-
21MEC6044.4	-	-	-	-	-	2	-	2	-	-	-	-	-	-
21MEC6044.5	-	-	-	-	-	1	-	-	-	-	2	-	-	-
21MEC6044.6	-	-	-	-	-	2	-	2	-	-	-	-	-	2

1: Low 2: Medium 3: High

NON - DESTRUCTIVE TESTING			
Course Code	**21MEC6045**	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 principles and concepts of NDT methods and their applications.
- Familiarize with various NDT techniques, their equipment, procedures, and interpretation of results.
- Develop skills in conducting NDT methods and interpreting test indications.
- Apply NDT techniques for defect detection and material characterization, considering their advantages, limitations, and acceptance standards.

Module-1 Overview of NDT (7 hours)

Overview of NDT: NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterisation. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT., Visual inspection – Unaided and aided, Visual Inspection Equipment– Borescope, Flexible Fiber Optic Borescope , Endoscope, Video Imagescope.

Module-2 Surface NDT Methods (8 hours)

Liquid Penetrant Testing - Introduction, Principles, Equipment, Procedures, types and properties of liquid penetrants, developers, Evaluation, hazards, Precautions, applications, advantages and limitations of various methods, Testing Procedure, Interpretation of results.

Magnetic Particle Testing- Theory of magnetism, Principle of Magnetic Particle Testing , different methods to generate magnetic fields, Magnetic Particle Testing Equipment, Magnetic Particle Testing Procedures, Methods of De- Magnetization, Magnetic Particle Medium, Interpretation and evaluation of test indications, Evaluation of Indications and Acceptance Standards, magnetic particle test, applications, advantages and limitations, Residual magnetism.

Module-3 Thermography and Eddy Current Testing (E.T) (8 hours)

Thermography- Principles, Contact and non contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation - infrared radiation and infrared detectors, Instrumentations and methods, applications.

Eddy Current Testing - Principle, Generation of eddy currents, Properties of eddy currents, Factors Affecting Eddy Current Response : Material Conductivity, Permeability, Frequency, Geometry, Proximity (Lift off) , Elements of Eddy current testing, Types of Probes, Typical Applications, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, Advantages, Limitations, Interpretation/Evaluation.

Module-4 Ultrasonic Testing (U.T) and Acoustic Emission (A.E) (9 hours)

Ultrasonic Testing- Introduction, Principle, Type of Ultrasonic Propagation – Ultrasonic probes- Types of Transducers – Ultrasonic Testing Techniques, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Method for Evaluating Discontinuities, Ultrasonic Testing Procedures for different component, Applications in inspection of castings, forgings, Extruded parts, bars, pipes, rails and dimensions measurements, Time of Flight Diffraction. Acoustic Emission Technique, Principle, A.E parameters, Applications.

Design and develop a solution for practical problem using NDT methods.

Module-5 Radiographic Testing (R.T) (8 hours)

Principle of X – ray radiography, equipment and methodology, Type of Industrial Radiation sources and Applications, GAMA Ray and X – Ray Equipments, Radiographic Procedure, Radiograph Interpretation, Radiography Image Quality Indicators, Radiographic Techniques, Film Processing- film and film less techniques, Methods of Viewing Radiographs, Radiographic Testing Procedures for welds. Precautions against radiation hazards, Exposure charts, Radiographic equivalence, Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography.

Course Outcomes: At the end of the course the student will be able to:	
21MEC6045.1	Apply NDT methods for defect detection and material characterization using appropriate techniques and equipment.
21MEC6045.2	Perform visual inspection, liquid penetrant testing, magnetic particle testing, thermography, eddy current testing, ultrasonic testing, and radiographic testing with proficiency, interpreting and evaluating results accurately.
21MEC6045.3	Select suitable NDT methods based on material characteristics, defect type, and inspection requirements.
21MEC6045.4	Demonstrate knowledge of safety protocols, precautions, and radiation hazards associated with NDT techniques.
21MEC6045.5	Solve practical problems related to NDT by analyzing complex situations, identifying defects or material characteristics, and proposing appropriate NDT solutions.
21MEC6045.6	Communicate NDT concepts and evaluation of inspection results effectively.

Sl. No.	**Title of the Book**	**Name of Author/s**	**Name of the Publisher**	**Edition & Year**
Textbooks				
1	Non – Destructive Testing and Evaluation of Materials	J Prasad, C G K Nair,	Tata McGraw Hill Education Private Limited.	2, 2011
2	Practical Non-Destructive Testing	Baldev Raj, T.Jayakumar, M.Thavasimuthu	Narosa Publishing House,	2009
3	Non-Destructive Testing Techniques	Ravi Prakash	New Age International Publishers	1, 2010
4	Introduction to Nondestructive Testing: A Training Guide	Paul E. Mix	Wiley-Interscience	2,2005
Reference Books				
1	Non – Destructive Examination and Quality Control	American Metals Society,	Metals Hand Book, Vol. 17, Metals Park, OH, USA.	9, 1989.
2	Non – Destructive Evaluation: A Tool in Design, Manufacturing and Service, (Revised)	Bray, Don E and Stanley, Roderic K,	CRC Press New York,	1997.
3	ASM Metals Handbook: Non-Destructive Evaluation and Quality Control	ASM Metals Handbook	ASM International	Volume-17 1989

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc20_mm07/preview
- https://www.classcentral.com/course/fundamentals-of-non-destructive-testing-22815
- https://www.edx.org/course/fundamentals-of-non-destructive-testing
- https://www.udemy.com/course/non-destructive-testing-methods/
- https://www.twi-global.com/locations/india/courses/non-destructive-testing-online-live-courses
- https://www.youtube.com/watch?v=5cNWF61Tmj0&list=PLyAZSyX8Qy5AePdV6vbGP4OJ

QOpbga-0Q

- https://www.nde-ed.org/
- https://eis.hu.edu.jo/ACUploads/10526/Ultrasonic%20Testing.pdf
- https://www.hse.gov.uk/comah/sragtech/ndt2.pdf

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
21MEC6045.1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
21MEC6045.2	-	2	-	-	-	-	-	-	-	-	-	-	-	-
21MEC6045.3	-	-	-	-	2	-	-	-	-	-	-	-	-	-
21MEC6045.4	-	-	-	-	-	2	-	-	-	-	-	-	-	-
21MEC6045.5	-	-	-	-	-	-	2	-	-	-	-	-	-	1
21MEC6045.6	-	-	-	-	-	-	-	-	-	2	-	-	-	-

1: Low 2: Medium 3: High

Environmental Studies			
Course Code	**21CIV605**	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	1:0:0	SEE Hours	02
Total Hours	15 hours Theory	Credits	01

Course Learning Objectives: This course will enable

- To create environmental awareness among the students.
- To gain knowledge on different types of pollution in the environment.

Module-1 Introduction to Ecology **3 hours**

Ecosystems (Structure and Function): Forest, Desert, Wetlands, River, Oceanic and Lake. Biodiversity: Types, Value; Hot-spots; Threats and Conservation of biodiversity, Forest Wealth, and Deforestation.

Module-2 Energy Systems and Natural Resources **3 hours**

Advances in Energy Systems (Merits, Demerits, Global Status and Applications): Hydrogen, Solar, OTEC, Tidal and Wind.

Natural Resource Management (Concept and case-studies): Disaster Management, Sustainable Mining, case studies, and Carbon Trading.

Module-3 Environmental Pollution and Public Health **3 hours**

Environmental Pollution (Sources, Impacts, Corrective and Preventive measures, Relevant Environmental Acts, Case-studies): Surface and Ground Water Pollution; Noise pollution; Soil Pollution and Air Pollution.

Waste Management & Public Health Aspects: Bio-medical Wastes; Solid waste; Hazardous wastes; E-wastes; Industrial and Municipal Sludge.

Module-4 Environmental Concerns **3 hours**

Global Environmental Concerns (Concept, policies and case-studies): Ground water depletion/recharging, Climate Change; Acid Rain; Ozone Depletion; Radon and Fluoride problem in drinking water; Resettlement and rehabilitation of people, Environmental Toxicology.

Module-5 Environmental Management **3 hours**

Latest Developments in Environmental Pollution Mitigation Tools (Concept and Applications): G.I.S. & Remote Sensing, Environment Impact Assessment, Environmental Management Systems, ISO14001; Environmental Stewardship- NGOs. Field work: Visit to an Environmental Engineering Laboratory or Green Building or Water Treatment Plant or Waste water treatment Plant; ought to be Followed by understanding of process and its brief documentation.

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

21CIV605.1	Understand the principles of ecology and environmental issues that apply to air, land, and water issues on a global scale
21CIV605.2	Develop critical thinking and/or observation skills and apply them to the analysis of a problem or question related to the environment.
21CIV605.3	Demonstrate ecology knowledge of a complex relationship between biotic and abiotic component.
21CIV605.4	Apply their ecological knowledge to illustrate and graph a problem and describe the realities that managers face when dealing with complex issues.
21CIV605.5	Address problems related to waste management and public health aspects
21CIV605.6	Understand about the Standards and latest tools to mitigate pollution.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Environmental studies	Benny Joseph	Tata McGraw-Hill	Edition 3, 2018
2	Environmental Studies –From Crisis to Cure	R Rajagopalan	Oxford Uni-Press	Edition 3, 2020
Reference Books				
1	A Basic Course in Environmental Studies	Surinder Deswal, Anupama Deswal	DhanpatRai Publishing Co. (P) Ltd	2017
2	Text book of Environmental Studies for Undergraduate Courses	Bharucha Erach	Universities Press	Edition 2, 2017
3	Environmental Studies	Ranjit R. J Daniels, Jagdish Krishnaswamy	John Wiley & Sons Inc.	2010
4	Perspective in Environmental Studies	Anubha Kaushik, C P Kaushik	New Age International Pvt. Ltd	Edition 3, 2009

Web links and Video Lectures (e-Resources):

- Coursera Course: Introduction to Environmental Science Specialization - https://coursera.org/share/e6c3c98f7215fd49f688e7ede71a0dfc
- NPTEL: Environmental Studies - https://onlinecourses.swayam2.ac.in/cec22_ge22/preview
- Directory of Open Access Books (DOAB) -Environmental Leadership Capacity Building in Higher Education: Experience and Lessons from Asian Program for Incubation of Environmental Leaders : http://link.springer.com/openurl?genre=book&isbn=978-4-431-54339-8
- Lec 31: Environmental Management Systems (EMS) - https://youtu.be/BYqLRGawoH0
- ISO 14001:2015 Training - Environmental Management - https://youtu.be/2f4pBIvXkBs

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
21CIV605.1	0	0	0	0	0	1	3	0	0	0	0	0	0	0
21CIV605.2	0	0	0	0	0	0	3	0	0	0	0	0	0	0
21CIV605.3	0	0	0	0	0	0	3	0	0	0	0	0	0	0
21CIV605.4	0	0	0	0	0	0	3	0	0	0	0	0	0	0
21CIV605.5	0	0	0	0	0	2	3	1	0	0	0	0	0	0
21CIV605.6	0	0	0	0	1	0	0	2	0	0	0	0	0	0

1: Low 2: Medium 3: High

CIM and Automation Lab			
Course Code	**21MEL606**	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Practical	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	0:0:2	SEE	3 Hours
Total Hours	10 Lab slots	Credits	01

Course Learning Objectives: The objective of the course is to

- To expose the techniques of CNC programming and cutting tool path generation through CNC simulation software by using G-Codes and M-codes.
- To educate and expose the students on the usage of CAM packages like Cadem etc.
- To understand the importance of automation in industries through exposure to CNC machines, FESTO lab for Hydraulics and Pneumatics.
- To analyze the working of single and double acting cylinders through interfacing of FESTO Pneumatic and Electro Pneumatic Kit.
- To introduce Programmable Logic Controllers (PLC) trainer from FESTO and create simple ladder logic program.

PRACTICAL
LIST OF EXPERIMENTS

Sl.No	Experiments
1	Manual CNC part programming using ISO Format G/M codes for Turning and Milling parts. Selection and assignment of tools, correction of syntax and logical errors, and verification of tool path using CNC program verification software.
2	CNC part programming using CAM packages : Simulation of Turning simulations to be carried out using simulation packages like: Cadem / CAMLab-Pro / Master-CAM.
3	CNC part programming using CAM packages : Simulation of Drilling simulations to be carried out using simulation packages like: Cadem / CAMLab-Pro / Master-CAM.
4	CNC part programming using CAM packages : Simulation of Milling simulations to be carried out using simulation packages like: Cadem / CAMLab-Pro / Master-CAM.
5	Internal and external threading operations: Write a CNC program to create internal and external threading on a cylindrical block.
	Demonstration Experiments (For CIE)
6	FESTO Pneumatic Kit with PLC to operate a single acting cylinder and double acting cylinder.
7	FESTO Electro Pneumatic Kit with PLC to operate a single acting cylinder and double acting cylinder.
8	Introduction to PLC trainer and implement a simple ladder logic program using digital inputs and outputs for PLC using FESTO

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

21MEL606.1	Explain the importance of CIM in today's technology, its impact on market competition and demonstrate the use of CAM software (SeeNC turn and SeeNC mill).
21MEL606.2	Write CNC Lathe part program for Turning, Facing, Chamfering, Grooving, Step turning, Taper turning, Circular interpolation etc.
21MEL606.3	Write CNC Mill Part programming for Point to point motions, Line motions, Circular interpolation, Contour motion, Pocket milling- circular, Rectangular, Mirror commands etc.
21MEL606.4	Apply Canned Cycles for Drilling, Peck drilling, Boring, Tapping, Turning, Facing, Taper turning Thread cutting etc.

21MEL606.5	Analyze the working of single and double acting cylinder through interfacing of FESTO Pneumatic and FESTO Electro Pneumatic Kit.
21MEL606.6	Analyze implementation of ladder logic program for conveyor control system, DC motor and traffic light control system.

Sl. No.	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
Textbooks				
1	Automation, Production System and Computer Integrated Manufacturing	M.P.Groover	Person India	2nd Edition, 2007
2	Principles of Computer Integrated Manufacturing	S. Kant Vajpayee	Prentice Hall India	1 January 1998
3	Industrial Automation & PLC Programming Manual	Department Of Mechanical Engineering, St Joseph Engineering College Vamanjoor, Mangaluru	Department of Mechanical Engineering, St Joseph Engineering College Vamanjoor, Mangaluru	2023
4	Programmable logic controllers: Industrial control.	Kamel, Khaled, and Eman Kamel	McGraw Hill Professional	2013
5	Digital logic and computer design	Mano, M. Morris.	Pearson Education India	2017
Reference Books				
1	Computer Integrated Manufacturing	J.A. Rehg and Henry. W.Krabber	Prentice Hall	3rd Edition, 2005
2	CAD/CAM	Zeid	Tata McGraw Hill	2009
3	Fluid Power with Applications	Anthony Esposito	Pearson	7th Edition, 2008
4	Hydraulics and Pneumatics	Andrew Parr	Jaico Publishing House	First Edition 1993
5	Programmable Logic Controllers Basic Level	FESTO Didactic 093311 en	FESTO Didactic	-
6	Pneumatic Basic Level	FESTO Didactic 093131 en	FESTO Didactic	-
7	Electro-pneumatics Basic Level	FESTO Didactic 091181	FESTO Didactic	-
8	Handbook on Practical Guide to Programmable Logic Controllers	Handbook (Free e-Book)	www.automationdirect.com	-

Web links and Video Lectures (e-Resources):

Web links:-

https://saliterman.umn.edu/sites/saliterman.dl.umn.edu/files/general/cnc_mill_programming.pdf.
https://www.slideshare.net/moniraghu/cnc-milling-programs.
https://nptel.ac.in/courses/112105211
https://nptel.ac.in/courses/112102103
https://electrical-engineering-portal.com/resources/plc-programming-training
https://www.automationdirect.com/ebooks/plc-handbook
https://worldofinstrumentation.com/best-free-and-paid-resources-for-learn-plc-programming/
https://www.plcacademy.com/
https://instrumentationtools.com/plc-programming-course-online-free/

PLC Programming videos:-

https://www.youtube.com/channel/UCGGBHStSD53vAfiPSSDg8fw
https://www.youtube.com/watch?v=y2eWdLk0-Ho

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
21MEL606.1	2	-	-	-	3	-	-	-	-	-	-	-	-	-
21MEL606.2	2	-	-	-	3	-	-	-	-	-	-	-	2	-
21MEL606.3	2	-	-	-	3	-	-	-	-	-	-	-	2	-
21MEL606.4	2	-	-	-	3	-	-	-	-	-	-	-	-	-
21MEL606.5	2	-	-	-	-	-	-	-	-	-	-	-	-	-
21MEL606.6	-	-	-	-	-	2	-	-	2	-	-	-	-	-

1: Low 2: Medium 3: High

Operation Research			
Course Code	**21MEC607**	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

- To enable the students to understand the scientific methods of providing various departments of an organization with a quantitative basis of decision making.
- To enable the students to understand the importance of various tools and techniques in finding optimal solutions to problems involving limited resources in the form of Men, Materials and machinery.

Module-1 Introduction to OR (8 hours)

Evolution of OR, Definitions of OR, Scope of OR Applications of OR Phases in OR study. Characteristics and limitations of OR, models used in OR, Linear Programming Problem (LPP), Generalized LPP- Formulation of problems as L.P.P. Solutions to LPP by graphical method (Two Variables).

Module-2 Linear Programming Problems (8 hours)

Simplex method, Canonical and Standard form of LP problem, slack, surplus and artificial variables, Solutions to LPP by Simplex method, Big-M Method and two-phase Simplex Method, Degeneracy in LPP. Concept of Duality, writing Dual of given LPP. Solutions to L.P.P by Dual Simplex Method.

Module-3 Transportation Problems (8 hours)

Transportation Problem: Formulation of transportation problem, types, initial basic feasible solution using North-West Corner rule, Vogel's Approximation method. Optimality in Transportation problem by Modified Distribution (MODI) method. Unbalanced T.P. Maximization T.P. Degeneracy in transportation problems, application of transportation problem.

Module-4 Network Analysis (8 hours)

Network analysis: Introduction, Construction of networks, Fulkerson's rule for numbering the nodes, AON and AOA diagrams; Critical path method to find the expected completion time of a project, determination of floats in networks, PERT networks, determining the probability of completing a project, predicting the completion time of project; Cost analysis in networks. Crashing of networks-Problems.

Module-5 (8 hours)

Game Theory: Definition, Pure Strategy problems, Saddle point, Max-Min and Min-Max criteria, Principle of Dominance, Solution of games with Saddle point. Mixed Strategy problems. Solution of 2X2 games by Arithmetic method, Solution of 2Xn m and mX2 games by graphical method. Formulation of games.

Course Outcomes: At the end of the course the student will be able to:	
21MEC607.1	Report the concepts and applications of OR in academic literature from the perspective of engineering and society to enhance quality of life for the given syllabus as per the given format.
21MEC607.2	Analyze the different principle/ methodologies of LPP and demonstrate its application in project management & finance through sensitivity analysis.
21MEC607.3	Analyze different methodologies of Transportation Problems by obtaining the optimal solution from the perspective of social welfare by identifying ethical aspects through group activities.

21MEC607.4	Justify a decision or course of action in evaluating the Network Analysis problems through credible academic literature.
21MEC607.5	Apply the concepts of game theory for the given case study by demonstrating ethical aspects.
21MEC607.6	Report the advancement and research opportunities in the OR with credible academic literature and case studies.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Operations Research	P K Gupta and D S Hira	S. Chand and Company LTD. Publications, New Delhi	2017
2	Operations Research, An Introduction	Hamdy A. Taha	PHI Private Limited	Tenth Edition, 2019
Reference Books				
1	Operations Research, Theory and Applications	J K Sharma	Trinity Press, Laxmi Publications Pvt.Ltd.	Sixth Edition, 2016
2	Operations Research	A M Natarajan, P Balasubramani	Pearson Education,	2005
3	Introduction to Operations Research	Hillier and Lieberman	Tata McGraw Hill	9th Edition 2012

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/110/106/110106062/
- https://www.edx.org/course/operations-research-an-active-approach

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
22MEC607.1	-	-	-	-	-	1	-	-	-	-	-	-	-	1
22MEC607.2	-	-	-	-	-	-	-	-	-	-	2	-	1	-
22MEC607.3	-	-	-	-	-	1	-	1	-	-	-	-	-	-
22MEC607.4	-	-	-	-	-	-	-	-	-	-	3	-	-	2
22MEC607.5	-	-	-	-	-	-	-	1	-	-	-	-	1	-
22MEC607.6	-	-	-	-	-	1	-	-	-	-	-	-	-	1

1: Low 2: Medium 3: High

Innovation and Intellectual Property			
Course Code	**21IIP609**	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Practical	SEE Marks	-
		Total Marks	50
Teaching Hours/Week (L:T:P)	0:0:2	SEE	2 Hours
Total Hours	20 Hrs	Credits	-

Course Learning Objectives:

1. Learn how to use online databases and search tools for conducting patent searches.
2. Develop skills in analyzing patent documents and identifying relevant prior art.
3. Gain proficiency in evaluating the patentability criteria for engineering inventions.
4. Understand the principles of technology gap analysis and patentability search.
5. Understand the patent drafting and patent prosecution.

Module-1 Basics of Intellectual Property Rights (4 Hours)

Creativity, Invention, and Innovation – Introduction to Intellectual Property Rights-types and Importance – Overview of Patent Law – Intellectual Property Management and Commercialization – Emerging Issues in Intellectual Property – Case Studies and Practical Examples – Ethical and Social Considerations.

Activity: Trademark Design Challenge – IP Case Study Analysis

Module-2 Patent Landscape Analysis – Technology Gap Analysis (4 Hours)

Overview of Patent Databases and Search Tools – Keyword Searching, Classification Searching, and Citation Searching – Methods for Analyzing Patent Data: Patent Counts, Citation Analysis, and Patent Mapping – Technology Gap Analysis – Patent Portfolios – Portfolio Strength Assessment – Identification of Key Players – Competitive Intelligence and Market Analysis.

Activity: Conduct Patent Landscape Analysis for the Proposed Capstone Project.

Module-3 Patentability Assessment (6 Hours)

Significance of Patentability Assessment – Patentability Criteria: Novelty, Non-obviousness (Inventive Step), and Industrial Applicability/Utility – Prior Art Searching and Analysis (Keyword Searching, Classification Searching, and Citation Searching) – Non-Patent Literature Search and Other sources of Prior Art – Patentability Reports and Assessments – Case Studies and Practical Examples.

Activity: Conduct a Patentability Search for the Proposed Capstone Project.

Module-4 Patent Drafting and Prosecution (6 Hours)

Significance of Patent Drafting and Prosecution – Structure and Components of a Patent Application – Drafting of Patent Specifications, Claims, and Drawings – Overview of Patent Prosecution Process

Activity: Prepare a Patent Draft for the Proposed Capstone Project.

Course Outcomes: At the end of the course, the student will be able to:	
21IIP609.1	Demonstrate proficiency in utilizing various online databases and search tools for conducting patent searches.
21IIP609.2	Develop advanced skills in analyzing patent documents to identify relevant prior art, including patents, patent applications, and non-patent literature.
21IIP609.3	Demonstrate a comprehensive understanding of the patentability criteria, including novelty, non-obviousness, and utility.
21IIP609.4	Explain the principles and methodologies of technology gap analysis and its relevance to patentability searches.

21IIP609.5	Gain insight into the patent drafting process, including the structure and components of patent applications, and patent prosecution.
21IIP609.6	Apply the acquired knowledge and skills in conducting practical activities, such as conducting patent landscape analysis, patentability searches, and drafting patent applications, to solve real-world problems and challenges in the field of intellectual property rights.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Reference Books/Sources				
1	Intellectual Property-A Primer for Academia (For Module 1)	Rupinder Tewari Mamtha Bhardway	Publication Bureau, Panjab University Chandigarh India	2021
2	Patent Landscape Reports (For Module 2)	WIPO - World Intellectual Property Organization		https://www.wipo.int/patentscope/en/programs/patent_landscapes/
3	Guidelines for Preparing Patent Landscape Reports (For Module 2)	Anthony Trippe, Patinformatics, LLC	World Intellectual Property Organization (WIPO)	2015
4	Patent Searching - Tools and Techniques (For Module 3)	David Hunt	John Wiley & Sons Inc	First edition 2007
5	The Complete Patent Book_ Everything You Need to Obtain Your Patent (For Module 4)	James L. Rogers	Sphinx Publishing	First Edition 2003

Additional Resources:

1. WIPO Patent Drafting Manual - Second Edition 2023, https://www.wipo.int/edocs/pubdocs/en/wipo-pub-867-23-en-wipo-patent-drafting-manual.pdf
2. Patent Drafting for Beginners - https://elearn.nptel.ac.in/shop/nptel/patent-drafting-for-beginners/?v=c86ee0d9d7ed
3. The Office of the Controller General of Patents, Designs and Trade Marks, Government of India - https://www.ipindia.gov.in/
4. Copyright Office, Government of India - https://copyright.gov.in/
5. United States Patent and Trademark Office - https://www.uspto.gov/
6. Espacenet – patent search - https://worldwide.espacenet.com/
7. The Lens - Free & Open Patent and Scholarly Search - https://www.lens.org/

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21IIP609.1	2	-	-	-	3	-	-	-	-	-	-	1	-	-
21IIP609.2	2	-	-	3	-	-	-	-	-	-	-	1	-	-
21IIP609.3	3	-	-	-	-	-	-	-	-	-	1	-	-	-
21IIP609.4	2	-	3	-	-	-	-	-	-	-	-	-	-	-
21IIP609.5	1	3	-	-	-	-	-	-	-	-	-	2	-	-
21IIP609.6	-	-	-	-	2	-	-	-	-	-	-	3	-	-

1: Low 2: Medium 3: High

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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. (CSE, ECE, EEE, ME, CIV), MBA & MCA Accredited by NBA, New Delhi

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