Scheme and Syllabus of

V and VI semesters

B.E. Mechanical Engineering

2025-26

(160 Credits NEP-2 Batch)

Mechanical Engineering

Our Motto: Work is Worship

Institute Vision:

To develop thoughtful and creative young minds in a learning environment of high academic ambience by synergising spiritual values and technological competence.

Institute Mission

1. To continuously strive for the total development of students by educating them in state-of-the-art-technologies and managerial competencies providing best in class learning experience with emphasis on skills, values and learning outcomes and helping them imbibe professional ethics and societal commitment.

2. To create research ambience that promotes interdisciplinary research catering to the needs of industry and society.

3. To collaborate with premier academic and research institutions and industries to strengthen multidisciplinary education, applied research, innovation, entrepreneurship and consulting ecosystems.

Department Vision

To be one of the Premier Centre for technical education and applied Research in Mechanical Engineering and to bring out globally acclaimed competent engineers with innovative ideas and ethical values to fulfil the societal needs.

Department Mission

M1- Develop as a Centre of Excellence in Mechanical Engineering by Facilitating the state-of-the-art infrastructure, industry relevant curriculum and effective skill oriented teaching-learning -teaching process.

M2- Contribute to the development of Nation by preparing the younger generation to pursue research and development in the thrust areas of mechanical engineering such as thermal power engineering, Manufacturing engineering, Material science engineering, Mechanical Design, Product design and Management.

M3- To Prepare mechanical engineering graduates to be professionally competent with strong entrepreneurial, ethical and spiritual values to fulfil societal requirements.

Program Outcomes:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an 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 of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources and modern engineering and IT tools including prediction and 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 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)

PSO1: Mechanical Engineering graduates will be able to pursue research on Advanced Materials and Manufacturing, Thermal sciences, and Advanced Management concepts.

PSO2: Mechanical Engineering graduates will be able to Design and Develop various Mechanical Equipment's for general and Advanced Applications.

PSO3: Mechanical Engineering graduates will be able to use Interdisciplinary Modern I.T tools in various applications.

Program Educational Objectives (PEOs)

PEO-1 - Graduates of mechanical engineering are working as competent technical and managerial leaders in Design, Manufacturing, Materials, Thermal, Automation and Management fields.

PEO-2 - Graduates of mechanical engineering exhibit leadership qualities with strong communication skills and able to work in team or individually with professional and ethical values which leads to improvement in the performance of the organization.

PEO-3 - Graduates of mechanical engineering program are involved in professional practices addressing societal needs, environmental issues with life-long learning.

SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMAKURU

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B.E. in Mechanical Engineering

SCHEME OF TEACHING AND EXAMINATION (2022 Scheme) (For AY 2025-26)

V Semester

Sl. No.	Course and Course Code		Course Title	Teaching / Paper setting Dept.	Teaching hrs.					Evaluation Duration in Hrs.		Total No. of Hours	Examination			Credits
					Lecture	Tutorial	Practical/ Drawing	Study Hour	Term Work/ Self-Study				CIE Marks	SEE Marks	Total Marks	
					L	T	P	SH	TW/SS	CIE	SEE					
1.	HSMS	SHS03	Management and Entrepreneurship	ME	42	0	0	14	27	4	3	90	50	50	100	3
2.	IPCC	S5MEI01	Manufacturing Processes	ME	42	0	28	14	29	4	3	120	50	50	100	4
3.	PCC	S5ME01	Design of Machine Elements	ME	42	28	0	14	29	4	3	120	50	50	100	4
4.	PCCL	S5MEL02	Computer Numerical Control Lab	ME	0	0	28	0	0	3	3	34	50	50	100	1
5.	PEC	S5MEE0X	Professional Elective Course-I	ME	42	0	0	14	27	4	3	90	50	50	100	3
6.	PROJ	S5MEP01	Mini Project / Extension Survey Project	ME	0	0	56	0	0	3	3	62	100	-	100	2
7.	AEC	SHS04	Research Methodology and IPR **(Board: IEM)**	ME, IM, CH	42	0	0	0	41	4	3	90	50	50	100	3
8.	HSMS	SHS05	Environmental Studies **(Board: CV)**	CV	28	0	0	0	25	4	3	60	50	50	100	2
9.	AEC	ARAS	Aptitude Related Analytical Skill	T&P	0	0	28	0	0	3	1.5	32.5	50	50	100	1
10.	NCMC	SMC01	National Service Scheme (NSS)	NSS CO	0	0	28	0	0	2	-	30	100	-	100	0
		SMC02	Physical Education (PE) (Sports and Athletics)	PED												
		SMC03	Yoga	PED												
												Total	**600**	**400**	**1000**	**23**
		AAP	AICTE Activity Points (Applicable for both Regular and Lateral Entry students)	40 hours community service to be documented and produced for the examination												

Note: **HSMS:** Humanity and Social Science and management Course**IPCC**: Integrated Professional Core Course, **PCCL**: Professional Core Course laboratory, **PEC**: Professional Elective Course**; PROJ**: Project/Mini Project; **AEC**: Ability Enhancement Course; **NCMC**: Non-Credit Mandatory Course, **L**: Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation.

Professional Elective Course (PEC) (Offered by the Department)

S5MEE01	Fundamentals of Automobile Design (TATA Technologies)	S5MEE03	Hydraulics and Pneumatics
S5MEE04	Gas Dynamics & Propulsion	S5MEE05	Advanced Engineering Materials
S5MEE07	Surface Engineering and Coating Technology	S5MEE08	Sustainable Industrial Systems and Ergonomics

Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practical of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical

part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governing the Degree of Bachelor of Engineering (B.E.) 2022-23 may please be referred.

National Service Scheme /Physical Education/Yoga: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE)(Sports and Athletics), and Yoga(YOG) with the concerned coordinator of the course during the first Week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the Degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of Degree.

Mini-project work: Mini Project is a laboratory-oriented/hands on course that will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications etc. Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.

CIE procedure for Mini-project:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department, one of them being the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of the project report, project presentation skill, and question and answer session in the ratio of 50:25:25. The marks awarded for the project report shall be the same for all the batches mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all the guides of the project. The CIE marks awarded for the Mini-project, shall be based on the evaluation of the project report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

No SEE component for Mini-Project.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of Engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering a professional elective is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

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B.E. in Mechanical Engineering

SCHEME OF TEACHING AND EXAMINATION (2022 Scheme) (For AY 2025-26)

VI Semester

Sl. No.	Course and Course Code		Course Title	Teaching / Paper setting Dept.	Teaching Hours					Evaluation Duration in hrs.		Total No. of Hours	Examination			Credits
					Lecture	Tutorial	Practical/ Drawing	Study Hour	Term Work/ Self-Study	CIE	SEE		CIE Marks	SEE Marks	Total Marks	
					L	T	P	SH	TW/SS							
1.	IPCC	S6MEI02	Robotics & Automation	ME	42	0	28	14	29	4	3	120	50	50	100	4
2.	IPCC	S6MEI03	Finite Element Methods & Analysis	ME	42	0	28	14	29	4	3	120	50	50	100	4
3.	PEC	S6MEE0X	Professional Elective Course-II	ME	42	0	0	14	27	4	3	90	50	50	100	3
4.	OE		Open Elective Course-I	ME	42	0	0		41	4	3	90	50	50	100	3
5.	PROJ	S6MEP01	Major Project Phase I	ME	0	0	56	0	0	1	3	60	100	-	100	2
6.	PCCL	S6MEL02	Ideation and Skill Development Lab	ME	0	0	28	0	0	3	3	34	50	50	100	1
7.	NCMC	SHS06	Soft Skills (Additional Course offered by SIT)	T&P	0	28	0	0	0	2	-	30	100	-	100	0
8.	NCMC	SMC01	National Service Scheme (NSS)	NSS CO	0	0	28	0	0	2	-	30	100	-	100	0
		SMC02	Physical Education (PE) (Sports and Athletics)	PED												
		SMC03	Yoga	PED												
												Total	**550**	**250**	**800**	**17**
AAP			AICTE Activity Points (Applicable for both Regular and Lateral Entry students)	40 hours community service to be documented and produced for the examination												

Note: **IPCC**: Integrated Professional Core Course, **PCC**: Professional Core Course; **PEC**: Professional Elective Course**; OEC:** Open Elective Course; **PROJ:** Project Phase –I; **PCCL**: Professional Core Course laboratory; **AEC**: Ability Enhancement Course, **SEC**: Skill Enhancement Course; **NCMC**: Non Credit Mandatory Course; **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation.

Professional Elective Course (PEC) (Offered by the Department)			
S6MEE01	Advanced Automobile Design (TATA Technologies)	S6MEE02	Total Quality Management
S6MEE03	Additive Manufacturing	S6MEE04	Refrigeration and Air Conditioning
S6MEE05	Metal Forming Processes	S6MEE06	Artificial Intelligence and Machine Learning

Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practical of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governing the Degree of Bachelor of Engineering (B.E.) 2022-23 may please be referred.

National Service Scheme /Physical Education/Yoga: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE)(Sports and Athletics), and Yoga(YOG) with the concerned coordinator of the course during the first Week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the Degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of Degree.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of Engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering a professional elective is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

Open Elective Courses: Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor. The minimum numbers of students' strength for offering Open Elective Course is 10. However, this condition shall not be applicable to class where the admission to the program is less than 10.

Project Phase-I : Students have to discuss with the mentor /guide and with their help he/she has to complete the literature survey and prepare the report and finally define the problem statement for the project work.

V SEMESTER

B.E. Mechanical Engineering

Management And Entrepreneurship

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3
Total Lecture Hours:	40	CIE Marks:	50
Sub. Code:	SHS03	SEE Marks:	50

Course objectives: This course will enable students to:	
1.	Understand the principles and functions of management through planning.
2.	Analyze the importance of organizing and staffing in an organization
3.	Analyze the importance of leading and controlling in an organization
4.	Inculcate entrepreneurial qualities and understand the need of rural entrepreneurship
5.	Acquire knowledge about funding agencies, understand procedure in applying for funds and analyze the cases of successful entrepreneurs

UNIT I
Introduction to Management: Definition of management, management skills, productivity and effectiveness, efficiency, functions and principles of management. **Planning:** Nature of planning, types of plans- purpose of vision, mission, goals, objectives strategies, policies; steps in planning, MBO, Strategic planning.
7 Hours

UNIT II
Organizing: Formal and informal organization, span of management, the structure and Process of organizing, Organizational structure: line and staff organization, Functional organization, matrix organization. **Staffing:** Definition, systems approach to HRM, factors affecting staffing, recruitment and selection, job design, skill and characteristics of a manager, selection process and techniques
9 Hours

UNIT III
Leading: Human factors in managing, motivation, Theory X and Y, the hierarchy of needs theory, leadership behavior and styles. **Controlling:** Basic control process, critical control points and standards, Benchmarking requirements for effective control**.**
6 Hours
UNIT IV
Entrepreneur & Entrepreneurship: Introduction, concept of Entrepreneur, characteristics of an entrepreneur, and qualities of an entrepreneur, functions of an entrepreneur, characteristics of entrepreneurship, factors affecting entrepreneurial growth. Entrepreneurship and economic development-rural, woman and social entrepreneurship **Financing and Institutional Support for Entrepreneurship:** Startups, business plans, venture capitalists, angel investors, funding agencies -commercial banks, development banks, NBFCS and incubation centres. Innovations and project trends.
10 Hours

UNIT V
Taxation benefits: Depreciation allowances, rehabilitation allowance, investment allowance and other tax concession benefits to an entrepreneur. **Case studies: 1.** How Zomato is Leading in Foodtech? A Zomato Case Study Ola case study: The story of a Millionaire without a car
8 Hours

TEXT BOOKS		
1	Harold Koontz, Heinz Weihric	Essentials of Management, McGraw Hill Education, 10th Edition, 2015
2	Lucy C. Morse	Managing Engineering and Technology, Pearson Education, 6th Edition, 2015.
3	S.S. Khanka	Entrepreneurial Development, S. Chand Publishing, 4th Edition, Reprint 2020.ISBN 978-81-219-1801-5, 2021

REFERENCE BOOKS		
1	James A.F. Stoner, R. Edward freeman, Daniel R. Gilbert	Management, Pearson Education, 6th Edition, 2018

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	describe various functions of management
CO2	apply the knowledge of management principles and strategies in various functional areas such as organizing and staffing.
CO3	apply the knowledge of management principles and strategies in various functional areas such as Leading and Controlling.
CO4	describe entrepreneurship, its characteristics, and benefits and identify various funding sources for starting a business venture
CO5	interpret various taxation benefits enjoyed by an entrepreneur and analyze the characteristics and strategies adopted by successful entrepreneurs.

Course Articulation Matrix

		POs												**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
COs	**CO1**	3					1							3		
	CO2	3											3	3		
	CO3	3											3	3		
	CO4	3					2					2	3	3		
	CO5	3	3										3	3		

Manufacturing Processes

Contact Hours/ Week:	3+0+2 (L+T+P)	Credits:	4
Total Lecture Hours:	39(L) + 26(P)	CIE Marks:	50
Sub. Code:	S5MEI01	SEE Marks:	50

UNIT I

Manufacturing Process: Introduction to basic manufacturing, Classification of manufacturing process, Applications.

Metal Casting: Introduction about metal casting, Steps involved in making casting, Advantages and limitations, Applications. Pattern making: Functions of pattern. Classification of pattern, Different pattern materials, various pattern allowances in design of pattern, Simple problems on design of pattern using pattern allowances.

Moulding sand ingredients: Types of moulding sand, properties of moulding sand, Types of binders and its functions, various types of additives and its functions.

Moulding Processes: Green Sand moulding procedure, - Green, Dry, Loam, Skin dried moulding and CO2 Moulding. Core- definition, Types of Core and functions.

8 Hours

UNIT II

Gating System: Elements of gating system, Requirements of gating system, Factors considered for proper functioning of gating system, Objectives of gating system and defects due to improper design.

Risering: functions, increasing riser efficiency, Defects in casting: Introduction, Types of defects, causes and remedies Melting Furnaces: Types of furnaces, constructional features & working of Cupola, Induction furnace.

Special casting Processes: Shell moulding, investment casting, Gravity die casting, Pressure dies casting – Submerged plunger type die casting, Centrifugal casting – True centrifugal casting, Continuous casting

8 Hours

UNIT III

Welding Processes: Introduction to Joining & Welding Processes, Weldability, Classification of Welding Processes, Types of joints, welding positions and techniques, Metallic arc welding, Gas welding , Resistance welding- Spot welding, projection and seam. Solid state Welding-Friction, Explosive welding, Thermo chemical welding- thermit welding, TIG welding, MIG welding, advantages and applications. Metallurgical effects of welding: Metallurgical effects of welding, formation of different weld zones, defects in welding and remedies.

8 Hours

UNIT IV

METAL FORMING Introduction and concepts: Classification of metal working processes, characteristics of wrought products, advantages and limitations of metal working processes. Hot and Cold working processes and its effect on mechanical properties.

Forging: Introduction to forging, classification of forging methods– Smith, drop, pressforging, forging operations, Forging equipment- Board hammer, Power hammer, Mechanical press and Hydraulic press.

Rolling: Introduction, Classifications, Types of rolling mills, hot and cold rolling,defects in rolled products.

8 Hours

UNIT V

Extrusion and Drawing: Types of extrusion processes, Rod, wire and tube drawing, Wire drawing die.

Sheet metal Forming: Introduction, Sheet metal forming methods- Shearing and Blanking, Bending, Progressive forming, Rubber forming, Stretch forming, Spinning, Deep drawing, Dies – Progressive, Compound, combination dies.

7 Hours

TEXT BOOKS		
1	O.P Khanna	Foundry Technology, Dhanpat rai publications, 2003 reprint
2	P N Rao	Manufacturing Technology Volume 1 &2, 4th Edition McGraw Hill (India) Pvt. Ltd. 2014
3	G E Dieter	Mechanical metallurgy, Mc Graw- Hill Publication, 2001

REFERENCE BOOKS		
1	Swaroop Kalpak Jain, Steuen R. Schmid	Manufacturing Technology, Pearson Education Asia, 5th Ed.2006.
2	Richard W Heine, Carl R Loper, Philip C Rosenthal	Principles of metal casting, Tata Mc Graw-Hill Publication 2002

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Identify and Distinguish different types of manufacturing processes. Enumerate the types of pattern, moulding sand, additives, pattern allowances and Solve numerical problems on pattern allowances.
CO2	Apply the knowledge of gates and riser systems, suggest suitable moulding /casting technique for getting desired casting.
CO3	Identify and suggest suitable welding technique for joining similar and dissimilar materials for various engineering applications.
CO4	Identify the different Metal Forming Processes and Discuss the fundamentals of Forging and Rolling processes
CO5	Describe different Extrusion, Drawing and Sheet metal forming processes.

Course Articulation Matrix

		POs												**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
COs	**CO1**	**3**	**1**											**3**		
	CO2	**3**												**3**		
	CO3	**3**												**3**		
	CO4	**3**												**3**		
	CO5	**3**												**3**		

MANUFACTURING PROCESS LAB	
1	Testing of Moulding sand and core sand Preparation of specimen and conduction of the following tests: a. Compression, Shear and Tensile tests b. Permeability test c. Core hardness and mould hardness tests d. Grain fineness test e. Clay content test f. Moisture content test
2	Foundry Practice: Use of foundry tools and other equipments. Preparation of moulds (ready to pour) using two boxes. Use of Split pattern, Match plate pattern and Core
3	Smithy models Preparing one model involving upsetting, drawing and bending operations.
	26 Hours

SCHEME OF EXAMINATION

There will be 10 questions, two from each unit and the students have to answer 5 full questions choosing one question from each unit.

Design of Machine Elements

Contact Hours/ Week:	3+2+0 (L+T+P)	Credits:	4.0
Total Lecture Hours:	39 (L) + 26 (T)	CIE Marks:	50
Sub. Code:	S5ME01	SEE Marks:	50

Course objectives:

This course introduces the design procedures for various mechanical elements. Concepts applied in this course are from previous courses such as Strength of materials and Dynamics of Machinery. The course aims to give knowledge on design against static and fatigue loadings. The course addresses designing of welded joints, riveted joints, springs, shafts, couplings, brakes, fasteners and other machine components and limited to strength and rigidity-based design. From this course student will learn about the**:**

1.	Introduce basic concepts of design process
2.	Familiarize standard codes and practices to select materials and geometric parameters
3.	Impart design principles involved in evaluating the critical design parameters of machine elements to satisfy functional and strength requirements
4.	The student shall learn to choose proper materials for different machine elements depending on their physical and mechanical properties. They will learn to apply the knowledge of material science in real life situations.
5.	Student shall gain a thorough understanding of the different types of failure modes and criteria. They will be conversant with various failure theories and be able to judge which criterion is to be applied for a particular situation

UNIT I

Introduction: Design procedure, Codes and Standards, Theories of failure, Materials Selection.
Design against static load: Stresses due to bending and torsional moment, Eccentric axial loading, Design of simple machine parts.
Stress concentration: Reduction of stress concentration, Determination of Stress concentration factor. Combined Stress concentration factor.

8 (L) + 5(T) Hours

UNIT II

Introduction to fatigue: Types of Cyclic Stresses, Endurance Limit, S-N Diagram, Gerber, Soderberg, Goodman and modified Goodman criterion, Design against combined loads.
Introduction to Impact load: stress due to impact load, axial and bending.
Design of weld Joints: Types of Welded Joints, Failures, Parallel, Transverse, eccentric, bending welded joints

8 (L) + 5(T) Hours

UNIT III

Riveted Joints: types, failures of riveted joints, Efficiency, problems on lap and but joints and eccentric load on Rivet.
Design of Springs: types of springs, coil springs of circular cross sections. fluctuating loads, concentric springs,
Leaf Springs: Introduction, stresses in semi elliptical leaf springs. Equalized stresses.

8 (L) + 5(T) Hours

UNIT IV

Design of Shafts: ASME & BIS codes for design of shaft, Design of solid and hollow shaft under combined loads.
Couplings: Types, Design of Rigid Flange Coupling and Bushed-pin Flexible Coupling.
Design of Temporary Joints: Nuts and bolts.

8 (L) + 5(T) Hours

UNIT V
Brakes and Clutches Types of cones, Cone clutches and disc clutch, Types of brakes. block brakes, Internal expanding brakes and disc brakes. **Power screws:** Efficiency and self-locking, Design of power screws; design of screw jack (complete design)
8 (L) + 6(T) Hours

TEXT BOOKS		
1	V. B. Bhandari	Design of Machine Elements, Tata McGraw Hill Publishing Co. Ltd., New -Delhi.2020, 978-9390177479
2	Joseph Edward Shigley	Mechanical Engineering Design, Tata McGraw Hill, New Delhi 2006. 978-0073121932

REFERENCE BOOKS		
1	Robert L.	Machine Design Norton -Pearson Education Asia, New Delhi, 2001. 4the edition, 2010, 978-0-13-612370-5
2	Hall, Holowinko, Laughlin,	Theory and Problems of Machine Design, Schaums Outline Series, 2002. 978-0070255951
3	N. C. Pandey and C. S. Shah,	Elements of Machine Design , 2002 -Chorotar Publishing House. 2015, 9385039105

ONLNINE RESOURCES (DATA HANDBOOK)		
1	Dr. K. Lingaiah,	Design Data Hand Book Vol. l, Suma Publications, Bangalore.
2	K. Mahadevan & Balaveera Reddy,	Design Data Hand Book, CBS Publication.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	explain design process, select material and adopt design codes, standards and design a component to meet static and with stress concentration constraints
CO2	design machine elements to meet fatigue and impact stresses and design and analyze welded joints
CO3	design and analyze riveted joints, design and analyze helical and leaf springs for the given application.
CO4	design shafts and couplings for power transmission subjected to combined loading application.
CO5	design and analyze brakes, clutches and power screws for mechanical applications.

Course Articulation Matrix

		POs												**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
COs	**CO1**	2	2	2									**1**		2	
	CO2		3	3											2	
	CO3		3	3											2	
	CO4		3												2	
	CO5		3												2	

Computer Numerical Control Lab

Contact Hours/ Week:	0+0+2 (L+T+P)	Credits:	01
Total Lecture Hours:	26	CIE Marks:	50
Sub. Code:	S5MEL02	SEE Marks:	50

Course Objectives:

- To acquire basic understanding of CNC programming using G-codes and M-codes.
- To expose the students to the techniques of CNC programming and cutting tool path generation through CNC simulation software.
- To understand the different kinds of CNC machines and their working principles.
- To write CNC programs and simulate using software.
- Learn to operate CNC machines for turning and milling operations.

Part – A (CNC Turning)

1. Reading the Machining sketches, Types of Dimensioning.
2. Introduction to programming codes for turning.
3. CNC Programming and Simulation.
4. Setting up of workpiece zero position and machining in CNC Turning machine

Part – B (CNC Milling)

1. Introduction to programming codes for milling.
2. CNC Programming and Simulation.
3. Setting up of workpiece zero position and machining in Vertical 3 Axis CNC Milling machine.

REFERENCE BOOK:

1	Mikell P. Grover	Automation Production Systems and Computer Integrated Manufacturing, PHI, 2004.
2	S. Kant Vajpayee	Principles of Computer Integrated Manufacturing, Prentice Hall India

Course Outcomes:

Upon undergoing this course the students are able to:

1) Generate CNC Lathe and Mill part programs involving different operations using different motion control systems with the help of CAM Packages.
2) Simulate Tool Path for different machining operations on small components using CAM Packages for CNC Lathe & CNC Milling Machines.
3) Analyze the usage of material and machine to optimize the time required for machining the components using suitable programs.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	POG	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3		3					2				3
CO2	3	3	3		3					2				3
CO3	3	3	3		3					2				3

CIE Marks:

For laboratory component: CIE marks for the practical course is computed by adding the average of the marks secured by the student for conducting each of the experiments with the marks secured in the test conducted at the end of the semester and also the marks secured for the open-ended experiments at the end of the course, if any.

Details	*Marks*
Regular Lab Work and writing lab records	(20+15) 35 marks
Lab test and Viva-voce at the end of the semester	(10+5) 15 marks
TOTAL	**50 marks**

SEE Marks:

ONE question from Turning operation (Part-A): **20 Marks**

ONE question from Milling operation (Part-B) : **20 Marks**

Viva Voce: **10 Marks**

Total: 50 Marks

Fundamentals of Automobile Design

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3
Total Lecture Hours:	39 hours	CIE Marks:	50
Sub. Code:	S5MEE01	SEE Marks:	50

Course objectives: This course will enable students to:	
	Design principles through historical examples
	Industrial design process from concept to production and utilize design studios for creative development.
	Computer-aided styling (CAS) for Class-A surface creation, and dives deep into BIW structure, components, and a detailed bonnet design case study with CAE analysis.
	Sheet metal formability, analyze manufacturing processes, and design and apply sheet metal forming dies.

UNIT I

AUTOMOTIVE DESIGN and DEVELOPMENT CYCLE

Introduction to Design, Good Design, good design examples of all time.

INDUSTRIAL DESIGN

Introduction to industrial design, application of Industrial Design, Product Life cycle, Automotive Design process Design Process for production release.

DESIGN STUDIO PROCESS

Product Conceptualization process, Case study.

7 Hours

UNIT II

CLASS A SURFACES

Introduction to Styling, Computer Aided Styling, Surfaces or Digital Clay Models, CAS Surfaces, Role of Class A Surface Engineer, Requirements for a surface to fulfil "Class A surface" Standards, Case Studies for Class A surfaces, Step by Step Process for Bonnet Class A surface Creation.

7 Hours

UNIT III

DESIGN and DEVELOPMENT of AUTOMOTIVE COMPONENTS

Introduction to Body in White (BIW): Various types of BIW, Types of BIW sub systems, various aggregates of BIW.

BONNET DESIGN CASE STUDY

Function of a bonnet, Inputs for the bonnet. Steps in Bonnet design-develop Hood Package Layout, develop typical sections, Define Block Surfaces in 3D, Dynamic Clearance Surfaces in 3D and Hood Structural Members. CAE 1 (Durability, Crash), Panel Detail Design, Define Body Assembly Process, CAE 2 (Durability, Crash, Individual Panel level), Design Updating and Detailing prototypes, Design Updating and Production Release.

9 Hours

UNIT IV

STEEL METAL FORMABILITY

Sheet metal design and manufacturing cycle, Simultaneous Engineering (SE) feasibility study, Autobody and its parts, important constituents of an automobile, Sheet metal processes, Spring back Force, Spring back allowance.

7 Hours

UNIT V

DIE DESIGN

Sheet metal parts and their operation like cutting, non-cutting etc., Presses, Various elements used in die design. Different types of dies, Animations describing the working of dies.

FIXTURE DESIGN Welding operations (Spot/Arc welding), Body coordinates, Location, 3- 2-1 principle, Fixture design, factors for design Consideration. Application of GD&T in Fixture design, Fixture Elements. Operations in sheet metal Fixture (Manual/Pneumatic/Hydraulic fixture). Design of Sheet metal parts (Rest/Clamp/location/Slide/Dump units/base), Types of Fixtures (Spot welding/Arc welding/Inspection Fixture/Gauges).
9 Hours

TEXT BOOKS		
1	Donald E. Malen	Fundamentals of Automobile Body Structure Design, 2nd Edition R-505. Published by SAE International with a Product Code of R-505, ISBN of 978-1-4686-0174-9, 2023
2	L. Morello, Lorenzo Rosti Rossini, Giuseppe Pia, Andrea Tonoli	The automotive body, Volume I : components Design, Springer Science & Business Media, ISBN: 9400705131, 9789400705135, 2011
3	L. Morello, Lorenzo Rosti Rossini, Giuseppe Pia, Andrea Tonoli	The automotive body, Volume II: Systems Design, Springer Science & Business Media, ISBN: 9400705166, 9789400705166, 2011

REFERENCE BOOKS		
1	Julian Happian- Smith, Elsevier	An Introduction to Modern Vehicle Design, Edited Julian Happian-Smith, Elsevier, 2004, ISBN: 0750650443, 9780750650441
2	Michael Grieves	Product Lifecycle Management 1st Edition, Michael Grieves, McGraw-Hill, ISBN: 9780071452304, 0071452303, Edition, 1st, 2005
3	Kalpakjian	Manufacturing Processes for Engineering Materials, Kalpakjian, Pearson Education India, 2009, ISBN: 8131702456, 9788131702451

ONLNINE RESOURCES	
1	http://myigetit.com/ Study MaiGet- IT (a proprietary product from Tata technologies Tata technologies (Ready Engineering Programme)

Course Outcomes:
Upon completion of this course the student will be able to:

CO1	identify key design examples, describe industrial design applications & outline the automotive product lifecycle
CO2	describe Class-A surface role & requirements, apply CAS techniques & create a bonnet Class-A surface using case studies.
CO3	outline bonnet design steps, develop 3D dynamic clearance surfaces & describe body assembly considering durability & crash (use case studies).
CO4	describe sheet metal design & manufacturing cycle, evaluate simultaneous engineering feasibility in sheet metal formability & identify key autobody constituents.
CO5	design sheet metal parts for specific operations, describe press types & die design elements, describe various dies with examples & develop fixture designs for welding.

Course Articulation Matrix

		POs												**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
COs	**CO1**	1	1									1			2	
	CO2	1	2								1			1		
	CO3	1	2								1	1			2	
	CO4	1	1									1				
	CO5	1	1								1	1		1		

Hydraulics and Pneumatics

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3.0
Total Lecture Hours:	39	CIE Marks:	50
Sub. Code:	S5MEE03	SEE Marks:	50

Course objectives:
The course provide student with knowledge on the application of fluid power in process, construction and manufacturing Industries and to know the fundamental principles, design and operation of hydraulic and pneumatic machines, components and systems and their application in recent automation revolution. The course imparts understanding of the fluids and components utilized in modern industrial fluid power systems and develops a measurable degree of competence in the design, construction and operation of fluid power circuits. It also emphasizes basic theory, components sizing, construction and function, how to read pneumatics and fluid power circuit diagrams using the correct symbols and troubleshooting techniques.

UNIT I

Introduction to Pneumatic control: Gas law, Choice of working medium, characteristics and Production of compressed air- Compressors, Preparation of compressed air- Driers, Filters, Regulators, Lubricators and Silencers. Structure of Pneumatic control system.
Pneumatic Circuit Design and Analysis: Use of logic gates- OR and AND gates in pneumatic applications. Practical examples involving the use of logic gates. Pressure dependent controls, Time dependent controls-Principle, Electro-Pneumatic control: Principles-signal input and output pilot assisted solenoid control of directional control valves, use of relay and contactors. Control circuitry for simple single cylinder applications.

7 Hours

UNIT II

Introduction to Hydraulic power: Pascal's law and problems on Pascal's Law, conversion of units. Structure of fluid power system. The Source of hydraulic power- classification and constructional features (gear pump, vane pumps and piston pumps). Pump selection and performance. Problems on performance of pumps.
Hydraulic Motors and Actuators: Hydraulic motors: Constructional features and performances (gear motor, vane motors and piston motors). Problems on performance of motors. Hydraulic Actuators: Constructional features, Mounting arrangements and Mechanics of cylinder loading.

8 Hours

UNIT III

Control Components in Hydraulic Systems:
Directional Control Valves – Classification, constructional features and symbolic representation.
Pressure control valves – Constructional features and symbolic representations (Pressure relief valve, pressure reducing valves, sequence valves and counter balance valve).
Flow control valves – Constructional features and symbolic representations (Needle valve, Pressure compensated flow control valve and Pressure & temperature compensated flow control valve).

8 Hours

UNIT IV

Hydraulic Circuit Design and Analysis: Control of single and double acting hydraulic cylinders. Regenerative circuit, counterbalance valve circuit, cylinder sequencing circuits. Hydraulic cylinder and motor synchronizing circuits, automatic cylinder reciprocating circuit. Speed control of hydraulic actuators, Fail Safe Circuits. Circuit for rapid advance, slow feed and

rapid return, Microprocessor control in Hydraulic system, Servo controlled extrusion press circuit.

8 Hours

UNIT V

Maintenance of Hydraulic systems: Hydraulic fluids; desirable properties, types of fluids. Sealing devices (types and materials used), reservoir system, filters (types, materials used and filter locations). Wear of moving parts due to solid particle contamination and trouble shooting.
Hydraulic Servo Technique-Function of a Hydraulic system, Mechanical Feed back and Application of Tracer value, Feedback in the system, Electro-hydraulic Servo System, Types of servo valves, Special Servo valve features

8 Hours

TEXT BOOKS

1	Anthony Esposito	'Fluid Power with applications', Fifth edition, Pearson Education, Inc, 2020
2	James L. Johnson	Introduction to Fluid Power', Thomson Learning, 2021
3	S.R. Majumdar	Pneumatic Systcms ', Tata McGraw Hill Publishing Co., 2020

REFERENCE BOOKS

1	S.R. Mujumdar	'Oil Hydraulic Systems -Principles and Maintenance', Tata McGraw Hill Publishing Company Ltd. ,2021
2	Peter Croser & Frank Ebel	Pneumatics Basic Level TP 101', by Peter Festo Didactic publication* - 2020

ONLNINE RESOURCES

1	https://www.udemy.com/course/introduction-of-hydraulics-and-pneumatics/
2	https://moodle.skillscommons.org/course/view.php
3	https://www.wisc-online.com/learn/technical/hydraulics-pneumatics
4	https://www.classcentral.com/course/swayam-oil-hydraulics-and-pneumatics

Course Outcomes: Upon completion of this course the student will be able to:

CO1	identify the pneumatic components, their symbol & usage, and to illustrate the Working of pneumatic control valves, circuits and their operation.
CO2	apply Pascal's law to hydraulic systems. Selecting pumps and analyzing them for given application and functional requirements of a power transmission system
CO3	identify, analyze and selecting based on functional requirements for a given application by knowing the working principle of hydraulic control valves.
CO4	design and understand the hydraulic circuits by choosing appropriate components, analyzing and arrangement of components used in hydraulic systems for intended usage and to visualize how the hydraulic/pneumatic circuit will work to accomplish the function
CO5	describe and solve common maintenance problems of components and interpret the working principle of Servo and Proportional valves.

Course Articulation Matrix

		POs												PSOs		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
COs	**CO1**	2													2	
	CO2	2													2	
	CO3		2												2	
	CO4		2												2	
	CO5	2													2	

Gas Dynamics and Propulsion

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3.0
Total Lecture Hours:	39	CIE Marks:	50
Sub. Code:	S5MEE04	SEE Marks:	50

Course objectives:
This course will enable students to:

	Understand fundamental concepts of compressible flows.
	Derive the equations for steady one-dimensional isentropic flow & Area-Mach number relations.
	Discuss the effects of friction and heat transfer on compressible flows through constant area duct.
	Understand the occurrence of shocks and calculate property changes across a Normal shock wave.
	Understand various classifications of propulsive devices and the working of air-breathing and non-air-breathing engines.

UNIT I

Fundamentals of Compressible Flows
Energy equation for a non-flow process, flow process, the adiabatic energy equation, Stagnation velocity of sound, Mach number and its significance, Stagnation Pressure, Temperature, Density and Enthalpy, Reference velocities, Effect of Mach number on compressibility. Various regions of flow, Wave propagation -Mach cone and Mach angle**.**

8 Hours

UNIT II

One Dimensional Isentropic Flow
Comparison of isentropic and adiabatic processes (compression and expansion), one dimensional isentropic flow in ducts of varying cross section- nozzles and diffusers, operation of nozzles under varying pressure ratio, mass flow rate in nozzles, critical properties and choking, area ratio as function of Mach number, shock waves in nozzles, discharge coefficients, and nozzle calculations, Working charts and gas tables, Numericals.

8 Hours

UNIT III

Wave Phenomenon-Normal Shock
Development of Normal shock waves, governing equations, Prandtl-Mayer relation, Rankine-Hugoniot relation, Mach number in the downstream of normal shock, variation of flow parameters across the normal shock (oblique shocks-concept only) Numericals on Normal Shocks.
Brief explanation with a sketch of development of oblique shock waves and Prandtl-Mayer expansion fan(or supersonic expansion fan).

7 Hours

UNIT IV

Flow in constant area duct with friction (Fanno flow): Fanno curve and Fanno flow equations, solution of Fanno flow equations, variation of flow properties, variation of Mach number with duct length, isothermal flow in constant area duct with friction (no problems on isothermal flows), tables and charts for Fanno flow**.**
Flow in constant area duct with heat transfer (Rayleigh flow): Simple heating relation of a perfect gas, Rayleigh curve and Rayleigh flow equations, variations of flow properties, maximum heat transfer, tables and charts for Rayleigh flow.
Numericals on Fanno and Rayleigh flows

8 Hours

UNIT V
Broad classification of propulsion systems, air-breathing and non-air-breathing engines. **Aircraft Propulsion Devices**: Classification of Aircraft engines, Piston-Prop, Turbojet, Turboprop, Turbofan, Ramjet and scramjet engines. **Rocket Propulsion Devices:** Types of rocket engines, Solid, Liquid and Hybrid Rockets. Comparison of rocket engines.
8 Hours

TEXT BOOKS		
1	Balachandran P.	Fundamentals of Compressible Fluid Dynamics, PHI Learning India Private Ltd., 2006.
2	S M Yahya	Fundamentals of Compressible Flows, New Age International Publishers, Sixth Edition, 2019.

REFERENCE BOOKS		
1	V. Babu	Fundamentals of Propulsion, ANE Books, 2009.
2	Robert D. Zucker and Oscar Biblarz	Fundamentals of Gas Dynamics, 2nd Edition, John Wiley and Sons, INC.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	**Apply the** basic concepts of thermodynamics and fluid mechanics to **solve** basic compressible fluid flow problems.
CO2	**Identify**, **formulate, and analyze** basic conservation equations to relate flow properties to the Mach number and area ratio to **solve** problems related to steady and 1-D isentropic flows.
CO3	**Identify**, **formulate, and analyze** basic conservation equations by considering friction and heat transfer to relate flow properties to the Mach number and **solve** related problems.
CO4	**Identify and analyze** conditions that result in normal shock formation to formulate the basic conservation and Prandtl Meyer equations to solve problems finding flow properties across the shock.
CO5	**Describe** the various propulsion devices used in aerospace applications.

Course Articulation Matrix

		POs												**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
COs	**CO1**	**3**												2		
	CO2		**3**											2		
	CO3		**3**											2		
	CO4		**3**											2		
	CO5	**2**												1		

Advanced Engineering Materials

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3.0
Total Lecture Hours:	39	CIE Marks:	50
Sub. Code:	S5MEE05	SEE Marks:	50

Course objectives:

Knowledge of Advanced Materials, its properties and applications are very important for all engineers. Knowledge of materials characteristics is very important for design and manufacturing a component and this forms the basic for any mechanical / manufacturing industry. The main objective of this course is to impart knowledge about materials and its characterization. It is useful in mechanical design, analysis, development, research, process planning, production planning and controlling activities of an industry. By studying this course student will learn;

1.	About various types of conventional and advanced materials.
2.	The mechanical properties of these materials.
3.	Applications of these materials with reference to their specific characteristics.
4.	About the advanced materials and their unique characteristics and their application.

UNIT I

Ferrous Materials: Fe-C phase diagram, steel, low carbon steel, dual phase steels, mild steels, micro-alloyed steels, weathering steels, free cutting steels, medium carbon steels, high strength structural steels, ausformed steels, martensitic stainless steels, austenitic stainless steels, properties and applications.

Cast Iron, Gray C I, White C I, Malleable C I, Nodular C I or Ductile Iron, Vermicular Graphite Iron, properties and applications.

7 Hours

UNIT II

Cu and Cu-alloys: Copper, Brass, Bronze, Nickle Silver, Cu-Ni alloys, Gun Metal

Aluminium and its Alloys: Aluminum, cast aluminum alloys, wrought aluminum alloys.

Ti and its alloys: α-Ti, β-Ti, (α+β)-Ti,

Mg and its alloys: Mg-Al, Mg-Zn, Mg-Rare Earth, Mg-Thorium alloys.

Super alloys: Ni, Fe and Co based super alloys, properties and applications.

8 Hours

UNIT III

Tool Materials – Classification, properties, heat treatment of high speed steel, medium duty tools, tools for cold and hot forming, tools for high speed cutting.

Bio-Materials: Bio compatibility, Applications, properties and applications.

Magnetic Materials: Magnetic fields, types of magnetism, soft magnetic materials, hard magnetic materials, properties and applications.

7 Hours

UNIT IV

Polymeric Materials: Thermoplastics, Thermosetting plastics.

Semi-conducting Materials: Intrinsic and extrinsic semi conduction, The Hall effect, semiconductor devices, properties and applications.

Superconducting Materials: Meissner effect, current flow and magnetic fields in superconductors, high critical temperature superconducting oxides

8 Hours

UNIT V
Smart Materials: Classification, piezoelectric, electrostrictive, magnetostrictive, rheological materials, smart gels, chromic materials, thermoresponsive materials, Working Properties of Smart Materials, Applications of Smart Materials
8 Hours

TEXT BOOKS		
1	W.F. Smith	Principles of Materials Science and Engineering, Mc Graw Hill, New York (2010)

REFERENCE BOOKS		
1	W.D. Callister	An Introduction to Materials Science & Engineering, John Wiley & Sons (2007)
2	V. Raghavan	Material Science and Engineering, Prentice Hall of India, 2004.
3	R. Sharma, Sharma	Heat Treatment: Principles and Techniques, Prentice Hall of India (2004)
4		Research Papers related to topics published in various journals.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	**determine** and **distinguish** the various types of conventional and advanced materials.
CO2	**define and describe** the various mechanical properties and its importance with reference to applications.
CO3	**describe** the importance of materials and their characteristics.
CO4	**analyze** the properties exhibited by materials and its suitability in a manufacturing industry.
CO5	will be able to **analyze** and **evaluate** the importance of various materials and its applications in industry.

Course Articulation Matrix

		POs												**PSOs**		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
COs	CO1	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-
	CO2	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-
	CO3	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-
	CO4	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-
	CO5	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-

Surface Engineering & Coating Technology

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3.0
Total Lecture Hours:	39	CIE Marks:	50
Sub. Code:	S5MEE07	SEE Marks:	50

Course objectives: This course will enable students to:	
1.	Introduce students to the principles, importance, and scope of surface engineering in enhancing the performance of engineering materials.
2.	Familiarize students with various surface preparation techniques and coating technologies.
3.	Develop a thorough understanding of metallic, thermal, vapor phase, and diffusion coatings.
4.	Provide insight into advanced surface modification methods and their industrial relevance.
5.	Equip students with the ability to evaluate and select appropriate surface engineering techniques for specific applications.

UNIT I
Surface engineering: Introduction to surface engineering, Scope of surface engineering for different engineering materials, Surface Preparation methods such as Chemical, Electrochemical, Mechanical: Sand Blasting, Shot peening, Shot blasting, Hydro-blasting, Vapor Phase Degreasing etc., Coatings: Classification, Properties and applications of Various Coatings.
8 Hours
UNIT II
Metallic coating: Hot Dipping, Galvanizing, Electrolytic and Electro less plating: Methodology used, mechanisms, important reactions involved, Process parameters and applications. Testing/ evaluation of metallic coatings.
8 Hours
UNIT III
Coating from Vapour Phase: PVD, and CVD: Various Methods used, mechanisms, important reactions involved, Process parameters and applications. Different methods for surface modification: Surface modification by use of directed energy beams, Plasma, Sputtering & Ion Implantation. Surface modification by Friction stir processing. Surface composites.
8 Hours
UNIT IV
Thermal spray coatings: Processes, Types of spray guns, Comparison of typical thermal spray processes, Surface Preparation, Finishing Treatment, Coating Structures and Properties, Applications.
8 Hours
UNIT V
Diffusion Coating: Carburizing, Carbonitriding, Siliconizing, Chromizing, Aluminizing, Boronizing, Boronitriding: Various Methods used, mechanisms, important reactions involved, Process parameters and applications.
8 Hours

TEXT BOOKS		
1	Roy, J. et al.	"Advanced Surface Coating Techniques for Modern Industrial Applications" IGI Global, 2022, **ISBN**: 9781799888944
2	J. Paulo Davim	"Surface Engineering Techniques and Applications: Research Advancements", IGI Global, 2023, **ISBN**: 9781668447582

3	Abdel Salam Hamdy Makhlouf	"Handbook of Smart Coatings for Materials Protection" (2nd Edition), Elsevier, 2023, **ISBN**: 9780323984157

REFERENCE BOOKS		
1	Ashutosh Tiwari, Lokman Uzun	Surface Engineering and Coatings: Advanced Techniques and Applications, Wiley-Scrivener, 2020, **ISBN**: 9781119555209
2	Robert B. Heimann	Thermal Spray Coatings: Properties, Processing, and Applications, Wiley-VCH, 2022, **ISBN**: 9783527349751
3	Vikas Mittal	Green Surface Coatings: Environmental-Friendly Approaches, Wiley-Scrivener, 2021, **ISBN**: 9781119620518

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	**Analyze** the suitability of specific surface engineering techniques for improving performance, durability, and wear/corrosion resistance of components in different engineering applications.
CO2	**Explain** the mechanisms and chemical reactions involved in various metallic coating techniques.
CO3	**Compare** and **contrast** various vapor phase coating methods based on their process parameters and applications.
CO4	**Identify** and **compare** different types of spray guns and thermal spray processes based on their working mechanisms and applications.
CO5	**Explain** the mechanisms and key chemical reactions involved in each diffusion coating method.

Course Articulation Matrix

		POs												**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
COs	**CO1**	3	2			2							2	3		
	CO2	3	2			2							2	3		
	CO3	3	2			2		2					2	3		
	CO4	3	2			2		2					2	3		
	CO5	3	2			2							2	3		

Sustainable Industrial Systems and Ergonomics

Contact Hours/ Week	: 3+0+0 (L+T+P)	Credits :	3.0
Total Lecture Hours	: 39	CIE Marks :	50
Course Code	: S5MEE08	SEE Marks :	50

Course Objectives:

1. To understand the principles of sustainable industrial engineering and their application in modern manufacturing systems.
2. To analyze and design work systems that optimize human well-being and overall system performance.
3. To integrate ergonomic principles into the design of products, tools, and workplaces for improved safety and efficiency.
4. To evaluate environmental, economic, and social impacts of industrial systems using sustainability metrics.
5. To apply lean, green, and ergonomic practices for waste reduction, resource optimization, and enhanced productivity.
6. To develop skills in analyzing work methods, measuring work performance, and conducting ergonomic assessments.
7. To foster a systems-thinking approach in designing sustainable and human-centered industrial environments.
8. To prepare students for industry challenges in ergonomics, occupational health, and sustainable manufacturing.

UNIT-I

PRODUCTIVITY & WORK STUDY: Introduction, Definition of productivity, factors affecting productivity, definition, objective & scope of work study,Basic procedure, human factors in work study, work study & management, work study & supervisor, work study & worker.

08Hrs

UNIT-II

METHOD STUDY

Introduction, Definition, objective & scope, charts to record movements in shop, process charts, flow process charts (Man and Machine type), Multiple activity charts, two handed process charts, Micro motion study, SIMO chart, principles of motion economy. **08Hrs**

UNIT-III

WORK MEASUREMENT

Definition, objectives, Basic procedure, techniques of work measurement, work sampling, need of confidence levels, sample size determination, Procedure for selecting random observation, Uses of work sampling, Predetermined time standards, different forms of PTS System, Uses of PTS system. simple problems. **08 Hrs**

UNIT-IV

TIME STUDY

Definition, time study equipment, Basic steps, selection of jobs, steps in time study, breaking jobs into elements, recording information, rating, standard performance, scales of rating, factors affecting rate of working, allowances, Calculation of allowances, standard time determination.

08Hrs

UNIT-V

INTRODUCTION TO INDUSTRIAL DESIGN

elements of design structure for industrial design in engineering application in modern manufacturing systems. Ergonomics and Industrial Design: Introduction, general approach to the man-machine relationship, workstation design-working position. **07Hrs**

TEXTBOOKS:

1	Work studay	Work study, ILO, 3rd edition, 2006, 3rd Revised Indian Edition published in 2015 by Oxford & IBH Publishing.
2	Human Factor Engineering	Sanders & McCormick 7th Edition, published in 1993 by McGraw-Hill Education.
3	An Introduction to Human Factors Engineering	John D. Lee and Christopher D. Wickens (2019)

REFERENCE BOOKS:

1	Applied Ergonomics Hand Book	Brain Shakel, Butterworth Scientific, London 1988
2	Introduction to Ergonomics	R. C. Bridger, McGraw Hill Publications.
3	Industrial Design for Engineers	Mayall W. H. London Hiffee Books Ltd., 1988
4	Work Study & Ergonomics	Suresh Dalela & Saurabh, standard publishers & distributors,1999

Course Outcomes:

Upon completion of this course the student will be able to:

CO1: discuss work study, Basic procedure, human factors in work study and factors affecting productivity (level 1, 2).

CO2: evaluate charts to record movements in shop, process charts, flow process charts (Man and Machine type) (Level 2, 3).

CO3: analyze techniques of work measurement, work sampling, (Level 3, 4).

CO4: discuss time study equipment, Basic steps, selection of jobs (Level 2, 3).

CO5: summarize application in modern manufacturing systems. Ergonomics and Industrial Design (level 1, 2, 3).

Articulation Matrix:

		POs												**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
COs	**CO1**	3	1				2						2	3		
	CO2	3	2				3						2	3		
	CO3	3	2				2						2	3		
	CO4	3	2				2						2	3		
	CO5	3	2				3						2	3		

Research Methodology and IPR

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3
Total Lecture Hours:	40	CIE Marks:	50
Sub. Code:	SHS04	SEE Marks:	50

UNIT I
RESEARCH METHODOLOGY: Objectives and motivation of research - Types of research - Research approaches - Significance of research - Research methods verses methodology - Research and scientific method - Importance of research methodology - Research process - Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations- Criteria of good research. Defining the research problem: Definition of research problem - Problem formulation - Necessity of defining the problem - Technique involved in defining a problem.
8 Hours

UNIT II
LITERATURE SURVEY AND DATA COLLECTION: Importance of literature survey - Sources of information - Assessment of quality of journals and articles - Information through internet. Effective literature studies approaches, analysis, plagiarism, and research ethics. Data - Preparing, Exploring, examining and displaying. Referencing methods
8 Hours

UNIT III
RESEARCH DESIGN AND ANALYSIS: Meaning of research design - Need of research design - Different research designs - Basic principles of experimental design - Developing a research plan - Design of experimental set-up - Use of standards and codes. Overview of Univariate/Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.
8 Hours

UNIT IV
INTELLECTUAL PROPERTY RIGHTS (IPR): Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. Role of WIPO and WTO ni IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.
8 Hours
UNIT V
PATENT RIGHTS (PR): Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs. Licenses, Licensing of related patents, patent agents,Registration of patent agents.
8 Hours

TEXT BOOKS

1	Peter S. Menel Mark A. Lemley, Robert P. Merges	"Intellectual Property in the New Technological-Vol. I Perspectives, 2021.

2	Laura R. Ford	"The Intellectual Property of Nations: Sociological and Historical Perspectives on a Modern Legal Institution Paperback -2021.

REFERENCE BOOKS		
1	R. Ganesan	"Research Methodology for Engineers", MJP Publishers, Chennai, 2011.
2	Cooper Donald R, Schindler Pamela S and Sharma JK	"Business Research Methods", Tata McGraw HillEducation, 11th Edition, 2012.
3	Catherine J. Holland	"Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
4	David Hunt, Long Nguyen, Matthew Rodgers	"Patent searching: tools &techniques", Wiley, 2007.
5	The Institute of Company Secretaries of India, Statutory bodyunder an Act of parliament	"Professional Programme Intellectual Property Rights, Lawand practice", September 2013.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Describe the research process & formulate research problem
CO2	Perform literature review, manage data & practice research ethics
CO3	Practice basic principles of experimental design, use standard codesand carry out research analysis
CO4	Distinguish between types of innovation, describe patenting procedure,maintenance and role of IPR establishments
CO5	Identify the significance of patent rights, licensing, technology transfer& manage patenting system

Course Articulation Matrix

		POs												**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
COs	**CO1**		3	2									2			
	CO2		3	2					3				2			
	CO3		3	3									2			
	CO4		3	2									2			
	CO5		3	2									2			

Environmental Studies

Contact Hours/ Week:	2-0-0-2	Credits:	2
Total Lecture Hours:	60 = 28(L)+0(T)+0(P)+32(S)	CIE Marks:	50
Sub. Code:	SHS05	SEE Marks:	50

Course objectives: This course will enable students to:	
1.	Describe the problems of depletion of natural resources due to deforestation, agricultural practices, and adverse environmental effects, pesticides, soil erosion, mining.
2.	Explain the different types of energy- renewable, non-renewable and energy conservation, the impact of environmental pollution on water quality, air quality, soil pollution and noise pollution.
3.	Describe solid waste management- disposal, treatment of different types of solid waste including MSW, e-waste, biomedical waste, the societal impact of environmental issues-ozone layer depletion, GHG effects, water conservation and harvesting and environmental protection & Acts

UNIT I
Introduction: Components of Environment and their interactions **Natural Resources:** Forest Resources-Deforestation, Causes of deforestation, Environmental effects of deforestation and solutions • Water resources, World's water reserves, Hydrological cycle • Land resources, Land degradation. Soil erosion, Causes and prevention, Soil conservation and its types• Numerical problems on rainfall & runoff
6 Hours

UNIT II
Energy and resources: • Types of Energy-Renewable, Non renewable & sustainable energy & their advantages and disadvantages• Renewable energy sources- Solar energy, Wind energy, Tidal energy, Ocean thermal energy. Geothermal energy, Hydroelectric power, Biomass energy, Hydrogen energy, Thermal power- environmental impacts • Conservation of energy • Numerical problems on Solar energy, Wind power
6 Hours

UNIT III
Environmental pollution: • Sources of pollution- Natural and anthropogenic sources • Pollutants - Classification & their effects on environment • Air Pollution -Composition of clean air, Sources of air pollution, Effect of air pollution on human health and climate • Water quality – Potable water, Wholesome water, Sources of water pollution Polluted water & Contaminated water• Common impurities in water(physical, chemical and bacteriological), Effects of impurities on human health • Soil Pollution – Sources, effects, and its control • Noise pollution- Sources of noise, Effects on human health & its control Numerical problems on pH, hardness of water, noise pollution
6 Hours

UNIT IV
Solid Waste Management: • Refuse, Garbage, Rubbish, Ash, types of solid waste• Necessity of safe disposal, Impacts on human health and environment• Classification of solid wastes- Quantity and composition of MSW, Collection of solid waste- methods• Disposal of solid waste-Sanitary land-fill• E-waste- Problems and solutions• Biomedical waste-Impacts on human health, storage, treatment methods and disposal• Numerical problems on moisture content, density & proportioning of land fill
5 Hours

UNIT V
Sustainable development: Issues on energy utilization, water conservation, concept of 3 R's, Rain water harvesting- methods • **Global environmental issues**: Population growth, Urbanization, Global warming, Acid rains, Ozone layer depletion & controlling measures. • Environmental acts, Regulations, Role of state & central governments, • Numerical problem on carbon foot print & rainwater harvesting.
5 Hours

TEXT BOOKS		
1	Joseph, B	Environmental Studies (2009), India: Tata McGraw-Hill. ISBN: 9781283922524
2	Tripathi, A. K	Environmental Studies(2016), India: Energy and Resources Institute. ISBN:9788179935828

REFERENCE BOOKS		
1	Erach Bharucha	Environmental studies for Undergraduate Courses, 1st Edition, University Press, (2013)
2	Santhosh Kumar Garg	Environmental Science and Engineering Ecology and Environmental Studies, Khanna Publishers, (2015), ISBN-10 : 8174092188 ISBN-13 : 978-8174092182

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Explain the importance of forestation, effects of deforestation, land degradation, adverse effects of mining on environment, using the principles of natural sciences compute the runoff from rainfall & estimates the conservation of water for beneficial use of humans.
CO2	Choose appropriate renewable energy sources by formulating, reviewing the literature, calculating the power potential of solar & wind energy and using the principles of natural sciences.
CO3	Explain the effects of pollution of air, water, soil & noise on humans and the environment, identify and analyze the pollution problems related to air, water, soil & noise and quantify pollution levels & draw valid inferences using the principles of engineering sciences
CO4	Describe Impact of solid waste on human health and environment, its safe disposal. Use population data & compute percapita solid waste generation, land area requirement for sanitary landfill
CO5	Appreciate the importance of sustainable development, current global environmental issues, present state & central governments protection acts, compute carbon footprint using data(vehicles/industries) & asses its impact on the environment.

Course Articulation Matrix

		POs												**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
COs	**CO1**						2									
	CO2						2									
	CO3						2									
	CO4						2									
	CO5						2									

VI SEMETER

Robotics & Automation

Contact Hours/Week	:	3+0+2 (L+T+P)	Credits	:	4.0
Total Lecture Hours	:	40	CIE Marks	:	50
Total Practical Hours	:	26	SEE Marks	:	50
Course Code	:	S6MEI02			

Course Objectives

The course " Robotics & Automation" is designed to provide students with a comprehensive understanding of the principles and applications of automation and robotics in modern manufacturing and industrial systems. From this course students will

i) gain insights into the fundamentals of automation, the interplay between automation and robotics, and the advanced functions of automated systems.

ii) explore the intricacies of robotic systems, including their anatomy, classification, and control mechanisms.

iii) analyze robot end effectors and sensors

iv) understand robot arm kinematics

v) develop skills in robot programming

UNIT I

Fundamentals of Automation: Introduction, Basic elements of an automated system, Types of automation, Advanced automation functions, Components and classification of manufacturing systems. Fundamentals of automated production lines and applications of automated production lines, numerical examples. Group Technology, Cellular Manufacturing, FMS and Automated Assembly Systems.

8 Hours

UNIT II

Basic Concepts in Robotics: Introduction, Relation between Automation and robotics, Industrial application of robotics, Robot anatomy, Classification of robotic systems, Configurations of robotic system, Types of joints and wrist, Degrees of Freedom, Robot Actuators, Types-Hydraulic, Pneumatic and Electric actuators, Advantages and disadvantages of drive systems, Precision of movement. Control system for robot joint – open and closed loop for robotic systems

8 Hours

UNIT III

Robot End effectors and Sensors in robotics, Machine Vision: End effectors, grippers, tools, Mechanical grippers and other types of grippers, Considerations in gripper selection and design, Sensors, types of robotic sensors and working principle, uses and applications, machine vision.

8 Hours

UNIT IV

Robot arm kinematics: Forward and inverse kinematics, rotation matrices and translation matrix, composite rotation matrix, numericals, Euler Angles representation, homogeneous transformations, numericals.

8 Hours

UNIT V

Trajectory Planning: Introduction, Need for interpolators in trajectory planning, generation of motion commands using hierarchichal robot system, trajectory planning, basic structure of interpolators.

Robot Programming: Manual Teaching, Lead-Through Teaching, Programming Languages, Programming with Graphics. Introduction to ROS-key features of ROS, Reasons for implementing ROS.

8 Hours

TEXTBOOKS		
1	M.P.Groover.	Industrial Robotics, Mc-Graw Hill International Editions, 2019, **ISBN**: 1259006212, 978-1259006210
2	M.P.Groover	Automation, Production Systems, and Computer Integrated Manufacturing, 5th edition, Pearson Publishers, 2020, **ISBN:** 978-0134605463, 0134605462
REFERENCE BOOKS		
1	K.S. Fu, R.C. Gonzales and Lee.	A Textbook on Robotics Mc Graw Hill International Editions, 2018, **ISBN:** 978-0-07-026510-3.
2	Yorem Koren	A Textbook on Robotics for Engineers McGraw Hill International Editions 2018, **ISBN:** 0-07-035399-9.
NPTEL – Resources		
1	Prof. Shrikrishna N. Joshi	AUTOMATION IN MANUFACTURING https://archive.nptel.ac.in/courses/112/103/112103293/#
2	Prof. Dilip Kumar Pratihar	ROBOTICS https://onlinecourses.nptel.ac.in/noc21_me76/preview

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	**illustrate** the basic concepts of automation and **analyze** latest automation technologies used in industries.
CO2	**explain** the fundamentals of robotic system, configurations and control system.
CO3	**formulate** the rotation matrices and **explain** robotic applications in manufacturing.
CO4	**apply** the concept of kinematics for robot motion analysis and **formulate** the rotation matrices.
CO5	**identify** different robotic programming languages and **develop** programs for simple applications.

Course Articulation Matrix

		POs											PSOs		
		1	2	3	4	5	6	7	8	9	10	11	1	2	3
COs	CO-1	3	3	2											
	CO-2	3	2												
	CO-3	3	3												
	CO-4	3	3	3		1									
	CO-5	3	3	3		3									

Robotics & Automation lab

List of Experiments

Part A - IOT

1. To interface LED with Arduino and write a program to turn
   a. ON LED for 1 sec
   b. increase/decrease brightness in a loop

   2 Hrs
2. To interface LDR with Arduino to turn ON LED

   2 Hrs
3. To interface DHT11 sensor and OLED with Arduino and write a program to print temperature and humidity readings. 2 Hrs
4. To interface pulse sensor with Arduino to display heart rate on OLED

   2 Hrs
5. To upload and Humidity and Temperature data to Thingsspeak cloud using ESP32 board

   2 Hrs
6. To control LED through internet using ESP32 board

   2 Hrs

Part B -MATLAB and Simulink

On ram of MATLAB and Simulink

2 Hrs

1. Forward and Inverse Kinematics of robotic link
   a. Computing coordinates the position of a link using joint angle
   b. Computing joint angle for a given position

   2 Hrs
2. Composite transformation of a cube

   2 Hrs
3. Simulating a spring mass damper system subjected to step input using Simulink

   2 Hrs
4. Simulating closed loop system under step input controlled by PID system

   2 Hrs
5. To model Cruise control using Simulink

   2 Hrs

Finite Element Methods & Analysis

Contact Hours/ Week:	3+0+2(L+T+P)	Credits:	4
Total Lecture Hours:	39 (L) + 26 (P)	CIE Marks:	50
Sub. Code:	S6MEI03	SEE Marks:	50

Course objectives:

To provide the basic concepts of finite element method and its applications to wide range of engineering problems and developing stiffness matrices for spring, truss, beam, plane stress problems and three-dimensional problems using the concept of direct equilibrium and potential energy methods. Students will be able:

1.	To learn basic principles of finite element analysis procedure.
2.	To learn the theory and characteristics of finite elements that represent engineering structures
3.	To learn and apply finite element solutions to structural, thermal, dynamic problems to develop the knowledge and skills needed to effectively evaluate finite element analyses.

UNIT I

INTRODUCTION TO FEA

Introduction to FEM, applications and limitations. FE Library and Structure of a FE packages, Preprocessor – Solver - Post processor. Equilibrium equations in elasticity subjected to body force, traction forces. Stress-strain relations for 1D, 2D, and 3D cases. Plane stress and plane strain condition. Strain-displacement relations in 2-D and 3-D. Definition of von-Mises stress. Different numerical methods.

8 Hours

UNIT II

ONE DIMENSIONAL FEM

Finite Element Modelling, Nodal degrees of freedom, Local and Global coordinate systems, Shape functions -Formulation of a linear bar element using principle of minimum potential energy. Boundary conditions- elimination method and penalty method. Temperature effects linear bar element. Formulation of quadratic bar element.

9 Hours

UNIT III

TRUSSES AND BEAMS

Formulation plane trusses element, Stiffness matrix, Problems on point load, Formulation beam element, Hermite shape functions for beam element and stiffness matrix. Problems on beams carrying concentrated and UDL loads

7 Hours

UNIT IV

TWO DIMENSIONAL FEA

Formulation of triangular and quadrilateral elements. Shape functions for higher order triangular and quadrilateral elements, Iso parametric – sub parametric – super parametric elements, Convergence criteria, pascal triangle. Introduction to 3-D elements

7 Hours

UNIT V

DYNAMIC CONSIDERATIONS AND STEADY STATE HEAT TRANSFER

Application of Dynamic analysis, formulation, element mass matrices for 1-D element, truss element, CST element, computation of eigen values and eigen vectors. Problems on bar. One-

dimensional steady state heat conduction, thermal boundary conditions and problems on composite wall.
8 Hours

TEXT BOOKS		
1	T R Chandrupatla and Belegundu	Introduction to Finite elements in Engineering, Pearson education, 4th Edition, 2011, **ISBN**-10: 0132162741
2	Daryl L Logan	A First Course in Finite Element methods, Thomson Learning 6th Edition, 2015, ISBN- 13: 978-1-305-63511-1

REFERENCE BOOKS		
1	S.S.Rao	The Finite Elements Method in Engineering, Fourth Edition, 2005, **ISBN**: 0750678283
2	Hutton	Fundamentals of Finite Element method, Mc Graw Hill, 2004, **ISBN**: 0071122311, 9780071122313
3	J N Reddy	Fundamentals of Finite Element method, Mc Graw Hill, 2004, **ISBN**: 0071122311, 9780071122313

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	**Apply** the knowledge of Solid Mechanics to obtain stress-strain relations in two- and three-dimensional conditions.
CO2	**Formulate** and **solve** equilibrium equations for one-dimensional structural problems using Finite Element concept
CO3	Finite element **formulation** of trusses and beams to determine displacement, stress and reaction of structures
CO4	Finite element **formulation** of triangular and quadrilateral elements to find the field variables.
CO5	**Apply** finite element method to **analyze** linear vibration systems and one-dimensional steady-state heat conduction problems.

Course Articulation Matrix

		POs												**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
COs	**CO1**	3	1	2											2	
	CO2		3	2											2	
	CO3		3	3											2	
	CO4		3												2	
	CO5		3												2	

FE MODELING AND ANALYSIS LABORATORY	
Course Learning Objectives	
1	Student should be able to analyze bars, trusses and beams problems for others and deformation analysis
2	Can learn to analyze thermal conduction and convection problems
3	Can learn to analyze fluid flow problems and analyze dynamic problems
PART-A **Study of a FEA package and modeling stress analysis of**	
1	Bars of constant section, tapered section and stepped bar (Minimum 4 exercises)
2	Trusses – (Minimum 2 exercises)
3	Beams – Simply supported, cantilever, beams with UDL and UVL etc. (Minimum 4 exercises)
4	Stress analysis of a 2D rectangular plate with hole, cutout etc (Minimum 3 exercises)
PART-B **Study of a FEA package and modeling stress analysis of**	
5	Dynamic Analysis • Bar subjected to forcing function • Fixed – fixed beam for natural frequency determination
6	Thermal Analysis – 2D problem with conduction and convection boundary conditions (Minimum 2 exercises)
7	Fluid flow Analysis – Potential distribution in the 2 – D bodies
8	Introduction of 3D modeling
	26 Hours

Advanced Automobile Design

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3
Total Lecture Hours:	39 hours	CIE Marks:	50
Sub. Code:	S6MEE01	SEE Marks:	50

Course objectives:

This course focuses on the application of engineering principles across the entire product lifecycle of Body-in-White (BIW) and automotive interior trims. Students will develop knowledge in areas like:

1.	Design and analysis: applying concepts of material selection, GD&T and CAE for BIW and trims.
2.	Manufacturing processes: understanding assembly sequences, joining methods and techniques like injection molding.
3.	Quality control: interpreting test results from physical testing of BIW and trims (crash, NVH, etc.).

UNIT I

REQUIREMENT SPECIFICATION in the PRE-PROGRAM STAGE

Voice of customer/ Customer feedback, Competitor insight, Innovation, Project & quality planning, Legislation, System Strategy Product life cycle and important gateways for BIW: Important design gateways, Prototype build, Production, Launch of vehicle. Identification of commodities for BIW.

BIW (Body In White)

Introduction, BIW commodities classification, BIW terminology, BIW assembly. Design concepts and considerations in BIW

BIW Parts, Driving factors for BIW Design, Design Considerations for Sheet Metal Parts. BIW Materials and Grades (Steel, Aluminum, composites) Evolution to Modern Design, Basic material selection criteria for automotive, Classification of Steel grade and their properties, AL used in Automotive Domain and their properties, Composite used in Automotive Domain and its application, Lightweight materials for future automotive industry. Future Trends in BIW: Energy Storing Body Panels, Light Weight Vehicle Technology, Latest Joining Technologies Used In BIW.

MANUFACTURING - SEQUENCE, WELDING & ASSEMBLY

Introduction Assembly sequence, Assembly sequence: Body Shop: BIW Assembly, Assembly Sequence: Paint Shop : BIW Painting, Assembly Sequence and Flow, Assembly sequence : Paint Shop : Trim & Final Assy.

9 Hours

UNIT II

GD & T(Geometric Dimensioning and Tolerancing) for BIW

GD&T, Benefits of GD&T, International Standards of GD&T, GD&T on Engineering drawing, Dimensional requirement, 3-2-1 Principle of location, Simulation of datum's for inspection, GD&T Symbols, Feature control frame.

SHEET METAL JOINING – WELDS and ADHESIVES

Sheet Metal Joining Process, Classification of Metal Joining process, Weld Types, Resistance Spot Welding (RSW), Tailor Welded Blank, Laser Beam Welding, Self-Piercing Rivets (SPRs), Adhesives, Conventional joining techniques.

6 Hours

UNIT III
DESIGN FAILURE MODES and EFFECTS ANALYSIS (DFMEA) Design Failure Modes and Effects Analysis (DFMEA), Objectives, Overview of the DFMEA Process, DFMEA Benefits DESIGN VERIFICATION - CAE METHODS and GATEWAY SUPPORTS Introduction to Design Verification, Design verification Application and Preparation, Gateway support for design verification. CAE (Computer-aided engineering) ANALYSIS – NVH(Noise, Vibration and Harshness), CRASH & DURABILITY: NVH Analysis, Crash Analysis, Durability Analysis TEST VALIDATION & ASSESSMENT: Vehicle Physical Testing, Crash Test Requirements-Frontal Testing, Rear & Side Impact Testing, Pedestrian testing & roll over, Four post rig test, Wind Tunnel Testing.
8 Hours

UNIT IV
PRODUCT LIFE CYCLE and IMPORTANT GATEWAYS for TRIMS Product Life Cycle, Design Milestones, Different Types of Builds, Launch of Vehicle Identification of commodities for Trims, Identification of different interior trim parts and their position in vehicle. Trim Materials in Automotive Material Classification and Properties, Plastic Materials and their Applications, Usage and Selection Criteria, Plastic Additives, Application in Instrument Panel Assembly DESIGN REQUIREMENTS and CONSIDERATIONS Vehicle regulations, Automotive Safety-Frontal impact, Side impact, Rear impact, Design for environment DESIGN of PLASTIC PART Plastic part overview, Plastic Part design, the principles behind the Engineering Plastic parts.
7 Hours

UNIT V
DESIGN VERIFICATION - CAE METHODS and GATEWAY SUPPORTS: Introduction to Automotive Interior trims, Load cases carried out to validate Automotive interior trims, CAE gateway support CAE Analysis - Moldflow of plastic parts, Crash & Durability: Introduction, Types of CAE Analysis on Automotive Interiors of Head Impact Analysis, Side Impact Analysis, Knee Impact Analysis, Durability Analysis, Creep Analysis, Moldflow Analysis, Applications of CAE Test Validation & Assessment. Introduction about Design Validation and verification, Various tests performed for design verification and validation, Case studies. MANUFACTURING PROCESS Vacuum Forming, Injection Molding, Heat stacking, Extrusion blow molding. ASSEMBLY SEQUENCE Assembly sequence of Side airbag, rear floor, clutch brake pedal assembly, headliner, pillar trims and seats FUTURE TRENDS AND FUTURE MATERIALS FOR TRIMS Plastic as a material, Necessity of lightweight materials.
9 Hours

TEXT BOOKS		
1	R. N. Bahl	Automobile Design, Publisher: Wiley, ISBN: 9789388425902, 9388425901 Edition: 1, 2019

2	L. Morello, Lorenzo Rosti Rossini, Giuseppe Pia, Andrea Tonoli	The automotive body, Volume I : components Design, Springer Science & Business Media, ISBN: 9400705131, 9789400705135, 2011
3	L. Morello, Lorenzo Rosti Rossini, Giuseppe Pia, Andrea Tonoli	The automotive body, Volume II: Systems Design, Springer Science & Business Media, ISBN: 9400705166, 9789400705166, 2011

REFERENCE BOOKS		
1	Julian Happian- Smith, Elsevier	An Introduction to Modern Vehicle Design, Elsevier, ISBN: 0750650443, 9780750650441, 2004
2	Mario Hirz, Wilhelm Dietrich, Anton	Integrated Computer- Aided Design in Automotive Development, Springer-Heidelberg New York Dordecht London, ISBN: 978-3-642- 11939-2, 978-3-642-11940-8(eBook)
3	Michael Grieves	Product Lifecycle Management, McGraw-Hill, ISBN: 9780071452304, 0071452303, Edition, 1st, 2005

ONLNINE RESOURCES		
1	Tata technologies (Ready Engineering Programme)	http://myigetit.com/ Study MaiGet- IT (a proprietary product from Tata technologies

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	analyze BIW requirements, classify welding & GD&T, outline assembly flow & evaluate CAE methods.
CO2	apply GD&T to BIW design, understand sheet metal joining (welding, rivets, adhesives).
CO3	perform DFMEA, utilize CAE for NVH, crash & durability, conduct vehicle testing, leverage design verification gateways.
CO4	apply product lifecycle knowledge, identify design milestones & regulations, analyze trim materials, design plastic parts (considering engineering & environment).
CO5	apply CAE to analyze automotive trims, understand diverse manufacturing processes, sequence assembly, analyze future trends in trim materials.

Course Articulation Matrix

		POs												**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
COs	**CO1**	1	1									1			2	
	CO2	1	2								1			1		
	CO3	1	2								1	1			2	
	CO4	1	1									1				
	CO5	1	1								1	1		1		

Total Quality Management

Contact Hours/ Week:	: 3+0+0 (L+T+P)	Credits:	3
Total Lecture Hours:	: 40	CIE Marks:	50
Sub. Code:	: S6MEE02	SEE Marks:	50

Course objectives: This course will enable students to:	
1.	To incorporate the importance of quality aspects in today's competitive era.
2.	To understand the customer requirements and offer the products which is needed.
3.	To know the strategies adopted for different production techniques.
4.	To create an awareness of certification by ISO.

UNIT I
Introduction : Definition, Quality Dimensions, Quality aspects – Quality of Design, Quality of Conformance and Quality of Performance, TQM Cultural change, Historical Review, Discussion on Benefits of TQM, Quality,Garvin's Nine dimensions of Quality, TQM frame work, Contribution of Quality Gurus-Juran (Quality Triology), Discussion on Demmings (14 Principles of Management), Contribution of Crosby,Ishikawa and Taguchi
8 Hours

UNIT II
Customer Orientation-Customer Focus, Customer satisfaction model Quality Function Deployment(QFD), Customer Satisfaction Measurement, Kano Model. **Problem Solving Tools**-Problem Solving Process, Seven QC Tools, Seven Management tool
8 Hours

UNIT III
Continuous Improvement Strategies-Deming Wheel, Zero Defect Concept, Benchmarking, Six sigma. Preventive Techniques-Failure Mode Effect Analysis, Poke Yoke.Quality Ambience- Five S for Quality Ambience, Time Management. Quality Control – Offline quality control, statistical quality control Statistical Quality Control – Causes of Variation in Quality, Central limit Theorem, Control charts for variables and attribute (simple problems only), Process capability studies (theory only).
8 Hours

UNIT IV
Leadership-Top Management Commitment, Leadership for TQM, Change Management, Motivational Strategies, Quality Circle Philosophy. **Team Development**-Synergy, Team Building, Types of Teams, Characteristics of Successful Teams, Team Members Roles, Effective Team Meetings, Common Team Problems.
6 Hours
UNIT V

Quality Certification-ISO 9000 series Certification ISO 9001: 2008 Certification, ISO 14000 Series Certification, Quality auditing, Quality Awards. **TQM Road Map**: Measurement of Quality, TQM Road Map, TQM Implementation Strategy, Why TQM Fails? **AI in TQM** Role of AI in TQM, Benefits of AI in improving quality, applications of AI in TQM, AI based concepts- predictive quality control, real time monitoring of quality, anomaly detection, software testing, visual inspection and predictive maintenance.
10 Hours

TEXT BOOKS		
1	L. Suganthi & Anand	Total Quality Management, PHI Learning Pvt. Ltd. -2021.
2.	Amitava Mitra	Fundamentals of Quality Control and Improvement, Third Edition, John Wiley & Sons publication,2020

REFERENCE BOOKS		
1	Dale H Besterfield	Total Quality Management, Pearson Education,3rd Edition,2019
2	Poornima M Charanthimath	Total Quality Management, Pearson Education, 4TH Edition,2021

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	**Explain** the concept and philosophies of quality and **Discuss** the contributions of quality gurus and their relevance to the management of modern organizations.
CO2	**Describe** various tools to capture the voice of customer and how QFD can be used to translate those requirements into product specifications; **Demonstrate** the ability to apply 7 QC and 7 management tools to solve industry related problems.
CO3	**Analyze** the appropriate techniques for achieving continuous improvements and Explain the procedure to apply the same.
CO4	**Analyze** the strategies for leadership, change management and team development in achieving organizational excellence.
CO5	**Explain** the procedure for obtaining ISO 9000, 9001& 14000 certification and conducting quality audits; **Illustrate** the road map for obtaining quality awards and implementing TQM.

Course Articulation Matrix:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3												3		
CO2	3	2											3		
CO3	3	2											3		
CO4	3	3							2			2	3		
CO5	3					2						3	3		

Additive Manufacturing

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3.0
Total Lecture Hours:	39	CIE Marks:	50
Sub. Code:	S6MEE03	SEE Marks:	50

Course objectives:
This course will enable students to:

1.	Learn the fundamentals of AM, Classification and Martials that can be processed in AM Processes.
2.	Understand the working, applications, advantages and limitation and materials used in Resin and Extrusion Based AM Process like Vat Photo polymerization, FDM process.
3.	Understand the working, applications, advantages and limitation and materials used in Sheet and Powder Based AM Process like LOM, UC, SLS and EBM processes.
4.	Explore the Directed Energy Deposition AM Processes like LENS and DMD. Also Friction stir additive manufacturing and Wire Arc Additive Manufacturing.
5.	Explore the Post Processing of AM Parts, Rapid Tooling - Direct and Indirect Tooling Methods and AM Applications in various fields.

UNIT I

3D Printing/Additive Manufacturing: Introduction, Steps in AM, Classification of AM processes, Process parameter and Process Selection. Advantages, Additive v/s Conventional Manufacturing processes, Applications. CAD for Additive Manufacturing. CAD design Data formats, Data translation, Data loss, STL format.

Materials: Various forms of raw material - Liquid, Solid, Wire and Powder. Polymers, Metals, Non-Metals, Ceramics and their desired properties. Introduction to Multifunctional and graded materials in AM.

8 Hours

UNIT II

Vat Photopolymerization AM Processes: Stereolithography (SL), Materials, Process. SL resin curing process, SL scan patterns, Mask Projection Processes, Two-Photon vat Photopolymerization, Process Benefits and Drawbacks, Applications of Vat Photopolymerization.

Extrusion - Based AM Processes: Fused Deposition Modelling (FDM), Principles, Materials, Process Modelling, Bio-Extrusion, Contour Crafting, Process, benefits and drawbacks, Applications of Extrusion-Based Processes

8 Hours

UNIT III

Sheet Lamination AM Processes: Bonding Mechanisms, Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC). Powder Bed Fusion AM Processes: Selective laser Sintering (SLS), Materials, Powder fusion mechanism and powder handling, Process Modelling, Electron Beam melting (EBM), Process Benefits and Drawbacks, Applications of Powder Bed Fusion Processes.

8 Hours

UNIT IV

Engineered Net Shaping (LENS), Direct Metal Deposition (DMD). Benefits and drawbacks, Applications of Directed Energy Deposition Processes. Friction stir additive manufacturing: Process, parameters, advantages, limitations and applications, functionally graded additive manufacturing components. Wire Arc Additive Manufacturing: Process, parameters, applications, advantages and disadvantages,

8 Hours

UNIT V

Post Processing of AM Parts: Overview on support material removal, Surface quality and aesthetic improvement. Rapid Tooling: Direct and Indirect Tooling Methods, Silicon rubber tooling, Aluminum filled epoxy tooling, Spray metal tooling, Investment casting, Vacuum casting, Direct Rapid Tooling Processes. AM Applications: Design, Engineering Analysis and planning applications, Rapid Tooling, Reverse Engineering, Medical Applications of RP.
7 Hours

TEXT BOOKS		
1	Gibson, I., Rosen, D. W., Stucker, B., Khorasani, M., Rosen, D., Stucker, B., & Khorasani, M.	Additive manufacturing technologies, (2021), (Vol. 17, pp. 160-186). Cham, Switzerland: Springer.
2	Bhatia, A. and A.K. Sehgal	Additive manufacturing materials, methods and applications: A review. Materials Today: Proceedings, 2023. 81: p. 1060-1067.
REFERENCE BOOKS		
1	Lieu W. Liou, Frank W. Liou	Rapid Prototyping and Engineering applications: A tool box for prototype development, CRC Press, 2007.
2	Mahamood R.M.	Laser Metal Deposition Process of Metals, Alloys, and Composite Materials, Engineering Materials and Processes, Springer International Publishing AG 2018
3	Chee Kai Chua, Kah Fai Leong	3D Printing and Additive Manufacturing: Principles and Applications: Fourth Edition of Rapid Prototyping, World Scientific Publishers, 2014

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	describe the fundamentals of AM, Classifications and process parameters, difference between conventional and AM processes. Illustrate Material selection for various AM processes.
CO2	describe Vat Photopolymerization process, benefits and drawbacks, and applications of Vat Photopolymerization. Illustrate extrusion - based AM Processes like FDM, Bio-Extrusion and Contour Crafting process.
CO3	describe bonding Mechanisms in Sheet Lamination AM Processes like LOM and UC AM Processes. Explain Powder fusion mechanism and powder handling in Powder Bed Fusion AM Processes.
CO4	analyze process, material delivery in Directed Energy Deposition AM Processes like LENS and DMD. Also understand the process and parameters that influence the models developed through Friction stir additive manufacturing and Wire Arc Additive Manufacturing.
CO5	describe Post Processing of AM Parts and Illustrate Different Rapid Tooling methods. Summarize AM Applications in various fields.

Course Articulation Matrix

		POs												**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
COs	**CO1**	3											2	3		
	CO2	3											2	3		
	CO3	3											2	3		
	CO4		3										2	3		
	CO5	3											2	3		

Refrigeration and Air-Conditioning

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3.0
Total Lecture Hours:	39	CIE Marks:	50
Sub. Code:	S6MEE04	SEE Marks:	50

Course objectives:

Studying refrigeration and air conditioning course equips undergraduate students with essential knowledge and skills that are highly valued in various engineering and technical fields. This course will assist in opening up job opportunities for UG students in a wide range of fields, including manufacturing, healthcare, food and beverage, pharmaceuticals, and construction. Each of these fields has unique challenges as well as potential for professional advancement. This course aim to provide a comprehensive education that prepares students for successful careers in the HVAC and refrigeration industry, equipped with the knowledge. From this course student will learn about the**:**

1.	thermodynamic principles of air cycle refrigeration systems, assessing component performance, and addressing aircraft refrigeration.
2.	principles of simple vapor compression refrigeration, including cycle analysis, efficiency and comparative advantages over air refrigeration systems.
3.	working and compare different kinds of compound vapor compression refrigeration systems, and uses of vapor absorption refrigeration systems.
4.	air conditioning systems, covering topics from introduction and psychrometry to various processes
5.	various applications of refrigeration and air-conditioning system

UNIT I

AIR CYCLE REFRIGERATION SYSTEM

Various air cycle refrigeration; assumptions, T-S chart, open and closed type air refrigeration cycle, merits anddemerits, reverse carnot cycle and its limitations, reverse Brayton cycle, ideal and actual aircraft refrigerationcycles, simple system, simple air evaporative cooling system, simple Bootstrap system, Bootstrap air evaporative, Numericals.

8 Hours

UNIT II

SIMPLE VAPOUR COMPRESSION REFRIGERATION SYSTEM

Various VCR, assumptions, TS-PH chart, analysis of actual and ideal cycle, merits and demerits of VCR over air refrigeration, types of VCR cycle, dry saturated vapour after compression, wet vapour after compression, superheated before and after compression, sub-cooled VCR, improvements of simple VCR, Numericals.

8 Hours

UNIT III

COMPOUND VAPOUR COMPRESSION REFRIGERATION SYSTEM:

Advantages of compound VCR, types of compound VCR, two stage compression with water intercooler, Numericals.

VAPOUR ABSORPTION REFRIGERATION SYSTEM:

Basic principle, compare VCR and VAR, Water-lithium bromide, ammonia-water, ammonia-hydrogen (Electrolux).

8 Hours

UNIT IV

AIR-CONDITIONING:

Introduction, Psychrometry chart and Processes, sensible heating, sensible cooling, By-pass factor, efficiency of coil, humidification, dehumidification, Cooling+Dehumidification, cooling+humidification, Heating+humidification, factors effecting AC, Classification,Comfort AC, Industrial AC, Winter AC, Summer AC, Year Round AC, Central AC, Room sensible heat factor, Grand Sensible heat factor, Effective Room sensible heat fctor, Numericals.

	8 Hours
UNIT V	
REFRIGERATION AND AIR CONDITIONING APPLICATIONS Solar energy based refrigeration system, steam and vapour jet refrigeration system, thermo-electric refrigeration system, vortex tubes, food processing applications, Industrial applications such as power plant, manufacturing and production field applications and Medical and cold treatment of metals, Application of Air conditioning in Industry, Sea water Air conditioning. Theory only no numericals.	
	7 Hours

TEXT BOOKS		
1	RK Rajput	A Textbook of Refrigeration and Air-Conditioning, SK Kataria and Sons,3rd Edition, Reprint 2019
2	RS Khurmi & JK Gupta	A Textbook of Refrigeration and Air-Conditioning, SChand& Co, 3rd Edition, 2011

REFERENCE BOOKS		
1	Arora Ramesh Chandra	Refrigeration and Air Conditioning , PHI Learning, 16th Edition, 2005
2	Ananthanarayanan	Basic Refrigeration and Air Conditioning, Tata McGraw-Hill Education, 2005
3	V Manohar Prasad	Refrigeration and Air-Conditioning, New Age International, 3rd Edition, 2015

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Analyze the air cycle refrigeration system to solve aircraft refrigeration cycles problems.
CO2	Analyze the Simple vapour compression refrigeration system to evaluate its performance.
CO3	Analyze the Compound vapour compression refrigeration system and understand the Vapour Absorption Refrigeration system.
CO4	Identify the Psychrometric processes for different applications and evaluate the parameters of air-conditioning system.
CO5	Enlist and understand the various applications of Refrigeration and air conditioning system.

Course Articulation Matrix

		POs												**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
COs	**CO1**	3	2											3		
	CO2	3	2											3		
	CO3	3	2											3		
	CO4	3	3	2										3		
	CO5	3												3		

SCHEME OF SEMESTER END EXAMINATION

Data Handbook/charts/tables are permitted. Answer any five full questions selecting one from each unit.

Metal Forming Processes

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3
Total Lecture Hours:	39	CIE Marks:	50
Sub. Code:	S6MEE05	SEE Marks:	50

Course objectives: This course will enable students to:	
1.	The advantages of utilizing metal-working processes
2.	Mechanical & Metallurgical factors involved in forming metals into useful shapes
3.	Mathematical analysis of the principal metalworking process
4.	The requirements for the process selection will be added, which are based on advantages and disadvantages.
5.	Forming of profiles using the convectional and advanced metal forming processes.

UNIT I
Introduction to Metal Forming: Introduction, stress-strain relations in elastic and plastic deformation. Concepts of true stress, true strain, triaxle& biaxial stresses. Determination of flow stress, principal stresses, yield criteria and their significance, Tresca& Von-Mises yield criteria, concepts of plane stress & plane strain. Deformation mechanisms, Hot and Cold working processes and its effect on mechanical properties..
8 Hours

UNIT II
Effects of Parameters: Effects of Temperature, strain rate, friction and lubrication, workability of materials, Residual stresses in metal forming.
Forging: Expressions for forging pressures& load in open die forging by slab analysis, concepts of friction hill and factors affecting it, closed die forging, Die-design parameters. Material flow lines in forging, forging defects, residual stresses in forging benefits of using forged components in industrial applications, Automation in forging industry, Forging Defects, Simple problems.
8 Hours

UNIT III
Rolling: Fundamentals of Rolling, Terminology of Rolled Product, Different Methods of Rolling, Expression for rolling load. Roll separating force. Frictional losses in bearing, power required in rolling, effects of front & back tensions, friction, friction hill. Maximum possible reduction. Defects in rolled products. Rolling variables, Roll mill automation. Simple problems.
Drawing: Introduction, Expression for drawing load by slab analysis, power requirement. Redundant work and its estimation, optimal cone angle & dead zone formation, drawing variables.
8 Hours

UNIT IV
Extrusion: Types of extrusion processes, extrusion equipment & dies, deformation, lubrication & defects in extrusion. Extrusion dies, extrusion of seamless tubes. Extrusion variables, Seamless Tube Production by Extrusion, Extrusion of Cable Sheathing, Extrusion Defects.
Sheet metal forming: Introduction of sheet metal forming methods, Shearing, Bending, Deep drawing, Sheet Metal Hydro forming process, Tube hydroforming process.
8 Hours

UNIT V

High Energy Rate Forming Methods: Principles, advantages and applications, explosive forming, electro hydraulic forming, Electromagnetic forming, High-Energy Rate Forging Effect of high speed on stress – strain relationship. Comparison of conventional and high velocity forming. **Powder Metallurgy:** Basic steps in Powder metallurgy brief description of methods of production of metal powders, conditioning and blending powders, compaction and sintering application of powder metallurgy components, advantages and limitations.
8 Hours

TEXT BOOKS		
1	George E. Dieter	Mechanical Metallurgy, McGraw-Hill, SI Metric Edition McGraw-Hill, 2017.
2	Bhaduri A.	Mechanical properties and working of metals and alloys. Singapore: Springer Singapore; 2018 May 12.
3	P. N Rao	Manufacturing Technology Volume 1, 4th Edition, McGraw Hill (India) Pvt. Ltd. 2017

REFERENCE BOOKS		
1	Henry S. Valberg	Applied Metal Forming - Including FEM Analysis", Cambridge University Press, 2010.
2	G.K. Lal, P.M. Dixit and N.Venkat Reddy	Applied Metal Forming - Including FEM Analysis", Cambridge University Press, 2010.
3	Serope Kalpakjian, Steven R Schmid	Manufacturing Engineering and Technology, 8thEdition, Pearson 2023

ONLNINE RESOURCES	
1	https://nptel.ac.in/courses/112107250
2	NPTEL :: Mechanical Engineering - NOC:Plastic Working Of Metallic Materials

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	illustrates fundamental concepts and their applications of different forming techniques and Solve for strain rates, temperatures and metallurgical states in forming problems using constitutive relations
CO2	describe the various factors affecting metal forming processes.
CO3	comprehend metal forming processes which impart the desired shape and size to a given material using Forging, Rolling, Extrusion and Drawing processes.
CO4	formulate mathematical equations which can solve relevant real world problems concerning to Forging, Rolling, Extrusion and drawing of metals.
CO5	illustrate the advanced metal forming processes and power metallurgy techniques its applications

Course Articulation Matrix

		POs												**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
COs	**CO1**															
	CO2															
	CO3															
	CO4															
	CO5															

Artificial Intelligence & Machine Learning

Contact Hours/ Week:	: 3+0+0 (L+T+P)	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: S6MEE06	SEE Marks:	50

Prerequisites: Mathematics and Statistics, Basic Python Programming Skills, Data Structures and Algorithms.

Course Objectives:

1. Familiarize with the fundamentals of artificial intelligence and machine learning algorithms.
2. Understand and apply search strategies and logical agents in problem-solving.
3. Comprehend the basics of machine learning with Python and its essential tools.
4. Explore unsupervised learning techniques and data preprocessing methods.
5. Gain knowledge of reinforcement learning and applications of AI&ML mechanical engineering problems.

Unit 1	**Introduction to Artificial Intelligence (AI)**	**08 Hrs.**
Introduction to AI: History & Foundations. **Intelligent Agents & Environment**: The Nature of Environment, The Structure of Agents. **Problem Solving by Searching:** Problem solving agents – Toy Problems, Real World Problems, Searching for Solutions. AI vs. Data Science.		
Unit 2	**Searching Strategies and Logical Agents**	**09 Hrs.**
Uninformed Search Strategies: Breadth-First Search, Depth-First Search. **Informed Search Strategies:** Greedy Best-First Search, A* Search, Heuristic Functions. **Logical Agents:** Knowledge-Based Agents, The Wumpus World, Logic, Propositional Logic.		
Unit 3	**Introduction to Machine Learning (ML) with Python**	**09 Hrs.**
Introduction to machine learning, Python – scikit learn, Essential libraries and Tools. **Supervised Learning:** Classification and Regression, Generalization, Overfitting and Underfitting. **Supervised Learning Algorithms:** k- Nearest - Neighbors, Linear Model, Naive Bayes, Decision Trees, Neural Networks (Deep Learning).		
Unit 4	**Unsupervised Learning**	**08 Hrs.**
Unsupervised Learning and Preprocessing: Types, challenges, Preprocessing and Scaling, Dimensionality Reduction, Feature Extraction and Manifold Learning, Clustering, k-means Clustering, Agglomerative Clustering.		
Unit 5	**Reinforced Learning and Applications of AI and ML**	**08 Hrs.**
Introduction, Characteristics of Reinforced Learning, Learning Task, Q Learning – Q Function, Algorithm for Learning Q, Convergence, Experimentation Strategies. Algorithms: Value Based, Policy Based, Model Based. **Application of AI and ML:** Human Machine Interaction, Predictive Maintenance and Health Management, Fault Detection, Material Inspection.		

Text Books:

1. Stuart Russell and Peter Norvig, **"Artificial Intelligence: A Modern Approach"**, 3rd Edition, Pearson, 2010, ISBN-13: 978-0-13-604259-4.
2. Yves Kodratoff, Ryszard S. Michalski, **"Machine Learning: An Artificial Intelligence Approach"**, Volume 3, Elsevier Science, 2014, ISBN:9780080510552.
3. Mitchell, Tom M. **"Machine learning"**. Volume 1, McGraw-hill New York, 1997, ISBN:978-0-07-042807-2.

References Books:

1. Zsolt Nagy, **"Artificial Intelligence and Machine Learning Fundamentals"**, Packt Publishing Ltd., 2018, ISBN 978-1-78980-165-1.
2. Ameet V Joshi, **"Machine Learning and Artificial Intelligence"**, 2nd Edition, Springer Cham, 2022, ISBN978-3-031-12281-1.
3. Kaushik Kumar, Divya Zindani, J. Paulo Davim, **"Artificial Intelligence in Mechanical and Industrial Engineering",** 1st Edition, CRC Press, 2021, ISBN 9781032012964.

Web References:

https://nptel.ac.in/courses/112/103/112103280/

Course Outcomes:

Upon completion of the course, the student will be able to:

CO1: Recall and **explain** the foundational concepts of artificial intelligence and machine learning.

CO2: Explain both uninformed and informed search strategies, along with the structure and functioning of logical agents.

CO3: Identify and **utilize** essential libraries and tools for implementing machine learning models in Python.

CO4: Explain key concepts related to unsupervised learning and preprocessing techniques, such as scaling and dimensionality reduction.

CO5: Describe the characteristics and learning tasks of reinforcement learning, and **apply** ML models to solve mechanical engineering problems.

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

		POs												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
COs	CO-1	1	2													2
	CO-2		1		2	3										2
	CO-3			2		3										3
	CO-4			1	2	3										2
	CO-5			1		3							1			3

Ideation and Skill Development Lab

Contact Hours/Week	:	0+0+2 (L+T+P)	Credits	:	1.0
Total Practical Hours	:	26	CIE Marks	:	50
Course Code	:	S6MEL02	SEE Marks	:	50

Part A – Additive Manufacturing
Understanding Manufacturing: concept of manufacturing, need, scope, advantages, limitation, application, materials, classification of manufacturing. AM evolution, Distinction between AM & CNC machining, steps in AM, Classification of AM processes - Vat Photo polymerization, Material Jetting, Binder Jetting, Extrusion-Based AM Processes, Sheet Lamination AM Processes, Powder Bed Fusion AM Processes, Advantages of AM and Types of materials for AM. Parameter Optimization in FDM based 3D Printer and importance of printing parameters in printing good quality parts. **Practicals** (a) Modelling & Printing of simple models like hexagonal headed bolt. Hexagonal rod and rounded headed bolt. (b) Modelling and printing of an isometric view using orthographic projections. (c) Modelling and Printing of 3D Printed nut & bolt assembly.
03 (T)+09 (P) Hours
PART B – CNC Wood router and Laser Engraving & Cutting
Introduction to CNC wood router, Important Components, working procedure, precautions to be taken while operating, Materials that can be processed in CNC Wood router, applications, advantages and limitations. Introduction to lasing action, Spontaneous and stimulated emission, Properties of Laser Light, Laser components and configurations for different applications, Laser care and safety, Laser Applications in Material Processing: welding, Hardening, Laser Alloying, cladding and Additive Manufacturing, Laser induced material removal: drilling, cutting, marking. Demo on Setting up of parameters in CNC wood router and laser engraving machine to complete the product. **Practicals –** (a) Modelling & creating a Model-1 using CNC wood router. (b) Modelling & creating a Model-2 using CNC wood router. (c) Modelling & Engraving of Profile-1 using Laser Engraving process. (d) Modelling & cutting of Profile -2 using Laser cutting process.

TEXTBOOKS		
1	C.P Paul, A.N Junoop	Additive Manufacturing: Principles, Technologies and Applications, McGraw Hill, 2021.
2	K. Thyagarajan, Ajoy Ghatak	Lasers: Fundamentals and applications, Springer, 2010, 2nd Edition.

REFERENCE BOOKS:		
1	Amit Bandyopadhyay Susmita Bose	Additive Manufacturing, Second Edition, CRC Press Taylor & Francis Group, 2020.
2	Willium T Selfvast	Laser Fundamentals, Cambridge Univ. Press, 2008.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Develop 3D printed model using modelling and 3D printing software.
CO2	Perform laser cutting and engraving for a given applications and develop wooden models using CNC wood router.

Course Articulation Matrix

		POs											PSOs		
		1	2	3	4	5	6	7	8	9	10	11	1	2	3
COs	CO-1	3				3	2			2			3		
	CO-2	3				3	2			2			3		1