Scheme and Syllabus

B.E. (Mechanical Engineering)

under

NEP 2020

Choice Based Credit System

1st to 8th Semester

One Batch One Scheme for 2025-2029

PANJAB UNIVERSITY

CHANDIGARH

The Department of Mechanical Engineering

Vision

To be Fountainhead of Technological solutions for Needs of Society and Industry.

Mission

1. To impart fundamental engineering skills and knowledge for analysis of engineering problems.
2. To engage with Industry and Society for taking up stimulating problems on merits.
3. To take the project execution to "Minimum Usable Prototype (MUP)" stage/Pilot-testing and secure IP rights.

Core Values

1. 100% coverage of syllabus by faculty.
2. Actual delivery of around 40 lectures for a subject.
3. Delivery of lecture for around 50 minutes by a faculty in a lecture class of one hour.
4. 100% engagement of Tutorials.
5. Presence of faculty in the lab during the entire time of lab class.
6. Regular checking of practical files by faculty.

Program Educational Objectives

1. Graduates will work as Mechanical Engineering Professionals in industry of repute.
2. Graduates will pursue higher education and research in multi-disciplinary fields.
3. Graduates will work on industry/society problems by establishing start-ups.

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

1. Ability to identify, formulate and solve multidisciplinary problems in the domain of Design and Manufacturing.
2. Ability to undertake industrial problems/projects/startup/entrepreneurship

Scheme of Examination and Teaching

1st Semester										
Course Code	**Course Name**	**Option**	**Hours per week**			**Credits**				
			L	**T**	**P**		**Internal Assessment**	**University Exam**	**Total**
ASC X01	Applied Chemistry	Theory	4	0	0	4	50	50	100
ASC X51	Applied Chemistry (P)	Practical	0	0	3	1	50	-	50
ASM 101	Calculus	Theory	4	1	0	5	50	50	100
HSMC X01	Professional Communication	Theory	2	0	0	2	50	50	100
HSMC X51	Professional Communication (P)	Practical	0	0	2	1	50	-	50
ESC X53	Workshop	Practical	0	0	4	2	50	-	50
MEC 101	Engineering Mechanics	Theory	3	0	0	3	50	50	100
MEC 151	Engineering Mechanics (P)	Practical	0	0	3	1	50	-	50
EVS X01	Environment Sciences	Theory	3	0	0	Non-credit	Satisfactory / Unsatisfactory	-	-
			16	**1**	**12**	**19**	**400**	**200**	**600**

2nd Semester									
Course Code	Course Name	Option	Hours per week			Credits	Marks		
			L	T	P		Internal Assessment	University Exam	Total
	Choice Based Physics Course	Theory	4	0	0	4	50	50	100
	Choice Based Physics Course (P)	Practical	0	0	3	1	50	-	50
ASM 201	Differential Equations and Transforms	Theory	4	1	0	5	50	50	100
EEC X01	Basic Electrical and Electronics Engineering	Theory	3	0	0	3	50	50	100
EEC X51	Basic Electrical and Electronics Engineering (P)	Practical	0	0	2	1	50	-	50
ESC X04	Engineering Graphics	Theory	1	0	0	1	50	50	100
ESC X54	Engineering Graphics (P)	Practical	0	0	3	1	50	-	50
ESC X01	Programming fundamentals	Theory	3	0	0	3	50	50	100
ESC X51	Programming fundamentals (P)	Practical	0	0	3	1	50	-	50
NSS-I	National Service Scheme	Theory	1	0	0	Non-Credit	Satisfactory / Unsatisfactory	-	-
UHV-II	Universal Human Values-II	Theory	3	0	0	3	50	50	100
Total			**19**	**1**	**11**	**23**	**500**	**300**	**800**

Summer Training:

Subject Code	Subject Name	L-T-P	Contact hrs/week	Credits	Assessment
ST 251	**Product Re-engineering and Innovation**	0-0-20	20	Nil	Satisfactory / Unsatisfactory

Note: The students will undergo a mandatory "Summer Training" of two weeks in their respective department/workshop after their second-semester exams. It will be a non-credited mandatory course, the result of which (satisfactory/unsatisfactory) will be reflected in their second-semester mark sheet.

3rd Semester											
No	Subject			Teaching Scheme		Examination Scheme					
	Code	Name	Cat	LTP	Cr	Theory			*Practical		
						Int	Ext	Tot	Int	Ext	Tot
1	MEC301	Basic Thermodynamics	DC	300	3	50	50	100	-	-	-
	MEC351	Basic Thermodynamics (P)		003	1	-	-	-	50	-	50
2	MEC302	Mechanics of Materials	DC	300	3	50	50	100	-	-	-
	MEC352	Mechanics of Materials (P)		003	1	-	-	-	50	-	50
3	MEC303	Kinematics of Machines	DC	300	3	50	50	100	-	-	-
	MEC353	Kinematics of Machines (P)		003	1	-	-	-	50	-	50
4	MEC304	Machine Drawing	DC	100	1	50	50	100	-	-	-
	MEC354	Machine Drawing (P)		004	2	-	-	-	100	-	100
5	MEC305	Manufacturing Processes	DC	300	3	50	50	100	-	-	-
	MEC355	Manufacturing Processes (P)		003	1	-	-	-	50	-	50
6	ASM301	Algebra and Complex Analysis	BS	310	4	50	50	100	-	-	-
Total				33	23	300	300	600	300	-	300

*Practical marks include continuous and end semester evaluation.

4th Semester												
No	Subject			Teaching Scheme		Examination Scheme					
	Code	Name	Cat	LTP	Cr	Theory			*Practical		
						Int	Ext	Tot	Int	Ext	Tot
1	MEC401	Engineering Thermodynamics	DC	300	3	50	50	100	-	-	-
	MEC451	Engineering Thermodynamics (P)		003	1	-	-	-	50	-	50
2	MEC402	Mechanics of Solids	DC	300	3	50	50	100	-	-	-
	MEC452	Mechanics of Solids (P)		003	1	-	-	-	50	-	50
3	MEC403	Dynamics of Machines	DC	300	3	50	50	100	-	-	-
	MEC453	Dynamics of Machines (P)		003	1	-	-	-	50	-	50
4	MEC404	Manufacturing Technology	DC	300	3	50	50	100	-	-	-
	MEC454	Manufacturing Technology (P)		003	1	-	-	-	50	-	50
5	MEC405	Fluid Mechanics	DC	300	3	50	50	100	-	-	-
	MEC455	Fluid Mechanics (P)		003	1	-	-	-	50	-	50
6	MEC406	Numerical Analysis	DC	300	3	50	50	100	-	-	-
	MEC456	Numerical Analysis (P)		002	1	-	-	-	50	-	50
7	#MEC457	Internship 1	DP	0020	1				50		50
Total				35	25	300	300	600	350	-	350

* Practical marks include continuous and end semester evaluation.

There will be a 4 week internship after the 4th Semester either in the institute or in an enterprise approved by the Principal / Head of the Department. Internship marks include mid semester evaluation and end semester evaluation.

5th Semester												
No	Subject			Teaching Scheme		Examination Scheme					
	Code	Name	Cat	LTP	Cr	Theory			*Practical		
						Int	Ext	Total	Int	Ext	Tot
1	MEC501	Design of Machine Elements 1	DC	300	3	50	50	100	-	-	-
	MEC551	Design of Machine Elements 1 (P)		002	1	-	-	-	50	-	50
2	MEC502	Computer Aided Design and Manufacturing	DC	300	3	50	50	100	-	-	-
	MEC552	Computer Aided Design and Manufacturing (P)		003	1	-	-	-	50	-	50
3	MEC503	Robotics	DC	300	3	50	50	100	-	-	-
	MEC553	Robotics (P)		003	1	-	-	-	50	-	50
4	MEC504	Mechanical Measurement and Metrology	DC	300	3	50	50	100	-	-	-
	MEC554	Mechanical Measurement and Metrology (P)		003	1	-	-	-	50	-	50
5	MEC505	Mechatronics	DC	300	3	50	50	100	-	-	-
	MEC555	Mechatronics(P)		003	1	-	-	-	50	-	50
6	MEC506	Fluid Machinery	DC	300	3	50	50	100	-	-	-
	MEC556	Fluid Machinery (P)		003	1	-	-	-	50	-	50
Total				35	24	300	300	600	300	-	300

*Practical marks include continuous and end semester evaluation.

6th Semester											
No	Subject			Teaching Scheme		Examination Scheme					
	Code	Name	Cat	LTP	Cr	Theory			*Practical		
						Int	Ext	Tot	Int	Ext	Tot
1	MEC601	Design of Machine Elements 2	DC	300	3	50	50	100	-	-	-
	MEC651	Design of Machine Elements 2 (P)		002	1	-	-	-	50	-	50
2	MEC602	Finite Element Methods	DC	300	3	50	50	100	-	-	-
	MEC652	Finite Element Methods (P)		003	1	-	-	-	50	-	50
3	MEC603	Mechanical Vibrations	DC	300	3	50	50	100	-	-	-
	MEC653	Mechanical Vibrations (P)		003	1	-	-	-	50	-	50
4	MEC604	Heat Transfer	DC	300	3	50	50	100	-	-	-
	MEC654	Heat Transfer (P)		003	1	-	-	-	50	-	50
5	MEC605	Mechanical Behavior of Materials	DC	300	3	50	50	100	-	-	-
	MEC655	Mechanical Behavior of Materials (P)		003	1	-	-	-	50	-	50
6	MEC606	Operations Research	DC	300	3	50	50	100	-	-	-
	MEC656	Operations Research (P)		003	1	-	-	-	50	-	50
7	#MEC657	Internship 2	DP	00<u>20</u>	1	-	-	-	50	-	50
Total				35	25	300	300	600	350		350

*Practical marks include continuous and end semester evaluation.

#There will be a four-week internship after the 6th Semester either in the institute or in an enterprise approved by the Principal / Head of the Department. Internship marks include mid semester evaluation and end semester evaluation.

7th Semester											
No	Subject			Teaching Scheme		Examination Scheme					
	Code	Name	Cat	LTP	Cr	Theory			*Practical		
						Int	Ext	Tot	Int	Ext	Tot
1	MEC701	Refrigeration and Air Conditioning	DC	300	3	50	50	100	-	-	-
	MEC751	Refrigeration and Air Conditioning (P)		003	1	-	-	-	50	-	50
2	MEC702	Automatic Control	DC	300	3	50	50	100	-	-	-
	MEC752	Automatic Control (P)		003	1	-	-	-	50	-	50
3	MEC703	Automobile Engineering	DC	300	3	50	50	100	-	-	-
	MEC753	Automobile Engineering (P)		003	1	-	-	-	50	-	50
4	#MEC704X	Elective 1	DE	310	4	50	50	100	-	-	-
5	#MEC704X	Elective 2	DE	310	4	50	50	100			
6	MEC755	Minor Project	DP	004	2	-	-	-	100	-	100
Total				30	22	250	250	500	250	-	250

* Practical marks include continuous and end semester evaluation

The minimum number of students required for an elective to be run is set at 10% of allocated class strength.
In the subject code ‘X’ is a placeholder for a letter indicating one of several subjects listed in the table of electives.

7th Semester Electives*		
No	Subject	
	Code	Name
1	MEC704a	Machine Learning
2	MEC704b	Internet of Things
3	MEC704c	Mechanics of Composites
	MEC704d	Work Study
5	MEC704e	Structural Dynamics
6	MEC704f	Vehicle Dynamics
7	MEC704g	Industrial Engineering
8	MEC704h	Continuum Mechanics
9	MEC704i	Probability and Statistics for Engineers
10	MEC704j	Total Quality Management
11	MEC 704k	Fracture and Fatigue
12	MEC704l	Introduction to Modern FORTRAN
13	MEC704m	Smart Materials and Structures
14	MEC704n	Optimization Methods in Engineering Design
15	HSMC701	Financial Management
16	HSMC702	Business laws
17	HSMC703	Human Resource Management

* Students who have enrolled for the optional minor degree cannot take elective subjects that are common with their optional minor degree subjects.

8th Semester (Option 1)											
No	Subject			Teaching Scheme		Examination Scheme					
	Code	Name	Cat	LTP	Cr	Theory			Practical*		
						Int	Ext	Tot	Int	Ext	Tot
1	MEC801	Advanced Machining Techniques	DC	300	3	50	50	100	-	-	-
	MEC851	Advanced Machining Techniques (P)		003	1	-	-	-	50	-	50
2	MEC802	Non-Conventional Energy Sources	DC	300	3	50	50	100			
3	MEC803	Computational Fluid Dynamics	DC	300	3	50	50	100	-	-	-
	MEC853	Computational Fluid Dynamics (P)		003	1	-	-	-	50	-	50
4	#MEC804X	Elective 3	DE	310	4	50	50	100	-	-	-
5	#MEC804X	Elective 4	DE	310	4	50	50	100	-	-	-
6	MEC855	Major Project	DP	008	4	-	-	-	150	-	150
Total				31	23	250	250	500	250	-	250

* Practical marks include continuous and end semester evaluation.

The minimum number of students required for an elective to be run is set at 10% of allocated class strength. In the subject code ‘X’ is a placeholder for a letter indicating one of several subjects listed in the table of electives.

8th Semester Electives*		
No	Subject	
	Code	Name
1	MEC804a	Tribology
2	MEC804b	Additive Manufacturing
3	MEC804c	Elasticity
4	MEC804d	Product Design Development
5	MEC804e	Variational Methods
6	MEC804f	Nanotechnology
	MEC804g	Production Operations Management
8	MEC804h	Internal Combustion Engines
9	MEC804i	Computational Solid Mechanics
10	MEC804j	Micromechanics
11	HSMC801	Project Management and Entrepreneurship

* Students who have enrolled for the optional minor degree cannot take elective subjects that are common with their optional minor specialization subjects.

8th Semester (Option 2)@								
No	Subject			Teaching Scheme		#Examination Scheme		
	Code	Name	Cat	Duration	Cr	Host	Dept	Tot
1	MEC 856	Internship 3	DP	01 semester	23	250	500	750
Total					23	250	500	750#

Internship marks are for mid and end semester evaluation

@The students who want to undergo one semester internship in the 8th semester (option 2) are required to follow the rules and regulations as laid down by the Training Committee of the concerned department/institute.

Mapping of course outcomes (COs) with Programme outcomes (POs) and Programme specific outcomes (PSOs)

Subject Code	Subject name	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
ASC X01	Applied Chemistry	Analyze molecular bonding and predict chemical properties.	3.00	2.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	1.00	1.00
		Apply stereochemical principles to understand molecular arrangements and properties.	3.00	2.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	1.00	1.00
		Utilize spectroscopic techniques for chemical analysis.	2.00	3.00	2.00	3.00	3.00	0.00	0.00	0.00	0.00	1.00	0.00	2.00	1.00	2.00
		Apply thermodynamic laws and catalysis principles to industrial chemical processes.	3.00	3.00	3.00	2.00	2.00	2.00	2.00	0.00	1.00	1.00	2.00	3.00	3.00	3.00
		Average Mapping	2.75	2.50	1.75	1.75	1.75	0.50	0.50	0.00	0.25	0.50	0.50	2.25	1.50	1.75
ASC X51	Applied Chemistry Lab	Perform titrations to determine chemical concentrations.	2.00	2.00	1.00	2.00	1.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00
		Apply spectroscopy principles to real sample analysis.	2.00	3.00	2.00	3.00	3.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	1.00	2.00
		Execute polymer and catalyst synthesis experiments.	2.00	2.00	3.00	3.00	2.00	1.00	1.00	0.00	2.00	1.00	1.00	2.00	3.00	3.00
		Conduct separation and qualitative analysis using chromatographic techniques.	2.00	3.00	2.00	3.00	2.00	0.00	0.00	0.00	1.00	1.00	0.00	2.00	1.00	2.00
		Average Mapping	2.00	2.50	2.00	2.75	2.00	0.50	0.50	0.00	1.25	1.00	0.25	1.75	1.50	2.00
ASM 101	Calculus	Analyze the convergence of infinite series.	3.00	2.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00	2.00	1.00	1.00
		Apply differentiation techniques for multivariable functions.	3.00	3.00	2.00	2.00	2.00	0.00	0.00	0.00	0.00	1.00	0.00	2.00	1.00	1.00
		Evaluate double and triple integrals and solve real-life problems.	3.00	3.00	2.00	2.00	2.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	1.00	2.00
		Apply vector calculus concepts such as gradient, divergence, and curl.	3.00	3.00	2.00	2.00	2.00	0.00	0.00	0.00	0.00	1.00	0.00	2.00	1.00	1.00
		Average Mapping	3.00	2.75	1.75	1.75	1.75	0.25	0.25	0.00	0.25	1.00	0.00	2.00	1.00	1.25
HSMC X01	Professional Communication	Demonstrate correct sentence structure and grammar usage.	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1.00	2.00	3.00	1.00	1.00	0.00	0.00
		Enhance their reading, writing, listening, and speaking skills.	0.00	0.00	0.00	0.00	1.00	2.00	0.00	1.00	2.00	3.00	1.00	2.00	0.00	1.00
		Communicate effectively within organizational settings.	0.00	0.00	0.00	0.00	1.00	3.00	0.00	2.00	3.00	3.00	2.00	2.00	0.00	2.00
		Use new media and non-verbal communication appropriately	0.00	0.00	0.00	0.00	2.00	3.00	0.00	1.00	2.00	3.00	1.00	2.00	0.00	2.00
		Average Mapping	0.00	0.00	0.00	0.00	1.00	2.25	0.00	1.25	2.25	3.00	1.25	1.75	0.00	1.25
HSMC X51	Professional Communication Lab	Speak clearly and confidently in public forums.	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1.00	2.00	3.00	1.00	1.00	0.00	0.00
		Participate effectively in group discussions and interviews.	0.00	0.00	0.00	0.00	1.00	2.00	0.00	1.00	2.00	3.00	1.00	2.00	0.00	1.00
		Understand non-verbal communication in professional settings.	0.00	0.00	0.00	0.00	1.00	3.00	0.00	2.00	3.00	3.00	2.00	2.00	0.00	2.00
		Deliver structured presentations with clarity.	0.00	0.00	0.00	0.00	2.00	3.00	0.00	1.00	2.00	3.00	1.00	2.00	0.00	2.00
		Average Mapping	0.00	0.00	0.00	0.00	1.00	2.25	0.00	1.25	2.25	3.00	1.25	1.75	0.00	1.25
ESC X53	Workshop	Identify tools and machines used in workshop practices.	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	2.00	1.00
		Demonstrate welding, fitting, carpentry, and machining operations.	2.00	1.00	1.00	1.00	2.00	1.00	1.00	1.00	2.00	1.00	0.00	1.00	3.00	2.00
		Perform fabrication and manufacturing tasks safely.	1.00	1.00	1.00	1.00	2.00	2.00	2.00	3.00	2.00	1.00	1.00	1.00	3.00	2.00
		Understand the impact of manufacturing techniques on product design.	2.00	2.00	3.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	2.00	3.00	2.00

Mapping of course outcomes (COs) with Programme outcomes (POs) and Programme specific outcomes (PSOs)

Subject Code	Subject name	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		Average Mapping	1.50	1.00	1.25	0.75	1.50	1.00	1.00	1.00	1.50	1.00	0.50	1.25	2.75	1.75
MEC 101	Engineering Mechanics	Analyze forces, moments, and equilibrium conditions in static structures.	3.00	3.00	2.00	2.00	1.00	0.00	0.00	0.00	1.00	1.00	0.00	2.00	1.00	1.00
		Calculate centroid, moment of inertia, and center of gravity of surfaces and solids.	3.00	3.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00	2.00	1.00	1.00
		Solve problems involving trusses, frames, and beams.	3.00	3.00	2.00	2.00	1.00	0.00	0.00	0.00	1.00	1.00	0.00	2.00	2.00	2.00
		Apply mechanical principles to simple machine and structure design.	3.00	3.00	3.00	2.00	2.00	1.00	1.00	0.00	1.00	1.00	1.00	2.00	3.00	2.00
		Average Mapping	3.00	3.00	2.00	1.75	1.25	0.25	0.25	0.00	0.75	1.00	0.25	2.00	1.75	1.50
MEC 151	Engineering Mechanics Lab	Conduct experiments on beams, trusses, and frames.	2.00	2.00	1.00	3.00	2.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	1.00	1.00
		Analyze experimental data and validate theoretical models.	3.00	3.00	2.00	3.00	2.00	0.00	0.00	0.00	1.00	1.00	0.00	2.00	1.00	1.00
		Apply concepts of equilibrium in practical scenarios.	3.00	3.00	2.00	2.00	1.00	1.00	0.00	0.00	1.00	1.00	0.00	2.00	1.00	1.00
		Develop technical report writing skills based on experimental observations.	1.00	1.00	0.00	1.00	1.00	1.00	0.00	1.00	2.00	3.00	1.00	1.00	0.00	1.00
		Average Mapping	2.25	2.25	1.25	2.25	1.50	0.50	0.00	0.25	1.50	1.50	0.25	1.50	0.75	1.00
EVS X01	Environment Sciences	Understand ecosystem structures, functions, and services.	1.00	1.00	0.00	0.00	0.00	2.00	3.00	1.00	0.00	1.00	0.00	1.00	0.00	0.00
		Analyze environmental pollution and its control measures.	2.00	2.00	1.00	1.00	0.00	3.00	3.00	1.00	1.00	1.00	0.00	2.00	0.00	1.00
		Apply knowledge of environmental laws and policies.	1.00	1.00	0.00	0.00	0.00	3.00	3.00	2.00	0.00	1.00	1.00	1.00	0.00	1.00
		Promote sustainable practices in personal and professional life.	0.00	0.00	1.00	0.00	0.00	3.00	3.00	3.00	1.00	1.00	1.00	2.00	1.00	2.00
		Average Mapping	1.00	1.00	0.50	0.25	0.00	2.75	3.00	1.75	0.50	1.00	0.50	1.50	0.25	1.00
ASP X03	Physics of materials	Qualitatively describe the bonding in materials and its effect on material properties and classify the materials into metals, ceramics and polymers based on their structure.	3.00	2.00	1.00	1.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00
		Identify various imperfections in the crystal structure and to correlate these to material properties. Identify diffusion processes and their applications.	3.00	2.00	1.00	1.00	2.00	0.00	0.00	0.00	1.00	0.00	0.00	2.00	0.00	0.00
		Understand the elastic, anelastic, viscoelastic and plastic properties of materials and relate these to material structure.	3.00	2.00	2.00	1.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00
		Understand the electrical, magnetic and optical properties of materials and discuss the applications of these.	3.00	2.00	1.00	2.00	1.00	2.00	1.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00
		Average Mapping	3.00	2.00	1.25	1.25	1.50	0.50	0.25	0.00	0.50	0.00	0.00	1.75	0.00	0.00
ASPX53	Physics of materials Lab	Understand the construction and working of measuring devices like vernier Calipers, screw gauge, spherometer etc. and electrical devices like ammeter, voltmeter, galvanometer, gaussmeter etc. (analog and digital)	3.00	2.00	1.00	1.00	0.00	0.00	1.00	1.00	2.00	1.00	0.00	2.00	0.00	0.00
		Identify and differentiate the materials based on their electrical, magnetic, thermal and optical properties	3.00	2.00	1.00	1.00	0.00	0.00	1.00	1.00	2.00	1.00	0.00	2.00	0.00	0.00
		Experimentally determine parameters like Elastic constatnt, thermal conductivity, electrical resistivity, Hall coefficient, Curie temperature, retentivity and coercivity etc. of various materials.	3.00	3.00	1.00	1.00	0.00	0.00	1.00	1.00	2.00	1.00	0.00	2.00	0.00	0.00
		Carry out the error analysis of their results., provide a theoretical explanations of their results and make a complete and cogent report of their findings.	3.00	2.00	1.00	1.00	0.00	0.00	1.00	1.00	2.00	1.00	0.00	2.00	0.00	0.00
		Average Mapping	3.00	2.25	1.00	1.00	0.00	0.00	1.00	1.00	2.00	1.00	0.00	2.00	0.00	0.00

Mapping of course outcomes (COs) with Programme outcomes (POs) and Programme specific outcomes (PSOs)

Subject Code	Subject name	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
ASM 201	Differential Equations and Transforms	The student will learn to solve Ordinary Differential equations and their applications to engineering problems.	3.00	3.00	2.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
		The students will be able to apply the tools of Laplace Transforms to model engineering problems and solve the resulting differential equations.	2.00	3.00	2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
		Students will understand the nature and behaviour of trigonometric (Fourier) series and apply it to solve boundary value problems.	2.00	2.00	3.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
		Students will be able to understand the formulation of partial differential equations and its solution techniques	2.00	2.00	3.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
		Average Mapping	2.25	2.50	2.50	2.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
EEC X01	Basic Electrical and Electronics Engineering	Solve electric circuits using theorems and analyse AC electrical circuits	3.00	3.00	1.00	1.00	1.00	0.00	0.00	0.00	1.00	2.00	2.00	0.00	3.00	1.00
		Explain the basics of transformers in electric systems.	3.00	3.00	1.00	1.00	1.00	0.00	0.00	0.00	1.00	2.00	2.00	0.00	3.00	1.00
		Explain the working principle and characteristics of semiconductor diodes	3.00	3.00	1.00	1.00	1.00	0.00	0.00	0.00	1.00	2.00	2.00	0.00	3.00	1.00
		Explain the working principle and characteristics of Bipolar Junction Transistors	3.00	3.00	1.00	1.00	1.00	0.00	0.00	0.00	1.00	2.00	2.00	0.00	3.00	1.00
		Average Mapping	3.00	3.00	1.00	1.00	1.00	0.00	0.00	0.00	1.00	2.00	2.00	0.00	3.00	1.00
EEC X51	Basic Electrical and Electronics Engineering Lab	Solve electric circuits using theorems and solve AC electrical circuits	2.00	1.00	3.00	1.00	1.00	1.00	1.00	1.00	3.00	2.00	1.00	2.00	3.00	0.00
		Perform the basic tests of transformers in electric systems.	2.00	1.00	3.00	1.00	1.00	1.00	1.00	1.00	3.00	2.00	1.00	2.00	3.00	0.00
		1. Find characteristics of semiconductor diodes.	2.00	1.00	3.00	1.00	1.00	1.00	1.00	1.00	3.00	2.00	1.00	2.00	3.00	0.00
		1. Find characteristics of Bipolar Junction Transistors.	2.00	1.00	3.00	1.00	1.00	1.00	1.00	1.00	3.00	2.00	1.00	2.00	3.00	0.00
		Average Mapping	2.00	1.00	3.00	1.00	1.00	1.00	1.00	1.00	3.00	2.00	1.00	2.00	3.00	0.00
ESC X04	Engineering Graphics	Prepare orthographic projections and interpret engineering drawings.	2.00	2.00	2.00	1.00	2.00	1.00	0.00	0.00	1.00	3.00	1.00	2.00	3.00	2.00
		Develop pictorial and isometric projections of objects.	2.00	2.00	2.00	1.00	2.00	1.00	0.00	0.00	1.00	3.00	1.00	2.00	3.00	2.00
		Create CAD drawings and 3D models using software tools.	2.00	2.00	3.00	1.00	3.00	1.00	1.00	0.00	1.00	2.00	1.00	2.00	3.00	3.00
		Apply drawing standards to engineering design documentation.	1.00	1.00	2.00	0.00	2.00	1.00	0.00	1.00	1.00	3.00	1.00	2.00	3.00	2.00
		Average Mapping	1.75	1.75	2.25	0.75	2.25	1.00	0.25	0.25	1.00	2.75	1.00	2.00	3.00	2.25
ESC X54	Engineering Graphics Lab	Prepare orthographic projections and interpret engineering drawings.	2.00	2.00	2.00	1.00	2.00	1.00	0.00	0.00	1.00	3.00	1.00	2.00	3.00	2.00
		Develop pictorial and isometric projections of objects.	2.00	2.00	2.00	1.00	2.00	1.00	0.00	0.00	1.00	3.00	1.00	2.00	3.00	2.00
		Create CAD drawings and 3D models using software tools.	2.00	2.00	3.00	1.00	3.00	1.00	1.00	0.00	1.00	2.00	1.00	2.00	3.00	3.00
		Apply drawing standards to engineering design documentation.	1.00	1.00	2.00	0.00	2.00	1.00	0.00	1.00	1.00	3.00	1.00	2.00	3.00	2.00
		Average Mapping	1.75	1.75	2.25	0.75	2.25	1.00	0.25	0.25	1.00	2.75	1.00	2.00	3.00	2.25
ESC X01	Programming fundamentals	Design algorithms and flowcharts for problem solving.	3.00	3.00	2.00	1.00	2.00	0.00	0.00	0.00	1.00	1.00	0.00	2.00	1.00	2.00
		Write, debug, and execute structured programs in C.	2.00	2.00	2.00	1.00	3.00	0.00	0.00	0.00	1.00	1.00	0.00	2.00	1.00	2.00

Mapping of course outcomes (COs) with Programme outcomes (POs) and Programme specific outcomes (PSOs)

Subject Code	Subject name	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		Apply decision making and loop control structures effectively.	3.00	3.00	2.00	1.00	2.00	0.00	0.00	0.00	1.00	1.00	0.00	2.00	1.00	2.00
		Implement modular programming using functions and arrays.	3.00	3.00	3.00	1.00	3.00	0.00	0.00	0.00	2.00	1.00	1.00	3.00	1.00	3.00
		Average Mapping	2.75	2.75	2.25	1.00	2.50	0.00	0.00	0.00	1.25	1.00	0.25	2.25	1.00	2.25
ESC X51	Programming fundamentals Lab	Design algorithms and flowcharts for problem solving.	3.00	3.00	2.00	1.00	2.00	0.00	0.00	0.00	1.00	1.00	0.00	2.00	1.00	2.00
		Write, debug, and execute structured programs in C.	2.00	2.00	2.00	1.00	3.00	0.00	0.00	0.00	1.00	1.00	0.00	2.00	1.00	2.00
		Apply decision making and loop control structures effectively.	3.00	3.00	2.00	1.00	2.00	0.00	0.00	0.00	1.00	1.00	0.00	2.00	1.00	2.00
		Implement modular programming using functions and arrays.	3.00	3.00	3.00	1.00	3.00	0.00	0.00	0.00	2.00	1.00	1.00	3.00	1.00	3.00
		Average Mapping	2.75	2.75	2.25	1.00	2.50	0.00	0.00	0.00	1.25	1.00	0.25	2.25	1.00	2.25
UHV-II	Universal Human Values-II	Students will recognize the crucial role of human values alongside technical skills for effective problem-solving and self-verify truth.	1.00	2.00	1.00	1.00	0.00	3.00	1.00	3.00	1.00	1.00	1.00	3.00	1.00	1.00
		Students will understand human desires versus physical needs and the importance of right understanding and respect in relationships.	0.00	1.00	0.00	0.00	0.00	3.00	1.00	3.00	2.00	2.00	1.00	2.00	0.00	1.00
		Students will analyze the interconnectedness of existence and the need for responsible human actions towards sustainability.	1.00	2.00	2.00	1.00	0.00	3.00	3.00	3.00	1.00	1.00	1.00	3.00	1.00	2.00
		Students will apply value-based understanding to their knowledge domain and integrate these principles for personal and societal well-being.	1.00	2.00	2.00	1.00	1.00	3.00	3.00	3.00	2.00	2.00	2.00	3.00	1.00	2.00
		Average Mapping	0.75	1.75	1.25	0.75	0.25	3.00	2.00	3.00	1.50	1.50	1.25	2.75	0.75	1.50
NSS-1	National Service Scheme	Ability to solve the community problems	1.00	2.00	2.00	2.00	1.00	3.00	2.00	2.00	3.00	2.00	2.00	2.00	1.00	2.00
		Being a socially responsible citizen	0.00	1.00	1.00	1.00	0.00	3.00	2.00	3.00	2.00	2.00	1.00	2.00	0.00	1.00
		Ability to lead in the democratic environments	0.00	1.00	2.00	1.00	1.00	3.00	1.00	2.00	3.00	3.00	2.00	2.00	0.00	2.00
		Development of national integration and social harmony	0.00	1.00	1.00	1.00	0.00	3.00	1.00	3.00	3.00	3.00	1.00	2.00	0.00	1.00
		Average Mapping	0.25	1.25	1.50	1.25	0.50	3.00	1.50	2.50	2.75	2.50	1.50	2.00	0.25	1.50
ST251	Product re-enginering and innovation	Analyze products for re-engineering opportunities.	2.00	3.00	2.00	2.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	2.00	3.00	2.00
		Generate novel product concepts through innovation.	2.00	3.00	3.00	2.00	2.00	1.00	1.00	0.00	2.00	1.00	1.00	3.00	3.00	3.00
		Evaluate feasibility of re-engineered/innovative ideas.	2.00	3.00	3.00	3.00	2.00	2.00	2.00	1.00	2.00	1.00	2.00	3.00	3.00	3.00
		Develop preliminary designs/prototypes	3.00	3.00	3.00	2.00	3.00	1.00	1.00	0.00	2.00	2.00	2.00	3.00	3.00	3.00
		Average Mapping	2.25	3.00	2.75	2.25	2.00	1.25	1.25	0.25	1.75	1.25	1.50	2.75	3.00	2.75
MEC-301	Basic Thermodynamics	Apply the first and second laws of thermodynamics to engineering problems.	3.00	3.00	2.00	2.00	1.00	1.00	2.00	0.00	0.00	1.00	0.00	2.00	3.00	1.00
		Analyze properties of pure substances and gas mixtures.	3.00	3.00	2.00	1.00	1.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	3.00	0.00
		Evaluate performance of basic thermal systems.	3.00	3.00	3.00	2.00	1.00	1.00	2.00	0.00	0.00	1.00	0.00	2.00	3.00	1.00
		Apply thermodynamic principles to power and refrigeration cycles.	3.00	3.00	3.00	2.00	1.00	1.00	2.00	0.00	0.00	1.00	0.00	2.00	3.00	1.00
		Average Mapping	3.00	3.00	2.50	1.75	1.00	0.75	1.75	0.00	0.00	1.00	0.00	1.75	3.00	0.75

Mapping of course outcomes (COs) with Programme outcomes (POs) and Programme specific outcomes (PSOs)

Subject Code	Subject name	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEC-351	Basic Thermodynamics Lab	Students will understand the principles of thermal energy. This includes the study of energy transformations and thermodynamic relationships applied to flow and non-flow processes in power and refrigeration cycles.	3.00	2.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00
		Identify and explain the construction and working of various boilers and condensers used in thermal systems.	2.00	3.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	2.00
		Conduct experiments to determine fuel properties (e.g., calorific value) and steam quality (e.g., dryness fraction) using standard calorimeters.	1.00	2.00	0.00	3.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	1.00	2.00
		Students will have analytical skills to solve and analyze a variety of steam related problems. Like boilers, condensers	3.00	3.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	3.00
		Average Mapping	2.25	2.50	1.25	0.75	0.25	0.00	0.00	0.00	0.25	0.00	0.00	0.75	1.50	2.00
MEC-302	Mechanics of Materials	Given a physical situation the student should be able to develop a physical understanding of the problem.	3.00	3.00	2.00	2.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
		The student should then be able to construct an idealized model.	3.00	3.00	3.00	2.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
		Using equilibrium, compatibility, and force-deformation relation the student should be able to generate the solution to the problem.	3.00	3.00	3.00	3.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
		The student should be able to analyze and design an element using the above principles.	3.00	3.00	3.00	3.00	1.00	2.00	2.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
		Average Mapping	3.00	3.00	2.75	2.50	0.75	1.25	1.25	0.00	1.00	1.00	0.00	2.00	3.00	1.00
MEC-352	Mechanics of Materials Lab	Understand the working principles of testing machines and conduct basic mechanical tests like tension, compression, shear, and bending.	2.00	2.00	1.00	2.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	2.00	3.00
		Perform torsion and impact tests to determine material properties such as modulus of rigidity and toughness.	2.00	2.00	0.00	3.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	2.00	2.00
		Evaluate the hardness of materials using Brinell, Vickers, Rockwell, and other standard methods.	2.00	2.00	0.00	3.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	2.00	2.00
		Analyze experimental data to determine material constants such as Young's modulus and shear modulus and prepare technical reports.	2.00	3.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	1.00	1.00	2.00
		Average Mapping	2.00	2.25	0.25	2.75	0.75	0.00	0.00	0.00	0.75	0.50	0.00	1.00	1.75	2.25
MEC-303	kinematics of machines	Analyze motion of mechanisms and linkages.	3.00	3.00	3.00	2.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
		Apply kinematic and dynamic analysis to machine components.	3.00	3.00	3.00	2.00	2.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
		Understand balancing and vibration in mechanical systems.	3.00	2.00	2.00	1.00	1.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	3.00	0.00
		Apply gyroscopic principles to engineering applications.	3.00	2.00	2.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	3.00	1.00
		Average Mapping	3.00	2.50	2.50	1.50	1.25	0.75	0.75	0.00	1.00	1.00	0.00	1.50	3.00	0.75
MEC-353	kinematics of machines Lab	Familiarity with common mechanisms used in machines and everyday life.	2.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	2.00
		Ability to calculate mobility (number of degrees-of-freedom) and enumerate rigid links and types of joints within mechanisms.	3.00	3.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	1.00
		Ability to conduct a complete (translational and rotational) mechanism position analysis.	3.00	3.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	2.00
		Analyze and interpret the operational behavior of various types of governors (Porter, Proell, Hartnell) under changing parameters like mass and spring compression.	3.00	3.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	2.00
		Average Mapping	2.75	2.50	1.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.75	1.75

Mapping of course outcomes (COs) with Programme outcomes (POs) and Programme specific outcomes (PSOs)

Subject Code	Subject name	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEC-304	Machine Drawing	Interpret and communicate engineering drawings having a number of symbols, standards and views.	2.00	1.00	3.00	1.00	2.00	1.00	1.00	0.00	2.00	3.00	0.00	1.00	2.00	1.00
		Apply and interpret various types of tolerances and geometric dimensioning symbols in accordance with industry standards.	2.00	1.00	3.00	1.00	2.00	1.00	1.00	0.00	2.00	3.00	0.00	1.00	2.00	1.00
		Understand the technical intricacies involved in drawing and working of screws, bolts, pipe fittings, cotter joint, knuckle joint, pulleys, brackets, couplings, bearings, engine parts, tail stock, screw jack, vices, valves etc.	2.00	1.00	3.00	1.00	2.00	1.00	1.00	0.00	2.00	3.00	0.00	1.00	2.00	2.00
		Create 3D models of engineering objects, machine drawings with different views, and an assembly of the objects that make up engineered systems, using a CAD system (e.g. AutoCAD etc.).	2.00	1.00	3.00	1.00	3.00	1.00	1.00	0.00	2.00	3.00	0.00	2.00	2.00	3.00
		Average Mapping	2.00	1.00	3.00	1.00	2.25	1.00	1.00	0.00	2.00	3.00	0.00	1.25	2.00	1.75
MEC-354	Machine Drawing Lab	Ability to communicate the ideas and concepts using CAD software.	1.00	0.00	2.00	0.00	3.00	0.00	0.00	0.00	0.00	2.00	0.00	1.00	2.00	2.00
		Ability to draw and communicate assembly drawings and sectional views.	1.00	0.00	2.00	0.00	3.00	0.00	0.00	0.00	0.00	2.00	0.00	1.00	2.00	2.00
		Ability to develop 3-D solid models of real life mechanical systems.	2.00	1.00	3.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	3.00	3.00
		Create 3D models of engineering objects, machine drawings with different views, and an assembly of the objects that make up engineered systems, using a CAD system (e.g. AutoCAD etc.).	2.00	1.00	3.00	0.00	3.00	0.00	0.00	0.00	0.00	2.00	0.00	1.00	3.00	1.00
		Average Mapping	1.50	0.50	2.50	0.00	3.00	0.00	0.00	0.00	0.00	1.50	0.00	1.00	2.50	2.00
MEC-305	Manufacturing Processes	Understand the fundamentals of Engineering Materials and select appropriate materials for specific applications.	3.00	2.00	2.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00	1.00	1.00	3.00	1.00
		Describe and apply various metal forming processes such as rolling, forging, extrusion, and sheet metal operations, and identify common defects and remedies.	3.00	3.00	2.00	2.00	1.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	3.00	1.00
		Analyze and apply casting and welding processes, understand the equipment used, and identify and identify its controlling parameter.	3.00	3.00	2.00	2.00	1.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	3.00	1.00
		Understand and apply the principles of powder metallurgy, including powder production, sintering, and finishing operations, and assess its advantages and limitations for manufacturing components.	3.00	3.00	2.00	2.00	1.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	3.00	1.00
		Average Mapping	3.00	2.75	2.00	1.75	1.00	0.25	0.25	0.00	0.75	0.75	0.50	1.00	3.00	1.00
MEC-355	Manufacturing Processes Lab	The Fundamentals of Engineering Materials	3.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00
		The principle working and controlling parameters of metal forming processes and the principle working and controlling parameters of welding	3.00	2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	3.00	2.00
		The principle working and controlling parameters of foundry and the process of mould making	3.00	2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	3.00	1.00
		Demonstrate understanding of the powder metallurgy process and its industrial applications.	3.00	2.00	2.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	3.00	1.00
		Average Mapping	3.00	1.75	1.75	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.50	1.25
ASM 301	Algebra and complex analysis	Student will learn to solve system of linear equations and related concepts and will be introduced to the idea of vector spaces and linear transforms along with their applications.	3.00	3.00	1.00	2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	1.00	0.00
		Student will be able to carry out various operations on matrices including its diagonalization using eigen vectors and shall be able to understand the concept of change of basis and its matrix representation.	3.00	3.00	1.00	2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	1.00	0.00

Mapping of course outcomes (COs) with Programme outcomes (POs) and Programme specific outcomes (PSOs)

Subject Code	Subject name	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		Student will be introduced to the concept of complex valued functions, the calculus of complex valued functions on elementary functions.	3.00	2.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
		Student will understand the concept of series representations of complex functions and its applications to solving complex integrals. Transformation using complex functions is also introduced.	3.00	3.00	0.00	2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00
		Average Mapping	3.00	2.75	0.50	1.75	1.75	0.00	0.00	0.00	0.00	0.00	0.00	1.75	0.50	0.00
MEC-401	Engeneering Thermodynamics	Calculate and interpret entropy and exergy changes in thermodynamic systems, and assess their impact on energy efficiency and irreversibilities.	3.00	3.00	2.00	2.00	2.00	1.00	2.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00
		Describe the characteristics of the Otto, Diesel, and Brayton power cycles and the method of analysis of each cycle.	3.00	3.00	2.00	2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00
		Apply the principles of gas mixtures, including mass and mole fraction analysis, to determine the properties and behavior of real and ideal gas mixtures in thermodynamic processes.	3.00	3.00	1.00	2.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00
		Use the principles of chemical and phase equilibrium to predict system behavior under equilibrium conditions, and calculate equilibrium constants for single and multi-component systems.	3.00	3.00	1.00	2.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00
		Average Mapping	3.00	3.00	1.50	2.00	1.50	0.25	0.50	0.00	0.00	0.00	0.00	1.00	1.00	0.00
MEC-451	Engeneering Thermodynamics lab	Identify components and explain the working of 2-stroke and 4-stroke diesel and petrol engines along with auxiliary systems.	3.00	2.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	0.00
		Conduct performance tests to evaluate B.H.P., I.H.P., thermal and mechanical efficiency of IC engines under various conditions.	2.00	2.00	0.00	3.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	2.00	0.00
		Analyze valve timing and performance curves (B.H.P. vs Torque, efficiency vs load) to assess engine behavior.	3.00	3.00	2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	0.00
		Estimate steam quality and prepare a heat balance sheet for diesel engine operations using calorimetry and energy accounting principles.	2.00	3.00	0.00	3.00	1.00	0.00	0.00	0.00	1.00	2.00	0.00	1.00	2.00	0.00
		Average Mapping	2.50	2.50	0.75	2.00	0.50	0.00	0.00	0.00	0.50	0.50	0.00	1.00	2.00	0.00
MEC-402	Mechanics of Solids	The student should be able to make free body diagrams	2.00	3.00	1.00	2.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00
		The student should be able to develop a physical understanding of a given problem.	2.00	3.00	1.00	2.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00
		Using equilibrium, compatibility, and force-deformation relation the student should be able to generate the solution to the problem.	3.00	3.00	2.00	3.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	0.00
		The student should feel comfortable with the use of approximate theoretical techniques, numerical methods, or experimental analysis or a combination to obtain a solution.	3.00	3.00	2.00	3.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	2.00	0.00
		Average Mapping	2.50	3.00	1.50	2.50	1.25	0.00	0.00	0.00	0.00	0.00	0.00	1.25	1.50	0.00
MEC-452	Mechanics of Solids lab	Analyze buckling and creep behavior in structural materials under axial and time-dependent loads.	3.00	3.00	2.00	2.00	1.00	0.00	1.00	0.00	0.00	1.00	1.00	2.00	3.00	2.00
		Conduct fatigue tests and interpret fatigue life based on stress-cycles data.	3.00	3.00	2.00	3.00	2.00	0.00	1.00	0.00	1.00	1.00	2.00	2.00	3.00	3.00
		Determine stress distribution in pressure vessels and locate shear centers in unsymmetrical sections.	3.00	3.00	3.00	2.00	2.00	0.00	1.00	0.00	0.00	1.00	1.00	2.00	3.00	2.00
		Demonstrate the use of strain gages and photo-elasticity techniques to analyze and visualize stress-strain behavior	3.00	3.00	2.00	3.00	3.00	0.00	1.00	0.00	1.00	2.00	1.00	2.00	3.00	3.00
		Average Mapping	3.00	3.00	2.25	2.50	2.00	0.00	1.00	0.00	0.50	1.25	1.25	2.00	3.00	2.50

Mapping of course outcomes (COs) with Programme outcomes (POs) and Programme specific outcomes (PSOs)

Subject Code	Subject name	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEC-403	Dynammics of machines	Students will be able to design gears and understand transmission of forces	3.00	3.00	3.00	2.00	1.00	1.00	0.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
		Students will be able to design different types of cam mechanism	3.00	3.00	3.00	2.00	1.00	1.00	0.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
		Students will be able to understand the inertia forces involved during engine force and power transmissions	3.00	3.00	2.00	2.00	1.00	1.00	0.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
		Students can generate various mechanisms related to lower pairs and solve engine problems related to balancing of rotating and reciprocating parts	3.00	3.00	3.00	3.00	1.00	1.00	0.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
		Average Mapping	3.00	3.00	2.75	2.25	1.00	1.00	0.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
MEC-453	Dynammics of machines Lab	Students will be able to design gears and understand transmission of forces	3.00	2.00	3.00	2.00	2.00	0.00	1.00	0.00	0.00	1.00	1.00	2.00	3.00	2.00
		Students will be able to design different types of cam mechanism	3.00	2.00	3.00	2.00	2.00	0.00	1.00	0.00	1.00	1.00	1.00	2.00	3.00	2.00
		Students will be able to understand the inertia forces involved during engine force and power transmissions	3.00	3.00	2.00	2.00	2.00	0.00	1.00	0.00	0.00	1.00	1.00	2.00	3.00	2.00
		Students can generate various mechanisms related to lower pairs and solve engine problems related to balancing of rotating and reciprocating parts	3.00	3.00	2.00	3.00	2.00	0.00	1.00	0.00	1.00	1.00	2.00	2.00	3.00	3.00
		Average Mapping	3.00	2.50	2.50	2.25	2.00	0.00	1.00	0.00	0.50	1.00	1.25	2.00	3.00	2.25
MEC-404	Manufacturing Technology	Describe the fundamentals of metal cutting and tool life.	3.00	2.00	1.00	1.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	2.00	1.00
		Explain the construction, features, and operations of center lathes and special-purpose lathes.	3.00	2.00	2.00	1.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	2.00	1.00
		Illustrate the working principle, functions, and specifications of shaping, planning, and slotting machines.	3.00	2.00	2.00	1.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	2.00	1.00
		Describe the principle, types, and operations of milling and drilling machines.	3.00	2.00	2.00	1.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	2.00	1.00
		Average Mapping	3.00	2.00	1.75	1.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	2.00	1.00
MEC-454	Manufacturing Technology lab	Identify the different components and operations of traditional machines.	3.00	1.00	1.00	0.00	2.00	0.00	0.00	0.00	2.00	1.00	1.00	1.00	2.00	1.00
		Operate and perform various machining operations on a lathe including turning, grooving, boring, and threading.	3.00	2.00	3.00	1.00	3.00	0.00	0.00	1.00	3.00	2.00	1.00	2.00	3.00	2.00
		Perform precision machining tasks such as grinding, reaming, and thread manufacturing with proper technique.	3.00	2.00	3.00	1.00	3.00	0.00	0.00	1.00	3.00	2.00	1.00	2.00	3.00	2.00
		Understand and explain various gear manufacturing processes used in the industry.	3.00	2.00	2.00	1.00	2.00	0.00	0.00	0.00	2.00	1.00	1.00	1.00	2.00	1.00
		Average Mapping	3.00	1.75	2.25	0.75	2.50	0.00	0.00	0.50	2.50	1.50	1.00	1.50	2.50	1.50
MEC-405	Fluid Mechanics	Explain the concept of fluid, stability of bodies in fluid and different types of fluid flows.	3.00	2.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	3.00
		Use Bernoulli's theorem to solve basic problems involving pressure losses through pipes and pipe bends and its application	3.00	3.00	2.00	2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	3.00
		Explain the importance of Dimensional Analysis techniques and dimensionless parameters in fluid mechanics; Reynolds number; Mach number.	3.00	2.00	0.00	2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	2.00
		Lean the concept of potential flow, viscous flow considering viscous forces	3.00	3.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	3.00	1.00
		Average Mapping	3.00	2.50	0.75	1.75	1.25	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.25	2.25
MEC-455	Fluid Mechanics Lab	Verify Bernoulli's theorem experimentally and usaing various flow measuring devices.	3.00	3.00	2.00	3.00	2.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	1.00	1.00

Mapping of course outcomes (COs) with Programme outcomes (POs) and Programme specific outcomes (PSOs)

Subject Code	Subject name	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		Analyze flow characteristics over different types of weirs and evaluate the metacentric height of a ship model and understand its significance for ship stability.	3.00	3.00	2.00	3.00	2.00	1.00	1.00	0.00	2.00	2.00	0.00	1.00	1.00	1.00
		Determine the friction factors for pipes with different diameters and analyze the effect of Reynolds number on flow resistance and analyze the head loss due to sudden expansion, contraction, and bends in pipeline flow.	3.00	3.00	2.00	3.00	2.00	0.00	0.00	0.00	2.00	2.00	0.00	1.00	1.00	1.00
		Use Pitot-static probes to determine velocity distribution in pipeline flow and understand its relevance to real-world fluid systems.	3.00	3.00	2.00	3.00	2.00	0.00	0.00	0.00	2.00	2.00	0.00	1.00	1.00	1.00
		Average Mapping	3.00	3.00	2.00	3.00	2.00	0.25	0.25	0.00	2.00	1.75	0.00	1.00	1.00	1.00
MEC-406	Numerical Anlysis	Choose and apply the appropriate numerical techniques to solve engineering problems when no closed-form, analytical solution exists.	2.00	3.00	1.00	3.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	2.00	1.00
		In addition to this, the students can interpret the results and assess accuracy. Identification and selection of machines for a specific application.	2.00	3.00	0.00	3.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	1.00	2.00
		Students will gain skills in performing numerical differentiation and integration to solve complex integral and derivative problems encountered in engineering applications.	3.00	3.00	0.00	3.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	1.00	0.00
		The students will be able to write their own programs (e.g. in MATLAB) to implement these numerical methods to solve engineering problems.	2.00	2.00	0.00	2.00	3.00	0.00	0.00	0.00	1.00	1.00	0.00	2.00	1.00	0.00
		Average Mapping	2.25	2.75	0.25	2.75	3.00	0.00	0.00	0.00	0.25	0.25	0.00	2.00	1.25	0.75
MEC-456	Numerical Anlysis Lab	Choose and apply the appropriate numerical techniques to solve engineering problems when no closed-form, analytical solution exists.	3.00	3.00	2.00	3.00	3.00	0.00	0.00	0.00	2.00	1.00	1.00	2.00	2.00	1.00
		The students can interpret the results and assess accuracy. Identification and selection of machines for a specific application.	3.00	3.00	2.00	3.00	3.00	0.00	0.00	0.00	2.00	2.00	1.00	2.00	2.00	1.00
		The students will be able to write their own programs (e.g. in MATLAB) to implement these numerical methods to solve engineering problems.	3.00	3.00	3.00	3.00	3.00	0.00	0.00	0.00	2.00	1.00	1.00	2.00	2.00	1.00
		Implement curve fitting techniques and apply them to real-world data for predictive modeling.	3.00	3.00	3.00	3.00	3.00	0.00	0.00	0.00	2.00	2.00	1.00	3.00	2.00	2.00
		Average Mapping	3.00	3.00	2.50	3.00	3.00	0.00	0.00	0.00	2.00	1.50	1.00	2.25	2.00	1.25
MEC457	Intership 1	Apply theoretical knowledge to perform practical tasks in areas such as manufacturing, maintenance, or design within an industrial setting.	3.00	2.00	2.00	1.00	2.00	1.00	1.00	1.00	3.00	2.00	2.00	2.00	3.00	3.00
		Identify and analyze real-world engineering problems and contribute to developing or improving mechanical processes or systems.	3.00	3.00	3.00	3.00	2.00	1.00	1.00	1.00	3.00	2.00	2.00	2.00	3.00	3.00
		Demonstrate effective communication, teamwork, and professional ethics while working in a multidisciplinary industrial environment.	0.00	0.00	0.00	0.00	0.00	2.00	0.00	3.00	3.00	3.00	2.00	2.00	0.00	2.00
		Observe and understand industrial workflows, equipment usage, and safety practices relevant to mechanical engineering operations.	0.00	0.00	0.00	0.00	2.00	2.00	1.00	2.00	2.00	1.00	0.00	2.00	2.00	2.00
		Average Mapping	1.50	1.25	1.25	1.00	1.50	1.50	0.75	1.75	2.75	2.00	1.50	2.00	2.00	2.50
MEC-501	Design of Machine Elements-I	Ability to design and analyze both permanent joints (riveted, welded, etc.) and temporary joints (Bolts, keys, cotter, knuckle) under concentric and eccentric loading conditions.	3.00	3.00	3.00	2.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
		Ability to design and analyze different types of levers.	3.00	3.00	3.00	2.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00

Mapping of course outcomes (COs) with Programme outcomes (POs) and Programme specific outcomes (PSOs)

Subject Code	Subject name	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		Ability to analyze and design keys, power transmission shafts (carrying various elements like pulleys, gears etc) and couplings.	3.00	3.00	3.00	2.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
		Ability to design and analyze power screws & screw jack.	3.00	3.00	3.00	2.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
		Average Mapping	3.00	3.00	3.00	2.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
MEC-551	Design of Machine Elements-I Lab	Ability to design and analyze both permanent joints (riveted, welded, etc.) and temporary joints (Bolts, keys, cotter, knuckle) under concentric and eccentric loading conditions.	3.00	3.00	3.00	2.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
		Ability to design and analyze different types of levers.	3.00	3.00	3.00	2.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
		Ability to analyze and design keys, power transmission shafts (carrying various elements like pulleys, gears etc) and couplings.	3.00	3.00	3.00	2.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
		Ability to design and analyze power screws & screw jack	3.00	3.00	3.00	2.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
		Average Mapping	3.00	3.00	3.00	2.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
MEC-502	CAD/ CAM	Understand the role of CAD/CAM in modern design and manufacturing.	1.00	0.00	1.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	1.00
		Knowledge about the concept of Geometric modeling and understanding of various geometrical transformations.	2.00	2.00	2.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	1.00
		Knowledge about the representations and manipulations of various curves, surfaces and solids.	2.00	2.00	2.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	1.00
		Understand the concepts of the NC, CNC and DNC machines and be able to select the appropriate code for performing particular tasks in these machines.	2.00	0.00	2.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	3.00	2.00
		Average Mapping	1.75	1.00	1.75	0.00	2.75	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.25	1.25
MEC-552	CAD/ CAM Lab	Understanding of various geometrical transformations.	3.00	2.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00
		Representations and manipulations of various curves, surfaces and solids.	3.00	2.00	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00
		Knowledge about the modelling of various mechanical parts in CAD software.	3.00	2.00	3.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	1.00
		Understanding of numerical controlled machines and basic part programming	2.00	2.00	3.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	2.00
		Average Mapping	2.75	2.00	2.00	0.00	2.50	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.50	0.75
MEC-503	Robotics	Identify and describe the components, classification, and applications of robotic systems in various industrial domains.	2.00	1.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	1.00
		Apply transformation matrices and kinematic equations to perform forward and inverse kinematic analysis of robotic arms.	3.00	3.00	2.00	2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	3.00	1.00
		Analyze robotic manipulator dynamics and implement control strategies for stable and accurate motion execution.	3.00	3.00	2.00	2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	3.00	1.00
		Evaluate and design basic manipulator systems, integrating sensors, actuators, and control logic to meet specified tasks.	3.00	3.00	3.00	2.00	3.00	0.00	0.00	0.00	1.00	0.00	1.00	2.00	3.00	2.00
		Average Mapping	2.75	2.50	1.75	1.50	2.25	0.00	0.00	0.00	0.25	0.00	0.25	1.75	2.75	1.25
MEC-553	Robotics Lab	Understand and be able to solve basic robot forward and inverse kinematics problems.	3.00	3.00	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00
		Understand and able to solve basic robotic dynamics, path planning and control problems.	3.00	3.00	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00
		Analyze and simulate the components of a manipulator, including drive systems and end-effectors, for real-world applications.	3.00	3.00	3.00	2.00	3.00	0.00	0.00	0.00	2.00	0.00	0.00	1.00	2.00	1.00
		Able to undertake practical robotics experiments that demonstrate the above skills	2.00	2.00	3.00	3.00	3.00	0.00	0.00	0.00	3.00	2.00	1.00	2.00	3.00	2.00

Mapping of course outcomes (COs) with Programme outcomes (POs) and Programme specific outcomes (PSOs)

Subject Code	Subject name	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		Average Mapping	2.75	2.75	2.50	1.25	2.50	0.00	0.00	0.00	1.25	0.50	0.25	1.25	1.75	0.75
MEC-504	**Mechanical Measurement and metrology**	Identify and describe the components and functional elements of measurement systems, including types of transducers and their operating characteristics.	2.00	1.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00
		Analyze and evaluate measurement data to assess the reliability of experimental results.	2.00	3.00	0.00	3.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	1.00	0.00
		Apply appropriate techniques and instruments for measurement of strain, pressure, flow, temperature and speed in engineering applications.	3.00	0.00	2.00	2.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	2.00	1.00
		Inspect and assess surface finish, dimensional accuracy, and geometric tolerances of mechanical components using modern metrology tools and standards.	2.00	0.00	2.00	2.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	2.00	1.00
		Average Mapping	2.25	1.00	1.00	1.75	2.50	0.00	0.00	0.00	0.00	0.00	0.00	1.75	1.50	0.50
MEC-554	**Mechanical Measurement and metrology Lab**	Demonstrate the ability to measure and calibrate various physical quantities (pressure, temperature, displacement, load, torque) using appropriate sensors and instruments.	3.00	2.00	2.00	2.00	3.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	1.00	1.00
		Apply calibration techniques to ensure the accuracy and reliability of measurement systems, including pressure gauges, thermocouples, and strain gauges.	3.00	3.00	2.00	3.00	3.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	1.00	1.00
		Analyze and interpret the data obtained from different types of measurement devices (e.g., planimeters, LVDTs, load cells) to assess their performance and accuracy in practical applications.	3.00	3.00	2.00	3.00	3.00	0.00	0.00	0.00	2.00	2.00	0.00	1.00	1.00	1.00
		Develop proficiency in using and selecting appropriate transducers and sensors for specific measurement tasks, including angular displacement, linear displacement, strain, and water level measurements.	3.00	3.00	3.00	2.00	3.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	1.00	1.00
		Average Mapping	3.00	2.75	2.25	2.50	3.00	0.00	0.00	0.00	2.00	1.25	0.00	1.00	1.00	1.00
MEC-505	**Mechtronics**	The students will be able to integrate mechanical, electronics, control and computer engineering in the design of Mechatronics systems.	3.00	2.00	3.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	3.00	2.00
		The students will learn the basics of microcontrollers, sensors and actuators embedded in automated machines.	2.00	0.00	0.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	2.00	1.00
		Design and evaluate analog signal processing systems.	3.00	2.00	2.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	2.00	1.00
		The students will be able to apply knowledge of basic mechatronics to construct a mechatronic system	3.00	0.00	3.00	0.00	3.00	0.00	0.00	0.00	2.00	2.00	2.00	2.00	3.00	2.00
		Average Mapping	2.75	1.00	2.00	0.00	3.00	0.00	0.00	0.00	0.50	0.50	0.50	2.00	2.50	1.50
MEC-555	**Mechtronics Lab**	Demonstrate the ability to acquire and process sensor signals using an A/D card and interface with a computer for real-time data analysis and control.	3.00	3.00	3.00	2.00	3.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	2.00	1.00
		Apply digital-to-analog conversion (D/A) techniques to send data signals from a computer to actuators for control in automation systems.	3.00	3.00	3.00	2.00	3.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	2.00	1.00
		Design and implement position and speed control systems for motors, including servo mechanisms and stepper motors, and analyze the impact of external loads.	3.00	3.00	3.00	3.00	3.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	3.00	2.00
		Develop proficiency in controlling industrial systems using PID controllers and pneumatic systems, and evaluate system performance under various load conditions.	3.00	3.00	3.00	3.00	3.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	3.00	2.00
		Average Mapping	3.00	3.00	3.00	2.50	3.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	2.50	1.50
MEC-506	**Fluid Machinery**	Explain principles of hydraulic machines and turbines.	3.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	2.00

Mapping of course outcomes (COs) with Programme outcomes (POs) and Programme specific outcomes (PSOs)

Subject Code	Subject name	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		Estimate the performance of Impulse and Reaction turbine.	3.00	3.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	0.00
		Solve the efficiency of centrifugal and reciprocating pumps.	3.00	3.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	1.00
		Performance analysis of hydraulic machines and Identify the various hydraulic control devices.	3.00	2.00	2.00	1.00	1.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	2.00	3.00
		Average Mapping	3.00	2.25	0.50	1.25	0.25	0.00	0.00	0.00	0.25	0.25	0.00	1.00	1.75	1.50
MEC-556	Fluid Machinery Lab	Analyze and determine the efficiencies of hydraulic machines, such as Hydraulic Rams, and evaluate their performance under different operating conditions.	3.00	3.00	2.00	3.00	2.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	1.00	1.00
		Demonstrate the ability to draw and interpret the performance characteristics of turbines (Francis and Pelton turbines) and pumps (centrifugal pumps) from experimental data.	3.00	3.00	2.00	3.00	2.00	0.00	0.00	0.00	2.00	2.00	0.00	1.00	1.00	1.00
		Understand the construction and working principles of reciprocating pumps, and perform tests to determine their performance parameters, such as flow rate, head, and efficiency.	3.00	2.00	2.00	2.00	2.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	1.00	1.00
		Investigate the impact of vane shape and vane angle on the performance of centrifugal fans, and optimize fan design based on experimental findings.	3.00	3.00	3.00	3.00	2.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	2.00	1.00
		Average Mapping	3.00	2.75	2.25	2.75	2.00	0.00	0.00	0.00	2.00	1.25	0.00	1.00	1.25	1.00
MEC-601	Design of Machine Elements-II	Ability to design and analyze different types of flexible drives (belt drive, rope drive and chain drive) and rigid drives (spur gear, helical gear, bevel gear and worm gear drive)	3.00	3.00	3.00	2.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	2.00	1.00
		Familiarity with different types of springs and spring terminology & ability to design and analyze coil springs and leaf spring	3.00	3.00	3.00	2.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	1.00	2.00
		Acquaintance with the working of sliding and rolling contact bearings & ability to design them.	3.00	3.00	3.00	2.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	1.00	2.00
		Ability to design and analyze clutches and brakes.	3.00	3.00	3.00	2.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	1.00	1.00
		Average Mapping	3.00	3.00	3.00	2.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	1.25	1.50
MEC-651	Design of Machine Elements-II Lab	Ability to design and analyze different types of flexible drives (belt drive, rope drive and chain drive) and rigid drives (spur gear, helical gear, bevel gear and worm gear drive)	3.00	3.00	3.00	2.00	2.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	3.00	2.00
		Familiarity with different types of springs and spring terminology & ability to design and analyze coil springs and leaf spring	3.00	3.00	3.00	2.00	2.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	3.00	2.00
		Acquaintance with the working of sliding and rolling contact bearings & ability to design them.	3.00	3.00	3.00	2.00	2.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	3.00	2.00
		Ability to design and analyze clutches and brakes.	3.00	3.00	3.00	2.00	2.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	3.00	2.00
		Average Mapping	3.00	3.00	3.00	2.00	2.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	3.00	2.00
MEC-602	Finite Element Methods	Understand the fundamental theory and principles of the Finite Element Method (FEM).	3.00	3.00	2.00	2.00	2.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
		Formulate and solve finite element models for different element types by applying appropriate boundary conditions.	3.00	3.00	3.00	3.00	2.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
		Apply basic finite elements such as truss, beam, frame, and plate elements to structural analysis problems.	3.00	3.00	3.00	3.00	2.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
		Analyze and solve dynamic problems using the Finite Element Method.	3.00	3.00	3.00	3.00	2.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
		Average Mapping	3.00	3.00	2.75	2.75	2.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
MEC-652	Finite Element Methods Lab	Demonstrate understanding of FEM discretization and shape functions through visualization and MATLAB programming.	3.00	3.00	2.00	2.00	3.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	2.00	1.00

Mapping of course outcomes (COs) with Programme outcomes (POs) and Programme specific outcomes (PSOs)

Subject Code	Subject name	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		Develop and implement MATLAB code for solving 1D and 2D FEM problems including trusses.	3.00	3.00	3.00	3.00	3.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	2.00	1.00
		Use ANSYS software to model and analyze static and dynamic structural problems under various boundary conditions.	3.00	3.00	3.00	3.00	3.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	3.00	2.00
		Apply FEM-based tools for simulation, optimization, and performance evaluation of engineering components in multi-physics environments	3.00	3.00	3.00	3.00	3.00	0.00	0.00	0.00	2.00	1.00	0.00	2.00	3.00	2.00
		Average Mapping	3.00	3.00	2.75	2.75	3.00	0.00	0.00	0.00	2.00	1.00	0.00	1.25	2.50	1.50
MEC-603	Mechanical Vibrations	The principle and working of Elements of a Vibrating system	3.00	2.00	2.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	3.00	0.00
		Formulation of Workable model of a Vibrating system	3.00	3.00	2.00	2.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	3.00	0.00
		Formulations and solution of equations of motion for various types of vibrating systems	3.00	3.00	2.00	2.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	3.00	0.00
		Methods to bring reduction in the levels of vibration in system to which they are harmful by learning to design vibration controlling Mechanical systems	3.00	3.00	3.00	3.00	2.00	2.00	2.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
		Average Mapping	3.00	2.75	2.25	2.00	1.25	1.25	1.25	0.00	1.00	1.00	0.00	2.00	3.00	0.25
MEC-653	Mechanical Vibrations Lab	Perform experiments to determine vibration characteristics such as natural frequency, damping ratio, and moment of inertia using standard test setups.	3.00	3.00	2.00	3.00	2.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	1.00	1.00
		Analyze vibration responses and identify dynamic system parameters from forced vibration experiments.	3.00	3.00	2.00	3.00	2.00	0.00	0.00	0.00	2.00	2.00	0.00	1.00	1.00	1.00
		Simulate time responses of single and multi-degree-of-freedom systems using SIMULINK and numerical techniques like Newmark-Beta method.	3.00	3.00	3.00	3.00	3.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	2.00	1.00
		Apply signal processing tools such as FFT to extract harmonic and natural frequencies from experimental vibration data.	3.00	3.00	3.00	3.00	3.00	0.00	0.00	0.00	2.00	2.00	0.00	1.00	2.00	1.00
		Average Mapping	3.00	3.00	2.50	3.00	2.50	0.00	0.00	0.00	2.00	1.50	0.00	1.00	1.50	1.00
MEC-604	Heat Transfer	Each student will be able to apply conservation of mass and energy to a control volume or control surface. Each student understands and can analyze conduction heat transfer in case of Cartesian, cylindrical and spherical problems and is able to solve them.	3.00	3.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	3.00	2.00
		Each student will be able to analyze extended surfaces .	3.00	3.00	3.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	3.00	2.00
		Each student understands the physical phenomena associated with convection, and will be able to solve convection heat transfer problems. Each student will be able to use empirical correlations to analyze external and internal, forced and free convection problems.	3.00	2.00	2.00	1.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	3.00	2.00
		Each student understands the physical mechanisms involved in radiation heat transfer. Each student will be able to calculate total, hemispherical radiative properties of real surfaces from their spectral, directional counterparts.	3.00	3.00	3.00	2.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00	2.00	3.00	2.00
		Average Mapping	3.00	2.75	2.50	1.75	2.00	1.25	1.25	1.00	1.00	1.00	1.00	2.00	3.00	2.00
MEC-654	Heat Transfer Lab	Measure thermal conductivity and analyze heat conduction through different materials, including lagging materials.	3.00	3.00	2.00	3.00	2.00	0.00	1.00	0.00	2.00	1.00	0.00	1.00	1.00	1.00
		Determine convective heat transfer coefficients for natural and forced convection scenarios and analyze influencing parameters.	3.00	3.00	2.00	3.00	2.00	0.00	1.00	0.00	2.00	2.00	0.00	1.00	1.00	1.00
		Evaluate the performance of heat exchangers and determine overall heat transfer coefficients for various flow configurations.	3.00	3.00	3.00	3.00	2.00	0.00	1.00	0.00	2.00	2.00	0.00	1.00	2.00	1.00

Mapping of course outcomes (COs) with Programme outcomes (POs) and Programme specific outcomes (PSOs)

Subject Code	Subject name	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		Conduct radiation heat transfer experiments to determine emissivity and Stefan-Boltzmann constant, and compare dropwise and filmwise condensation	3.00	3.00	3.00	3.00	2.00	0.00	1.00	0.00	2.00	2.00	0.00	1.00	2.00	1.00
		Average Mapping	3.00	3.00	2.50	3.00	2.00	0.00	1.00	0.00	2.00	1.75	0.00	1.00	1.50	1.00
MEC-605	Mechanical behavior of materials	understand the response of material under loading during its life and analyse the scope of its failure	3.00	3.00	2.00	2.00	1.00	1.00	1.00	2.00	2.00	1.00	1.00	2.00	3.00	2.00
		analyse and design covering elastic and plastic deformation, fracture fatigue and creep of crystalline materials	3.00	3.00	3.00	2.00	2.00	1.00	2.00	2.00	1.00	1.00	2.00	2.00	3.00	2.00
		create solutions using cost effective materials for desired mechanical behaviour	3.00	2.00	3.00	2.00	2.00	1.00	2.00	2.00	2.00	1.00	2.00	2.00	3.00	3.00
		Analyze the stress-strain behavior and deformation mechanisms in metals and anisotropic materials.	3.00	3.00	2.00	2.00	2.00	1.00	1.00	2.00	2.00	1.00	1.00	2.00	3.00	2.00
		Average Mapping	3.00	2.75	2.50	2.00	1.75	1.00	1.50	2.00	1.75	1.00	1.50	2.00	3.00	2.25
MEC-655	Mechanical behavior of materials Lab	Understand the impact of heat treatment on mechanical properties	3.00	2.00	1.00	2.00	1.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	1.00	1.00
		Understand the type of material failure which helps in design and material selection	3.00	3.00	2.00	2.00	1.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	2.00	1.00
		Understand the structure and deformation under loading	3.00	2.00	1.00	2.00	1.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	1.00	1.00
		Conduct mechanical tests (tensile, hardness, impact) on heat-treated specimens and correlate test results with microstructural changes	3.00	3.00	2.00	3.00	2.00	0.00	0.00	0.00	3.00	2.00	0.00	2.00	2.00	2.00
		Average Mapping	3.00	2.50	1.50	2.25	1.25	0.00	0.00	0.00	2.25	1.25	0.00	1.25	1.50	1.25
MEC-606	Operations research	Understand scope, objectives, phases, models & limitations of operations research.	3.00	3.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	3.00	2.00	2.00	2.00
		Understand the theoretical working of linear programming techniques like graphical, simplex algorithm and dual simplex technique.	3.00	3.00	3.00	2.00	2.00	2.00	1.00	1.00	1.00	2.00	3.00	2.00	3.00	2.00
		Solve specialized linear programming problems like transportation and assignment models & model a dynamic system as queuing model and computation of its important performance measures.	3.00	3.00	2.00	2.00	2.00	2.00	2.00	1.00	1.00	2.00	3.00	2.00	3.00	3.00
		Solve network models using PERT and CPM techniques	3.00	2.00	3.00	2.00	2.00	2.00	2.00	1.00	1.00	1.00	3.00	2.00	3.00	2.00
		Average Mapping	3.00	2.75	2.50	2.00	1.75	1.75	1.50	1.00	1.00	1.50	3.00	2.00	2.75	2.25
MEC-656	Operations research Lab	1.Understand scope, objectives, phases, models & limitations of operations research.	2.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	1.00	2.00	1.00	0.00	1.00
		2.Understand the theoretical working of linear programming techniques like graphical, simplex algorithm and dual simplex technique.	3.00	3.00	2.00	2.00	2.00	0.00	0.00	0.00	1.00	1.00	2.00	1.00	1.00	1.00
		3.Solve specialized linear programming problems like transportation and assignment models & model a dynamic system as queuing model and computation of its important performance measures.	3.00	3.00	3.00	3.00	3.00	0.00	0.00	0.00	2.00	1.00	3.00	1.00	2.00	2.00
		4.Solve network models using PERT and CPM techniques	3.00	3.00	3.00	3.00	3.00	0.00	0.00	0.00	2.00	1.00	3.00	1.00	2.00	2.00
		Average Mapping	2.75	2.50	2.00	2.00	2.25	0.00	0.00	0.00	1.50	1.00	2.50	1.00	1.25	1.50
#MEC657	INTERSHIP 2	Apply theory to practical engineering tasks.	3.00	2.00	2.00	1.00	2.00	1.00	1.00	1.00	3.00	2.00	1.00	2.00	3.00	3.00
		Analyze and evaluate existing mechanical systems.	3.00	3.00	2.00	3.00	2.00	1.00	1.00	1.00	3.00	2.00	2.00	2.00	3.00	3.00

Mapping of course outcomes (COs) with Programme outcomes (POs) and Programme specific outcomes (PSOs)

Subject Code	Subject name	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		Demonstrate professional communication and teamwork.	1.00	1.00	1.00	1.00	1.00	2.00	1.00	3.00	3.00	3.00	2.00	2.00	2.00	3.00
		Document and present internship experiences.	1.00	2.00	1.00	2.00	2.00	1.00	1.00	2.00	3.00	3.00	2.00	3.00	2.00	3.00
		Average Mapping	2.00	2.00	1.50	1.75	1.75	1.25	1.00	1.75	3.00	2.50	1.75	2.25	2.50	3.00
MEC-701	Refrigeration and Air Conditioning	Explain the basic refrigeration concepts, including natural and mechanical refrigeration, refrigeration cycles, and their applications in different systems.	3.00	2.00	2.00	1.00	2.00	1.00	1.00	0.00	0.00	2.00	1.00	3.00	3.00	2.00
		Analyze and compare different refrigeration systems such as air refrigeration, vapor compression, and vapor absorption systems, and determine their efficiencies and limitations.	3.00	3.00	3.00	2.00	2.00	1.00	1.00	0.00	0.00	1.00	1.00	3.00	3.00	2.00
		Identify the properties and environmental impact of refrigerants, and select appropriate refrigerants for specific applications while considering global warming and ozone depletion potential.	2.00	2.00	2.00	1.00	1.00	3.00	3.00	2.00	1.00	2.00	1.00	2.00	2.00	3.00
		Apply psychrometric relations and charts to analyze air conditioning processes, and perform heat load calculations to design air conditioning systems.	3.00	3.00	3.00	2.00	2.00	0.00	1.00	0.00	0.00	2.00	1.00	3.00	3.00	2.00
		Average Mapping	2.75	2.50	2.50	1.50	1.75	1.25	1.50	0.50	0.25	1.75	1.00	2.75	2.75	2.25
MEC-751	Refrigeration and Air Conditioning Lab	Understand various cycles used in RAC	3.00	1.00	1.00	0.00	1.00	1.00	2.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
		Understand various refrigerants available	3.00	1.00	1.00	0.00	1.00	1.00	2.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
		Understand various air conditioning methods for different environment	3.00	2.00	2.00	1.00	1.00	2.00	3.00	0.00	1.00	1.00	1.00	1.00	2.00	2.00
		Understand different equipments used in RAC and designing air conditioning systems for different applications	3.00	2.00	3.00	1.00	1.00	2.00	3.00	0.00	2.00	1.00	2.00	2.00	3.00	3.00
		Average Mapping	3.00	1.50	1.75	0.50	1.00	1.50	2.50	0.00	1.25	1.00	1.25	1.25	1.75	1.75
MEC-702	Automatic Controls	Model and represent physical systems in terms of transfer functions and state-space equations, and analyze their time and frequency-domain responses.	3.00	3.00	3.00	2.00	2.00	0.00	0.00	0.00	0.00	2.00	1.00	3.00	3.00	2.00
		Apply block diagram reduction, signal flow graphs, and Mason's rule to simplify complex system models for analysis and design.	3.00	2.00	2.00	2.00	2.00	0.00	0.00	0.00	0.00	2.00	1.00	2.00	3.00	1.00
		Design and analyze control systems using root-locus and frequency-response methods, including tuning PID controllers and applying compensation techniques.	3.00	3.00	3.00	2.00	2.00	0.00	0.00	1.00	1.00	2.00	1.00	3.00	3.00	2.00
		Analyze the stability of control systems using Routh-Hurwitz criterion, Nyquist criterion, and frequency-response methods to determine system performance.	3.00	3.00	3.00	3.00	2.00	0.00	0.00	0.00	0.00	2.00	1.00	3.00	3.00	2.00
		Average Mapping	3.00	2.75	2.75	2.25	2.00	0.00	0.00	0.25	0.25	2.00	1.00	2.75	3.00	1.75
MEC-752	Automatic Controls Lab	Implement two-mode (P + I) and (P + D) controllers on real-time temperature/flow control systems and analyze their performance.	3.00	3.00	3.00	3.00	3.00	0.00	0.00	0.00	2.00	1.00	1.00	1.00	2.00	2.00
		Implement and fine-tune a three-mode (P + I + D) control system on a temperature/flow trainer to achieve desired system stability and response.	3.00	3.00	3.00	3.00	3.00	0.00	0.00	0.00	2.00	1.00	1.00	1.00	2.00	2.00
		Apply the Ziegler-Nichols method to tune controllers for optimal performance in real-world control systems.	3.00	3.00	3.00	3.00	3.00	0.00	0.00	0.00	2.00	1.00	1.00	1.00	3.00	2.00
		Simulate and analyze the dynamic behavior of first-order and second-order systems using LabVIEW software, understanding system characteristics.	3.00	3.00	3.00	3.00	3.00	0.00	0.00	0.00	2.00	1.00	1.00	1.00	3.00	2.00
		Average Mapping	3.00	3.00	3.00	3.00	3.00	0.00	0.00	0.00	2.00	1.00	1.00	1.00	2.50	2.00
MEC-703	Automobile Engineering	Basic understanding about working of automobile	2.00	1.00	1.00	0.00	1.00	1.00	2.00	1.00	0.00	1.00	1.00	2.00	2.00	1.00

Mapping of course outcomes (COs) with Programme outcomes (POs) and Programme specific outcomes (PSOs)

Subject Code	Subject name	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		Understanding, importance of various sub-systems in performance of automobile	3.00	2.00	2.00	1.00	2.00	1.00	2.00	1.00	0.00	2.00	1.00	2.00	3.00	2.00
		Understand importance of control in automobile	2.00	2.00	2.00	1.00	2.00	0.00	1.00	1.00	0.00	2.00	1.00	2.00	3.00	2.00
		Environmental friendly automobiles	1.00	1.00	1.00	0.00	1.00	2.00	3.00	3.00	1.00	2.00	1.00	1.00	2.00	3.00
		Average Mapping	2.00	1.50	1.50	0.50	1.50	1.00	2.00	1.50	0.25	1.75	1.00	1.75	2.50	2.00
MEC-753	Automobile Engineering Lab	Identify and explain the function of essential automotive systems such as steering, braking, and fuel systems.	3.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	2.00	1.00	1.00	1.00	1.00	1.00
		Perform basic mechanical maintenance tasks such as tire removal, valve grinding, and piston reassembly.	2.00	2.00	2.00	1.00	2.00	1.00	1.00	2.00	3.00	1.00	1.00	1.00	2.00	2.00
		Diagnose common engine and braking system issues using standard workshop tools.	2.00	3.00	2.00	2.00	2.00	1.00	1.00	2.00	3.00	2.00	1.00	1.00	2.00	2.00
		Demonstrate safe and effective handling of modern components like GDI systems and battery replacements	2.00	2.00	2.00	1.00	2.00	2.00	2.00	2.00	3.00	1.00	1.00	2.00	2.00	2.00
		Average Mapping	2.25	2.00	1.75	1.00	1.75	1.25	1.25	1.75	2.75	1.25	1.00	1.25	1.75	1.75
MEC755	Minor Project	Ability to identify complex engineering problems and formulate technical or research gaps and project objectives.	3.00	3.00	3.00	3.00	2.00	1.00	1.00	1.00	2.00	3.00	3.00	3.00	3.00	3.00
		Ability to propose a solution methodology to an existing problem.	3.00	2.00	3.00	2.00	3.00	1.00	2.00	1.00	2.00	3.00	3.00	3.00	3.00	3.00
		Ability to validate the proposed solution theoretically and/or experimentally	2.00	1.00	2.00	1.00	1.00	0.00	1.00	0.00	3.00	3.00	2.00	2.00	2.00	2.00
		Ability to communicate using project reports, paper publications and presentations.	2.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	3.00	3.00	3.00	2.00	2.00	3.00
		Average Mapping	2.50	1.75	2.25	1.75	1.75	0.50	1.25	0.75	2.50	3.00	2.75	2.50	2.50	2.75
MEC801	Advanced Manufacturing Techniques	The principle and working of nontraditional machining methods	2.00	2.00	2.00	1.00	2.00	1.00	1.00	0.00	0.00	1.00	1.00	2.00	3.00	2.00
		The principle working and controlling parameters of EDM,LBM, IBM	3.00	2.00	2.00	2.00	2.00	1.00	1.00	0.00	0.00	1.00	1.00	2.00	3.00	2.00
		The principle working and controlling parameters of AJM, WJM and AWJM	3.00	2.00	2.00	2.00	2.00	1.00	1.00	0.00	0.00	1.00	1.00	2.00	3.00	2.00
		The principle working and controlling parameters of Chemical , electro chemical machining and USM	3.00	2.00	2.00	2.00	2.00	1.00	1.00	1.00	0.00	1.00	1.00	2.00	3.00	2.00
		Average Mapping	2.75	2.00	2.00	1.75	2.00	1.00	1.00	0.25	0.00	1.00	1.00	2.00	3.00	2.00
MEC851	Advanced Manufacturing Techniques Lab	The principle and working of nontraditional machining methods	2.00	2.00	2.00	1.00	2.00	1.00	1.00	0.00	0.00	1.00	1.00	2.00	3.00	2.00
		The principle working and controlling parameters of EDM,LBM, IBM	3.00	2.00	2.00	2.00	2.00	1.00	1.00	0.00	0.00	1.00	1.00	2.00	3.00	2.00
		The principle working and controlling parameters of AJM, WJM and AWJM	3.00	2.00	2.00	2.00	2.00	1.00	1.00	0.00	0.00	1.00	1.00	2.00	3.00	2.00
		The principle working and controlling parameters of Chemical , electro chemical machining and USM	3.00	2.00	2.00	2.00	2.00	1.00	1.00	1.00	0.00	1.00	1.00	2.00	3.00	2.00
		Average Mapping	2.75	2.00	2.00	1.75	2.00	1.00	1.00	0.25	0.00	1.00	1.00	2.00	3.00	2.00
MEC802	Non-Conventional Energy Sources	Describe the primary renewable energy resources and technologies.	2.00	1.00	2.00	1.00	2.00	2.00	3.00	3.00	1.00	2.00	1.00	2.00	2.00	3.00
		Comprehensive understanding of current and possible future role of various renewable energy sources.	2.00	2.00	2.00	1.00	2.00	2.00	3.00	3.00	1.00	2.00	1.00	2.00	2.00	3.00

Mapping of course outcomes (COs) with Programme outcomes (POs) and Programme specific outcomes (PSOs)

Subject Code	Subject name	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		Access and decide the appropriate renewable energy as an alternate for conventional power in any engineering field.	3.00	2.00	2.00	2.00	2.00	2.00	3.00	3.00	1.00	2.00	1.00	2.00	3.00	3.00
		Explain the need and significance of renewable energy sources for sustainable development.	2.00	2.00	1.00	1.00	2.00	3.00	3.00	3.00	1.00	2.00	1.00	1.00	2.00	3.00
		Average Mapping	2.25	1.75	1.75	1.25	2.00	2.25	3.00	3.00	1.00	2.00	1.00	1.75	2.25	3.00
MEC-803	Computational Fluid Dynamics	Understand and explain the governing equations of fluid dynamics and their physical significance.	3.00	2.00	2.00	2.00	2.00	0.00	0.00	0.00	0.00	2.00	1.00	3.00	3.00	2.00
		Classify different types of PDEs and apply suitable numerical methods for solving them.	3.00	3.00	2.00	3.00	3.00	0.00	0.00	0.00	0.00	2.00	1.00	3.00	3.00	2.00
		Implement discretization techniques such as Finite Difference and Finite Volume methods to solve flow problems.	3.00	2.00	3.00	3.00	3.00	0.00	0.00	0.00	0.00	2.00	1.00	3.00	3.00	2.00
		Analyze and solve steady and unsteady flow problems using solution algorithms like SIMPLE and evaluate their stability and convergence.	3.00	3.00	3.00	3.00	3.00	0.00	0.00	0.00	0.00	2.00	1.00	3.00	3.00	2.00
		Average Mapping	3.00	2.50	2.50	2.75	2.75	0.00	0.00	0.00	0.00	2.00	1.00	3.00	3.00	2.00
MEC-853	Computational Fluid Dynamics Lab	Simulate and analyze 2D heat conduction and temperature distribution under different boundary conditions.	3.00	3.00	3.00	3.00	3.00	0.00	1.00	0.00	2.00	1.00	1.00	1.00	2.00	1.00
		Solve and visualize flow fields such as lid-driven cavity and flow over external geometries (e.g., sphere, airfoil).	3.00	3.00	3.00	3.00	3.00	0.00	1.00	0.00	2.00	1.00	1.00	1.00	2.00	1.00
		Apply numerical techniques to evaluate thermal performance of extended surfaces like fins.	3.00	3.00	3.00	3.00	3.00	0.00	1.00	0.00	2.00	1.00	1.00	1.00	2.00	1.00
		Assess the effects of attack angle and geometry on aerodynamic performance using CFD tools	3.00	3.00	3.00	3.00	3.00	0.00	1.00	0.00	2.00	1.00	1.00	2.00	3.00	2.00
		Average Mapping	3.00	3.00	3.00	3.00	3.00	0.00	1.00	0.00	2.00	1.00	1.00	1.25	2.25	1.25
MEC-855	Major Project	Identify, formulate, and analyze complex engineering problems using theoretical and practical knowledge.	3.00	3.00	3.00	3.00	2.00	1.00	1.00	1.00	2.00	3.00	3.00	3.00	3.00	3.00
		Design and implement a system, process, or component to meet specified needs within realistic constraints.	3.00	2.00	3.00	2.00	3.00	1.00	2.00	1.00	2.00	3.00	3.00	3.00	3.00	3.00
		Effectively communicate technical information through documentation and oral presentations.	2.00	1.00	2.00	1.00	1.00	0.00	1.00	0.00	3.00	3.00	2.00	2.00	2.00	2.00
		Work effectively in teams and demonstrate leadership, initiative, and responsibility in executing the project.	2.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	3.00	3.00	3.00	2.00	2.00	3.00
		Average Mapping	2.50	1.75	2.25	1.75	1.75	0.50	1.25	0.75	2.50	3.00	2.75	2.50	2.50	2.75
MEC704a	Machine Learning	Ability to apply machine learning techniques to solve regression and classification problems	3.00	3.00	3.00	2.00	3.00	0.00	1.00	0.00	0.00	1.00	2.00	3.00	3.00	3.00
		Ability to design and implement machine learning algorithms for various applications	3.00	3.00	3.00	3.00	3.00	0.00	1.00	0.00	1.00	2.00	2.00	3.00	3.00	3.00
		Ability to analyze and evaluate the performance of different machine learning models	3.00	3.00	2.00	3.00	3.00	0.00	1.00	0.00	1.00	2.00	2.00	3.00	3.00	3.00
		Average Mapping	3.00	3.00	2.67	2.67	3.00	0.00	1.00	0.00	0.67	1.67	2.00	3.00	3.00	3.00
MEC704b	Internet of Things	Ability to understand the fundamentals of IoT and its applications	3.00	2.00	1.00	1.00	1.00	0.00	1.00	0.00	0.00	1.00	2.00	2.00	3.00	2.00
		Ability to design and develop IoT systems using appropriate hardware and software components	3.00	3.00	3.00	3.00	3.00	0.00	1.00	0.00	1.00	2.00	2.00	3.00	3.00	3.00
		Ability to apply IoT concepts to solve real-world problems in various domains	3.00	3.00	3.00	3.00	3.00	0.00	1.00	0.00	1.00	2.00	2.00	3.00	3.00	3.00
		Ability to analyze and evaluate IoT technologies and their impact	3.00	3.00	2.00	3.00	3.00	0.00	1.00	0.00	1.00	2.00	2.00	3.00	3.00	3.00
		Average Mapping	3.00	2.75	2.25	2.50	2.50	0.00	1.00	0.00	0.75	1.75	2.00	2.75	3.00	2.75
MEC704c	Mechanics of Composites	Ability to select appropriate composite materials for specific engineering applications	3.00	2.00	2.00	1.00	1.00	0.00	1.00	0.00	0.00	1.00	1.00	2.00	3.00	2.00

Mapping of course outcomes (COs) with Programme outcomes (POs) and Programme specific outcomes (PSOs)

Subject Code	Subject name	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		Ability to predict the elastic properties, strength, and thermal properties of composite materials	3.00	3.00	3.00	2.00	1.00	0.00	1.00	0.00	0.00	1.00	1.00	2.00	3.00	3.00
		Ability to analyze and design laminated composite structures	3.00	3.00	3.00	3.00	2.00	0.00	1.00	0.00	0.00	1.00	1.00	2.00	3.00	3.00
		Ability to apply failure theories and characterization methods to composite materials	3.00	3.00	3.00	3.00	2.00	0.00	1.00	0.00	0.00	1.00	1.00	2.00	3.00	3.00
		Average Mapping	3.00	2.75	2.75	2.25	1.50	0.00	1.00	0.00	0.00	1.00	1.00	2.00	3.00	2.75
MEC704d	Work Study	Ability to apply work study techniques to improve productivity and efficiency	3.00	3.00	3.00	2.00	2.00	1.00	1.00	1.00	2.00	2.00	3.00	2.00	3.00	3.00
		Ability to analyze and design work methods using various charts and diagrams	3.00	3.00	3.00	3.00	2.00	1.00	1.00	1.00	2.00	2.00	2.00	2.00	3.00	3.00
		Ability to measure work and set time standards	3.00	3.00	3.00	3.00	2.00	1.00	1.00	1.00	2.00	2.00	3.00	2.00	3.00	3.00
		Ability to apply ergonomic principles in workplace design	3.00	3.00	3.00	2.00	2.00	3.00	3.00	2.00	2.00	2.00	2.00	2.00	3.00	3.00
		Average Mapping	3.00	3.00	3.00	2.50	2.00	1.50	1.50	1.25	2.00	2.00	2.50	2.00	3.00	3.00
MEC704e	Structural Dynamics	Ability to model and analyze structural components and systems under dynamic loads	3.00	3.00	3.00	3.00	2.00	1.00	1.00	1.00	2.00	1.00	1.00	2.00	3.00	2.00
		Ability to determine the dynamic response of SDOF and MDOF systems	3.00	3.00	3.00	3.00	2.00	1.00	1.00	1.00	2.00	1.00	1.00	2.00	3.00	2.00
		Ability to analyze structural systems subjected to harmonic loading	3.00	3.00	3.00	3.00	2.00	1.00	1.00	1.00	2.00	1.00	1.00	2.00	3.00	2.00
		Ability to perform structural dynamic analysis of beams	3.00	3.00	3.00	3.00	2.00	1.00	1.00	1.00	2.00	1.00	1.00	2.00	3.00	2.00
		Average Mapping	3.00	3.00	3.00	3.00	2.00	1.00	1.00	1.00	2.00	1.00	1.00	2.00	3.00	2.00
MEC704f	Vehicle Dynamics	Ability to analyze the dynamics of vehicles in motion	3.00	3.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00
		Ability to model and analyze longitudinal and lateral vehicle dynamics	3.00	3.00	3.00	3.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	3.00	2.00
		Ability to understand tire mechanics and vehicle handling characteristics	3.00	3.00	3.00	3.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	3.00	2.00
		Ability to evaluate vehicle performance in terms of ride comfort and safety	3.00	3.00	3.00	3.00	2.00	3.00	2.00	2.00	1.00	2.00	2.00	3.00	3.00	3.00
		Average Mapping	3.00	3.00	2.75	2.75	2.00	1.50	1.25	1.25	1.00	1.25	1.25	2.25	2.75	2.25
MEC 704g	Industrial Engineering	Ability to apply industrial engineering principles to improve productivity and efficiency	3.00	3.00	3.00	2.00	2.00	2.00	2.00	1.00	2.00	2.00	3.00	2.00	3.00	3.00
		Ability to design and develop products considering various factors	3.00	3.00	3.00	3.00	2.00	2.00	2.00	1.00	2.00	2.00	3.00	2.00	3.00	3.00
		Ability to analyze and design work systems using appropriate techniques	3.00	3.00	3.00	3.00	2.00	2.00	2.00	1.00	3.00	3.00	3.00	3.00	3.00	3.00
		Ability to plan and design facilities for efficient operations	3.00	3.00	3.00	3.00	3.00	2.00	2.00	1.00	3.00	3.00	3.00	3.00	3.00	3.00
		Average Mapping	3.00	3.00	3.00	2.75	2.25	2.00	2.00	1.00	2.50	2.50	3.00	2.50	3.00	3.00
MEC704h	Continuum Mechanics	Ability to apply mathematical concepts to describe the behavior of continuous media	3.00	3.00	2.00	2.00	2.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	2.00	1.00
		Ability to analyze the kinematics of deformation and motion in solids and fluids	3.00	3.00	2.00	2.00	2.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	2.00	1.00
		Ability to understand and apply balance laws to continuum mechanics problems	3.00	3.00	3.00	3.00	2.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	3.00	2.00
		Ability to develop and apply constitutive relations for different materials	3.00	3.00	3.00	3.00	2.00	0.00	0.00	0.00	1.00	1.00	0.00	2.00	3.00	2.00
		Average Mapping	3.00	3.00	2.50	2.50	2.00	0.00	0.00	0.00	1.00	1.00	0.00	1.25	2.50	1.50
MEC704i	Probability and Statistics for Engineers	Ability to apply statistical methods to analyze engineering data	3.00	3.00	2.00	3.00	3.00	1.00	1.00	1.00	2.00	2.00	2.00	2.00	3.00	2.00
		Ability to understand and apply probability concepts and distributions	3.00	3.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	1.00
		Ability to use statistical process control techniques for quality improvement	3.00	3.00	3.00	3.00	3.00	2.00	2.00	1.00	2.00	2.00	2.00	3.00	3.00	3.00

Mapping of course outcomes (COs) with Programme outcomes (POs) and Programme specific outcomes (PSOs)

Subject Code	Subject name	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		Ability to design and analyze experiments	3.00	3.00	3.00	3.00	3.00	1.00	1.00	1.00	2.00	2.00	2.00	3.00	3.00	2.00
		Average Mapping	3.00	3.00	2.50	2.75	2.75	1.25	1.25	1.00	1.75	1.75	1.75	2.50	2.75	2.00
MEC704j	Total Quality Management	Ability to understand and apply the principles of Total Quality Management	3.00	2.00	2.00	1.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	3.00	3.00
		Ability to implement TQM practices in organizations	3.00	3.00	3.00	2.00	2.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
		Ability to use statistical process control tools for quality improvement	3.00	3.00	3.00	3.00	3.00	2.00	2.00	2.00	3.00	3.00	3.00	3.00	3.00	3.00
		Ability to apply various TQM tools and techniques for process optimization	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
		Average Mapping	3.00	2.75	2.75	2.25	2.25	2.50	2.50	2.50	2.75	2.75	2.75	2.75	3.00	3.00
MEC704k	Fracture and Fatigue	Ability to understand the mechanisms of fracture and fatigue in materials	3.00	2.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	2.00	1.00
		Ability to apply fracture mechanics principles to predict crack growth and failure	3.00	3.00	3.00	3.00	2.00	1.00	1.00	0.00	1.00	1.00	1.00	2.00	3.00	2.00
		Ability to analyze and design structures to prevent fracture and fatigue	3.00	3.00	3.00	3.00	2.00	1.00	1.00	0.00	2.00	2.00	2.00	2.00	3.00	2.00
		Ability to evaluate fracture toughness and fatigue life of materials	3.00	3.00	3.00	3.00	2.00	1.00	1.00	0.00	2.00	2.00	2.00	2.00	3.00	2.00
		Average Mapping	3.00	2.75	2.50	2.50	1.75	1.00	1.00	0.00	1.50	1.50	1.25	1.75	2.75	1.75
MEC704l	Introduction to Modern FORTRAN	Ability to write and execute Fortran programs	2.00	1.00	1.00	0.00	3.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
		Ability to use Fortran for numerical computations and engineering applications	3.00	3.00	2.00	2.00	3.00	0.00	0.00	0.00	1.00	1.00	1.00	2.00	2.00	2.00
		Ability to implement various programming constructs in Fortran	3.00	2.00	2.00	1.00	3.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
		Ability to develop programs using advanced Fortran features	3.00	3.00	3.00	2.00	3.00	0.00	0.00	0.00	1.00	1.00	1.00	2.00	2.00	2.00
		Average Mapping	2.75	2.25	2.00	1.25	3.00	0.00	0.00	0.00	1.00	1.00	1.00	1.50	1.50	1.50
MEC704m	Smart Materials and Structures	Ability to understand the properties and applications of smart materials	3.00	2.00	2.00	1.00	1.00	2.00	2.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00
		Ability to select and apply smart sensors for structural health monitoring	3.00	3.00	3.00	3.00	2.00	2.00	2.00	1.00	2.00	2.00	2.00	2.00	3.00	3.00
		Ability to design and implement smart actuators for various applications	3.00	3.00	3.00	3.00	2.00	2.00	2.00	1.00	2.00	2.00	2.00	2.00	3.00	3.00
		Ability to analyze and design smart composite structures	3.00	3.00	3.00	3.00	2.00	2.00	2.00	1.00	2.00	2.00	2.00	3.00	3.00	3.00
		Average Mapping	3.00	2.75	2.75	2.50	1.75	2.00	2.00	1.00	1.75	1.75	1.75	2.25	2.75	2.75
MEC704n	Optimization Methods in Engineering Design	Ability to formulate and solve optimization problems in engineering design	3.00	3.00	3.00	3.00	2.00	1.00	1.00	1.00	2.00	2.00	2.00	2.00	3.00	2.00
		Ability to apply various optimization techniques to find optimal solutions	3.00	3.00	3.00	3.00	2.00	1.00	1.00	1.00	2.00	2.00	2.00	2.00	3.00	2.00
		Ability to use optimization software and tools	3.00	2.00	3.00	2.00	3.00	1.00	1.00	1.00	2.00	2.00	2.00	2.00	3.00	2.00
		Ability to analyze and compare different optimization methods	3.00	3.00	3.00	3.00	2.00	1.00	1.00	1.00	2.00	2.00	2.00	3.00	3.00	2.00
		Average Mapping	3.00	2.75	3.00	2.75	2.25	1.00	1.00	1.00	2.00	2.00	2.00	2.25	3.00	2.00
HSMC701	Financial Management	Ability to understand the basic principles of financial management	2.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	2.00	2.00	3.00	2.00	1.00	2.00
		Ability to analyze financial statements and make financial decisions	2.00	3.00	2.00	2.00	2.00	1.00	1.00	1.00	2.00	2.00	3.00	2.00	1.00	3.00
		Ability to evaluate investment proposals and manage working capital	2.00	3.00	3.00	3.00	2.00	1.00	1.00	1.00	2.00	2.00	3.00	2.00	1.00	3.00
		Ability to understand the functions of financial markets and institutions	2.00	2.00	1.00	1.00	2.00	1.00	1.00	1.00	2.00	2.00	3.00	2.00	1.00	2.00
		Average Mapping	2.00	2.25	1.75	1.50	1.75	1.00	1.00	1.00	2.00	2.00	3.00	2.00	1.00	2.50

Mapping of course outcomes (COs) with Programme outcomes (POs) and Programme specific outcomes (PSOs)

Subject Code	Subject name	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
HSMC702	**Business Laws**	Ability to understand the legal and regulatory framework of business	2.00	1.00	1.00	0.00	1.00	2.00	2.00	3.00	2.00	2.00	2.00	2.00	1.00	2.00
		Ability to analyze the impact of the business environment	2.00	3.00	2.00	2.00	1.00	3.00	3.00	3.00	2.00	2.00	2.00	2.00	1.00	3.00
		Ability to understand the principles of corporate social responsibility and governance	2.00	2.00	2.00	1.00	1.00	3.00	3.00	3.00	2.00	2.00	2.00	2.00	1.00	3.00
		Ability to apply the basic principles of contract, partnership, and company law	3.00	3.00	3.00	2.00	1.00	2.00	2.00	3.00	2.00	3.00	3.00	3.00	2.00	3.00
		Average Mapping	2.25	2.25	2.00	1.25	1.00	2.50	2.50	3.00	2.00	2.25	2.25	2.25	1.25	2.75
HSMC703	**Human Resource Management**	Ability to understand the principles and practices of human resource management	2.00	1.00	2.00	0.00	1.00	3.00	2.00	3.00	3.00	3.00	3.00	3.00	1.00	2.00
		Ability to apply HRM functions such as planning, recruitment, and selection	2.00	3.00	3.00	2.00	2.00	3.00	2.00	3.00	3.00	3.00	3.00	3.00	1.00	3.00
		Ability to design and implement training and development programs	2.00	3.00	3.00	3.00	2.00	3.00	2.00	3.00	3.00	3.00	3.00	3.00	1.00	3.00
		Ability to understand performance appraisal, compensation, and employee health and safety	2.00	2.00	2.00	1.00	1.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	1.00	3.00
		Average Mapping	2.00	2.25	2.50	1.50	1.50	3.00	2.25	3.00	3.00	3.00	3.00	3.00	1.00	2.75
MEC804a	**Tribology**	Students will be able to describe the concepts of tribology and characterize surfaces	3.00	2.00	1.00	1.00	1.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00
		Students will be able to analyze different types of friction and wear mechanisms	3.00	3.00	2.00	2.00	1.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	2.00	1.00
		Students will be able to apply lubrication theories to solve engineering problems	3.00	3.00	3.00	2.00	2.00	0.00	0.00	0.00	1.00	1.00	1.00	2.00	2.00	2.00
		Students will be able to design bearings and apply tribology in manufacturing	3.00	3.00	3.00	2.00	2.00	0.00	0.00	0.00	1.00	1.00	1.00	2.00	3.00	2.00
		Average Mapping	3.00	2.75	2.25	1.75	1.50	0.00	0.00	0.00	1.00	1.00	0.50	1.50	2.00	1.50
MEC804b	**Additive Manufacturing**	Students will be able to explain the basic principles and applications of additive manufacturing	3.00	1.00	1.00	0.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	2.00	1.00	1.00
		Students will be able to analyze material selection and behavior in AM processes	3.00	3.00	2.00	2.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	2.00	2.00	1.00
		Students will be able to classify and compare different AM technologies	3.00	2.00	2.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	2.00	2.00	1.00
		Students will be able to develop and apply mathematical models for AM processes	3.00	3.00	3.00	3.00	2.00	1.00	1.00	0.00	1.00	1.00	1.00	3.00	3.00	2.00
		Average Mapping	3.00	2.25	2.00	1.50	1.25	1.00	1.00	0.00	1.00	1.00	1.00	2.25	2.00	1.25
MEC804c	**Elasticity**	Students will be able to apply mathematical tools to analyze deformation and strain	3.00	3.00	2.00	2.00	2.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	2.00	1.00
		Students will be able to analyze stress and equilibrium in elastic materials	3.00	3.00	2.00	2.00	2.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	2.00	1.00
		Students will be able to utilize strain energy principles in problem-solving	3.00	3.00	2.00	2.00	2.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	2.00	1.00
		Students will be able to solve elasticity problems in various dimensions	3.00	3.00	3.00	3.00	2.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	3.00	2.00
		Average Mapping	3.00	3.00	2.25	2.25	2.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	2.25	1.25
MEC804d	**Product Design and Development**	Students will be able to describe the design process and product life cycle management tools	2.00	1.00	2.00	0.00	2.00	1.00	1.00	0.00	2.00	2.00	3.00	2.00	1.00	2.00
		Students will be able to apply value engineering and concurrent engineering principles	3.00	3.00	3.00	2.00	2.00	1.00	1.00	0.00	3.00	2.00	3.00	2.00	2.00	3.00
		Students will be able to select appropriate materials and processes for product design	3.00	3.00	3.00	2.00	2.00	1.00	1.00	0.00	2.00	2.00	2.00	2.00	3.00	3.00
		Students will be able to design products considering manufacturability, assembly, safety, and other factors	3.00	3.00	3.00	2.00	2.00	3.00	2.00	2.00	3.00	3.00	3.00	3.00	3.00	3.00
		Average Mapping	2.75	2.50	2.75	1.50	2.00	1.50	1.25	0.50	2.50	2.25	2.75	2.25	2.25	2.75

Mapping of course outcomes (COs) with Programme outcomes (POs) and Programme specific outcomes (PSOs)

Subject Code	Subject name	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEC804e	Variational Methods	Students will be able to formulate elasticity problems using differential forms	3.00	3.00	2.00	2.00	2.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	2.00	1.00
		Students will be able to apply virtual work principles to solve engineering problems	3.00	3.00	3.00	3.00	2.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	2.00	1.00
		Students will be able to utilize solution methods for beam and structural analysis	3.00	3.00	3.00	3.00	2.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	3.00	2.00
		Students will be able to apply finite element and variational methods to solve complex problems	3.00	3.00	3.00	3.00	3.00	0.00	0.00	0.00	1.00	1.00	0.00	2.00	3.00	2.00
		Average Mapping	3.00	3.00	2.75	2.75	2.25	0.00	0.00	0.00	1.00	1.00	0.00	1.25	2.50	1.50
MEC804f	Nanotechnology	Students will be able to describe the fundamental concepts and applications of nanotechnology	3.00	1.00	1.00	0.00	1.00	2.00	2.00	1.00	1.00	1.00	1.00	2.00	1.00	1.00
		Students will be able to explain various tools used for nano measurement and characterization	3.00	2.00	1.00	1.00	2.00	1.00	1.00	0.00	1.00	1.00	1.00	2.00	1.00	1.00
		Students will be able to describe different nanofabrication methods	3.00	2.00	2.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	2.00	2.00	1.00
		Students will be able to discuss the applications of nanomaterials in various fields	3.00	2.00	2.00	1.00	1.00	3.00	3.00	1.00	1.00	2.00	2.00	3.00	2.00	2.00
		Average Mapping	3.00	1.75	1.50	0.75	1.25	1.75	1.75	0.50	1.00	1.25	1.25	2.25	1.50	1.25
MEC804g	Production Operations Management	Students will be able to describe the functions and evolution of production and operations management	2.00	1.00	1.00	0.00	1.00	1.00	1.00	0.00	1.00	1.00	2.00	1.00	1.00	1.00
		Students will be able to analyze product and process design methodologies	3.00	3.00	3.00	2.00	2.00	1.00	1.00	0.00	2.00	2.00	2.00	2.00	2.00	2.00
		Students will be able to apply capacity planning and facility layout techniques	3.00	3.00	3.00	2.00	2.00	1.00	1.00	0.00	2.00	2.00	3.00	2.00	3.00	3.00
		Students will be able to utilize demand forecasting and operation scheduling methods	3.00	3.00	3.00	3.00	3.00	1.00	1.00	0.00	2.00	2.00	3.00	2.00	3.00	3.00
		Average Mapping	2.75	2.50	2.50	1.75	2.00	1.00	1.00	0.00	1.75	1.75	2.50	1.75	2.25	2.25
MEC804h	Internal Combustion Engines	Students will be able to describe the operation and characteristics of SI and DI engines	3.00	1.00	1.00	0.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
		Students will be able to analyze engine combustion processes	3.00	3.00	2.00	2.00	2.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	2.00	1.00
		Students will be able to evaluate engine performance and emissions	3.00	3.00	2.00	3.00	2.00	2.00	2.00	0.00	1.00	2.00	2.00	2.00	2.00	2.00
		Students will be able to discuss alternative fuels and advanced engine technologies	3.00	2.00	2.00	2.00	2.00	3.00	3.00	0.00	1.00	2.00	2.00	3.00	2.00	2.00
		Average Mapping	3.00	2.25	1.75	1.75	1.75	1.75	1.75	0.00	1.00	1.50	1.50	1.75	1.75	1.50
MEC804i	Computational Solid Mechanics	Students will be able to apply finite element methods and continuum mechanics principles	3.00	3.00	3.00	3.00	3.00	0.00	0.00	0.00	2.00	1.00	1.00	2.00	3.00	2.00
		Students will be able to utilize variational calculus and linearization techniques	3.00	3.00	3.00	3.00	2.00	0.00	0.00	0.00	1.00	1.00	1.00	2.00	3.00	2.00
		Students will be able to implement Lagrangian formulations in computational mechanics	3.00	3.00	3.00	3.00	2.00	0.00	0.00	0.00	1.00	1.00	1.00	2.00	3.00	2.00
		Students will be able to develop and apply constitutive equations in FE analysis	3.00	3.00	3.00	3.00	3.00	0.00	0.00	0.00	2.00	1.00	1.00	3.00	3.00	3.00
		Average Mapping	3.00	3.00	3.00	3.00	2.50	0.00	0.00	0.00	1.50	1.00	1.00	2.25	3.00	2.25
MEC804j	Micromechanics	Students will be able to describe defects in solids and elasticity concepts	3.00	2.00	1.00	1.00	1.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	2.00	1.00
		Students will be able to analyze the behavior of inclusions in elastic solids	3.00	3.00	2.00	2.00	2.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	2.00	1.00
		Students will be able to explain the elastic fields of dislocations and disclinations	3.00	3.00	2.00	2.00	2.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	2.00	1.00
		Students will be able to analyze crack behavior, defect interactions, and homogenization techniques	3.00	3.00	3.00	3.00	2.00	0.00	0.00	0.00	1.00	1.00	0.00	2.00	3.00	2.00

Mapping of course outcomes (COs) with Programme outcomes (POs) and Programme specific outcomes (PSOs)

Subject Code	Subject name	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		Average Mapping	3.00	2.75	2.00	2.00	1.75	0.00	0.00	0.00	1.00	1.00	0.00	1.25	2.25	1.25
HSMC801	**Project Management and Entrepreneurship**	Students will be able to describe the characteristics and functions of entrepreneurship	1.00	1.00	2.00	0.00	1.00	2.00	1.00	2.00	2.00	2.00	3.00	2.00	1.00	3.00
		Students will be able to discuss the role of women entrepreneurs and the importance of MSMEs	1.00	1.00	1.00	0.00	1.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00	1.00	3.00
		Students will be able to conduct SWOT analysis for project identification	2.00	3.00	3.00	3.00	2.00	2.00	1.00	2.00	3.00	2.00	3.00	2.00	2.00	3.00
		Students will be able to develop project plans and understand financial and marketing functions	2.00	3.00	3.00	2.00	2.00	2.00	1.00	2.00	3.00	3.00	3.00	3.00	2.00	3.00
		Average Mapping	1.50	2.00	2.25	1.25	1.50	2.25	1.25	2.00	2.50	2.25	2.75	2.25	1.50	3.00

Progamme articulation matrix PAM)

Subject Code	Subject name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
ASC X01	Applied Chemistry	2.75	2.50	1.75	1.75	1.75	0.50	0.50	0.00	0.25	0.50	0.50	2.25	1.50	1.75
ASC X51	Applied Chemistry (P)	2.00	2.50	2.00	2.75	2.00	0.50	0.50	0.00	1.25	1.00	0.25	1.75	1.50	2.00
ASM 101	Calculus	3.00	2.75	1.75	1.75	1.75	0.25	0.25	0.00	0.25	1.00	0.00	2.00	1.00	1.25
HSMC X01	Professional Communication	0.00	0.00	0.00	0.00	1.00	2.25	0.00	1.25	2.25	3.00	1.25	1.75	0.00	1.25
HSMC X51	Professional Communication (P)	0.00	0.00	0.00	0.00	1.00	2.25	0.00	1.25	2.25	3.00	1.25	1.75	0.00	1.25
ESC X53	Workshop	1.50	1.00	1.25	0.75	1.50	1.00	1.00	1.00	1.50	1.00	0.50	1.25	2.75	1.75
MEC 101	Engineering Mechanics	3.00	3.00	2.00	1.75	1.25	0.25	0.25	0.00	0.75	1.00	0.25	2.00	1.75	1.50
MEC 151	Engineering Mechanics (P)	2.25	2.25	1.25	2.25	1.50	0.50	0.00	0.25	1.50	1.50	0.25	1.50	0.75	1.00
EVS X01	Environment Sciences	1.00	1.00	0.50	0.25	0.00	2.75	3.00	1.75	0.50	1.00	0.50	1.50	0.25	1.00
ASP X03	Physics of materials	3.00	2.00	1.25	1.25	1.50	0.50	0.25	0.00	0.50	0.00	0.00	1.75	0.00	0.00
ASPX53	Physics of materials (P)	3.00	2.25	1.00	1.00	0.00	0.00	1.00	1.00	2.00	1.00	0.00	2.00	0.00	0.00
ASM 201	Differential Equations and Transforms	2.25	2.50	2.50	2.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
EEC X01	Basic Electrical and Electronics Engineering	3.00	2.75	2.00	1.00	1.00	0.00	0.00	0.00	0.75	0.00	0.00	1.00	1.75	0.00
EEC X51	Basic Electrical and Electronics Engineering (P)	3.00	3.00	1.75	2.50	2.25	0.00	0.00	0.00	1.00	2.00	1.50	2.00	3.00	2.50
ESC X04	Engineering Graphics	1.75	1.75	2.25	0.75	2.25	1.00	0.25	0.25	1.00	2.75	1.00	2.00	3.00	2.25
ESC X54	Engineering Graphics (P)	1.75	1.75	2.25	0.75	2.25	1.00	0.25	0.25	1.00	2.75	1.00	2.00	3.00	2.25
ESC X01	Programming fundamentals	2.75	2.75	2.25	1.00	2.50	0.00	0.00	0.00	1.25	1.00	0.25	2.25	1.00	2.25
ESC X51	Programming fundamentals (P)	2.75	2.75	2.25	1.00	2.50	0.00	0.00	0.00	1.25	1.00	0.25	2.25	1.00	2.25
UHV-II	Universal Human Values-II	0.75	1.75	1.25	0.75	0.25	3.00	2.00	3.00	1.50	1.50	1.25	2.75	0.75	1.50
NSS-1	National Service Scheme	0.25	1.25	1.50	1.25	0.50	3.00	1.50	2.50	2.75	2.50	1.50	2.00	0.25	1.50
ST251	Product re-enginering and innovation	2.25	3.00	2.75	2.25	2.00	1.25	1.25	0.25	1.75	1.25	1.50	2.75	3.00	2.75
MEC-301	Basic Thermodynamics	3.00	3.00	2.50	1.75	1.00	0.75	1.75	0.00	0.00	1.00	0.00	1.75	3.00	0.75
MEC-351	Basic Thermodynamics Lab	2.25	2.50	1.25	0.75	0.25	0.00	0.00	0.00	0.25	0.00	0.00	0.75	1.50	2.00
MEC-302	Mechanics of Materials	3.00	3.00	2.75	2.50	0.75	1.25	1.25	0.00	1.00	1.00	0.00	2.00	3.00	1.00
MEC-352	Mechanics of Materials Lab	2.00	2.25	0.25	2.75	0.75	0.00	0.00	0.00	0.75	0.50	0.00	1.00	1.75	2.25
MEC-303	kinematics of machines	3.00	2.50	2.50	1.50	1.25	0.75	0.75	0.00	1.00	1.00	0.00	1.50	3.00	0.75
MEC-353	kinematics of machines Lab	2.75	2.50	1.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.75	1.75
MEC-304	Machine Drawing	2.00	1.00	3.00	1.00	2.25	1.00	1.00	0.00	2.00	3.00	0.00	1.25	2.00	1.75
MEC-354	Machine Drawing Lab	1.50	0.50	2.50	0.00	3.00	0.00	0.00	0.00	0.00	1.50	0.00	1.00	2.50	2.00
MEC-305	Manufacturing Processes	3.00	2.75	2.00	1.75	1.00	0.25	0.25	0.00	0.75	0.75	0.50	1.00	3.00	1.00
MEC-355	Manufacturing Processes Lab	3.00	1.75	1.75	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.50	1.25
ASM 301	Algebra and complex analysis	3.00	2.75	0.50	1.75	1.75	0.00	0.00	0.00	0.00	0.00	0.00	1.75	0.50	0.00
MEC-401	Engeneering Thermodynamics	3.00	3.00	1.50	2.00	1.50	0.25	0.50	0.00	0.00	0.00	0.00	1.00	1.00	0.00
MEC-451	Engeneering Thermodynamics lab	2.50	2.50	0.75	2.00	0.50	0.00	0.00	0.00	0.50	0.50	0.00	1.00	2.00	0.00
MEC-402	Mechanics of Solids	2.50	3.00	1.50	2.50	1.25	0.00	0.00	0.00	0.00	0.00	0.00	1.25	1.50	0.00
MEC-452	Mechanics of Solids lab	3.00	3.00	2.25	2.50	2.00	0.00	1.00	0.00	0.50	1.25	1.25	2.00	3.00	2.50
MEC-403	Dynammics of machines	3.00	3.00	2.75	2.25	1.00	1.00	0.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
MEC-453	Dynammics of machines Lab	3.00	2.50	2.50	2.25	2.00	0.00	1.00	0.00	0.50	1.00	1.25	2.00	3.00	2.25
MEC-404	Manufacturing Technology	3.00	2.00	1.75	1.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	2.00	1.00
MEC-454	Manufacturing Technology lab	3.00	1.75	2.25	0.75	2.50	0.00	0.00	0.50	2.50	1.50	1.00	1.50	2.50	1.50
MEC-405	Fluid Mechanics	3.00	2.50	0.75	1.75	1.25	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.25	2.25
MEC-455	Fluid Mechanics Lab	3.00	3.00	2.00	3.00	2.00	0.25	0.25	0.00	2.00	1.75	0.00	1.00	1.00	1.00
MEC-406	Numerical Anlysis	2.25	2.75	0.25	2.75	3.00	0.00	0.00	0.00	0.25	0.25	0.00	2.00	1.25	0.75
MEC-456	Numerical Anlysis Lab	3.00	3.00	2.50	3.00	3.00	0.00	0.00	0.00	2.00	1.50	1.00	2.25	2.00	1.25
MEC457	Intership 1	1.50	1.25	1.25	1.00	1.50	1.50	0.75	1.75	2.75	2.00	1.50	2.00	2.00	2.50
MEC-501	Design of Machine Elements-I	3.00	3.00	3.00	2.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00

Progamme articulation matrix PAM)

Subject Code	Subject name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEC-551	Design of Machine Elements-I Lab	3.00	3.00	3.00	2.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
MEC-502	CAD/ CAM	1.75	1.00	1.75	0.00	2.75	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.25	1.25
MEC-552	CAD/ CAM Lab	2.75	2.00	2.00	0.00	2.50	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.50	0.75
MEC-503	Robotics	2.75	2.50	1.75	1.50	2.25	0.00	0.00	0.00	0.25	0.00	0.25	1.75	2.75	1.25
MEC-553	Robotics Lab	2.75	2.75	2.50	1.25	2.50	0.00	0.00	0.00	1.25	0.50	0.25	1.25	1.75	0.75
MEC-504	Mechanical Measurement and metrology	2.25	1.00	1.00	1.75	2.50	0.00	0.00	0.00	0.00	0.00	0.00	1.75	1.50	0.50
MEC-554	Mechanical Measurement and metrology Lab	3.00	2.75	2.25	2.50	3.00	0.00	0.00	0.00	2.00	1.25	0.00	1.00	1.00	1.00
MEC-505	Mechtronics	2.75	1.00	2.00	0.00	3.00	0.00	0.00	0.00	0.50	0.50	0.50	2.00	2.50	1.50
MEC-555	Mechtronics Lab	3.00	3.00	3.00	2.50	3.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	2.50	1.50
MEC-506	Fluid Machinery	3.00	2.25	0.50	1.25	0.25	0.00	0.00	0.00	0.25	0.25	0.00	1.00	1.75	1.50
MEC-556	Fluid Machinery Lab	3.00	2.75	2.25	2.75	2.00	0.00	0.00	0.00	2.00	1.25	0.00	1.00	1.25	1.00
MEC-601	Design of Machine Elements-II	3.00	3.00	3.00	2.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	1.25	1.50
MEC-651	Design of Machine Elements-II Lab	3.00	3.00	3.00	2.00	2.00	0.00	0.00	0.00	2.00	1.00	0.00	1.00	3.00	2.00
MEC-602	Finite Element Methods	3.00	3.00	2.75	2.75	2.00	1.00	1.00	0.00	1.00	1.00	0.00	2.00	3.00	1.00
MEC-652	Finite Element Methods Lab	3.00	3.00	2.75	2.75	3.00	0.00	0.00	0.00	2.00	1.00	0.00	1.25	2.50	1.50
MEC-603	Mechanical Vibrations	3.00	2.75	2.25	2.00	1.25	1.25	1.25	0.00	1.00	1.00	0.00	2.00	3.00	0.25
MEC-653	Mechanical Vibrations Lab	3.00	3.00	2.50	3.00	2.50	0.00	0.00	0.00	2.00	1.50	0.00	1.00	1.50	1.00
MEC-604	Heat Transfer	3.00	2.75	2.50	1.75	2.00	1.25	1.25	1.00	1.00	1.00	1.00	2.00	3.00	2.00
MEC-654	Heat Transfer Lab	3.00	3.00	2.50	3.00	2.00	0.00	1.00	0.00	2.00	1.75	0.00	1.00	1.50	1.00
MEC-605	Mechanical behavior of materials	3.00	2.75	2.50	2.00	1.75	1.00	1.50	2.00	1.75	1.00	1.50	2.00	3.00	2.25
MEC-655	Mechanical behavior of materials Lab	3.00	2.50	1.50	2.25	1.25	0.00	0.00	0.00	2.25	1.25	0.00	1.25	1.50	1.25
MEC-606	Operations research	3.00	2.75	2.50	2.00	1.75	1.75	1.50	1.00	1.00	1.50	3.00	2.00	2.75	2.25
MEC-656	Operations research Lab	2.75	2.50	2.00	2.00	2.25	0.00	0.00	0.00	1.50	1.00	2.50	1.00	1.25	1.50
#MEC657	INTERSHIP 2	2.00	2.00	1.50	1.75	1.75	1.25	1.00	1.75	3.00	2.50	1.75	2.25	2.50	3.00
MEC-701	Refrigeration and Air Conditioning	2.75	2.50	2.50	1.50	1.75	1.25	1.50	0.50	0.25	1.75	1.00	2.75	2.75	2.25
MEC-751	Refrigeration and Air Conditioning Lab	3.00	1.50	1.75	0.50	1.00	1.50	2.50	0.00	1.25	1.00	1.25	1.25	1.75	1.75
MEC-702	Automatic Controls	3.00	2.75	2.75	2.25	2.00	0.00	0.00	0.25	0.25	2.00	1.00	2.75	3.00	1.75
MEC-752	Automatic Controls Lab	3.00	3.00	3.00	3.00	3.00	0.00	0.00	0.00	2.00	1.00	1.00	1.00	2.50	2.00
MEC-703	Automobile Engineering	2.00	1.50	1.50	0.50	1.50	1.00	2.00	1.50	0.25	1.75	1.00	1.75	2.50	2.00
MEC-753	Automobile Engineering Lab	2.25	2.00	1.75	1.00	1.75	1.25	1.25	1.75	2.75	1.25	1.00	1.25	1.75	1.75
MEC755	Minor Project	2.50	1.75	2.25	1.75	1.75	0.50	1.25	0.75	2.50	3.00	2.75	2.50	2.50	2.75
MEC801	Advanced Manufacturing Techniques	2.75	2.00	2.00	1.75	2.00	1.00	1.00	0.25	0.00	1.00	1.00	2.00	3.00	2.00
MEC851	Advanced Manufacturing Techniques Lab	2.75	2.00	2.00	1.75	2.00	1.00	1.00	0.25	0.00	1.00	1.00	2.00	3.00	2.00
MEC802	Non-Conventional Energy Sources	2.25	1.75	1.75	1.25	2.00	2.25	3.00	3.00	1.00	2.00	1.00	1.75	2.25	3.00
MEC-803	Computational Fluid Dynamics	3.00	2.50	2.50	2.75	2.75	0.00	0.00	0.00	0.00	2.00	1.00	3.00	3.00	2.00
MEC-853	Computational Fluid Dynamics Lab	3.00	3.00	3.00	3.00	3.00	0.00	1.00	0.00	2.00	1.00	1.00	1.25	2.25	1.25
MEC-855	Major Project	2.50	1.75	2.25	1.75	1.75	0.50	1.25	0.75	2.50	3.00	2.75	2.50	2.50	2.75
MEC704a	Machine Learning	3.00	3.00	2.67	2.67	3.00	0.00	1.00	0.00	0.67	1.67	2.00	3.00	3.00	3.00
MEC704b	Internet of Things	3.00	2.75	2.25	2.50	2.50	0.00	1.00	0.00	0.75	1.75	2.00	2.75	3.00	2.75
MEC704c	Mechanics of Composites	3.00	2.75	2.75	2.25	1.50	0.00	1.00	0.00	0.00	1.00	1.00	2.00	3.00	2.75
MEC704d	Work Study	3.00	3.00	3.00	2.50	2.00	1.50	1.50	1.25	2.00	2.00	2.50	2.00	3.00	3.00
MEC704e	Structural Dynamics	3.00	3.00	3.00	3.00	2.00	1.00	1.00	1.00	2.00	1.00	1.00	2.00	3.00	2.00

Progamme articulation matrix PAM)

Subject Code	Subject name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEC704f	Vehicle Dynamics	3.00	3.00	2.75	2.75	2.00	1.50	1.25	1.25	1.00	1.25	1.25	2.25	2.75	2.25
MEC 704g	Industrial Engineering	3.00	3.00	3.00	2.75	2.25	2.00	2.00	1.00	2.50	2.50	3.00	2.50	3.00	3.00
MEC704h	Continuum Mechanics	3.00	3.00	2.50	2.50	2.00	0.00	0.00	0.00	1.00	1.00	0.00	1.25	2.50	1.50
MEC704i	Probability and Statistics for Engineers	3.00	3.00	2.50	2.75	2.75	1.25	1.25	1.00	1.75	1.75	1.75	2.50	2.75	2.00
MEC704j	Total Quality Management	3.00	2.75	2.75	2.25	2.25	2.50	2.50	2.50	2.75	2.75	2.75	2.75	3.00	3.00
MEC704k	Fracture and Fatigue	3.00	2.75	2.50	2.50	1.75	1.00	1.00	0.00	1.50	1.50	1.25	1.75	2.75	1.75
MEC704l	Introduction to Modern FORTRAN	2.75	2.25	2.00	1.25	3.00	0.00	0.00	0.00	1.00	1.00	1.00	1.50	1.50	1.50
MEC704m	Smart Materials and Structures	3.00	2.75	2.75	2.50	1.75	2.00	2.00	1.00	1.75	1.75	1.75	2.25	2.75	2.75
MEC704n	Optimization Methods in Engineering Design	3.00	2.75	3.00	2.75	2.25	1.00	1.00	1.00	2.00	2.00	2.00	2.25	3.00	2.00
HSMC701	Financial Management	2.00	2.25	1.75	1.50	1.75	1.00	1.00	1.00	2.00	2.00	3.00	2.00	1.00	2.50
HSMC702	Business Laws	2.25	2.25	2.00	1.25	1.00	2.50	2.50	3.00	2.00	2.25	2.25	2.25	1.25	2.75
HSMC703	Human Resource Management	2.00	2.25	2.50	1.50	1.50	3.00	2.25	3.00	3.00	3.00	3.00	3.00	1.00	2.75
MEC804a	Tribology	3.00	2.75	2.25	1.75	1.50	0.00	0.00	0.00	1.00	1.00	0.50	1.50	2.00	1.50
MEC804b	Additive Manufacturing	3.00	2.25	2.00	1.50	1.25	1.00	1.00	0.00	1.00	1.00	1.00	2.25	2.00	1.25
MEC804c	Elasticity	3.00	3.00	2.25	2.25	2.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	2.25	1.25
MEC804d	Product Design and Development	2.75	2.50	2.75	1.50	2.00	1.50	1.25	0.50	2.50	2.25	2.75	2.25	2.25	2.75
MEC804e	Variational Methods	3	3	2.75	2.75	2.25	0	0	0	1	1	0	1.25	2.5	1.5
MEC804f	Nanotechnology	3	1.75	1.5	0.75	1.25	1.75	1.75	0.5	1	1.25	1.25	2.25	1.5	1.25
MEC804g	Production Operations Management	2.75	2.5	2.5	1.75	2	1	1	0	1.75	1.75	2.5	1.75	2.25	2.25
MEC804h	Internal Combustion Engines	3	2.25	1.75	1.75	1.75	1.75	1.75	0	1	1.5	1.5	1.75	1.75	1.5
MEC804i	Computational Solid Mechanics	3	3	3	3	2.5	0	0	0	1.5	1	1	2.25	3	2.25
MEC804j	Micromechanics	3	2.75	2	2	1.75	0	0	0	1	1	0	1.25	2.25	1.25
HSMC801	Project Management and Entrepreneurship	1.5	2	2.25	1.25	1.5	2.25	1.25	2	2.5	2.25	2.75	2.25	1.5	3

Syllabus - BE Mechanical Engineering

1st Semester

Course Code	**ASC X01**
Course Title	**Applied Chemistry**
Type of Course	**Core**
L T P	**4 0 0**
Credits	**4**
Course Assessment Methods End Semester Assessment(University Exam) Continuous Assessment (Minors, Assignments, Quiz)	 50 50
Course Prerequisites	Chemistry at 10+2 level
Course Objectives (CO)	To teach the fundamentals of basic chemical sciences essential for the development of new technologies to all branches of engineering.
Course Outcome	1. Analyze molecular bonding and predict chemical properties. 2. Apply stereochemical principles to understand molecular arrangements and properties. 3. Utilize spectroscopic techniques for chemical analysis. 4. Apply thermodynamic laws and catalysis principles to industrial chemical processes.

Note for the examiner: The end semester question paper will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt two questions from each section.

SYLLABUS

SECTION - A

Chemical Bonding

Molecular orbital theory and its applications to the formation of homonuclear (H_2, N_2) and heteronuclear diatomic molecules (NO, CO, CN), Valence bond theory as applicable to coordination compounds and its limitations. Crystal Field Theory, Splitting of octahedral, tetrahedral and square planner complexes, crystal field stabilization energies of octahedral and tetrahedral complexes and its application. **[CO 1]**

Stereochemistry of Organic Compounds

Concept of isomerism. Types of isomerism. Optical isomerism–enantiomers, optical activity, properties of enantiomers, diastereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization, R & S systems of nomenclature. Geometric isomerism– determination of configuration of geometric isomers, E & Z system of nomenclature Conformational isomerism – conformational analysis of ethane and n-butane; conformations of cyclohexane, Newman projection. **[CO 2]**

Spectroscopy

Spectroscopy: UV- Introduction, Lambert-Beer's Law, selection rules, electronic transitions, Application to simple organic molecules (auxochrome, chromophore), effect of conjugation and solvent on transition of organic molecules, Woodward-Fieser Rules for calculating λmax for dienes. Infrared Spectroscop- Introduction, Principle of IR spectroscopy-Fundamental vibrations, Application to simple organic molecules (effect of masses of atoms, bond strength, nature of substituent, hydrogen bonding on IR frequency), sample preparation for IR. **[CO 3]**

SECTION - B

Thermodynamics

Review of objectives and limitations of chemical thermodynamics, State functions, Thermodynamic equilibrium, work, heat, internal energy, enthalpy, heat capacity. Zeroth law of thermodynamics, First law of thermodynamics Reversible, isothermal and adiabatic expansion & compression of an ideal gas. Irreversible isothermal and adiabatic expansion of an ideal gas. Carnot cycle and efficiency of reversible engines, Enthalpy change and its measurement. Flame temperature, Second and third law of thermodynamics. Concept of entropy. Gibb's and Helmholtz equations. Simple numericals for calculating w, q, ΔE, ΔH and entropy. **[CO 4]**

Catalysis

Catalysis and general characteristics of a catalytic reactions, Homogeneous catalysis, Heterogenous catalysis, Acid base catalysis and Enzyme catalysis – Michealis Menten equations, Application of catalysis for industrially important processes – Hydrogenation (Wilkinson's catalyst), Hydroformylation, Acetic acid process, Wacker process. **[CO 5]**

Polymers

General introduction, classification of polymers, Mechanism of addition and condensation polymerization, Idea of number average and weight average molecular masses of polymers, Properties and uses of polystyrene, polyester, polyamide, epoxy, phenol-formaldehyde and silicon resins. **[CO 6]**

Books suggested:

RECOMMENDED BOOKS			
S.No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1.	Atkin's Physical Chemistry	Peter Atkins, Julio de Paula	7th Ed., Oxford University Press
2	Concise Inorganic Chemistry	J D Lee	5th Edition, Chapman & Hall, 2003
3	Organic Chemistry	Joseph M. Hornback	Brooke Cole Publishing Company U.S.A.
4	A Textbook of Engineering Chemistry	Shashi Chawla	Dhanpat Rai & Co. Pvt. Ltd., Delhi (2008)
5	Principles of Physical Chemistry	Puri, Sharma and Pathania	W.H. Freeman & Co. 2008.
6	Introductory Polymer Chemistry	G.S.Mishra	John Wiley & Sons, New York, 1993
7	Introduction to spectroscopy	D. S. Pavia, G.M. Lasmpman and G.S. Kriz	4th Edition, Thomson learning, Indian Edition 2012.
8	Basic Inorganic Chemistry.	F.A. Cotton, G. Wilkinson and P.L. Gaus	3rd Ed., John Wiley & Sons
9	Inorganic Chemistry- Principles of structure and reactivity	James E. Huheey, Ellen A. Keiter and Richard L. Keiter	4th Ed. Pearson Edu. Asia
10	Organic Chemistry	S. M. Mukherji, S. P. Singh & R. P. Kapoor	1st Edition, Vol. 2, 1985, New Age International Pvt. Ltd

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	1				2					1
CO2	3	2										1
CO3	3		2				1					1
CO4	3	2		2								1
CO5	2											1
CO6	3	2										1

Course Code	**ASC X51**
Course Title	**Applied Chemistry (P)**
Type of Course	**Core**
L T P	**0 0 3**
Credits	**1**
Course Objectives	To teach the fundamentals of chemical sciences essential for the development of new technologies to all branches of engineering.
Course Prerequisites	Chemistry at 10+2 level
Course Assessment Methods Practical (Continuous and end semester evaluation)	50
Course Outcome :	1. Perform titrations to determine chemical concentrations. 2. Apply spectroscopy principles to real sample analysis. 3. Execute polymer and catalyst synthesis experiments. 4. Conduct separation and qualitative analysis using chromatographic techniques.

Instruction for Students: The candidate will be attending a laboratory session of three hours weekly and has to perform any eight experiments.

List of Experiments:

1. Verify Lambert Beer's law using spectrophotometer and CoCl2 or K2Cr2O7 solution. **CO1**
2. To determine the strength of an acid solution by using a conductivity meter. **CO4**
3. Determination of saponification number of oil. **CO5**
4. Preparation of a phenol formaldehyde resin. **CO6**
5. Experiments on TLC (determination of Rf values and identification of various compounds). **CO7**
6. To determine the heat of neutralization of reaction. **CO3**
7. Determination of total hardness of a water sample. **CO1**
8. Determination of copper. **CO1**
9. Determination of chloride ion and dissolved O2 in water. **CO1**
10. Preparation of an inorganic complex/organic compound.**CO5**

Books Recommended:

1. A. I. Vogel : A textbook of Quantitative Inorganic Analysis, 2000, Published by Longman Gp. Ltd, 4th edition.
2. Shashi Chawla: Essentials of Experimental Engineering Chemistry. Published by Dhanpat Rai & Co. Delhi (2001).
3. Vogel's text book of quantitative chemical analysis, 6th Ed by J. Mendham, R. C. Denny, J. D. Barnes and M. J. K. Thomas, Pearson Education.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2		1		1	2					1
CO2	3	2		1	3	1	1					1
CO3	3			1		1	1					1
CO4	3	2		1		1	1					1
CO5	2			1		1	1					1
CO6	3	2		1		1	1					1

Course Code	**ASM 101**
Course Title	**Calculus**
Type of Course	**Core**
L T P	**4 1 0**
Credits	**5**
Course Assessment Methods End Semester Assessment(University Exam) Continuous Assessment (Minors, Assignments, Quiz)	 50 50
Course Prerequisites	Mathematics at 10+2 level
Course Objectives (CO)	1. To understand the behaviour of infinite series and its use. 2. To learn the concepts of functions of two and more than two variables and their applications. 3. To learn the methods to evaluate multiple integrals and their applications to various problems. 4. To understand the concepts of Vector calculus and their use in engineering problems.
Course Outcome	1. The students are able to test the behaviour of infinite series. 2. Ability to analyze functions of more than two variables and their applications. 3. Ability to evaluate multiple integrals and apply them to practical problems. 4. Ability to apply vector calculus to engineering problems.

SYLLABUS

Note for the examiner: The semester question paper will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt two questions from each section.

SECTION-A

FUNCTIONS OF ONE VARIABLE

Sequences and Series: Sequences, Limits of sequences, Infinite series, series of positive terms, Integral test, Comparison test, Ratio test, Root test. Alternating series, Absolute and Conditional Convergence, Leibnitz test. Power series: radius of convergence of power series, Taylor's and Maclaurin's Series. (Scope as in Chapter 10, Sections 10.1 – 10.9 of Reference 1).

Integral Calculus: Length of curves, Volume (disk and washer method) and surface areas of revolution (Scope as in Chapter 6, 6.1, 6.3, 6.4 of Reference 1).

DIFFERENTIAL CALCULUS OF FUNCTIONS OF TWO AND THREE VARIABLES

Concept of limit and continuity of a function of two and three variables, Partial derivatives, total derivative, composite function, differentiation of an implicit function, chain rule, Taylor's theorem (statement only), Maxima and minima of a function of two and three variables, Lagrange's method of multipliers (Scope as in Chapter 14, Sections 14.1-14.4, 14.6-14.10 of Reference 1).

SECTION-B

INTEGRAL CALCULUS OF FUNCTIONS OF TWO AND THREE VARIABLES

Double and triple integrals, Change of order of integration, Applications to area and volumes. (Scope as in Chapter 15, Sections 15.1-15.5, 15.7-15.8 of Reference 1).

VECTOR DIFFERENTIAL CALCULUS
Vector-valued functions and space curves and their tangents, integration, arc lengths, unit tangent vector, Curvature and torsion of a curve, Gradient of a Scalar field, Directional Derivative (Scope as in Chapter 13, Sections 13.1-13.5 Chapter 14, Section 14.5 of Reference 1).

VECTOR INTEGRAL CALCULUS
Line integrals, Vector fields, Work, Circulation and Flux, Path Independence, Potential functions and Conservative fields, Green's theorem in the plane, Surface Areas and Surface Integrals, Stoke's Theorem, Gauss Divergence Theorem (Statements only) (Scope as in Chapter 16 of Reference 1).

RECOMMENDED BOOKS			
S. No.	**NAME**	**AUTHORS**	**PUBLISHER**
1.	Calculus	Maurice D. Weir, Joel Hass, Frank R. Giordano, Thomas	12th edition, Pearson Education.
2.	Advanced Engineering Mathematics	E. Kreyszig.	8th edition , John Wiley.
3.	Advanced Engineering Mathematics	Michael D. Greenberg	2nd edition, Pearson Education.
4.	Advanced Engineering Mathematics	Wylie and Barrett	Tata McGraw Hill
5.	Higher Engineering Mathematics	B. V. Ramana	Tata McGraw Hill.

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	3	2	3								1
CO2	3	2	2	2								1
CO3	3	2	3	3								1
CO4	2	3	2	2								1

Course Code	**HSMC X01**
Course Title	**Professional Communication**
Type of Course	**Core**
L T P	**2 0 0**
Credits	**2**
Course Assessment Methods End Semester Assessment (University Exam) Continuous Assessment (Minors, Assignments, Quiz)	 **50** **50**
Course Prerequisites	Basic knowledge of English Language and Grammar
Course Outcomes (CO)	1. Demonstrate Correct Sentence Structure And Grammar Usage. 2. Enhance Their Reading,writing,listening,and speaking skills. 3. Communicate Effectively Within Organizational Settings. 4. Use new media and non-verbal communication appropriately.

Syllabus

Note for the examiner: The semester question paper will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt two questions from each section.

Section A

English Grammar : Subject-verb agreement , Noun-pronoun agreement , Misplaced modifiers , Articles , Prepositions , Tenses, One word substitutes , Idioms and Phrases , Active-Passive , Synonyms –Antonyms

Basic Writing Skills : Sentence Structures, Use of phrases and clauses in sentences , Importance of proper punctuation , Creating coherence , Organizing principles of paragraphs in documents, Techniques for writing precisely , Paragraph , Essay and Letter writing.

Communication details : Four Fundamental communication methods namely Writing, Speaking, Listening and Reading ,7 Cs of Communication , Barriers to Communication
[CO 2]

Section B

Communication in Organizations : Formal- Informal Communication, Communication Networks, Intra and Inter Firm Communication

Communication methods : Reports and their types , Layout of a report , writing a report ,Office notice , Memo ,Business proposals, Minutes of meeting

[CO 3]

Modes of Communication: Emerging channels of communication , Telephone and Email Etiquettes, Non-Verbal Communication, Cross culture communication, Formal Presentations

[CO 4]

Reference Books

1. Practical English Usage. Michael Swan. OUP. 1995.

2. Remedial English Grammar. F.T. Wood. Macmillan.2007

3. On Writing Well. William Zinsser. Harper Resource Book. 2001

4. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.

5. Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.

6. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	2	2	2	-	2	1	-	3	3	3	2
CO2	-	2	2	2	-	2	1	-	3	3	3	2
CO3	-	2	2	2	-	2	1	-	3	3	3	2
CO4	-	2	2	2	-	2	1	-	3	3	3	2

Course Code	**HSMC X51**
Course Title	**Professional Communication (P)**
Type of Course	**Core**
L T P	**0 0 2**
Credits	**1**
Course Assessment Methods (Continuous and end semester evaluation)	**50**
Course Prerequisites	Basic knowledge of English Language and Grammar
Course Outcomes (CO)	1. Speak Clearly And Confidently In Public Forums. 2. Participate effectively in group discussions and interviews. 3. Understand non-verbal communication in professional settings. 4. Deliver Structured Presentations With Clarity.

Practical Oral Communication (This unit involves interactive practice sessions in Language Lab)

1. Telling something about oneself [CO1 , CO2, CO3]

2. Story Telling and Event [CO1 , CO2]

3. Listening Comprehension [CO4]

4. Pronunciation, Intonation, Stress and Rhythm [CO1, CO2, CO3]

5. Common Everyday Situations: Conversations and Dialogues [CO1, CO2,CO3]

6. Communication at Workplace [CO3 , CO4]

7. Facing an Interview [CO1, CO2]

8. Formal Presentations [CO1, CO2, CO3, CO4]

Reference Books

1. Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	-	2	2	2	-	2	1	-	3	3	3	2
CO 2	-	2	2	2	-	2	1	-	3	3	3	2
CO 3	-	2	2	2	-	2	1	-	3	3	3	2
CO 4	-	2	2	2	-	2	1	-	3	3	3	2

Course Code	ESC X53
Course Title	Workshop (P)
Course Type	Core
Course LTP	0 0 4
Course Credits	2
Course Assessment ● Continuous	50 (Practical Performance, Report Writing, and Viva Voce)
Course Prerequisites	Basic workshop practices
Course Objectives	1. Know different machines, tools and equipment, Identify different Engineering materials, metals and non-metals. 2. Understand different Mechanisms, Use of Machines, Tools and Equipment. 3. Knowledge of basic Manufacturing Processes in Electronics, Electrical, Machine, Welding, Fitting, Sheet Metal.Smithy, Foundry and Carpentry Workshops.
Course Outcomes	1. Identify Tools And Machines Used In Workshop Practices. 2. Demonstrate welding, fitting, carpentry, and machining operations. 3. Perform Fabrication And Manufacturing Tasks Safely. 4. Understand the impact of manufacturing techniques on product design.

List of Experiments

1. Welding Shop :
   Joining Processes, Welding and its Classification, Welding Processes, Fusion Welding, Pressure Welding, Electric Arc Welding, Gas Welding, Resistance Welding, Metal Inert gas Welding, Welding Joints, Welding Positions, Welding defects, Welding Applications, Basic welding design and Procedures, identification of materials,
   Jobs: Butt Joint in Flat Position using SMAW, Lap Joint using Spot Welding, Edge Joint in Horizontal Position using SMAW, Tee Joint in Flat position using SMAW, Corner Joint in vertical position using SMAW.
   Defect Identification and marking, Edge preparation and Fillet making, Tacking, Distortion identification.

2. Electronics Shop:
   To know about Soldering mechanism and techniques, Familiarity with Electronic Components / symbols, Testing of electronic components, Application of Soldering, Circuit Assembly
   Jobs : Practice of Soldering and desoldering, Identification and testing of a) passive electronic components b) Active electronic components, Assembly of Regulated Power supply circuit/Soldering of Full wave rectifier..

3. Electrical Shop:
   Introduction of Various Electric wirings, Wiring Systems, Electrical wiring material and fitting, different type of cables, Conduit pipe and its fitting, inspection points, switches of all types, Distribution boards, M.C.B's etc., Electric Shock and its management. Electric Tools: Conversance with various tools and to carry out the following: Measurement of wire sizes using SWG and micrometer
   Identification of Phase and neutral in single phase supply
   Jobs: To control a lamp with a single way switch.To control a lamp from two different places,To assemble a fluorescent lamp with its accessories
   To control a lamp, fan and a three pin socket in parallel connection with single way switches

4. Fitting Shop:
   Introduction of Fitting, different type of operations, Tools, materials, precision instruments like Vernier caliper and Micrometer etc, Safety precautions and Practical demonstration of tools and equipments
   Jobs:To make a square from MS Flat, Punching, Cutting, Filling techniques and practice, Tapping, Counter Drilling.

5. Smithy Shop:
   Introduction of Smithy and Forging process, Tools and Equipment, Operations, Heat Treatment processes, Advantages, Dis-advantages, Defects and Safety precautions.
   Jobs: Drawing and Upsetting Practice using Open Hearth Furnace, Cold working process practice, Heat Treatment \: Annealing and hardening process

6. Machine Shop:
   Application, Function and different parts, Operations of Lathe, Type of Cutting Tools and their materials, Drill machine Types, applications and Functions. Hacksaw machines and functions, Work Holding devices and tools, chucks, Vices, machine Vices, V Block, Measuring Instruments uses, Shaper and Milling machine Applications.
   Jobs: To perform Marking, Facing, Turning,taper Turing, Grooving, Knurling, parting, Drilling, Reaming operations on lathe machine,Hacksawing practice on Power hacksaw,Shaping operation practice on Shaper.

7. Carpentry Shop:
   Classification of Tree, Timber. Advantages and uses of Timber, Seasoning of Wood, Tools Used, Defects and Prevention of Wood,
   Jobs: Tee Joint, Cross Joint,Tenon Joint, L Shape Joint, Practice of Wood Working Lathe, Practice on multi-purpose Planer.

8. Foundry Shop:
   Introduction to Foundry, Advantages and Disadvantages of castings process, Introduction to pattern and various hand tools, Ingredients of Green sands, Various Hand Molding processes, Introduction to Casting Defects.
   Jobs: Identification and uses of hand tools, Preparation of Green sand in Muller, Preparation of Sand Mould of Single piece solid pattern, Split pattern, Preparation of Green sand Core, casting of a Mould and study its defects.

Textbooks

Title	Author	Publisher
Introduction to Basic Manufacturing Processes and Workshop Technology	Rajender Singh	New Age International Publication
Workshop Technology Part 1-3	Chapman	CBS Publishers
Workshop Practice Manual: Essential Exercises for Creativity	Jatinder Madan, Prince Pal Singh	Amazon Kindle

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	1	2	3	3	1	2	3	1	1	3	3	3
CO2	1	2	1	1	-	2	1	2	2	2	2	3	3	3
CO3	3	-	1	2	3	3	1	2	3	1	1	3	3	3
CO4	1	2	1	1	-	2	1	2	2	2	2	3	3	3
CO5	3	1	1	2	3	3	-	3	3	2	-	3	-	2
CO6	3	3	2	2	3	3	2	3	3	2	3	3	3	3

Course Code	**MEC101**
Course Title	**Engineering Mechanics**
Course Type	**Core**
Course LTP	3 0 0
Course Credits	3
Course Assessment ● **Continuous** ● **End of Semester**	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Physics, Calculus
Course Objectives	1. The objective of this course is to present the basic principles of statics and dynamics 2. Develop proficiency in applying these principles to formulate and solve statics and dynamics problems. 3. Develop sound understanding of the principles of mechanics as these are prerequisites to understanding courses such as - mechanics of deformable bodies, mechanics of fluids, and mechanics of machines.
Course Outcomes	1. Analyze Forces,moments,and equilibrium conditions in static structures. 2. Calculate Centroid,moment of inertia,and center of gravity of surfaces and solids. 3. Solve Problems Involving Trusses,frames,and beams. 4. Apply mechanical principles to simple machine and structure design.

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Equilibrium of a Particle : Vector Addition of Forces, Position Vectors, Dot Product, Conditions for Equilibrium of a Particle, Free Body Diagram, Coplanar Force Systems. (3)
2. Equilibrium of a RIgid Body : Moment of a Force, cross product, Principle of Moments, Moment of a Force about an axis, Moment of a Couple,
   Centre of Mass, Centre of Gravity, Centroid, Resultant of General Distributed Loading, Area Moment of Inertia, Mass Moment of Inertia.
   Conditions for Rigid Body Equilibrium, Free Body Diagrams, Equations of Equilibrium, Constraints and Statical Determinacy. (7)
3. Structural Analysis : Simple Trusses, Method of Joints, Zero-Force Members, Method of Sections, Frames and Machines, Internal Forces, Shear and Moment. (6)
4. Friction : Characteristics and Problems involving Dry Friction. (4)

Part B

5. Kinematics of a Particle : Rectilinear Motion, Curvilinear Motion, Relative Motion. (3)
6. Kinetics of a Particle : Force and Acceleration - Newton's Second Law of Motion, Equation of Motion, Equation of Motion for a System of Particles. || Work and Energy - Work of a Force, Principle of Work and Energy (and also for a System of Particles), Power and Efficiency, Conservative Forces and Potential Energy, Conservation of Energy. || Impulse and Momentum - Principle of Linear Impulse and Momentum (and also for a System of Particles), Conservation of Linear Momentum for a System of Particles, Impact, Angular Momentum, Principle of Angular Impulse and Momentum. (9)
7. Plane Kinematics of a RIgid Body : Planar RIgid Body Motion, Translation, Rotation about a fixed axis, Absolute Motion Analysis, Relative Motion Analysis. (3)
8. Planar Kinetics of a RIgid Body : Equations of Motion - Mass Moment of Inertia, Equations of Motion for Translation, Rotation, and General motion || Work and Energy - Kinetic Energy, Work of a Force, Work of a Couple, Principle of Work and Energy. || Impulse and Momentum - Linear and Angular Momentum, Principle of Impulse and Momentum, Conservation of Momentum.(5)

Textbooks

Title	Author	Publisher
Engineering Mechanics - Statics and Dynamics (14^{th} ed.)	Hibbeler	Pearson

References

Title	Author	Publisher
Vector Mechanics for Engineers - Statics and Dynamics (12^{th} ed.)	Beer	McGrawHill

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO1	3	2	2	2	1					1	1	1	2	2
CO2	3	3	2	2	2	1	1			1	1	1	2	2
CO3	3	3	3	3	2	1	1			1	1	1	2	2
CO4	2	2	2	2	1	1	1			1	1	1	2	2
CO5	2	3	3	2	1	1	1			1	1	2	2	2
CO6	2	2	3	1	2	1	1			1	1	1	2	2

Course Code	**MEC151**
Course Title	**Engineering Mechanics Practical**
Course Type	**Core**
Course LTP	0 0 3
Course Credits	1
Course Assessment ● **Continuous**	 50 (Practical Performance, Report Writing, and Viva Voce)
Course Prerequisites	Physics and Calculus
Course Objectives	1. To teach students the basic principles underlying the statics and dynamics of particles and rigid bodies. 2. To train students to identify, formulate and solve engineering problems in statics and rigid body dynamics. 3. To introduce students to the concepts of work-energy and impulse-momentum for rigid bodies and body systems.
Course Outcomes	1. Conduct Experiments On Beams,trusses,and frames. 2. Analyze experimental data and validate theoretical models. 3. Apply Concepts Of Equilibrium In Practical Scenarios. 4. Develop technical report writing skills based on experimental observations.

List of Experiments

1. Fundamentals of Statics - Accumulation and resolution of forces with force Parallelogram.
2. Equilibrium of forces.
3. Law of levers - Determination of moments and equilibrium of moments.
4. Inclined Plane and Friction - Determination of the friction coefficient.
5. To verify the law of Moments using Parallel Force apparatus (simply supported type) and bell crank lever.
6. To find CG and moment of Inertia of an irregular body using the Computation method.
7. Forces in a Simple Bar Structure – Measurement and Calculation of bar forces by the method of joints
8. To determine the mechanical advantage, Velocity ratio and efficiency of simple machines (screw jack,wheel and axle)
9. To find the time period of a simple and compound pendulum.
10. To determine the velocity ratio of a simple , compound and epicyclic gear trains
11. Determination of parameters of system of pulleys.

Textbooks

Title	Author	Publisher
Engineering Mechanics - Statics and Dynamics (14th ed.)	Hibbeler	Pearson
Vector Mechanics for Engineers - Statics and Dynamics (12th ed.)	Beer	McGrawHill

References

Title	Author	Publisher
https://www.gunt.de/en/		
https://www.tecquipment.com/		

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	2	2	2	1	1	1			1	1	2	2	1
CO2	3	2	2	2	2	1	1			1	1	2	2	2
CO3	3	3	3	2	2	1	1			1	1	2	2	2
CO4	2	2	2	2	1	1	1			1	1	2	1	1
CO5	3	2	2	2	2	1	1			1	1	2	2	2
CO6	3	3	3	3	2	3	1	3	2	2	2	3	3	3

Course Code	**EVS X01**
Course Title	**Environment Sciences**
Course Type	**Core**
Course LTP	3 0 0
Course Credits	**Non-Credit**
Total lectures	36
Course Assessment Methods: ● End Semester Assessment (University Exam.) ● Continuous Assessment (Sessional)	**Satisfactory/unsatisfactory**
Course Objectives	1. To recognize major concepts of environmental sciences and demonstrate an in-depth understanding of the environment. 2. Evaluate the scale of degradation of the environment and its allied problems, 3. Reflect on the role and responsibility of everyone in the interconnected world 4. Encourage social participation toward the conservation of the Environment
Course Outcomes	1. Understand Ecosystem Structures,functions,and services. 2. Analyze Environmental Pollution And Its Control Measures. 3. Apply Knowledge Of Environmental Laws And Policies. 4. Promote sustainable practices in personal and professional life.

SYLLABUS	
Note: The examination will be solely based on Internal assessment. The examiner will evaluate the student's performance by MCQs/Assignments/Presentations/projects etc. from time to time during the semester.	
SECTION-A	**Hours**
General Introduction, multidisciplinary nature and scope of environment studies, environmental degradation.	**(5)**
Ecology	**(7)**

Structure and function of ecosystem, types of ecosystem, Ecological balance, and principles of environmental impact assessment. Introduction to biodiversity, International concern over environmental problems	
Air pollution and control Atmospheric composition, Sources and types of air pollutants, primary and secondary pollutants. Air quality, effects of air pollution, greenhouse effect, ozone layer depletion, smog and photochemical smog, acid rain, theory and effects. Standards and control measures.	**(6)**
SECTION-B	
Water pollution and control Hydrosphere, Natural water, Different types of water pollutants, Origin of pollutants and their effects on river/lake/groundwater. Standards and control. Water pollution	**(4)**
Land & Noise Pollution Lithosphere, Components of soil, Various types of pollutants (municipal, industrial, agricultural, hazardous solid wastes): their origin and effects, Collection and disposal, Solid-waste Management. Noise pollution, classification of noise pollution, effects of noise pollution, and control measures.	**(7)**
Social Issues and the Environments Introduction and case studies, Environmental impact assessment, concept of sustainable development, rainwater harvesting, watershed management, wasteland reclamation, population and economic growth, environmental ethics, laws relating to the environment	**(7)**

Recommended Books			
S.No.	**NAME**	**AUTHORS**	**PUBLISHER**
1.	Introduction to Environmental Engineering and Science	C. M. Masters	Prentice Hall of India Pvt. Ltd., 1991
2.	Environmental Science	B. J. Nebel	Prentice Hall Inc., 1987
3.	Environmental Chemistry	A K De	6th edition, New Age International, New Delhi, 2006.

4	Environmental Science and Engineering	J.G. Henry and G.W. Heinke	2nd edition, PHI Publisher, 2011
5	Environmental Studies,	A. Bhaskar	Pearson Publisher, 201

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	1	1		1							1
CO2	2							1				1
CO3	2		2									1
CO4	2	1		1								1
CO5	2	2							1			1
CO6	2	1										1

2nd Semester

Course Code	**ASP X01**
Course Title	**Applied Physics**
Type of Course	**Core**
L T P	**4 0 0**
Credits	**4**
Course Assessment Methods End Semester Assessment (University Exam) Continuous Assessment (Minors, Assignments, Quiz)	 **50** **50**
Course Prerequisites	Physics and mathematics at 10+2 level
Course Outcomes (CO)	After the completion of this course the students will be able to 1. Understand the free, damped and forced oscillations theoretically as well as analytically. 2. Understand the development of Maxwell's equations, electromagnetic wave theory and propagation of EM waves in various media. 3. Understand the concept of polarization, methods of production of polarized light and applications of polarization. 4. Understand the working principle and applications of laser; optical fibers and their applications.

SYLLABUS

Note for the examiner: The semester question paper will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt two questions from each section.

Section A

Oscillations: Complete mathematical treatment for mechanical as well as electrical free, damped and forced oscillators.

Simple harmonic oscillator: Equation of motion, Physical characteristics of SHM. Superposition of two SHMs executing in the same and perpendicular direction of same frequency and different frequencies, Lissajous figures.

Damped Oscillations: Differential equation of a damped oscillator and different kinds of damping, Methods of describing damping of an oscillator - logarithmic decrement, relaxation time, quality factor.

Forced Oscillations: Differential equation of forced oscillator, dependence of oscillation parameters on driving frequency, power, bandwidth, Quality factor and amplification of forced oscillator, resonance in forced oscillators, vibration insulator

[CO1]

Electromagnetic Waves: Introduction to vector calculus, Maxwell equations (derivations and physical significance). Electromagnetic waves in vacuum and conducting medium, Poynting vector and Poynting theorem, Reflection and transmission of electromagnetic waves for normal incidence. **[CO2]**

Section B

Polarization: Methods of polarization, double refraction, quarter and half wave plates, analysis of polarized light, Fresnel theory for optical activity, polarimeter (biquartz and laurent's half-shade devices), babinet compensator, Kerr effect, applications of polarization in testing of materials, LCDs, 3D movies
[CO3]

Lasers and Optical Fibers: Elementary idea of LASER production, spontaneous emission, stimulated emission, Einstein's coefficients, Helium-Neon, Ruby and semiconductor lasers, Applications of lasers in optical communication and storage, defence, geophysical sciences.

Basics of optical fiber: Numerical aperture, coherent and incoherent bundle, step index and graded index fiber, material dispersion, applications of fibers in sensors and communication.
[**CO4]**

Reference Books:
1. Physics of Vibrations and Waves (5th Edition, John Wiley & Sons) – H.J.Pain
2. Optics – Ajoy Ghatak
3. Fundamentals of Optics by F. Jenkins and H.E. White
4. Introduction to Electrodynamics, David J. Griffiths

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO 1	3	2	1	1			1	1	2	1		2
CO 2	3	2	1	1			1	1	2	1		2
CO 3	3	3	1	1			1	1	2	1		2
CO 4	3	2	2	1			1	1	2	1		2

Course Code	**ASP X51**
Course Title	**Applied Physics (P)**
Type of Course	**Core**
L T P	**0 0 3**
Credits	**1**
Course Assessment Methods (Continuous and end semester evaluation)	**50**
Course Prerequisites	Physics and mathematics at 10+2 level
Course Outcomes (CO)	After the completion of this course the students will be able to 1. Work with measuring instruments like vernier calipers, screw gauge, spectrometer, spherometer and cathode ray oscilloscope etc.. 2. Perform data analysis and interpretations such as significant figures, error calculations, graphical representation of the data, calculation of slope and intercept using least square fitting method. 3. Understand the concepts of oscillatory motion using experimental demonstrations. 4. Understand the concepts of optical phenomena by performing related experiments.

List of Experiments: Students need to perform a minimum of six experiments selecting at least three experiments each from **Group A** and **Group B**

Group A: Oscillations and Waves

1. To determine the velocity of ultrasonic waves in different liquids using ultrasonic interferometer. **[CO1, CO2, CO3]**
2. To study the frequency response and to find resonant frequencies of LCR series and parallel circuits. Also to find the quality factor and bandwidth in LCR. **[CO1, CO2, CO3]**
3. To determine the value of acceleration due to gravity and radius of gyration using bar pendulum. **[CO1, CO2, CO3]**
4. Study of transverse and longitudinal standing waves and the measurement of the frequency of the electrically maintained Tuning fork. **[CO1, CO2, CO3]**
5. To study damping effects in the spring mass system. **[CO1, CO2, CO3]**
6. To study Lissajous figures obtained by superposition of oscillations with different frequencies and phases. **[CO1, CO2, CO3]**

Group B: Optics

7. To find the wavelength of sodium light using Fresnel's biprism. **[CO1, CO2, CO4]**
8. (i) To determine the wavelength of He-Ne laser using transmission grating. **[CO1, CO2, CO4]**
   (ii) To determine the slit width using the diffraction pattern.
9. To determine the wavelength of sodium light by Newton's rings method. **[CO1, CO2, CO4]**
10. To determine the wavelength of sodium light using a diffraction grating. **[CO1, CO2, CO4]**
11. To find the specific rotation of sugar solution using a Laurant's Half shade/ Bi-quartz Polarimeter. **[CO1, CO2, CO4]**
12. To find the refractive index of a prism using spectrometer. **[CO1, CO2, CO4]**
13. To determine the wavelength of a laser using Michelson interferometer. **[CO1, CO2, CO4]**

Reference Books: (To understand the concepts of experiments and related theories)

1. B. Sc. Practical Physics by C. L. Arora
2. Physics of Vibrations and Waves (5th Edition, John Wiley & Sons) – H.J.Pain
3. Optics – Ajoy Ghatak
4. Fundamentals of Optics by F. Jenkins and H.E. White

CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO 11**	**PO12**
CO1	3	2	1	1			1	1	2	1		2
CO2	3	2	1	1			1	1	2	1		2
CO3	3	3	1	1			1	1	2	1		2
CO4	3	2	1	1			1	1	2	1		2

Course Code	**ASP X02**
Course Title	**Quantum Physics**
Type of Course	**Core**
L T P	**4 0 0**
Credits	**4**
Course Assessment Methods End Semester Assessment (University Exam) Continuous Assessment (Minors, Assignments, Quiz)	 **50** **50**
Course Prerequisites	Physics and mathematics at 10+2 level
Course Outcomes (CO)	After the completion of this course the students will be able to 1. Understand the basics of the special theory of relativity and its applications. Students will be familiarized with various relativistic effects like Lorentz transformations, simultaneity, length contraction, time dilation, Doppler effect, addition of velocities, variation of mass with velocity and mass-energy relation. 2. Understand historical development of quantum mechanics; concepts of duality and uncertainty principle; wave function and its interpretation; Schrodinger equation. 3. Apply Schrödinger equation to various modular systems and solve for simple potentials such as potential step, potential well, potential barrier; linear harmonic oscillator (one-dimensional) and 3-D rigid box. 4. Apply quantum mechanical concepts to understand the origin of some of the properties exhibited by solids like energy bands in solids and specific heat of solids.

SYLLABUS

Note for the examiner: The semester question paper will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt two questions from each section.

Section A

Unit I: Special Theory of Relativity

Inertial and non-inertial frames of reference, Galilean transformation, Michelson Morley Experiment, Postulates of special theory of relativity, Lorentz transformation, Simultaneity, Length contraction, Time dilation, Doppler effect, Addition of velocities, variation of mass with velocity, mass-energy relation, Relativistic momentum

(Section 1.1 to 1.5, 1.7 to 1.9 of Book 1)
[**CO1]**

Unit II: Origin and Postulates of Quantum Mechanics

Quantum theory of light, Blackbody Radiation, Photoelectric effect and X-ray emission, Compton effect, pair production, de-Broglie hypothesis, particle diffraction, uncertainty principle and its applications

Postulates of quantum mechanics, wave function, Born interpretation (qualitative) and normalization, Schrodinger theory, Time-dependent and Time-independent Schrodinger equation, Operators, expectation values, Ehrenfest theorem

(Sections 2.1-2.10, 3.1-3.5, 3.7-3.10, 5.1-5.7 of Book 1)
[**CO2]**

Section B

Unit III: Applications of Quantum Mechanics

Particle in a box (Rigid, non-rigid and 3-D), Potential step, Potential Barrier, Tunneling, Linear harmonic oscillator (one-dimensional)

(Sections 5.8 – 5.11 of Book 1)
[**CO3]**

Unit IV: Application of Quantum Mechanics to Crystalline Solids

Free Electron theory of Metals (Classical and Sommerfeld), Bloch's theorem for particles in a periodic potential, Kronig-Penney Model and origin of energy bands (semi-qualitative), Specific heat of solids

(Sections 6.35-6.38, 6.40, 6.41, 7.1-7.5 of book 4 and Section 1 of Chapter 10 of Book 3)
[**CO4]**

References:

1. Concepts of Modern Physics, by Arthur Beiser (McGraw-Hill)
2. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles by Eisberg and Resnick
3. Introduction to Solids by Leonid V. Azaroff
4. Elementary Solid state Physics by M.Ali Omar (Pearson Education)
5. Solid State Physics, by C. Kittel (Wiley Eastern)
6. Solid State Physics, by S.O. Pillai (New Age International)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO 1	3	2	1	1			1	1	2	1		2
CO 2	3	2	1	1			1	1	2	1		2
CO 3	3	3	1	1			1	1	2	1		2
CO 4	3	2	2	1			1	1	2	1		2

Course Code	**ASP X52**
Course Title	**Quantum Physics(P)**
Type of Course	**Core**
L T P	**0 0 3**
Credits	**1**
Course Assessment Methods (Continuous and end semester evaluation)	**50**
Course Prerequisites	Physics and mathematics at 10+2 level
Course Outcomes (CO)	After the completion of this course the students will be able to 1. Understand the construction and working of Measuring devices like vernier calipers, screw gauge, spherometer etc.. and use electrical instruments like ammeter, voltmeter, galvanometer, gaussmeter etc. 2. Perform experiments using specialized tools andtechniques to probe the phenomena of quantum mechanics like uncertainty priniciple, quantization of energy etc. and to verify the laws of probability and quantum statistics. 3. Experimentally determine quantum parameters like energy band gap, excitation energy, hydrogen spectrum wavelengths in visible region, Planck's constant etc. 4. Carry out the error analysis of their results and provide their theoretical interpretation.

List of Experiments

1. To study the quantized energy level of the first excited state in the Argon using the Frank-Hertz setup. **[CO2, CO3, CO4]**
2. To find the value of Planck's constant and evaluate the work function of cathode material by used of photoelectric cell. **[CO1, CO2, CO3, CO4]**
3. To study various characteristics of photo-voltaic cell: (a) Voltage-current characteristics, (b) loading characteristics, (c) power-resistance characteristics and (d) inverse square law behavior of the photo-current with distance of source of light from photo-voltaic cell **[CO1, CO2, CO4]**
4. To study the response of a photo-resistor to varying intensity of light falling on it and deduce spectral sensitivity of its semiconductor material. **[CO1, CO3, CO4]**
5. To study the Balmer Series of Hydrogen spectrum using diffraction grating and calculate Rydberg constant. **[CO1, CO3, CO4]**
6. To evaluate charge on an oil drop using Millikan's oil drop method. **[CO1, CO2, CO4]**
7. To verify Rutherford's alpha scattering formula using a mechanical model. **[CO1, CO2, CO4]**
8. To calculate charge to mass ratio of an electron using Thomsonś method. **[CO1, CO2, CO4**]
9. To determine Hall coefficient of a given semiconductor material and evaluate charge carrier type, density and mobility of charge carriers. **[CO1, CO3, CO4]**

10. To study temperature dependence of resistivity of a semiconductor using four probe method and determine the energy band gap of a given semiconductor. **[CO1, CO3, CO4]**
11. To determine the velocity of ultrasonic waves in different liquids using ultrasonic interferometer. **[CO1, CO2, CO4]**
12. To study probability theory using coins. **[CO1, CO2, CO4]**
13. To study probability and statistics using two dice. **[CO1, CO2, CO4**]

CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**
CO1	3	2	1	1			1	1	2	1		2
CO2	3	2	1	1			1	1	2	1		2
CO3	3	3	1	1			1	1	2	1		2
CO4	3	2	1	1			1	1	2	1		2

Course Code	**ASP X03**
Course Title	**Physics of Materials**
Type of Course	**Core**
L T P	**4 0 0**
Credits	**4**
Course Assessment Methods End Semester Assessment (University Exam) Continuous Assessment (Minors, Assignments, Quiz)	 **50** **50**
Course Prerequisites	Physics and mathematics at 10+2 level
Course Outcomes (CO)	After the completion of this course the students will be able to 1. Qualitatively describe the bonding in materials and its effect on material properties and classify the materials into metals, ceramics and polymers based on their structure. 2. Identify various imperfections in the crystal structure and to correlate these to material properties. Identify diffusion processes and their applications. 3. Understand the elastic, anelastic, viscoelastic and plastic properties of materials and relate these to material structure. 4. Understand the electrical, magnetic and optical properties of materials and discuss the applications of these.

SYLLABUS

Note for the examiner: *The semester question paper will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt two questions from each section.*

SECTION - A

Crystal structure: Bonding forces and energies, Primary and Secondary bonds, Space Lattices, Symmetries in a cubic lattice, Crystal Structures (cubic and hexagonal cells), Assignment of coordinates, directions and planes in crystals, Linear, Planar and Space densities in crystals, close packed morphology (Hexagonal and cubic close packing), single and polycrystalline structures, interstitial spaces (trigonal, tetrahedral and octahedral voids)

Structure of ceramics (NaCl, Zinc blende, silica and silicates, diamond crystal, Graphite, Fullerenes and carbon nanotubes), Determination of Crystal Structures using X-ray diffraction, Imperfections in metals and ceramics (Point, line, surface and volume imperfections)

Diffusion: Diffusion mechanisms, steady state diffusion, non-steady state diffusion, factors affecting diffusion, applications based on diffusion (corrosion resistance of Duralumin, carburization of steel, decarburization of steel, doping of semiconductors)

SECTION - B

Elastic and Plastic properties: Elastic behaviour and its atomic model, rubber like elasticity, anelastic behaviour, relaxation processes, viscoelastic behaviour, tensile properties (Yield strength, Tensile Strength, Ductility, Resilience, Toughness), dislocations and plastic deformation, characteristics of dislocations, slip systems, mechanisms of strengthening in metals (grain size reduction, solid-solution strengthening, strain hardening).

Electrical properties: Electrical Conductivity in metals and semiconductors, Temperature Dependence of resistivity, Energy Band Structures in Solids (Qualitative), Hall effect, Capacitance, field vectors and polarization, types of polarization, frequency dependence of dielectric constant, dielectric strength, dielectric materials, ferroelectricity and piezoelectricity

Magnetic properties: Basic terminology related to magnetism, diamagnetism, paramagnetism, ferromagnetism, anti-ferromagnetism and ferrimagnetism, Influence of Temperature on Magnetic Behavior, Domains and Hysteresis, Magnetic Anisotropy, Soft and hard Magnetic Materials, Magnetic Storage

Optical Properties: Interaction of radiation with matter (metals and non-metals), Refraction, reflection, absorption, transmission, color, opacity and translucency in insulators, luminescence, photoconductivity, Lasers, Optical Fibers in Communications

RECOMMENDED BOOKS			
S.No.	**NAME**	**AUTHORS**	**PUBLISHER**
1.	Material science and engineering – An Introduction	William D Callister	6^{Th} edition, John Willey and Sons.
2.	Material Science and Engineering – A First Course	V. Raghvan	4^{th} edition, Eastern economy edition
3.	Solid State Physics	S. O. Pillai	New Age International
4.	Introduction to Solids	Leonid V Azaroff	Tata McGraw Hill, 3^{rd} edition.

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	1	1	1				1			1
CO2	3	2	1	1	2				1			2
CO3	3	2	2	1	2							2
CO4	3	2	1	2	1	2	1					2

Course Code	**ASP X53**
Course Title	**Physics of Materials (P)**
Type of Course	**Core**
L T P	**0 0 3**
Credits	**1**
Course Assessment Methods (Continuous and end semester evaluation)	**50**
Course Prerequisites	Physics and mathematics at 10+2 level
Course Outcomes (CO)	After the completion of this course the students will be able to 1. Understand the construction and working of measuring devices like vernier Calipers, screw gauge, spherometer etc. and electrical devices like ammeter, voltmeter, galvanometer, gaussmeter etc. (analog and digital) 2. Identify and differentiate the materials based on their electrical, magnetic, thermal and optical properties. 3. Experimentally determine parameters like Elastic constant, thermal conductivity, electrical resistivity, Hall coefficient, Curie temperature, retentivity and coercivity etc. of various materials. 4. Carry out the error analysis of their results., provide a theoretical explanations of their results and make a complete and cogent report of their findings.

List of Experiments

1. To study the quantized energy of the first excited state in Argon using the Frank-Hertz Set-up. **[CO1, CO2, CO3, CO4]**

2. To find the value of Planck's constant and evaluate the work function of cathode material by use of photoelectric cell.**[CO1, CO2, CO3, CO4]**

3. To study various characteristics of photovoltaic cell: (a) Voltage-current characteristics (b) loading characteristics (c) power-resistance characteristics and (d) inverse squarelaw behavior of photocurrent with distance of source of light from photovoltaic cell.**[CO1, CO2, CO3, CO4]**

4. To study the response of a photoresistor to varying intensity of light falling on it and deduce spectral sensitivity of its semiconductor material.**[CO1, CO2, CO3, CO4]**

5. To determine Hall coefficient of a semiconductor material and then evaluate the type, density and mobility of charge carrier in a given semiconductor material.**[CO1, CO2, CO3, CO4]**

6. To study the hysteresis loop of magnetic material (iron, nickel and steel) and determine its retentivity, coercivity and energy dissipated per unit volume per cycle of hysteresis.**[CO1, CO2, CO3, CO4]**

7. To study temperature dependence of resistivity of a semiconductor material using four probe method and further deduce the band gap of this semiconductor.**[CO1, CO2, CO3, CO4]**

8. To determine the Curie temperature of a ferroelectric material by measuring dielectric constant as a function of temperature.**[CO1, CO2, CO3, CO4]**

9. To determine thermal conductivity of bad conductor by using guarded plate method (Lee's disc method).**[CO1, CO2, CO3, CO4]**

10. To study the diamagnetic, paramagnetic and ferromagnetic behaviour of magnetic materials.**[CO1, CO2, CO3, CO4]**

CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO1	3	2	1	1			1	1	2	1		2
CO2	3	2	1	1			1	1	2	1		2
CO3	3	3	1	1			1	1	2	1		2
CO4	3	2	1	1			1	1	2	1		2

Course Code	**ASM 201**
Course Title	Differential Equations and Transforms
Type of Course	**Core**
L T P	**4 1 0**
Credits	**5**
Course Assessment Methods End Semester Assessment(University Exam) Continuous Assessment (Minors, Assignments, Quiz)	 50 50
Course Prerequisites	Mathematics at 10+2 level
Course Objectives	1. To understand ordinary differential equations and solution techniques. 2. To understand the concept of Laplace transform and its properties. 3. To understand the concept of Fourier series and its properties. 4. To understand the concept of partial differential equations and its solution techniques.
Course Outcome	1. The student will learn to solve Ordinary Differential equations and their applications to engineering problems. 2. The students will be able to apply the tools of Laplace Transforms to model engineering problems and solve the resulting differential equations. 3. Students will understand the nature and behaviour of trigonometric (Fourier) series and apply it to solve boundary value problems. 4. Students will be able to understand the formulation of partial differential equations and its solution techniques.

SYLLABUS

Note for the examiner: The semester question paper will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt two questions from each section.

SECTION – A

ORDINARY DIFFERENTIAL EQUATIONS
Review of geometrical meaning of the differential equation, directional fields, exact differential equations(scope as in chapter 8, sections 8.1 – 8.10 of reference 5), solution of differential equations with constant coefficients; methods of differential operators (scope as in chapter 9, sections 9.1 – 9.5 of reference 5).

Non-homogeneous equations of second order with constant coefficients: Solution by method of variation of parameters, reduction by order (scope as in chapter 9, section 9.7, 9.10 of reference 5). Power series method of solution (scope as in chapter 10, section 10.2 of reference 5)

Laplace Transforms
Laplace transform, Inverse transforms, shifting, transform of derivatives and integrals. Unit step function, second shifting theorem, Dirac's Delta function. Differentiation and integration of transforms. Convolution Theorem on Laplace Transforms. Application of Laplace transforms to solve ordinary differential equations with initial conditions (Scope as in Chapter 6, Sections 6.1 – 6.6 of Reference 2).

SECTION – B

Fourier Series and Transforms: Periodic functions, Fourier series, Even and odd series, half range expansions, Complex Fourier Series, Approximation by trigonometric polynomials. Fourier integrals, Fourier Cosine and Sine transforms, Fourier Transforms (Scope as in Chapter 11, Sections 11.1 – 11.2, 11.4-11.5, 11.7 – 11.9 of Reference 2).

Partial Differential Equations: Partial differential equations of first order, origin, solution of linear partial differential equations of first order, Integral surfaces passing through a given curve (Scope as in Chapter 2, Sections 1, 2, 4, 5 of Reference 1).

Boundary Value Problems: D'Alembert's solution of wave equation, separation of variables: one dimension heat and wave equation (Scope as in Chapter 12, Sections 12.1, 12.3 – 12.4, 12.6, 12.9 of Reference 2).

RECOMMENDED BOOKS			
S.No.	**NAME**	**AUTHORS**	**PUBLISHER**
1.	Elements of Partial Differential Equations	Ian N. Sneedon	McGraw Hill,Singapore 1957.
2.	Advanced Engineering Mathematics	E. Kreyszig.	10th edition , John Wiley.
3.	Advanced Engineering Mathematics	Michael D. Greenberg	2nd edition, Pearson Education.
4.	Advanced Engineering Mathematics	Wylie and Barrett	Tata McGraw Hill
5.	Higher Engineering Mathematics	B.V.Ramana	Tata McGraw Hill.
6.	Advanced Engineering Mathematics	R. K. Jain, S. R. K. Iyenger	Narosa Publications
7.	Theory and problems of Differential Equations	Frank Ayers	Shuam outline series, McGraw-Hill, Singapore, 1957

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	3								1
CO2	2	3	2	2								1
CO3	2	2	3	2								1
CO4	2	2	3	2								1

Course Title	**Basic Electrical and Electronics Engineering**
Course Code	**EEC X01**
Type of Course	Core
L T P	3 0 0
Credits	3
Course Assessment Methods End Semester Assessment (University Exam.) Continuous Assessment (Sessional, Assignments, Quiz)	 50 50
Course Objectives	1. To understand basic theorems and concept of DC/AC supply in electrical circuits. 2. To understand the basics of transformers. 3. To understand the basic concepts of semiconductor diodes. 4. To understand the basic concepts of Bipolar Junction Transistors.
Course Outcome (s)	1. Apply fundamental laws of electrical circuits such as Ohm's Law, Kirchhoff's Laws, and analyze DC circuits using mesh and nodal methods along with network theorems (Thevenin's, Norton's, Superposition, Maximum Power Transfer). 2. Analyze single-phase and three-phase AC circuits, calculate average and RMS values, and determine power and power factor using appropriate methods including the two-wattmeter method 3. Understand the construction, working principle, testing methods, and performance characteristics of single-phase transformers. 4. Explain the working principles and characteristics of semiconductor diodes and bipolar junction transistors (BJTs), and apply them in basic electronic circuits such as rectifiers, clippers, clampers, and logic gates.

Note for Examiner- Examiner will set 7 questions of equal marks. First question will cover whole syllabus, having 10 conceptual questions of 1 mark each or 5 questions of 2 mark each and is compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

PART-A

DC circuits: Voltage and current sources, KCL, KVL, Network analysis by mesh and node analysis, Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum-power transfer theorem (numerical based on these theorem).

(7 hours)

AC Fundamentals: Average and RMS values of alternating quantities, solution and phasor diagram of single phase ac circuits with sinusoidal source excitation, voltages and currents in star and delta connected systems, power in a three phase system, solution of three phase balanced circuits, power and power factor measurement by two watt-meters method.

(8 hours)

Transformers: Introduction, Basic Principle, EMF equation, losses, efficiency and condition for maximum efficiency, voltage regulation, open circuit and short circuit tests.

(7 hours)

PART-B

Semiconductor Diodes: Ideal Diode, Semiconductor materials, Energy Levels, Extrinsic materials: n and p type, Semiconductor diode: working principle, silicon semiconductor diode characteristics, Zener region and Zener diode, Si vs Ge diode characteristics, effect of temperature on the characteristics, Light Emitting Diode (working principle).

(8 hours)

Diode Applications: Load Line Analysis, Series Diode Configurations with DC inputs, Parallel and Series-Parallel configurations, AND/OR gates, Sinusoidal inputs: Half wave and full wave rectifications, Clipper and clampers.

(7 hours)

Bipolar Junction Transistors: Transistor construction and operation, Common-Base configuration: working principle, characteristics and applications, Common-Emitter configuration: working principle, characteristics and applications, Common-Collector configuration: working principle, characteristics and applications

(8 hours)

Recommended Books:			
S. No.	Name	Author	Publisher
1	Basic Electrical Engineering	T.K. Nagsarkar and M.S. Sakhija	Oxford University Press, 2004
2	Electric and Electronics Technology	Edward Hughes	Pearson education Publication Asia, 2003.
3	Electronics Devices and Circuit Theory	ROBERT BOYLESTAD LOUIS NASHELSKY	PRENTICE HALL Upper Saddle River, New Jersey Columbus, Ohio

CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
1	3	3	1	1	1	0	0	0	1	2	2	0	3	1	1
2	3	3	1	1	1	0	0	0	1	2	2	0	3	1	1
3	3	3	1	1	1	0	0	0	1	2	2	0	3	1	1
4	3	3	1	1	1	0	0	0	1	2	2	0	3	1	1

Course Title	**Basic Electrical and Electronics Engineering (P)**
Course Code	**EEC X51**
Type of Course	Core
L T P	0 0 2
Credits	1
Course Assessment Methods Practical (Continuous and end semester evaluation)	50
Course Objectives	1. To understand basic theorems and concept of DC/AC supply in electrical circuits. 2. To understand the basics of transformers. 3. To understand the basic concepts of semiconductor diodes. 4. To understand the basic concepts of Bipolar Junction Transistors.
Course Outcomes	1. Apply basic electrical theorems and analyze AC/DC circuits using phasor diagrams and network theorems such as Superposition, Thevenin's, Norton's, and Maximum Power Transfer. 2. Demonstrate the behavior of RLC circuits and three-phase systems, and analyze relationships between line and phase quantities in star and delta configurations. 3. Conduct and interpret open circuit and short circuit tests on transformers to model their equivalent circuits. 4. Analyze the V-I characteristics and operational behavior of semiconductor devices including diodes, Zener diodes, and bipolar junction transistors in various configurations (CB, CE, CC).

Note: Any eight experiments are to be done.

1. Measure resistance and inductive reactance of a choke coil, make a series RLC circuit using the choke coil and obtain its phasor diagram.
2. To prove Superposition and Maximum Power Transfer theorem.
3. To prove Thevenin's and Norton's theorem.
4. To find out the relationship between line current & phase current, between line voltage & phase voltage for star and delta connected loads supplied from balanced three phase supply.
5. Perform Open circuit and short circuit tests on a single phase transformer and to draw its equivalent circuit.
6. To study the V-I characteristics of a semiconductor diode.
7. To study the characteristics of a Zener diode.
8. To study the characteristics of Common-Base configuration of a BJT.
9. To study the characteristics of Common-Emitter configuration of a BJT.
10. To study the characteristics of Common-Collector configuration of a BJT.

CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	P O 10	PO 11	PO 12	PSO 1	PSO2	PSO3
1	2	1	3	1	1	1	1	1	3	2	1	2	3	0	1
2	2	1	3	1	1	1	1	1	3	2	1	2	3	0	1
3	2	1	3	1	1	1	1	1	3	2	1	2	3	0	1
4	2	1	3	1	1	1	1	1	3	2	1	2	3	0	1

Course Code	**ESC X04**
Course Title	**Engineering Graphics**
Course Assessment Methods End Semester Assessment(University Exam) Continuous Assessment (Minors, Assignments, Quiz)	 50 50
Course Objectives (CO)	1. To learn computer-aided-drafting skills using computer software. 2. To communicate ideas using engineering drawings. 3. To be able to interpret and express using standard symbols and conventions of engineering drawing.
Course Outcomes	1. Prepare orthographic projections and interpret engineering drawings. 2. Develop pictorial and isometric projections of objects. 3. Create CAD drawings and 3D models using software tools. 4. Apply drawing standards to engineering design documentation.

SYLLABUS

Note for the examiner: The semester question paper will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt two questions from each section.

Section A

1. Introduction: Demonstrating knowledge of the theory of CAD software, Tabs and Panels, The Command Line Box, Command Tools, Starting a New Drawing , Naming a Drawing , Drawing Units, Drawing Limits, Grid and Snap, Save and Save As, Open, Close, Terminology and Conventions, Linear Dimension, Dimension Styles, Units, Aligned Dimensions, Radius and Diameter Dimensions, Angular Dimensions, Ordinate Dimensions, Baseline Dimensions, Continue Dimension, Quick Dimension, Center Mark, MLEADER and QLEADER, Text, Dimensioning Holes, Placing Dimensions, Fillets and Rounds, Polar Dimensions, Chamfers, Symbols and Abbreviations.

2. Fundamentals of 2D Construction and Advanced Commands: Line-Random Points, Erase, Line-Snap Point, Line-Dynamic Inputs, Construction Line, Circle, Circle Centerlines, Polyline, Spline, Ellipse, Rectangle, Polygon, Point, Text, Move, Copy, Offset, Mirror, Array, Rotate, Trim, Extend, Break, Chamfer, Fillet, Table, OSNAP, Layer command.

3. **Orthographic Projections**: Principles of Orthographic Projections-Conventions - Projections of Points, Projection of line- Parallel to both H.P. and V.P., Parallel to one and inclined to other, and inclined to both, contained in profile plane. True length and angle determination of straight line: Rotation method and Auxiliary plane method, Traces of a line, Difference between plane and lamina, Projection of lamina- Parallel to one and perpendicular to other, Perpendicular to one and inclined to other, Inclined to both reference planes.

4. **Projection of Regular Solids:** Definition of Solids, Types of solids, and elements of solids, Projection of solids in first quadrant- with axis parallel to one and perpendicular to other, axis parallel to one inclined to other and axis inclined to both the principle planes.

Section B

5. **Section of Solids:** Theory of Sectioning, Cutting Plane Lines, Section Lines, Hatch, Styles of Section Lines, Sectioning of Prism, Pyramid, Cone and Cylinder (Simple Cases).

6. Development of Surfaces: Purpose of development, Methods of development of prism, cylinder, cone and pyramid surfaces (for right angled solids only).

7. Isometric Projection: Classification of pictorial views, Basic Principle of Isometric projection, Difference between isometric projection and isometric drawing. Isometric projection of solids such as cube, prism, pyramid and cylinder.

Suggested Books			
Title	**Author**	**Publisher**	**Edition**
Engineering Graphics with AutoCAD	James Bethune	Pearson	2016
Fundamentals of Engg. Drawing	Warren J. Luzadder	Literary Licensing, LLC	2015
Engineering Drawing and Design	Cecil Jensen	Mc-Graw Hill	2012
Manual of Engineering Drawing	T.E. French	WENTWORTH Press	2016

CO	**PO 1**	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	3	-	1	1	1		2	3	2	1	3	2
CO2	3	2	3	1	1	1	1	-	2	3	1	1	3	1
CO3	3	2	3	1	3	1	1	-	2	3	1	1	2	3
CO4	3	1	3	1	3	1	1	-	2	3	1	1	3	1
CO5	2	1	3	-	3	-	-	-	1	3	-	1	2	1
CO6	2	1	3	-	3	-	-	-	1	3	-	1	2	1

Course Code	**ESC X54**
Course Title	**Engineering Graphics (P)**
Course Assessment Methods Practical (Continuous and end semester evaluation)	 **50**
Course Objectives	1. To learn computer-aided-drafting skills using computer software. 2. To be able to apply computer aided drafting tools to create 2D engineering drawings
Course Outcomes	1. Prepare orthographic projections and interpret engineering drawings. 2. Develop pictorial and isometric projections of objects. 3. Create CAD drawings and 3D models using software tools. 4. Apply drawing standards to engineering design documentation.

The candidates will be required to make AutoCAD drawing sheets covering the following as per B.I.S. SP46-2003 for general engineering drawing:

1. To draw two dimensional drawings in AutoCAD by using draw, modify, dimension, layers and object-snap toolbars.
2. To draw orthographic views of points.
3. To draw orthographic views of lines and to find traces of the lines.
4. To find true length of lines using rotation as well as trapezoidal method.
5. To draw orthographic views of laminas in different positions.
6. To draw orthographic views of polyhedral solids in different positions.
7. To draw orthographic views of solids of revolution in different positions.
8. To draw sectional views of solids, true sections and apparent sections.
9. To draw isometric views of laminas and solids.
10. To draw development of polyhedral solids.
11. To draw development of solids of revolution.
12. To draw basic solid models using AutoCAD by using solids and solid editing toolbars and related commands.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	-	1	1	1		2	3	2	1	3	2
CO2	3	2	3	1	1	1	1	-	2	3	1	1	3	1
CO3	3	2	3	1	3	1	1	-	2	3	1	1	2	3
CO4	3	1	3	1	3	1	1	-	2	3	1	1	3	1
CO5	2	1	3	-	3	-	-	-	1	3	-	1	2	1
CO6	2	1	3	-	3	-	-	-	1	3	-	1	2	1

Course Code	**ESC X01**
Course Title	Programming Fundamentals
Type of Course	Core
L T P	3 0 0
Credits	3
Course Assessment Methods End Semester Assessment (University Exam.) Continuous Assessment (Sessional, Assignments, Quiz)	 50 50
Course Prerequisites	None
Course Outcomes (CO)	1. Design algorithms and flowcharts for problem solving. 2. Write, debug, and execute structured programs in C. 3. Apply decision making and loop control structures effectively. 4. Implement modular programming using functions and arrays.

SYLLABUS

Note for Examiner- Examiner will set 7 questions of equal marks. First question will cover whole syllabus, having 10 conceptual questions of 1 mark each or 5 questions of 2 mark each and is compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

SECTION-A

Unit–1: Introduction to Programming **[06]**

Introduction to components of a computer system: Memory, processor, I/O devices, storage, operating system, concept of assembler, compiler, interpreter, loader and linker.

Concept of algorithm: Representation of an algorithm, flowchart, Pseudocode with examples, converting algorithms to programs.

Programming Basics: Structure of C program, writing and executing the first C program, Syntax and logical errors in compilation, object and executable code. Components of C language, standard I/O in C, data types, variables and constants, memory storage, storage classes.

Unit –2: Expressions and Statements **[10]**

Expressions and their evaluation: Operands and Operators, formation of expressions using arithmetic, relational, logical and bitwise operators, precedence and associativity rules , mixed operands, type conversion and evaluation of expressions.

Statements: Simple and compound statements, Conditional Branching: if and switch statements, nested if-else, dangling else problem, use of break and default with switch. Iteration and loops: use of while, do while and for loops, nested loops, use of break and continue statements.

Unit– 3: Arrays & Basic Algorithms **[07]**

Arrays: Array notation and representation, manipulating array elements, using multi-dimensional arrays, character arrays and strings.

Basic Algorithms: Searching and Sorting Algorithms (Bubble, Insertion and Selection), finding roots of equations, notion of order of complexity through example programs.

SECTION-B

Unit–4: Functions **[09]**

Introduction, advantages of modularizing a program into functions, types of functions, passing parameters to functions: call by value, call by reference, passing arrays to functions, recursion with example programs.

Unit – 5: Structures , Union, Enums and Bit-fields **[06]**
Defining, declaring and usage of structures, unions and their arrays, passing structures and unions to functions, introduction to enums and bit-fields.

Unit – 6: Pointers and File handling **[07]**
Pointers: Introduction, declaration, applications, dynamic memory allocation (malloc, calloc, realloc, free), use of pointers in self-referential structures.
File handling: File I/O functions, standard C pre-processors, defining and calling macros, command-line arguments.

TEXT BOOKS			
S. No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1.	Schaum's Outline of Programming with C	Byron Gottfried	McGraw-Hill
2	Programming in C: A practical approach	Dr. Ajay Mittal	Pearson Education, 2010
3	The C programming	Kernighan Brain W. and Ritchie Dennis M	Pearson Education
4	Computer Basics and C Programming	V. Rajaraman	PHI Learning, 2015
5	Computer Concepts and Programming in C	E Balaguruswamy	McGraw Hill
6	Computer Science- A Structured Programming Approach Using C	Behrouz A.Forouzan, Richard F. Gilberg, Thomson, Third Edition	Cengage Learning - 2007

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1	1	1	1	1		1			1	1	-
CO2	2	2	1	1	1			1	1				1	-
CO3	2	1	2	1								2		
CO4	3	3	1	1				2				1	1	1
CO5	3	2	2	1					1				1	1
CO6	2	3	1	1	1			1	1			2	1	1

Course Code	**ESC X51**
Course Title	Programming Fundamentals **(P)**
Type of Course	Core
L T P	0 0 3
Credits	1
Course Assessment Methods Practical (Continuous and end semester evaluation)	50
Course Prerequisites	None
Course Outcomes (CO)	1. Design algorithms and flowcharts for problem solving. 2. Write, debug, and execute structured programs in C. 3. Apply decision making and loop control structures effectively. 4. Implement modular programming using functions and arrays.

Lab1: Familiarization with programming environment

Lab 2: Simple computational problems using arithmetic expressions

Lab 3: Problems involving if-then-else structures

Lab 4: Iterative problems e.g., sum of series

Lab 5: 1D Array manipulation, Arrays: searching, sorting

Lab 6: Matrix problems, String operations

Lab 7: Simple functions and parameter passing

Lab 8: Numerical methods (Root finding, numerical differentiation, numerical integration)

Lab 9: Recursive functions

Lab 10: Pointers and structures

Lab 11: File operations

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	1	1	1		1			1	1	-
CO2	2	2	1	1	1			1	1				1	-
CO3	2	1	2	1								2		
CO4	3	3	1	1				2				1	1	1
CO5	3	2	2	1					1				1	1
CO6	2	3	1	1	1			1	1			2	1	1

Course Code	NSS-I
Course Title	National Service Scheme
Course Type	HS
Course LTP	1 0 0
Course Credits	Non-Credit
Course Assessment • Continuous • End of Semester	________________
Course Prerequisites	No prerequisites
NSS Objectives	1. To identify the needs and problems of the community 2. To develop a sense of social and civic responsibility 3. To acquire leadership qualities and democratic attitudes 4. To practise national integration and social harmony
NSS Outcomes	1. Ability to solve the community problems 2. Being a socially responsible citizen 3. Ability to lead in the democratic environments 4. Development of national integration and social harmony

Syllabus

Note - The examiner will evaluate the students on a continuous basis as per different activities in which the students must participate actively.

Part A

1. About NSS, History and Objectives of NSS
2. NSS Motto
3. NSS Logo
4. NSS Lakshya Geet
5. Tree plantation drives
6. Cleanliness drives
7. Blood donation drives
8. Road safety campaigns
9. First aid awareness programmes
10. Disaster management sessions

Part B

11. Activities focused on rural areas
12. Activities focused on underprivileged communities
13. Literacy drives
14. Environment awareness rallies
15. Walkathon, marathon and cycle rallies for Fit India campaigns
16. Celebrating festivals through sharing and caring programmes
17. Participation in parade camps
18. Participation in NSS camps
19. Gender equality awareness programmes
20. Awareness programmes related to days of national and international importance

Textbooks

Title	Author	Publisher
NSS and Youth Development	Dr. Sunita Agarwalla	Mahaveer Publications(2021)
National Service Scheme Manual	Government of India	Ministry of Youth Affairs and Sports (2006)

References

Title	Author	Publisher

Course Code	UHV II
Course Title	Universal Human Values-II
Course Type	HS
Course LTP	3 0 0
Course Credits	3
Course Assessment ● Continuous ● ● End of Semester	50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	No prerequisites
Course Objectives	1. To introduce the fundamental concepts of value education and their relevance to holistic development. (Focuses on foundational understanding) 2. To facilitate self-exploration and understanding of human aspirations, needs, and relationships. (Focuses on introspection and interpersonal skills) 3. To enable students to comprehend the interconnectedness within the family, society, nature, and existence. (Focuses on understanding harmony at different levels) 4. To equip students with the ability to apply value-based principles in decision-making and professional conduct. (Focuses on application and ethical implications)
Course Outcomes	1. Students will recognize the crucial role of human values alongside technical skills for effective problem-solving and self-verify truth. 2. Students will understand human desires versus physical needs and the importance of right understanding and respect in relationships. 3. Students will analyze the interconnectedness of existence and the need for responsible human actions towards sustainability. 4. Students will apply value-based understanding to their knowledge domain and integrate these principles for personal and societal well-being.

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

UNIT 1: Introduction to Value Education

Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education); Understanding Value Education; Self-exploration as the Process for Value Education; Continuous Happiness and Prosperity; the Basic Human Aspirations; Happiness and Prosperity -Current Scenario; Method to Fulfil the Basic Human Aspirations.

UNIT 2: Harmony in the Human Being

Understanding Human being as the Co-existence of the Self and the Body; Distinguishingbetween the Needs of the Self and the Body; Exploring the difference of Needs of Self and Body; The Body as an Instrument of the Self; Understanding Harmony in the Self; Harmony of the Self with the Body; Programme to ensure self-regulation and Health.

UNIT 3: Harmony in the Family and Society

Harmony in the Family the Basic Unit of Human Interaction; 'Trust' the Foundational Value inRelationship; Exploring the Feeling of Trust; 'Respect' as the Right; Other Feelings, Justice in Human-to-Human Relationship; Understanding Harmony in the Society; Vision for the Universal Human Order; Practice Session PS9 Exploring Systems to fulfil Human Goal.

Part B

UNIT 4: Harmony in the Nature/Existence

Understanding Harmony in the Nature; Interconnectedness, self-regulation and Mutual Fulfillment among the Four Orders of Nature; Realizing Existence as Co-existence at All Levels; The Holistic Perception of Harmony in Existence.

UNIT 5: Implications of the Holistic Understanding a Look Professional Ethics

Natural Acceptance of Human Values; Definitiveness of (Ethical) Human Conduct; A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order; Competence in Professional Ethics; Holistic Technologies, Production Systems and Management Models-Typical Case Studies; Strategies for Transition towards Value-based Life and Profession.

Textbooks

Title	Author	Publisher
A Foundation Course in Human Values and Professional Ethics	R R Gaur, R Asthana, G P Bagaria	UHV Publications, UHV Foundation, Delhi Third revised edition, 2023. ISBN: 978-81-957703-7-3 (Printed Copy) ISBN: 978-81-957703-6-6 (e-book) uhv.org.in

The Teacher's Manual for A Foundation Course in Human Values and Professional Ethics	R R Gaur, R Asthana G P Bagaria	UHV Publications, UHV Foundation, Delhi Third revised edition, 2023. ISBN: 978-81-957703-5-9 (Printed Copy) ISBN: 978-81-957703-0-4 (e-book) uhv.org.in

References

Title	Author	Publisher
JeevanVidya: EkParichaya	A Nagaraj	JeevanVidyaPrakashan, Amarkantak, 1999.
Human Values	A.N. Tripathi	New Age Intl. Publishers, New Delhi, 2004
The Story of My Experiments with Truth	Mohandas Karamchand Gandhi	Maple Press,2011
Small is Beautiful	E. F Schumacher	Harper Perennial, 2010
Slow is Beautiful	Cecile Andrews	New Society Publishers,2006
Economy of Permanence	J C Kumarappa	Sarva Seva Sangh Prakashan, 1995
Bharat Mein Angreji Raj	Pandit Sunderlal	Prabhat Prakashan,2018
Rediscovering India	Dharampal	Advent Books Division,1983
Hind Swaraj or Indian Home Rule	Mohandas K. Gandhi	Pilgrims Publishing,1983

India Wins Freedom	Maulana Abdul Kalam Azad	Orient BlackSwan,1988
Life of Vivekananda	Romain Rolland (English)	Advaita Ashrama, India, 2010
Gandhi	Romain Rolland (English)	Srishti Publishers & Distributors,2002

3rd Semester

Course Code	MEC301
Course Title	Basic Thermodynamics
Course Type	Core
Course LTP	300
Course Credits	3
Course Assessment • Continuous • End of Semester	50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Introduction to Thermodynamics
Course Objectives	1. To present a comprehensive and rigorous treatment of classical thermodynamics while retaining an engineering perspective. 2. Understand the applications of engineering thermodynamics in real life situations 3. To lay the groundwork for subsequent studies in such fields as fluid mechanics, heat transfer and to prepare the students to effectively use thermodynamics in the practice of engineering. 4. To develop an intuitive understanding of thermodynamics by emphasizing the physics and physical argument
Course Outcomes	1. Apply the first and second laws of thermodynamics to engineering problems. 2. Analyze properties of pure substances and gas mixtures. 3. Evaluate performance of basic thermal systems. 4. Apply thermodynamic principles to power and refrigeration cycles.

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Introduction: Thermodynamics and Energy, Application Areas of Thermodynamics, Systems and Control Volumes , Properties of a System, Continuum , State and Equilibrium, Processes and Cycles, Temperature and the Zeroth Law of

Thermodynamics, Temperature Scales,

2. Energy, Energy Transfer, General energy Analysis: Forms of Energy, Energy Transfer by Heat, Energy Transfer by Work, Electrical Work, Mechanical Forms of Work, Non mechanical Forms of Work, The First Law of Thermodynamics, Energy Balance, Energy Change of a System, Mechanisms of Energy Transfer, Efficiencies of Mechanical and Electrical Devices

3. Properties of Pure Substances: Pure Substance, Phases of a Pure Substance Phase Change Processes of Pure Substances, The T-v Diagram ,The P- v Diagram, The PT Diagram, The P v T Surface Enthalpy—A Combination Property , Saturated Liquid and Saturated Vapor States, Saturated Liquid Vapor Mixture, Superheated Vapor , Compressed Liquid, Reference State and Reference Values The Ideal Gas Equation of State , Compressibility Factor, van der Waals Equation of State.

4. Analysis Of Closed Systems: Moving Boundary Work, Polytropic Process, Energy Balance for Closed Systems, Specific Heats, Internal Energy, Enthalpy, and Specific Heats of Ideal Gases, Specific Heat Relations of Ideal Gases, Internal Energy, Enthalpy, and Specific Heats of Solids and Liquids Internal Energy Changes Enthalpy Changes

Part B

5. Mass and Energy Analysis of Control volumes: Conservation of Mass, Mass and Volume Flow Rates, Conservation of Mass Principle, Mass Balance for Steady Flow Processes, steady Incompressible Flow, Flow Work and the Energy of a Flowing Fluid, Total Energy of a Flowing Fluid, Energy Transport by Mass, Energy Analysis of Steady Flow Systems, Steady Flow Engineering Devices, Energy Analysis of Unsteady Flow Processes.

6. The Second Law Of Thermodynamics: Introduction to the Second Law, Thermal Energy Reservoirs, Heat Engines, Thermal Efficiency, Kelvin Planck Statement, Refrigerators and Heat Pumps, Coefficient of Performance, Heat Pumps, Performance of Refrigerators, Air Conditioners, and Heat Pumps, Clausius Statement Equivalence of the Two Statements, Perpetual Motion Machines, Reversible and Irreversible Processes, The Carnot Cycle, The Reversed Carnot Cycle , The Carnot Principles, The Thermodynamic Temperature Scale, The Carnot Heat Engine, The Carnot Refrigerator and Heat Pump.

7. Vapor And Combined Power Cycles: The Carnot Vapor Cycle, Rankine Cycle: The Ideal Cycle for Vapor Power Cycles, Energy Analysis of the Ideal Rankine Cycle, Deviation of Actual Vapor Power Cycles from Idealized Ones, Method to Increase the Efficiency of the Rankine Cycle, The Ideal Reheat Rankine Cycle ,The Ideal Regenerative Rankine Cycle, Open Feed water Heaters, Closed Feed water Heaters, Second Law Analysis of Vapor Power Cycles, Cogeneration, Combined Gas Vapor Power Cycles.

Textbooks

Title	Author	Publisher
Fundamentals of Thermodynamics	Borgnakke	Wiley (2009)

Fundamentals of Engineering Thermodynamics	Moran	Wiley (2015)
Engineering Thermodynamics	Cengel	McGraw-Hill (2015)

References

Title	Author	Publisher

Course Code	MEC351
Course Title	Basic Thermodynamics (P)
Course Type	Core
Course LTP	002
Course Credits	1
Course Assessment • Continuous	50 (Practical Performance, Report Writing, and Viva Voce)
Course Prerequisites	
Course Objectives	1. Understand the applications of engineering thermodynamics in real life situations 2. Understand working and application of boilers 3. Understanding the thermodynamics of separating throttling calorimeter 4. Understanding the steam condensers operations and uses Understanding the steam condensers operations and uses
Course Outcomes	1. Students will understand the principles of thermal energy. This includes the study of energy transformations and thermodynamic relationships applied to flow and non-flow processes in power and refrigeration cycles. 2. Identify and explain the construction and working of various boilers and condensers used in thermal systems. 3. Conduct experiments to determine fuel properties (e.g., calorific value) and steam quality (e.g., dryness fraction) using standard calorimeters. 4. Students will have analytical skills to solve and analyze a variety of steam related problems. Like boilers, condensers

List of Experiments

1. Study of Babcock and Wilcox boiler.
2. Study of Lancashire Boiler.
3. To Study of working, construction, mountings and accessories of various types of boilers
4. To find the calorific value of a sample of fuel using a Bomb calorimeter.
5. To measure the dryness fraction of steam using a separating throttling calorimeter.
6. To study the working of a thermal power plant by visiting the site.

7. Study of construction and operation of various types of steam condensers.

Textbooks

Title	Author	Publisher

References

Title	Author	Publisher

Course Code	MEC302
Course Title	Mechanics of Materials
Course Type	Core
Course LTP	300
Course Credits	3
Course Assessment • Continuous • End of Semester	50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Statics and Dynamics of Rigid Bodies
Course Objectives	1. Provide clear understanding of principles, assumptions, and limitations underlying the mechanics of deformable solids in equilibrium. 2. Apply above principles to engineering design based on strength, stiffness, and stability criteria.
Course Outcomes	1. Given a physical situation the student should be able to develop a physical understanding of the problem. 2. The student should then be able to construct an idealized model. 3. Using equilibrium, compatibility, and force-deformation relation the student should be able to generate the solution to the problem. 4. The student should be able to analyze and design an element using the above principles.

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Stress : Equilibrium of a Deformable Body, Stress, Average Normal Stress in an Axially Loaded Bar, Average Shear Stress, Allowable Stress Design, Limit State Design.

2. Strain : Deformation, Strain.

3. Mechanical Properties of Materials : Tension and Compression Test, The Stress-Strain Diagram, Stress-Strain behavior of Ductile and Brittle Materials, Strain Energy, Poisson's Ratio, The Shear Stress-Strain Diagram.

4. Axial Load : Saint-Venant's Principle, Elastic Deformation of an Axially Loaded Member, Principle of Superposition, Statically Indeterminate Axially Loaded Members, The Force and Displacement Methods of Analysis for Axially Loaded Members, Thermal Stress.

5. Torsion : Torsional Deformation of a Circular Shaft, The Torsion Formula, Power Transmission, Angle of Twist, Statically Indeterminate Torque-Loaded Members.

Part B

6. Bending : Shear and Moment Diagrams, Bending Deformation of a Straight Member, The Flexure Formula.
   Shear in Straight Members, The Shear Formula, Shear Flow in Built-Up Members, Shear Flow in Thin-Walled Members.
   Elastic Curve, Slope and Displacement of Determinate and Indeterminate Beams by Integration. Discontinuity Functions.

7. Combined Loading : Thin-Walled Pressure Vessels. State of Stress caused by Combined Loading.
   Plane Stress Transformation, Equations, and Mohr Circle. Principal Stresses, Maximum in-plane Shear Stress. Absolute Maximum Shear Stress.
   Plane Strain Transformation, Equations, and Mohr Circle. Absolute Maximum Shear Strain. Strain Rosettes.
   Material Property Relations. Failure Theories. Prismatic Beam Design. Shaft Design.

8. Buckling : Critical Load. Ideal Column with Pin Supports. Columns with Various Supports. Secant Formula.

9. Energy Methods : External Work and Strain Energy. Elastic Strain Energy for Various Types of Loading. Conservation of Energy. Impact Loading. Principle of Virtual Work and Applications.Castigliano's Theorem and Applications.

Textbooks

Title	Author	Publisher
Mechanics of Materials	Hibbeler	Pearson (2018)
Engineering Mechanics of Solids	Popov	Pearson (2016)
Mechanics of Materials	Goodno	Cengage (2019)
Mechanics of Materials	Beer	McGraw Hill (2015)

References

Title	Author	Publisher
Strength of Materials	Ryder	MacMillan (1969)

<table>
<tr><td>Course Code</td><td>MEC352</td></tr>
<tr><td>Course Title</td><td>Mechanics of Materials (P)</td></tr>
<tr><td>Course Type</td><td>Core</td></tr>
<tr><td>Course LTP</td><td>002</td></tr>
<tr><td>Course Credits</td><td>1</td></tr>
<tr><td>Course Assessment
• Continuous</td><td>
50 (Practical Performance, Report Writing, and Viva Voce)</td></tr>
<tr><td>Course Prerequisites</td><td>Calculus, Statics and Dynamics of Rigid Bodies</td></tr>
<tr><td>Course Objectives</td><td>The experiments aim at providing practical knowledge of the theory material covered in the Mechanics of Materials class.</td></tr>
<tr><td>Course Outcomes</td><td>1. Understand the working principles of testing machines and conduct basic mechanical tests like tension, compression, shear, and bending.
2. Perform torsion and impact tests to determine material properties such as modulus of rigidity and toughness.
3. Evaluate the hardness of materials using Brinell, Vickers, Rockwell, and other standard methods.
4. Analyze experimental data to determine material constants such as Young’s modulus and shear modulus and prepare technical reports.</td></tr>
<tr><td colspan="2">List of Experiments

1. Study Universal Testing Machine and perform Tension, Compression, Bending, and Shear tests.
2. Study Torsion testing machines and perform torsion tests.
3. Study of Izod and Charpy apparatus and perform impact tests.
4. Study hardness of various materials with Brinell, Vickers, Pyramid, and Rockwell hardness tests
5. Study Spring testing machines and perform tests on helical spring to determine Shear Modulus.
6. Study Beam bending apparatus and perform beam bending test to determine Young’s Modulus.</td></tr>
<tr><td colspan="2">Textbooks
<table><tr><th>Title</th><th>Author</th><th>Publisher</th></tr><tr><td></td><td></td><td></td></tr></table></td></tr>
</table>

References

Title	Author	Publisher
Strength of Materials	Ryder	MacMillan
Strength of Materials	Hearn	Butterworth Heinemann
GUNT	https://www.gunt.de/en/	
TecQuipment	https://www.tecquipment.com/	

Course Code	MEC303
Course Title	Kinematics of Machines
Course Type	Core
Course LTP	300
Course Credits	3
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Statics and Dynamics of Rigid Bodies
Course Objectives	1. Know different machine elements and mechanisms. 2. Understand Kinematics and Dynamics of different machines and mechanisms. 3. Select Suitable Drives and Mechanisms for a particular application.
Course Outcomes	1. Analyze motion of mechanisms and linkages. 2. Apply kinematic and dynamic analysis to machine components. 3. Understand balancing and vibration in mechanical systems. 4. Apply gyroscopic principles to engineering applications.

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Basics of Mechanisms: Classification of mechanisms – Basic kinematic concepts and definitions – Degree of freedom, Mobility – Kutzbach criterion, Gruebler’s criterion – Grashof’s Law. Kinematic inversions of four-bar chains, slider crank chains and double slider crank chains . Velocity and acceleration analysis of simple mechanisms – Graphical method– Velocity and acceleration polygons. Velocity analysis using instantaneous centers .Description of some common mechanisms – Quick return mechanisms. Coriolis component of Acceleration

2. Kinematic Synthesis of Mechanisms: Movability, Number synthesis, Frudensteins's equation. Chebyshev spacing of precision points, Two and three position synthesis of Four-bar mechanism and slider crank mechanism, Overlay Method, Block's method, Transmission angle, Limit position and Least square techniques.

3. Flywheel and turning moment diagrams: Turning moment and crank effort diagrams for steam and IC engine, fluctuation of speed, coefficient of fluctuation of speed and energy. Simple problems on turning moment diagrams and determination of   size of flywheel taking centrifugal stresses into consideration.

Part B

4. Governors: Introduction, Function and types of governors, Centrifugal governors, Watt governor, Porter governor, Proell governor, Hartnell governor, Wilson Hartnell Governor,characteristics of governor, stability, Sensitivity, isochronism, Hunting ,controlling forces and stability, Effort and power of governor,controlling force curve, Effect of sleeve friction

5. Friction In Machine Elements: Surface contacts – Sliding and Rolling friction – Friction drives. Friction in screw threads –Screw jack with square and V threadsFriction in Bearings:Pivots and collar bearingsFriction clutches :Single disc clutch, multiple disc clutch, cone clutchFriction in brakes- Shoe brake, band brakes ,band and block brakes.Dynamometers: Prony brake, rope brake.Belt transmission dynamometer Epicyclic gear train dynamometer, torsion dynamometer, Bevis Gibson flashlight dynamometer.

6. Belt, Ropes And Chains: Belt and rope drives – Action of belts on pulleys Velocity ratio and slip, creepFlat and V-Belts ,Open and Cross Belt,Law of belting ,Ratio of tight side to slack side tension , Power transmitted and centrifugal tension.Conditions for maximum power transmission from belt drive.Types of chains, length of chain.

Textbooks

Title	Author	Publisher
Theory of Machines and Mechanisms	Uicker	OUP (2009)
Kinematics, Dynamics, and Design of Machinery	Waldron	Wiley (2016)
Mechanisms and Machines: Kinematics, Dynamics, and Synthesis	Stanisic	Cengage (2014)
Kinematics and Dynamics of Machinery	Wilson	Pearson (2008)
Kinematics and Dynamics of Machinery	Norton	McGrawHill (2017)

References

Title	Author	Publisher
Fundamentals of Kinematics and Dynamics of Machines and Mechanisms	Vinogradov	CRC (2000)
Kinematics and Dynamics of Mechanical Systems: Implementation in MATLAB® and SimMechanics®	Rusell	CRC (2018)
Theory of Machines	Bevan	CBS (2005)
Mechanics of Machines I and II	Hannah	Butterworth and Heinemann (1984)
Mechanics of Machines	Cleghorn	OUP (2015)
Principles of Vibration	Tongue	OUP (2002)
Kinematics and Dynamics of Machines	Martin	Waveland Press (2002)
Kinematics and Linkage Design	Hall	Waveland Press (1986)
Analysis of Mechanisms	Hall	Waveland Press (1987)

Course Code	MEC353
Course Title	Kinematics of Machines (P)
Course Type	Core
Course LTP	002
Course Credits	1
Course Assessment • Continuous	50 (Practical Performance, Report Writing, and Viva Voce)
Course Prerequisites	Statics and Dynamics of Rigid Bodies
Course Objectives	1. This design-oriented course addresses the kinematics and dynamics of mechanisms with applications to linkage systems, reciprocating engines, and industrial machinery. 2. Conventional as well as innovative rigid-body dynamic systems are studied. Problems of kinematics and dynamics are framed in a form suited for computer analysis.
Course Outcomes	1. Familiarity with common mechanisms used in machines and everyday life. 2. Ability to calculate mobility (number of degrees-of-freedom) and enumerate rigid links and types of joints within mechanisms. 3. Ability to conduct a complete (translational and rotational) mechanism position analysis. 4. Analyze and interpret the operational behavior of various types of governors (Porter, Proell, Hartnell) under changing parameters like mass and spring compression.

List of Experiments

1. Find the moment of inertia of a given body with the help of Fly-wheel. Calculate the minimum possible periods of oscillation if the point of suspension may be moved .
2. Study and draw the sketches of different inversions of single slider chain and double slider crank chain.
3. Find the coefficient of friction for different belt material on a cast iron : Pulley.
4. To perform the various practical on Universal Governor Apparatus.
5. Determination the characteristics of sleeve position against speed for all governors.
6. Determination of the characteristics curves of radius of rotation against controlling force for all governors.

7. To study the effect of varying the mass of central sleeve for porter and proell Governors.
8. To study the effects of varying initial spring compression for Hartnell Governor.

Textbooks

Title	Author	Publisher

References

Title	Author	Publisher

Course Code	MEC304
Course Title	Machine Drawing
Course Type	Core
Course LTP	100
Course Credits	1
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Engineering Graphics
Course Objectives	1. To enable students to be able to communicate their ideas and concepts using sketches, symbols and engineering drawings. 2. To understand drawing and working of a number of machine elements. 3. To develop the technical skills necessary to create or modify the machine drawing using Computer Aided Drafting system.
Course Outcomes	1. Interpret and communicate engineering drawings having a number of symbols, standards and views. 2. Apply and interpret various types of tolerances and geometric dimensioning symbols in accordance with industry standards. 3. Understand the technical intricacies involved in drawing and working of screws, bolts, pipe fittings, cotter joint, knuckle joint, pulleys, brackets, couplings, bearings, engine parts, tail stock, screw jack, vices, valves etc. 4. Create 3D models of engineering objects, machine drawings with different views, and an assembly of the objects that make up engineered systems, using a CAD system (e.g. AutoCAD etc.).
Syllabus Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.	

Part A

1. Tolerancing: Introduction, Direct Tolerance Methods, Tolerance Expressions, Understanding Plus and Minus Tolerances, Creating Plus and Minus Tolerances with AutoCAD, Limit Tolerances, Creating Limit Tolerances by Using AutoCAD, Angular Tolerances, Standard Tolerances, Double Dimensioning, Chain Dimensions and Baseline Dimensions, Tolerance Studies, Rectangular Dimensions, Hole Locations, Choosing a Shaft for a Toleranced Hole, Standard Fits (Metric Values), Nominal Sizes, Hole and Shaft Basis, Preferred and Standard Sizes, Surface Finishes, Surface Control Symbols.

2. Geometric Tolerances: Introduction, Tolerances of Form, Flatness, Straightness, Straightness (RFS and MMC), Circularity, Cylindricity, Geometric Tolerances Created by Using AutoCAD, Tolerances of Orientation, Datums, Perpendicularity, Parallelism, Angularism, Profiles, Runouts, Positional Tolerances, Virtual Condition, Floating Fasteners, Fixed Fasteners.

3. Threads and Fasteners: Introduction, Thread Terminology, Thread Callouts (Metric Units), Thread Callouts (English Units), Thread Representations, Orthographic Views of Internal Threads, Sectional Views of Internal Thread Representations, Types of Threads, How to Draw an External Square Thread, How to Draw an Internal Square Thread, How to Draw an External Acme Thread, Bolts and Nuts, Screws, Studs, Head Shapes, Nuts, Standard Screws, Setscrews, Washers, Keys, Rivets, Springs, Tool Palettes.

4. Working Drawings: Introduction, Assembly Drawings, Drawing Formats (Templates), Title Block, Revision Block, Tolerance Block, Release Block, Parts List (Bill of Materials–BOM), Detail Drawings, First-Angle Projection, Drawing Notes, Design Layouts.

Part B

5. Gears, Bearings, and Cams: Introduction, Types of Gears, Gear Terminology—Spur, Spur Gear Drawings, Selecting Spur Gears, Center Distance Between Gears, Combining Spur Gears, Gear Terminology—Bevel, How to Draw Bevel Gears, Worm Gears, Helical Gears, Racks, Ball Bearings, Bushings, Cam Displacement Diagrams, Cam Motions, Cam Followers.

6. Fundamentals of 3D Drawing: Introduction, The World Coordinate System, Viewpoints, Perspective and Parallel Grids, 3D Modeling, User Coordinate System (UCS), Editing a Solid Model, Creating UCSs on a Perspective Grid, Rotating a UCS Axis, Visual Errors, Orthographic Views, Line Thickness, Using the Thickness Command to Create Objects.

7. Modeling: Introduction, Box, Sphere, Cylinder, Cone, Wedge, Torus, Extrude, Revolve, Helix, Polysolid, Loft, Intersect, Union and Subtract, Solid Modeling

and UCSs, Combining Solid Objects, Intersecting Solids, Solid Models of Castings, Thread Representations in Solid Models, List, Massprop, Face and Edge Editing.

8. Projects: Introduction, Socket and Spigot Joint for Hydraulic Pipes, Flanged Joint for Hydraulic Pipes, Flat Belt Pulley, V-Belt Pulley, Rope Pulley, Wall Bracket, Cotter Joint with Sleeve, Cotter Joint with Socket and Spigot Ends, Cotter Joint with a Gib, Knuckle Joint, Butt-Muff Coupling, Half-Lap Muff Coupling, Split-Muff Coupling, Flanged Coupling, Protected Flanged Coupling, Bushed Pin Type Flanged Flexible Coupling, Claw Coupling, Universal Coupling (Hooke's Joint), Oldham Coupling, Footstep bearing, Journal bearing, Ball bearing, Roller bearing

Textbooks

Title	Author	Publisher
Engineering Graphics with AutoCAD	Bethune	Pearson (2016)
Fundamentals of Engg. Drawing	Luzadder	Literary Licensing LLC (2015)
Engineering Drawing and Design	Jensen	Mc-Graw Hill (2012)
Manual of Engineering Drawing	French	Wentworth (2016)

References

Title	Author	Publisher

Course Code	MEC354
Course Title	Machine Drawing (P)
Course Type	Core
Course LTP	004
Course Credits	2
Course Assessment • Continuous	100 (Practical Performance, Report Writing, and Viva Voce)
Course Prerequisites	Engineering Graphics
Course Objectives	1. To develop the technical skills necessary to successfully use a computer aided drafting system such as Auto-CAD. 2. To develop the technical skills necessary to produce assembly drawings. 3. To develop the ability to produce 3-D Solid model of engineering products using CAD system
Course Outcomes	1. Ability to communicate the ideas and concepts using CAD software. 2. Ability to draw and communicate assembly drawings and sectional views. 3. Ability to develop 3-D solid models of real life mechanical systems. 4. Create 3D models of engineering objects, machine drawings with different views, and an assembly of the objects that make up engineered systems, using a CAD system (e.g. AutoCAD etc.).

List of Experiments

The candidates will be required to make at least 20 three-dimensional solid models covering the following as per B.I.S. SP46-2003 for general engineering drawing:

1. Simple Solids including Prisms, Pyramids, Cylinders, Cones, Spheres, Wedges and their combinations using Extrude, Union, Subtraction, Intersection Commands (Minimum 5 Solid Models)
2. Socket and Spigot Joint for Hydraulic Pipes, Flanged Joint for Hydraulic Pipes (Minimum 1 Solid Model)
3. Flat Belt Pulley, V-Belt Pulley, Rope Pulley, Brackets (Minimum 2 Solid Models)
4. Cotter Joint with Sleeve, Cotter Joint with Socket and Spigot Ends, Cotter Joint with a Gib, Knuckle Joint (Minimum 3 Solid Models)

5. Butt-Muff Coupling, Half-Lap Muff Coupling, Split-Muff Coupling, Flanged Coupling, Protected Flanged Coupling, Bushed Pin Type Flanged Flexible Coupling, Claw Coupling, Universal Coupling (Hooke’s Joint), Oldham Coupling (Minimum 3 Solid Models)
6. Footstep bearing, Journal bearing, Ball bearing, Roller bearing, Plummer block (Minimum 2 Solid Models)
7. I.C. Engine Piston, Connecting Rod, Spark Plug, Fuel Pump, Fuel Injector (Minimum 1 Solid Model)
8. Tail Stock, Screw Jack, Bench Vice, Crane Hook (Minimum 1 Solid Model)
9. Lever Safety Valve, Spring Loaded Safety Valve (Minimum 1 Solid Model)
10. Milling Vise, Tenon Jig (Minimum 1 Solid Model)

Textbooks

Title	Author	Publisher
Engineering Graphics with AutoCAD	Bethune	Pearson (2016)
Fundamentals of Engg. Drawing	Luzadder	Literary Licensing LLC (2015)
Engineering Drawing and Design	Jensen	Mc-Graw Hill (2012)
Manual of Engineering Drawing	French	Wentworth (2016)

References

Title	Author	Publisher

<table>
<tr><td>Course Code</td><td>MEC305</td></tr>
<tr><td>Course Title</td><td>Manufacturing Processes</td></tr>
<tr><td>Course Type</td><td>Core</td></tr>
<tr><td>Course LTP</td><td>300</td></tr>
<tr><td>Course Credits</td><td>3</td></tr>
<tr><td>Course Assessment
Continuous
End of Semester</td><td>
50 (Sessionals, Assignments, Quizzes)
50 (University Examination)</td></tr>
<tr><td>Course Prerequisites</td><td>Workshop, Engineering Drawing</td></tr>
<tr><td>Course Objectives</td><td>To understand the importance and need of Manufacturing processes
Awareness, practical exposure to, and applications of various Manufacturing processes</td></tr>
<tr><td>Course Outcomes</td><td>Understand the fundamentals of Engineering Materials and select appropriate materials for specific applications.
Describe and apply various metal forming processes such as rolling, forging, extrusion, and sheet metal operations, and identify common defects and remedies.
Analyze and apply casting and welding processes, understand the equipment used, and identify and identify its controlling parameter.
Understand and apply the principles of powder metallurgy, including powder production, sintering, and finishing operations, and assess its advantages and limitations for manufacturing components.</td></tr>
<tr><td colspan="2"> Syllabus Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part. Part A Fundamentals of Engineering Materials:
Metal (Cast Iron, Pig Iron and Steel) and Alloys (Aluminum, Copper, Magnesium, Nickel and Steel), Non-ferrous materials (Aluminum, Cobalt, Copper, lead, Magnesium, Nickel, Tin and Zinc) and Nonmetal, Mechanical</td></tr>
</table>

behavior, Physical properties, Manufacturing properties, Testing, Applications of Engineering Materials. (Lectures 10)

2. Metal forming:
    a. Definition and classification of metal forming, type of rolling, hot rolling, rolling mills, forging, smith forging, drop forging, machining forging and press forging, defects in forging.
    b. Pipe and Tube manufacture, extrusion, hot spinning, drawing and cupping, piercing, cold rolling, wire drawing, rod and tube drawing, metal spinning, coining, embossing and shot peening, sheet metal working operations, piercing, blanking, bending and drawing, punch and die setup, presses. (Lectures 10)

Part B

3. Foundry:
   Introduction to Casting Processes, Basic Steps in Casting Process, Expandable and permanent mould casting processes, Pattern, Types of Patterns, Pattern Allowances, Risers, Runners, Gates, Moulding Sand and its composition, Sand Preparation, Molding Methods, Core Sands and Core Making, Core Assembly, Mold Assembly, Melting and Pouring, Cooling and Solidification, Elementary and brief description of various melting furnaces, Fettling, (Lectures 7)

4. Welding:
    a. Definition and classification, types of welded joints, weldability, Gas welding: oxy-acetylene welding, equipment, lighting up, type of flames, welding techniques, welding of cast iron, flame cutting, advantages and limitations Electric arc welding : principle, metal transfer in arc welding, straight & reverse polarity in AC & DC, relative merits & demerits, various electric arc welding processes, coding & selection of welding electrodes.
    b. TIG, MIG welding processes, electric resistance welding, spot, butt, seam, upset, projection & high frequency resistance welding, thermit welding, brazing and soldering, description of special welding techniques, choice of process for welding, defects in welding joint, their causes and remedies. (Lectures 10)

5. Powder Metallurgy:

   Definition and classification of metal powder, advantages and limitations, metal powder product, method of producing powders, briquetting and sintering, hot iso-static Processing , sizing and finishing operation. (Lectures 3)

Textbooks

Title	Author	Publisher

Workshop Technology (Part 1,2, and 3)	Chapman	Butterworth Heinemann (1972)
Workshop Processes, Practices and Materials	Black	Routledge (2015)
Principles of Modern Manufacturing	Groover	Wiley (2018)
DeGarmo's Materials and Processes in Manufacturing	Black	Wiley (2017)
Manufacturing Engineering and Technology	Kalpakjian	Pearson (2018)

References

Title	Author	Publisher
Materials and manufacturing Technology	Lindberg	PHI (1988)
Manufacturing Processes and Systems	Ostwald	Wiley (1997)

<table>
<tr><td>Course Code</td><td>MEC355</td></tr>
<tr><td>Course Title</td><td>Manufacturing Processes (P)</td></tr>
<tr><td>Course Type</td><td>Core</td></tr>
<tr><td>Course LTP</td><td>002</td></tr>
<tr><td>Course Credits</td><td>1</td></tr>
<tr><td>Course Assessment
• Continuous</td><td>50 (Practical Performance, Report Writing, and Viva Voce)</td></tr>
<tr><td>Course Prerequisites</td><td>Workshop, Engineering Drawing</td></tr>
<tr><td>Course Objectives</td><td>1. To state the importance and need of Manufacturing processes
2. To tell the students about various tool materials.
3. To make the students aware of various Manufacturing processes
4. To give the students practical exposure of various Manufacturing processes
5. To tell the students about applications of various Manufacturing processes</td></tr>
<tr><td>Course Outcomes</td><td>1. The Fundamentals of Engineering Materials
2. The principle working and controlling parameters of metal forming processes and the principle working and controlling parameters of welding
3. The principle working and controlling parameters of foundry and the process of mould making
4. Demonstrate understanding of the powder metallurgy process and its industrial applications.</td></tr>
<tr><td colspan="2">List of Experiments
1. Experimental work pertaining to study & use of sand testing equipment
2. To prepare a mould & do casting.
3. Study of casting defects.
4. To prepare a lap joint using- electric arc welding.
5. To prepare a joint using- gas/spot welding.
6. Application of MIG/TIG welding
7. To study various processes of powder metallurgy</td></tr>
<tr><td colspan="2">Textbooks
<table><tr><td>Title</td><td>Author</td><td>Publisher</td></tr></table></td></tr>
</table>

Workshop Technology (Part 1,2, and 3)	Chapman	Butterworth Heinemann (1972)

References

Title	Author	Publisher

Course Code	ASM301
Course Title	Algebra and Complex Analysis
Course Type	Core
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Calculus, Differential Equations
Course Objectives	This course is an introduction to a broad range of mathematical techniques for solving problems that arise in Science and Engineering. The goal is to provide a basic understanding of the derivation, analysis and use of these techniques along with a detailed understanding of linear algebra in engineering applications.
Course Outcomes	1. Student will learn to solve system of linear equations and related concepts and will be introduced to the idea of vector spaces and linear transforms along with their applications. 2. Student will be able to carry out various operations on matrices including its diagonalization using eigen vectors and shall be able to understand the concept of change of basis and its matrix representation. 3. Student will be introduced to the concept of complex valued functions, the calculus of complex valued functions on elementary functions. 4. Student will understand the concept of series representations of complex functions and its applications to solving complex integrals. Transformation using complex functions is also introduced.
Syllabus Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of	

one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Systems of Linear equations : Introduction, Linear equations, solutions, Linear equations in two unknowns, Systems of linear equations, equivalent systems, Elementary operations, Systems in Triangular and echelon form, Reduction Algorithm, Matrices, Row equivalence and elementary row operations, Systems of Linear equations and matrices, Homogeneous systems of Linear equations. (Scope as in Chapter 1, Sections 1.1-1.10 of Reference 1)

2. Vector Spaces : Introduction, Vector spaces, examples of vector spaces, subspaces, Linear combinations, Linear spans, Linear dependence and Independence, Basis and Dimension, Linear equations and vector spaces. (Scope as in Chapter 5, Sections 5.1-5.8 of Reference 1)

3. Eigenvalues and Eigenvectors, Diagonalization : Introduction, Polynomials in matrices, Characteristic polynomial, Cayley-Hamilton theorem, Eigen-values and Eigen-vectors, computing Eigen-values and Eigen-vectors, Diagonalizing matrices. (Scope as in Chapter 8, Sections 8.1-8.5 of Reference 1).

4. Linear Transformations : Introduction, Mappings, Linear mappings, Kernal and image of a linear mapping, Rank- Nullity theorem (without proof), singular and non-singular linear mappings, isomorphisms. (Scope as in Chapter 9, Sections 9.1-9.5 of Reference 1).

Part B

5. Complex Functions : Definition of a Complex Function, Concept of continuity and differentiability of a complex function, Cauchy – Riemann equations, necessary and sufficient conditions for differentiability (Statement only). Study of complex functions: Exponential function, Trigonometric functions, Hyperbolic functions, real and imaginary part of trigonometric and hyperbolic functions, Logarithmic functions of a complex variable, complex exponents (Scope as in Chapter 12, Sections 12.3 – 12.4, 12.6 – 12.8 of Reference 4).

6. Laurent Series of function of complex variable, Singularities and Zeros, Residues at simple poles and Residue at a pole of any order, Residue Theorem (Statement only) and its simple applications (Scope as in Chapter 15, Sections 15.1 – 15.3 of Reference 4).

Textbooks

Title	Author	Publisher

Shaum's Outline of Theory and Problems of Linear Algebra	Lipschutz	McGraw Hill (1991)
Complex Variables and Applications	Churchill	McGraw Hill (1996)
Linear Algebra	Sahai and Bist	Narosa (2002)
Advanced Engineering Mathematics	Greenberg	Pearson
Advanced Engineering Mathematics	Kreyszig	Wiley

References

Title	Author	Publisher

4^{th} Semester

Course Code	MEC401
Course Title	Engineering Thermodynamics
Course Type	Core
Course LTP	300
Course Credits	3
Course Assessment • Continuous • End of Semester	50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Thermodynamics
Course Objectives	The purpose of this course is to enable the student to gain an understanding of how thermodynamic principles govern the behavior of various systems and have knowledge of methods of analysis and design of complicated thermodynamic systems.
Course Outcomes	1. Calculate and interpret entropy and exergy changes in thermodynamic systems, and assess their impact on energy efficiency and irreversibilities. 2. Describe the characteristics of the Otto, Diesel, and Brayton power cycles and the method of analysis of each cycle. 3. Apply the principles of gas mixtures, including mass and mole fraction analysis, to determine the properties and behavior of real and ideal gas mixtures in thermodynamic processes. 4. Use the principles of chemical and phase equilibrium to predict system behavior under equilibrium conditions, and calculate equilibrium constants for single and multi-component systems.
Syllabus Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.	

Part A

1. Entropy: Entropy, The Increase of Entropy Principle , Entropy Change of Pure Substances , Isentropic Processes, Property Diagrams Involving Entropy, Entropy and Entropy Generation in Daily Life, The T ds Relations, Entropy Change of Liquids and Solids, The Entropy Change of Ideal Gases,Entropy Generation, Closed Systems, Control Volumes, Entropy Generation Associated with a Heat Transfer Process

2. Exergy: Introduction, Work Potential of energy Associated with Kinetic and Potential Energy, Reversible Work and Irreversibility, Second Law Efficiency, Exergy Change of a System, Exergy of a Fixed Mass, Exergy of a Flow Stream, Exergy Transfer by Heat, Work, And Mass, The Decrease of Exergy Principle and Exergy Destruction, Exergy Balance: Closed Systems Exergy Balance: Control Volumes, Exergy Balance for Steady Flow Systems, Reversible Work, Second Law Efficiency of Steady Flow Devices

Part B

3. Gas Power Cycles: Basic Considerations in the Analysis of Power Cycles, The Carnot Cycle and its Value in Engineering, Air Standard Assumptions, An Overview of Reciprocating Engines, Otto Cycle: The Ideal Cycle for Spark Ignition Engines, Diesel Cycle: The Ideal Cycle for Compression Ignition Engines, Stirling and Ericsson Cycles, Brayton Cycle: The Ideal Cycle for Gas Turbine Engines, Development of Gas Turbines, Deviation of Actual Gas Turbine Cycles from Idealized Ones, The Brayton Cycle with Regeneration, The Brayton Cycle with Intercooling, Reheating, and Regeneration, Ideal Jet Propulsion Cycles, Modifications to Turbojet Engines, Second Law Analysis of Gas Power Cycles.

4. Gas Mixtures: Composition of a Gas Mixture: Mass and Mole Fractions, p- v- T Behavior of Gas Mixtures: Ideal and Real Gases, Ideal Gas Mixtures, Real Gas Mixtures, Ideal Gas Mixtures Real Gas Mixtures

5. Chemical and Phase Equilibrium: Criterion for Chemical Equilibrium, The Equilibrium Constant for Ideal Gas Mixtures, Chemical Equilibrium for Simultaneous Reactions, Variation of Equilibrium constant with Temperature Phase Equilibrium for a Single Component System ,The Phase Rule, Phase Equilibrium for a Multicomponent System.

Textbooks

Title	Author	Publisher
Fundamentals of Thermodynamics	Borgnakke	Wiley (2009)
Fundamentals of Engineering Thermodynamics	Moran	Wiley (2015)

Engineering Thermodynamics	Cengel	McGraw-Hill (2015)

References

Title	Author	Publisher

Course Code	MEC451
Course Title	Engineering Thermodynamics (P)
Course Type	Core
Course LTP	002
Course Credits	1
Course Assessment • Continuous	 50 (Practical Performance, Report Writing, and Viva Voce)
Course Prerequisites	Thermodynamics
Course Objectives	The experiments aim at providing practical knowledge in thermodynamics and to implement practical engineering problems.
Course Outcomes	1. Identify components and explain the working of 2-stroke and 4-stroke diesel and petrol engines along with auxiliary systems. 2. Conduct performance tests to evaluate B.H.P., I.H.P., thermal and mechanical efficiency of IC engines under various conditions. 3. Analyze valve timing and performance curves (B.H.P. vs Torque, efficiency vs load) to assess engine behavior. 4. Estimate steam quality and prepare a heat balance sheet for diesel engine operations using calorimetry and energy accounting principles.

List of Experiments

1. Study of constructional details, cooling system, Lubrication system and Fuel Flow system of following Engines;
    a. Two stroke and four stroke Diesel engine.
    b. Four stroke Petrol Engine.

2. To find the mechanical and thermal efficiency of a Diesel Engine.

3. To draw the valve timing diagram for a Diesel Engine

4. Determination of B.H.P. at various loads (pump being given fixed setting not to be changed by (governor) for a Diesel Engine/Semi Diesel Engine. Graphical representation of B.H.P. and torque with speed and its interpretation.

5. Trial of a Diesel Engine/Semi Diesel Engine. Determination of B.H.P., fuel consumption ,I.H.P. and mechanical efficiency at various loads (speed

parameters constant). Discussion on variation of thermal efficiency and specific fuel consumption with B.H.P.

6. To estimate the indicated power, friction power and mechanical efficiency of a multi cylinder petrol engine when running at constant speed under constant settings of a carburetor (Morse test).

7. To obtain a power consumption curve, thermal and mechanical efficiency curve for the four stroke diesel engine when tested over a range of power from no load to full load. Also to draw up the heat balance sheet for this range of output of power.

8. Study of multi cylinder diesel engines.

9. To determine dryness fraction of steam using separating and throttling calorimeters.

Textbooks

Title	Author	Publisher

References

Title	Author	Publisher

Course Code	MEC402
Course Title	Mechanics of Solids
Course Type	Core
Course LTP	300
Course Credits	3
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Statics and Dynamics of RIgid Bodies, Mechanics of Materials
Course Objectives	1. Provide clear understanding of principles, assumptions, and limitations underlying the mechanics of deformable solids in equilibrium. 2. Apply above principles to engineering design based on strength, stiffness, and stability criteria.
Course Outcomes	1. The student should be able to make free body diagrams 2. The student should be able to develop a physical understanding of a given problem. 3. Using equilibrium, compatibility, and force-deformation relation the student should be able to generate the solution to the problem. 4. The student should feel comfortable with the use of approximate theoretical techniques, numerical methods, or experimental analysis or a combination to obtain a solution.

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Basic Concepts : Force, Stress, Stress-Strain relations, Strains, Strain-Displacement relations, Displacements.

2. Transformations, Equilibrium, and Compatibility : Stress transformations, Strain transformations, Generalized Stress-Strain relations, Equilibrium equation, Compatibility relation

3. Concepts from The Theory of Elasticity : Plane elasticity problems, Airy stress function, Prandtl's stress function in torsion.

4. Topics from Advanced Mechanics of Materials : Shear Flow, Torsion of Closed Thin-walled Tubes, Bending of Unsymmetrical Beams, Shear in Thin-Walled Beams, Composite Beams, Curved Beams, Bending of Flat Plates, Thick-Walled Cylinders and Rotating Disks, Contact Stress, Stress Concentrations.

Part B

5. Energy Techniques in Stress Analysis : Work, Strain Energy, Castigliano's First Theorem, Complementary Strain Energy, Castigliano's Second Theorem, Virtual Load Method.

6. Strength, Failure Modes, and Design Considerations : Strength, Design Factor, Strength Theories, Fracture Mechanics, Fatigue Analysis, Structural Stability, Inelastic Behavior, Engineering Approximations.

7. Experimental Stress Analysis : Analysis Techniques, Strain Gages - Configurations, Instrumentations, Measurements. Theory of Photoelasticity, Photoelasticity Techniques

Textbooks

Title	Author	Publisher
Advanced Strength and Applied Stress Analysis	Budynas	McGraw Hill (2011)

References

Title	Author	Publisher
Advanced Mechanics of Materials	Boresi	Wiley (2009)
Advanced Mechanics of Materials and Applied Elasticity	Ugural	Pearson (2019)
Advanced Mechanics of Materials	Cook	Pearson (2013)
Advanced Mechanics of Materials	Bickford	Pearson (2015)
Experimental Stress Analysis	Dally	McGraw Hill
Elasticity	Timoshenko	McGraw Hill
Elasticity: Theory, Applications & Numerics	Sadd	Elsevier (2014)
Introduction to Mechanics of Solids	Crandall	McGraw Hill (2017)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	-	1	1	1		2	3	2	1	3	2
CO2	3	2	3	1	1	1	1	-	2	3	1	1	3	1
CO3	3	2	3	1	3	1	1	-	2	3	1	1	2	3
CO4	3	1	3	1	3	1	1	-	2	3	1	1	3	1
CO5	2	1	3	-	3	-	-	-	1	3	-	1	2	1
CO6	2	1	3	-	3	-	-	-	1	3	-	1	2	1

Course Code	MEC452
Course Title	Mechanics of Solids (P)
Course Type	Core
Course LTP	002
Course Credits	1
Course Assessment • Continuous	 50 (Practical Performance, Report Writing, and Viva Voce)
Course Prerequisites	Mechanics of Materials
Course Objectives	The experiments aim at providing practical knowledge of the theory material covered in the Mechanics of Solids class.
Course Outcomes	1. Analyze buckling and creep behavior in structural materials under axial and time-dependent loads. 2. Conduct fatigue tests and interpret fatigue life based on stress-cycles data. 3. Determine stress distribution in pressure vessels and locate shear centers in unsymmetrical sections. 4. Demonstrate the use of strain gages and photo-elasticity techniques to analyze and visualize stress-strain behavior

List of Experiments

1. Study of Buckling Test
2. Study time dependent deformation with Creep test.
3. Study of wood testing machines and performance of various tests on it.
4. Study Fatigue behavior and perform a Fatigue test.
5. Experiment to find the shear center for unsymmetrical sections.
6. Experiment to determine stress distribution in thin cylindrical pressure vessels.
7. Strain Gage Demonstration
8. Photo-elasticity Demonstration

Textbooks

Title	Author	Publisher

References

Title	Author	Publisher
Strength of Materials	Ryder	MacMillan
Strength of Materials	Hearn	Butterworth Heinemann

GUNT	https://www.gunt.de/en/	
TecQuipment	https://www.tecquipment.com/	

Course Code	MEC403
Course Title	Dynamics of Machines
Course Type	Core
Course LTP	300
Course Credits	3
Course Assessment • Continuous • End of Semester	50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Kinematics of Machines
Course Objectives	1. To educate students on different gear and gear train mechanisms 2. To introduce functioning of various types of cams 3. To give knowledge about balancing and inertia forces of various engine parts
Course Outcomes	1. Students will be able to design gears and understand transmission of forces 2. Students will be able to design different types of cam mechanism 3. Students will be able to understand the inertia forces involved during engine force and power transmissions 4. Students can generate various mechanisms related to lower pairs and solve engine problems related to balancing of rotating and reciprocating parts

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Inertia Forces in Mechanism: Determination of Forces and couples for a link, inertia of reciprocating parts, dynamically equivalent system. Analytical and graphical methods, inertia force analysis of basic engine 5 mechanism (crank, connecting rod and piston etc). Torque required to overcome inertia and gravitational force of a four bar linkage.

2. Lower Pairs, Universal Joint - single and double, calculation of maximum torque, Oldham's Coupling, steering mechanism including. AcKermann's and Davis steering mechanism. Mechanisms with lower pairs, pantograph, exact and approximate straight line motion, engine indicators.elliptical trammel .

3. Gyroscope - Definition, axis of spin, axis of precession gyroscope, gyroscopic couple, Gyroscope effect on the momentum of ships and vehicle, ship stabilization, stability of automobile and locomotive taking a turn.

4. Cams:Types of cams and followers, definition – basic circle & least radius, angle of ascent, dwell, 7 descent & action. Displacement, velocity and acceleration diagrams for the followers with uniform velocity motion, simple harmonic motion, uniform acceleration and retardation, determination of maximum velocity, acceleration and retardation, analysis of follower motion for pre-specified cam profiles (tangent cams and convex cams).

Part B

5. Balancing: Classification , need for balancing, balancing for simple and multiple masses, static and dynamic balancing – Primary and secondary balancing for reciprocating masses, inside and 7 outside the cylinder locomotive balancing, swaying couple and variation of tractive effort, partial balancing of locomotive, balancing of the coupled locomotives and its advantages multi cylinder in the line engines (primary and secondary balancing conditions and their applications), balancing of V-engines balancing machines (Static balancing M/c: dynamic balancing M/c, universal balancing M/c), introduction of balancing of the flexible rotors.

6. Gears: Toothed gears are their uses, types of toothed gears (spur gears, internal spur gears, spur and rack, bevel gears, helical gears, double helical gears, spiral gears, worm gears) definitions, pitch circle diameter, pitch surface, pitch point, circular pitch, diametral pitch, module pitch, addendum, dedendum, clearance addendum circle, outside diameter, internal diameter, dedendum circle, root diameter ,base. Base circle diameter, face and flank of tooth, fillet, angle of obliquity or pressure angle, path of contact, arc of contact, arc of approach, condition for correct gearing, forms of teeth, cycloid and its teeth variants epicycloids and hypocycloid, involute methods of drawing in involute and cycloidal curves, interference in involute gears and methods of its removal, comparison of involute and cycloidal gear systems.

7. Gear Trains: Types of gear trains single and compound epicyclic gear trains, Problems involving their applications, estimation of velocity ratio of worm and worm wheel, helical and spiral gears (Determination of No. teeth, spiral angle and efficiency).

Textbooks

Title	Author	Publisher

Theory of Machines and Mechanisms	Uicker	OUP (2009)
Kinematics, Dynamics, and Design of Machinery	Waldron	Wiley (2016)
Mechanisms and Machines: Kinematics, Dynamics, and Synthesis	Stanisic	Cengage (2014)
Kinematics and Dynamics of Machinery	Wilson	Pearson (2008)
Kinematics and Dynamics of Machinery	Norton	McGrawHill (2017)

References

Title	Author	Publisher
Fundamentals of Kinematics and Dynamics of Machines and Mechanisms	Vinogradov	CRC (2000)
Kinematics and Dynamics of Mechanical Systems: Implementation in MATLAB® and SimMechanics®	Rusell	CRC (2018)
Theory of Machines	Bevan	CBS (2005)
Mechanics of Machines I and II	Hannah	Butterworth and Heinemann (1984)
Mechanics of Machines	Cleghorn	OUP (2015)
Principles of Vibration	Tongue	OUP (2002)
Kinematics and Dynamics of Machines	Martin	Waveland Press (2002)
Kinematics and Linkage Design	Hall	Waveland Press (1986)
Analysis of Mechanisms	Hall	Waveland Press (1987)

Course Code	MEC453
Course Title	Dynamics of Machines (P)
Course Type	Core
Course LTP	002
Course Credits	1
Course Assessment • Continuous	 50 (Practical Performance, Report Writing, and Viva Voce)
Course Prerequisites	Kinematics of Machines
Course Objectives	1. To educate students on different gear and gear train mechanisms 2. To introduce functioning of various types of cams 3. To give knowledge about balancing and inertia forces of various engine parts
Course Outcomes	1. Students will be able to design gears and understand transmission of forces 2. Students will be able to design different types of cam mechanism 3. Students will be able to understand the inertia forces involved during engine force and power transmissions 4. Students can generate various mechanisms related to lower pairs and solve engine problems related to balancing of rotating and reciprocating parts

List of Experiments

1. Balance experimentally the given known force by introducing two weight (forces) parallel to the given force in two different planes and verify the result by analytical method.

2. Study the dynamic balancing machine & balance of a given body i.e. rotor by different methods.

3. Study the working and construction of the two types of steering gears. Draw neat sketches of each type and measure the angle in Ackerman's steering gear fined in different vehicles. Find the ratio of intersection of two arms from the front axle to the base of the vehicle.

4. Study the different types of mechanisms for tracing out the approximate straight line.

5. Find out the pressure distribution graph analytically & practically around a simple Journal bearing under variable load conditions on the shaft.

6. To plot n-ϴ (follower displacement Vs cam rotation) curves for different cam and follower arrangements

7. To study gyroscopic effect on rotating disc and to verify the gyroscopic couple Experimentally.

8. Study the whirling speed apparatus and calculate the critical speed of the given System.

9. To study the model of an Epicyclic gear train and to determine the speed ratio.

10. To study the various tooth profiles and to generate the involute profile on a blank.

Textbooks

Title	Author	Publisher

References

Title	Author	Publisher

Course Code	MEC404
Course Title	Manufacturing Technology
Course Type	Core
Course LTP	300
Course Credits	3
Course Assessment • Continuous • End of Semester	50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Manufacturing Processes
Course Objectives	1. The primary objective of this course is to help the student gain the knowledge about traditional manufacturing machines like lathe, drilling, milling, grinding and welding machines. 2. To understand various tools and tool signatures used on these machines.
Course Outcomes	1. Describe the fundamentals of metal cutting and tool life. 2. Explain the construction, features, and operations of center lathes and special-purpose lathes. 3. Illustrate the working principle, functions, and specifications of shaping, planning, and slotting machines. 4. Describe the principle, types, and operations of milling and drilling machines.

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Metal cutting & Tool life:
   Basic tool geometry, single point tool nomenclature, chips- types and mechanism of chips formation, theoretical and experimental determination of shear angle, orthogonal and oblique metal cutting, metal cutting theories, relationship of velocities, forces and power consumption. Effect of operating parameters life tool geometry, cutting speed, feed depth of out, coolant, materials etc on forces temp.

Tool life, surface finish etc., tool life relationship, tailor equation of tool life, tool material and mechanism. (7Hours)

2. Centre Lathe and Special Purpose Lathes:
   Centre lathe, constructional features, cutting tool geometry, various operations, taper turning methods, thread cutting methods, special attachments, machining time and power estimation. Capstan and turret lathes – automats– single spindle, Swiss type, automatic screw type, multi spindle - Turret Indexing mechanism, Bar feed mechanism. (4 Hours)

3. Shaping & Planning:
   Principle, description & functions of lathe, specifications, work holding devices, tools & operations. Working principle of shaper, planer and slotter, Specification of shaper, planer and slotting machine Quick return mechanism, types of tools Speed and feed used in above processes. Commonly used cutting tool materials. (5 Hours)

4. Milling & Drilling :
   Milling; principle, types of milling machines, specifications of milling machine, Introduction to indexing, Multipoint cutting tool, Types of milling cutters. Principles, Classification of drilling machine, Different operations on drilling machine,Speed and feed in drilling. (4 Hours)

Part B

5. Grinding, Boring and Broaching:
   Types of grinding machines. Grinding wheels- Elements, codification and selection, balancing, dressing, loading and truing, About Boring and Broaching operations and applications. (7 Hours)

6. Gear Cutting:
   Gear teeth introduction and terminology, Gear manufacturing by: casting; Template methods; Gear shaper process; rack planning process; Hobbing process; Bevel gear cutting, Cutting worm and worm wheel, Gear finishing (5 Hours)

7. Thread Manufacturing:
   Screw threads: Introduction & classification, Elements of screw threads, specification, forms and error of screw threads; Processes of making threads using die heads, Thread milling, thread grinding, tread tapping, Automatic screw machine. (4Hours)

8. Metal Finishing and Coating:
   Purpose of super finishing, surface roughness.Introduction of Honing, Lapping Polishing, Buffing and super-finishing.Metal Spraying.Metal Coating; galvanizing, electro-plating and anodizing. (4Hours)

Textbooks

Title	Author	Publisher

Principles of Manufacturing Materials and Process	Campbell	Tata McGraw Hill
Groover's Principles of Modern Manufacturing	Groover	Wiley (2018)
Manufacturing Engineering and Technology	Kalpakjian	Pearson (208)

References

Title	Author	Publisher
Workshop Technology (Part 1, 2, 3)	Chapman	CBS (2001)

Course Code	MEC454
Course Title	Manufacturing Technology (P)
Course Type	Core
Course LTP	002
Course Credits	1
Course Assessment • Continuous	50 (Practical Performance, Report Writing, and Viva Voce)
Course Prerequisites	Internship-1
Course Objectives	1. The objective of this course is to help the student gain the knowledge and skills about traditional manufacturing machines like lathe, drilling, milling, grinding and welding machines. 2. To understand various tools and tool signatures used on these machines.
Course Outcomes	1. Identify the different components and operations of traditional machines. 2. Operate and perform various machining operations on a lathe including turning, grooving, boring, and threading. 3. Perform precision machining tasks such as grinding, reaming, and thread manufacturing with proper technique. 4. Understand and explain various gear manufacturing processes used in the industry.
List of Experiments: 1. To prepare a job on the lathe machine involves turning, grooving, drilling, boring & threading operation. 2. To prepare a job on a shaper machine. 3. To prepare a job on a milling machine. 4. To prepare a job on a drill machine involves drilling, countersinking & reaming operations. 5. To prepare a job involves-Grinding and thread manufacturing operations. 6. To study the different processes of gear manufacturing	

Course Code	MEC405
Course Title	Fluid Mechanics
Course Type	Core
Course LTP	300
Course Credits	3
Course Assessment • Continuous • End of Semester	50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Statics and Dynamics of RIgid Bodies, Thermodynamics
Course Objectives	1. To understand the structure and the properties of the fluid. 2. To understand the behavior of fluids at rest or in motion and the complexities involved in solving the fluid flow problems. 3. To solve different type of problems related to fluid flow in pipes and do the prototype study of different type of machines
Course Outcomes	1. Explain the concept of fluid, stability of bodies in fluid and different types of fluid flows. 2. Use Bernoulli's theorem to solve basic problems involving pressure losses through pipes and pipe bends and its application 3. Explain the importance of Dimensional Analysis techniques and dimensionless parameters in fluid mechanics; Reynolds number; Mach number. 4. Lean the concept of potential flow, viscous flow considering viscous forces

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Fundamental Concepts: Basic Fluid Properties, Classification of fluids, Viscosity, Vapour pressure, Surface Tension and Capillarity.
2. Fluid Statics: Pressure, Absolute and Gauge Pressure, Static Pressure Variation, Pressure Variation for Incompressible, Pressure Variation for Compressible Fluids,

Measurement of Static Pressure, Hydrostatic Forces on Plane Surfaces, Hydrostatic Forces on an Incline Plane Surface, Buoyancy and Stability,

3. Kinematics of Fluid Motion: Types of Flow Description, Types of Fluid Flow, Graphical Descriptions of Fluid Flow, Fluid Acceleration, Streamline Coordinates, The Reynolds Transport Theorem. Rate of Flow and Average Velocity, Continuity Equation.
4. Dimensional Analysis and Similitude: Dimensional Analysis, Important Dimensionless Numbers, The Buckingham Pi Theorem, Model and Similitude.

Part B

5. Energy of Moving Fluids: Euler's Equations of Motion, The Bernoulli Equation, Applications of Bernoulli's Equation: Pipe flow, venturimeter, orifice, mouth pieces, weirs and notches, Flow through pipes, minor and major losses, Energy and the Hydraulic Gradient.
6. Viscous Flow within Enclosed Surfaces: Equation of motion for laminar flow through pipes: Hagen Poiseuille formula, Flow between parallel flat plates, couette flow, Plane Poiseuille flow, Transition from laminar to turbulent, Reynolds experiment, Eddy viscosity, Mixing length concept.
7. Viscous Flow over External Surfaces: The Concept of the Boundary Layer, Laminar Boundary Layers, The Momentum Integral Equation, Turbulent Boundary Layers, Laminar and Turbulent Boundary Layers, Lift and Drag on an Aerofoil.
8. Compressible Flow: Wave Propagation through a Compressible Fluid, Isentropic Flow through a Variable Area, Isentropic Flow through Converging and Diverging Nozzles, Normal Shock and Oblique Shocks.

Textbooks

Title	Author	Publisher
Fluid Mechanics	White	McGraw-Hill (2017)
Fluid Mechanics	Cengel	McGraw-Hill (2017)
Fluid Mechanics	Hibbeler	Pearson (2017)
Fluid Mechanics	Munson	Wiley (2015)
Fluid Mechanics	Fox	Wiley (2015)
Mechanics of Fluids	Potter	Cengage (2015)

References

Title	Author	Publisher

Course Code	MEC455
Course Title	Fluid Mechanics (P)
Course Type	Core
Course LTP	002
Course Credits	1
Course Assessment • Continuous	50 (Practical Performance, Report Writing, and Viva Voce)
Course Prerequisites	
Course Objectives	
Course Outcomes	1. Verify Bernoulli's theorem experimentally and usaing various flow measuring devices. 2. Analyze flow characteristics over different types of weirs and evaluate the metacentric height of a ship model and understand its significance for ship stability. 3. Determine the friction factors for pipes with different diameters and analyze the effect of Reynolds number on flow resistance and analyze the head loss due to sudden expansion, contraction, and bends in pipeline flow. 4. Use Pitot-static probes to determine velocity distribution in pipeline flow and understand its relevance to real-world fluid systems.

List of Experiments

1. To verify Bernoulli's theorem.
2. To calibrate a venturimeter and to determine its coefficient of discharge.
3. To calibrate an orifice meter and study the variation of the coefficient of discharge with the Reynolds number
4. To study the flow over V- notch (weir) and Rectangular notch and to find their coefficient of discharge.
5. To determine the metacentric height of a ship model.
6. To determine the friction coefficients for pipes of different diameters.

7. To determine the head loss in a pipe line due to sudden expansion/ sudden contraction/ bend.

8. To determine the velocity distribution for pipeline flow with a pitot static probe.

9. Experimental evaluation of free and forced vortex flow.

Textbooks

Title	Author	Publisher

References

Title	Author	Publisher

Course Code	MEC406
Course Title	Numerical Analysis
Course Type	Core
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Intermediate Calculus and Basic algebra
Course Objectives	1. To understand accuracy and concept of error analysis. 2. To locate roots of non linear equations by iterative methods. 3. To understand the basics of interpolation theory, interpolating a function for data, numerical differentiation and integration. 4. To find unknowns using Gauss elimination method, Gauss Siedel method.
Course Outcomes	1. The student will learn different types of errors and their computations. 2. Finding roots of non linear equations by different iterative methods. 3. To estimate unknown values within a given range or outside a given range of set of known data, to estimate the derivative of function on discrete data and to compute integral of function on discrete data. 4. Solve linear system of equations by direct and iterative methods, and to solve initial value problems of ODE's by numerical methods.

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. **Error analysis**: Relative error, Absolute error, Round-off error, Truncation error, significant digits and numerical instability. (Scope as in Section 1.3, Chapter 1 of Reference 1).

2. **Transcendental and polynomial equations:** Bisection method, Iteration Method based on first degree equation: Secant method, Regula-falsi method and Newton – Raphson methods, Rate of convergence of Secant method, Regula-Falsi method and Newton-Raphson Method. Bairestow's method to find quadratic factor of a polynomial (Scope as in corresponding topics in Section 2.3, 2.5, 2.9 of Chapter 2 of Reference 1)

3. **Interpolation:** Polynomial interpolation: Finite differences, Lagrange and Newton interpolation (Forward, Backward and Divided difference methods), inverse interpolation, Hermite interpolation (Scope as in corresponding topics in Section 4.1-4.3, 4.5 of Chapter 4 of Reference 1)

<u>Section B</u>

4. **Solution of Linear Systems:** Gauss elimination method, Gauss-Seidel method, Cholesky's Decomposition. Matrix inversion: Gauss-Jordan method. Eigenvalue problem: Bounds on Eigenvalues (Gerschgorin and Brauer theorems), Householder's method for symmetric matrices, Power method (Scope as in corresponding topics in Section 3.2, 3.4, 3.6, 3.9, 3.11 of Chapter 3 of Reference 1).
5. **Numerical Integration:** Trapezoidal Rule, Simpson's 1/3 and 1/8 rule, Romberg integration, Newton – Coates formulae (Scope as in corresponding topics in Section 5.7, 5.8 of Chapter 5 of Reference 1).
6. **Numerical solutions of ordinary differential equations:** Taylor's series, Euler and Runge – Kutta methods. Finite difference methods for boundary value problems (Scope as in corresponding topics in Section 6.4 of Chapter 6 of Reference 1).
7. **Functional approximation:** Chebyshev polynomials, Economization of power series, Least square approximation (Scope as in corresponding topics in Section 4.9 of Chapter 4 of Reference 1).

Textbooks

Title	Author	Publisher
Numerical Methods for Scientific and Engineering Computation	M. K. Jain, S. R. K. Iyenger, R. K. Jain.	New Age International Publishers, New Delhi 2004

Introduction Methods of Numerical Analysis	S. S. Sastry	Prentice Hall of India, New Delhi, 2005
Computer Oriented Numerical Methods	V. Rajaraman	Prentice Hall of India, New Delhi, 1980
Numerical Mathematical Analysis	James B. Scarborough	
Applied Numerical Analysis	C. F. Gerald, P. O. Wheatley	Pearson Education, Delhi, 2002.

Course Code	MEC456
Course Title	Numerical Analysis (Practical)
Course Type	Core
Course LTP	003
Course Credits	1
Course Assessment ● Continuous	50
Course Prerequisites	
Course Objectives	1. To understand accuracy and concept of error analysis. 2. To locate roots of non linear equations by iterative methods. 3. To understand the basics of interpolation theory, interpolating a function for data, numerical differentiation and integration. 4. To find unknowns using Gauss elimination method, Gauss Siedel method.
Course Outcomes	1. The student will learn different types of errors and their computations. 2. Finding roots of non linear equations by different iterative methods. 3. To estimate unknown values within a given range or outside a given range of set of known data, to estimate the derivative of function on discrete data and to compute integral of function on discrete data. 4. Solve linear system of equations by direct and iterative methods, and to solve initial value problems of ODE's by numerical methods.

List of practicals:

1. Interpolation
2. Numerical integration
3. Curve fitting
4. Approximations
5. Solution of simultaneous equations
6. Matrix manipulation
7. Eigenvalue problems
8. Solution of ordinary differential equations.

Course Code	MEC457
Course Title	Internship 1
Course Type	Core (Mandatory internship lasting four weeks in a reputed Mechanical Engineering related Company or Research Organization)
Course LTP	0020
Course Credits	1
Course Assessment • Continuous • End of Semester	50
Course Prerequisites	Statics and Dynamics, Thermodynamics and Workshop practice
Course Objectives	1. To provide an exposure to students to an industrial work environment. 2. To make the students aware of work ethics and professional ethics.
Course Outcomes	1. Apply theoretical knowledge to perform practical tasks in areas such as manufacturing, maintenance, or design within an industrial setting. 2. Identify and analyze real-world engineering problems and contribute to developing or improving mechanical processes or systems. 3. Demonstrate effective communication, teamwork, and professional ethics while working in a multidisciplinary industrial environment. 4. Observe and understand industrial workflows, equipment usage, and safety practices relevant to mechanical engineering operations.

5th Semester

Course Code	MEC501
Course Title	Design of Machine Elements 1
Course Type	Core
Course LTP	300
Course Credits	3
Course Assessment • Continuous • End of Semester	50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Kinematics and Dynamics of Machines, Mechanics of Materials
Course Objectives	1. Develop the ability to analyze and evaluate the different loads and stresses acting on a machine element. 2. Understand the various failure modes of the element. 3. Apply the basic principles of mechanics to design the machine element which can meet the desired needs.
Course Outcomes	1. Ability to design and analyze both permanent joints (riveted, welded, etc.) and temporary joints (Bolts, keys, cotter, knuckle)under concentric and eccentric loading conditions. 2. Ability to design and analyze different types of levers. 3. Ability to analyze and design keys, power transmission shafts (carrying various elements like pulleys, gears etc) and couplings. 4. Ability to design and analyze power screws & screw jack.

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Introduction:
   Scope and meaning of design with special reference to machine design, design process, codes and standards, economic aspects of design, safety aspects of design. Stress and strength, Design factors and Factors of safety, Concept of tearing, bearing, shearing, crushing, bending,torsion ,deflection and stiffness. Basic criteria of selection material, mechanical properties of materials, Failures resulting from static loading, stress concentration, methods of avoiding stress

concentration, Introduction to fatigue in metals, mechanism of fatigue failure, S-N diagram, endurance limit, Fatigue strength, Endurance limit modifying factors, Fatigue stress concentration factor and notch sensitivity

2. Design of Levers:
   First, second and third types of levers, Design of hand lever, foot lever, bell crank lever, safety valve lever

3. Design of Non permanent Joints :
   Thread standards and definitions, Basic types of screw fastening, Bolt strength, Statically loaded tension joints-Preload, Design of eccentrically loaded bolted joints.Design of spigot and socket cotter joint, Design of knuckle joint.

4. Design of Permanent Joints:
   Riveted Joints: Types of failures of riveted joints, strength and efficiency of a riveted joint,Design of butt and lap joints of a boiler, design of Lozenge joint, design of eccentrically loaded riveted joints.
   Welded Joints: Types of welded joints, strength of a welded joint, design of welded joints for various loading conditions in torsion, shear or direct loads, design of eccentrically loaded welded joints.

Part B

5. Design of Shafts:
   Design of solid and hollow shafts for transmission of torque, bending moments and axial forces, Design of shaft for rigidity.

6. Design of keys and couplings:
   Types of keys, effect of keyway on strength of shaft, design of keys under different loading conditions. Types of couplings, design of sleeve coupling, clamp coupling, flange coupling and pin type flexible coupling.

7. Design of Pipe Joints:
   Design of pipes, design of circular, oval and square flanged pipe joints

8. Power Screw:
   Various types of threads used in power screw drives, conditions for self-locking and overhauling, efficiency of power screw drives, stresses developed in screws, design procedure for power screw drives like screw jack etc.

Textbooks

Title	Author	Publisher
Machine Design	Norton	Pearson (2018)
Shigley's Mechanical Engineering Design	Budynas	McGraw Hill (2017)
Machine Component Design	Juvinall	Wiley (2016)

References

Title	Author	Publisher
Machinery's Handbook	Oberg	Industrial Press (2020)

Course Code	MEC551
Course Title	Design of Machine Elements 1 (P)
Course Type	Core
Course LTP	002
Course Credits	1
Course Assessment • Continuous	50 (Practical Performance, Report Writing, and Viva Voce)
Course Prerequisites	Statics and Dynamics of Rigid Bodies, Mechanics of Materials, Kinematics and Dynamics of Machines, Engineering Drawing
Course Objectives	The Design assignments aim at providing application of the basic principles of mechanics to design the various machine elements considering the static and dynamic strength parameters.
Course Outcomes	1. Ability to design and analyze both permanent joints (riveted, welded, etc.) and temporary joints (Bolts, keys, cotter, knuckle)under concentric and eccentric loading conditions. 2. Ability to design and analyze different types of levers. 3. Ability to analyze and design keys, power transmission shafts (carrying various elements like pulleys, gears etc) and couplings. 4. Ability to design and analyze power screws & screw jack

List of Experiments

Design assignments to be given so as to cover the syllabus outlined in MEC 501

Textbooks

Title	Author	Publisher

References

Title	Author	Publisher

Course Code	MEC502
Course Title	Computer Aided Design and Manufacturing
Course Type	Core
Course LTP	300
Course Credits	3
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Manufacturing Technology
Course Objectives	1. To introduce the student to the basic concepts of computer-aided design (CAD) and computer-aided manufacturing (CAM). 2. To expose the student to contemporary computer design tools for mechanical engineers. 3. To prepare the student to be an effective user of a CAD/CAM system.
Course Outcomes	1. Understand the role of CAD/CAM in modern design and manufacturing. 2. Knowledge about the concept of Geometric modeling and understanding of various geometrical transformations. 3. Knowledge about the representations and manipulations of various curves, surfaces and solids. 4. Understand the concepts of the NC, CNC and DNC machines and be able to select the appropriate code for performing particular tasks in these machines.

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Basic concepts: Historical background of CAD.General design and manufacturing, Sequential and concurrent engineering, Computer aided design (CAD), Computer aided manufacturing (CAM), CAD/CAM, CIM. and CAD, General design Process, Application of computers in the design process. Concepts of CAD, CAM, CAD/CAM and CIM. Applications and benefits of CAD/CAM. Product life cycle management (PLM), types of production, automation, and its types.

2. Geometric Modelling: Introduction & need of geometric modelling, types: wire frame,surface and solid model, coordinate systems (model, working, screen). Geometric modelling (B-rep, CSG, Feature based). Geometric model representation (octree, voxel, B-rep).

3. Curves: Representation of curves: implicit, explicit, and parametric. Analytic curves – lines, circles, ellipses, parabolas, hyperbolas, conics. Synthetic curves: Hermite, Bezier, B-spline and NURBS. Numerical problems on intersection, division, using parametric equations. Equation of tangents on curves.

4. Transformations: 2D and 3D Transformations: translation, rotation, scaling, reflection, and shear. Homogeneous transformation, concatenated transformations. Numerical problems to obtain transformation of curves and objects like triangle and polygon.

Part B

5. Surfaces:Surface representation. Parametric representation of analytical surface; plane, cylindrical, conical, torus, swept surface, surface of revolution). Synthetic surfaces. Ruled, Coons, Ferguson, bilinear.

6. Solids:Solid model representation. Construction of solid models; constructive solid geometry (CSG) and feature based modelling. Solid representations; B-rep (boundary representation), stereolithography, voxel and octree. Useful concepts for solid modelling: Euclidean space, half-spaces, regularized sets, boundary evaluation, Euler’s rule for polyhedral parts. Geometric kernels. Capabilities and facilities provided in the modern CAD systems: application modules, programming. CAD data exchange.

7. NC machines: Introduction, basic components (Set of instructions, machine control unit, machine tool). Historical background of NC. Modern CNC machines. Coordinate axis and reference positions (work zero, machine zero). CNC configurations with multiple axes. Direct numerical control, adaptive control. NC part programming: Introduction and basic terms, description of alphanumeric (G,M) codes. Automated part programming.

8. Construction details of NC machines: Principle of axis control, types of motors (stepper, servo). Classification of feedback controls. Encoders. Slideways. Spindle

movements, Tool and work holding devices. Backlash error and recirculating ball screw arrangement. Important considerations in CNC machine construction.

Textbooks

Title	Author	Publisher
CAD/ CAM Theory and (P)	Zeid	McGraw Hill (2009)
CAD/CAM	Groover and Zimmers	Pearson (2003)
Automation, Production Systems and Computer-Integrated Manufacturing	Groover	Pearson (2016)

References

Title	Author	Publisher

Course Code	MEC552
Course Title	Computer Aided Design and Manufacturing (P)
Course Type	Core
Course LTP	002
Course Credits	1
Course Assessment • Continuous	50 (Practical Performance, Report Writing, and Viva Voce)
Course Prerequisites	Manufacturing Technology
Course Objectives	1. To introduce the students about the basic concepts of computer-aided design (CAD) and computer-aided manufacturing (CAM). 2. To expose the students to contemporary computer design tools for mechanical engineers. 3. To prepare the students to be an effective user of a CAD/CAM system.
Course Outcomes	1. Understanding of various geometrical transformations. 2. Representations and manipulations of various curves, surfaces and solids. 3. Knowledge about the modelling of various mechanical parts in CAD software. 4. Understanding of numerical controlled machines and basic part programming

List of Experiments

1. Write a program to generate a circle, an ellipse, and a tabulated cylinder.
2. Implement programmes for the graphics representation of scaling. translation, rotation, shear and 2D transformations using concatenation.
3. Implement programs for the graphics representation of scaling, translation, rotation, and mirror 3D transformations.
4. Implement programs for projection of geometric entities on orthographic planes.
5. Implement programmes for the graphics representation cubic Hermite curves and surfaces.
6. Implement programmes for the graphics representation of Bezier/B-splines curves/Surfaces.
7. CAD modeling practice on drafting, 3d geometric model, assembly using CAD software.

8. Implement the concept of CAD/CAM using software including CAD modelling, assembly, drafting and manufacturing with an example.
9. Write part program of jobs to be machined on CNC lathe.
10. Write a part program of jobs to be machined on CNC mill.

Textbooks

Title	Author	Publisher
Mastering CAD/CAM	Zeid	McGraw Hill (2006)

References

Title	Author	Publisher

Course Code	MEC503
Course Title	Robotics
Course Type	Core
Course LTP	300
Course Credits	3
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Exam.)
Course Prerequisites	Statics, Rigid Body Dynamics
Course Objectives	1. The purpose of this course is to introduce students to basics of forward kinematics, inverse kinematics and modeling 2. This course also introduces students to dynamics and trajectory planning of simple manipulators.
Course Outcomes	1. Identify and describe the components, classification, and applications of robotic systems in various industrial domains. 2. Apply transformation matrices and kinematic equations to perform forward and inverse kinematic analysis of robotic arms. 3. Analyze robotic manipulator dynamics and implement control strategies for stable and accurate motion execution. 4. Evaluate and design basic manipulator systems, integrating sensors, actuators, and control logic to meet specified tasks.

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Fundamentals of Robots: Introduction to robotics, anatomy of robot, robot classification and configurations, characteristics and applications of Robots.

2. Spatial Descriptions and Transformations: Position, orientation and frames, transformation from one frame to another, mapping of frames, transform equation, description of orientations of frames, Inverse of transformation matrices, Conventions for affixing frames to Links, forward manipulator kinematics.

3. Inverse Manipulator Kinematics: Solvability, Algebraic versus Geometric solutions, reduction to polynomial solution, Pieper's solution, Examples of inverse manipulator kinematics.

4. Velocity Propagation: Linear and rotational velocities of rigid bodies, velocity propagation, Jacobians, static forces in manipulators.

Part B

5. Manipulator Dynamics: Acceleration of a rigid body, Mass distribution, Iterative, Newton equation-Euler Dynamic formulation, manipulator's dynamic equation, Langrangian mechanics, Cartesian Space torque equation

6. Trajectory Planning: Joint space vs. Cartesian-space descriptions, Joint space trajectories, Cartesian space trajectories.

7. Linear Control of Manipulators: Feedback and Closed-Loop Control, Control of second order linear systems, control Law, trajectory-following control, modeling and control of single joint.

8. Manipulator Mechanism Design: Kinematic configuration, actuation schemes, stiffness and deflections, force and position sensing.

9. Sensors: Robot sensors: proximity, range, force, tactile, visual, auditory sensors. position sensing, force sensing.

Textbooks

Title	Author	Publisher
Introduction to Robotics	Craig	Pearson (2005)

References

Title	Author	Publisher
Introduction to Robotics	Niku	Wiley
Fundamentals of Robotics	Schilling	Pearson
A Textbook on Industrial Robotics	Ganesh Hegde	University Science Press

Course Code	MEC553
Course Title	Robotics (P)
Course Type	Core
Course LTP	002
Course Credits	1
Course Assessment • Continuous	50 (Lab Report, Practical Performance, Viva Voce)
Course Prerequisites	Statics, Rigid Body Dynamics
Course Objectives	1. The purpose of this course is to introduce students to basics of forward kinematics, inverse kinematics and modeling 2. This course also introduces students to dynamics and trajectory planning of simple manipulators.
Course Outcomes	1. Understand and be able to solve basic robot forward and inverse kinematics problems. 2. Understand and able to solve basic robotic dynamics, path planning and control problems. 3. Analyze and simulate the components of a manipulator, including drive systems and end-effectors, for real-world applications. 4. Able to undertake practical robotics experiments that demonstrate the above skills

List of Experiments

1. Study of different types of manipulators based on configuration and application.
2. Study of different types of robotics links and joints.
3. Forward and Inverse kinematics for PUMA 560
4. Design of two link manipulator using D&H parameters in Matlab using robotics Toolbox (Peter Corke)
5. Design of PUMA 560 D & H parameters in Matlab using robotics Toolbox (Peter Corke)
6. Study of different components of manipulators with drive systems and end effectors.
7. Simulate polynomial trajectories in MATLAB

Textbooks

Title	Author	Publisher

References

Title	Author	Publisher

Course Code	MEC504
Course Title	Mechanical Measurement and Metrology
Course Type	Core
Course LTP	300
Course Credits	3
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Applied Mathematics, Fluid Mechanics, Mechanics of Materials
Course Objectives	1. To educate students on different measurement systems and on common types of errors 2. To introduce different types of sensors, transducers and strain gauges used for measurement. 3. To give knowledge about thermocouples, thermometers and flow meters used for measurements 4. To introduce measuring equipment used for linear and angular measurements. 5. To familiarize students with micro and nano scale measurements
Course Outcomes	1. Identify and describe the components and functional elements of measurement systems, including types of transducers and their operating characteristics. 2. Analyze and evaluate measurement data to assess the reliability of experimental results. 3. Apply appropriate techniques and instruments for measurement of strain, pressure, flow, temperature and speed in engineering applications. 4. Inspect and assess surface finish, dimensional accuracy, and geometric tolerances of mechanical components using modern metrology tools and standards.
Syllabus Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper	

will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Fundamentals of Mechanical Measurement:
   Need and classification of measurements and instruments: basic and auxiliary functional elements of a measurement system; Mechanical vs. electrical/electronics instruments, primary, secondary and working standards. Functional elements of an instrument, Active and passive transducers, Analog & digital modes of operation, Null & deflection methods, Input-output configuration of instruments and measurement systems, Static characteristics and static calibration, dynamic characteristics.

2. Static and Dynamic Characteristics of Instruments:
   Range and span, accuracy and precision, calibration, hysteresis and dead zone, sensitivity and linearity, threshold and resolution: speed of response, lag, fidelity and dynamic error, dead time and dead zone.Zero, first and second order systems and their response to step, ramp and sinusoidal input signals

3. Assessing and Presenting Experimental Data:
   Common types of error. Introduction to uncertainty. Estimation of precision uncertainty. Theory based on the population. Theory based on the sample. Goodness of fit. Statistical analysis by computer. Bias and single-sample uncertainty. Propagation of uncertainty. Examples of uncertainty analysis. Minimizing error in designing experiments.Statistical analysis of test data.

4. Strain and Stress: Measurement and Analysis :
   Electro-mechanical sensors and transducers – variable resistance,inductance and capacitive pickups, photocells and piezo-electric transducers, and application of these elements for measurement of position/displacement, speed/velocity/acceleration, force and liquid level etc. Resistance strain gauges, gauge factor, bonded and unbonded gauges, surface preparation and bonding techniques, signal conditioning and bridge circuits, temperature compensation, application of strain gauges for direct, bending and torsional loads.

Part B

5. Pressure and Flow Measurement:
   Static and dynamic pressures. Pressure-measuring systems. Pressure-measuring transducers. Gravitational-type transducers. Elastic-type transducers. Elastic diaphragms. Secondary transducers used with diaphragms. Strain-gage pressure cells. Measurement of high pressure. Measurement of low pressure. Dynamic characteristics of pressure-measuring systems. Calibration methods.

Bourdon tube, diaphragm and bellows, vacuum measurement-Mcleod gauge, thermal conductivity gauge and ionization gauge; Dead weight pressure gauge tester.

6. Flow characteristics. Obstruction meters. Obstruction meters for compressible fluids. Predictability of obstruction meter performance. The variable-area meter. Additional flowmeters. Measurements of fluid velocities. Pressure probes. Thermal anemometry. Scattering measurements. Calibration of flow-measuring devices. Flow visualization.Electromagnetic flow meters, ultrasonic flow meters and hot wire anemometer:

7. Temperature Measurement:
   Thermal expansion methods- bimetallic thermometers, liquid-in-glass thermometer and filled-in-system thermometers; thermo-electric sensors-common thermo couples, reference junction considerations, special materials and configurations: metal resistance thermometers and thermistors; optical and total radiation pyrometers; calibration standards.Use of bimaterials. Pressure thermometers. Thermoresistive elements. Thermocouples. Semiconductor-junction temperature sensors. The linear-quartz thermometer.. Other methods of temperature indication. Special problems. Measurement of heat flux.

8. Speed, Forces, Torque and Shaft Power Measurement:
   Vibrometers and accelerometers. Elementary vibrometers and vibration detectors. Elementary accelerometers. The seismic instrument. General theory of the seismic instrument. The seismic accelerometer. Practical accelerometers. Calibration. Calibration of vibrometers. Calibration of accelerometers. Mechanical tachometers, vibration tachometer and stroboscope; proving ring, hydraulic and pneumatic load cells, torque on rotating shafts, Different types of Dynamometers: electrical and mechanical.

9. Metrology: Basics of Metrology, Accuracy and Precision, Standards of measurements. Metrology of Gears and screw threads: Gear tooth terminology, Sources of errors in manufacturing of gears, Measurement of tooth thickness. Measurement of tooth profile. Backlash checking. Measurement of straightness, flatness, squareness, parallelism, roundness and cylindricity, non-contact profiling systems, Metrology of Surface finish: Surface Metrology Concepts and terminology, Analysis of surface traces, Specification of surface Texture characteristics, and Method of measuring surface finish: Stylus system of measurement, Stylus probe instruments, Wave length, frequency and cut off, other methods for measuring surface roughness: Pneumatic method, Light Interference microscopes, Mecrin Instruments.

Textbooks

Title	Author	Publisher

Measurement Systems	Doebelin	McGraw-Hill (2017)
Mechatronics and Measurement Systems	Alciatore	McGraw Hill (2011)
Mechatronics a Multidisciplinary Approach	Bolton	Pearson (2014)
Mechanical Measurements	Beckwith	Pearson (2013)

References

Title	Author	Publisher

Course Code	MEC554
Course Title	Mechanical Measurement (P)
Course Type	Core
Course LTP	002
Course Credits	1
Course Assessment • Continuous	 50 (Practical Performance, Report Writing, and Viva Voce)
Course Prerequisites	
Course Objectives	
Course Outcomes	1. Demonstrate the ability to measure and calibrate various physical quantities (pressure, temperature, displacement, load, torque) using appropriate sensors and instruments. 2. Apply calibration techniques to ensure the accuracy and reliability of measurement systems, including pressure gauges, thermocouples, and strain gauges. 3. Analyze and interpret the data obtained from different types of measurement devices (e.g., planimeters, LVDTs, load cells) to assess their performance and accuracy in practical applications. 4. Develop proficiency in using and selecting appropriate transducers and sensors for specific measurement tasks, including angular displacement, linear displacement, strain, and water level measurements.

List of Experiments

1. Measurement of the area of an object by using a planimeter.
2. Calibration of Pressure-gauge with the help of a dead weight gauge tester.
3. Calibration of thermocouple.
4. Measurement of speed by photoelectric pick up/ electromagnetic pick up/ proximity type sensors.
5. Measurement angular displacement by capacitive transducer.
6. Measurement of linear displacement by linear motion potentiometer/ servo potentiometer/ LVDT/ inductive pick up/ capacitive pick up.
7. Measurement of load using load cell.
8. Measurement of strain using strain gauge.
9. Measurement of Torque.
10. Measurement of water level.

Textbooks

Title	Author	Publisher

References

Title	Author	Publisher

Course Code	MEC505
Course Title	Mechatronics
Course Type	Core
Course LTP	300
Course Credits	3
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Exam.)
Course Prerequisites	Basics of Electrical and Electronics Engineering, Statics and Dynamics of RIgid Bodies, Mechanics of Materials
Course Objectives	1. To enable the students to understand the modern mechatronics components. 2. To enable the students to understand the interdisciplinary fundamentals of mechanical engineering, electrical engineering, control systems, computer engineering and their integration. 3. This course focuses particularly on providing an overview of embedded controllers like microprocessors/microcontrollers, PLCs, sensors etc. and applications of mechatronics to observe and control various mechanical systems: thermal systems, motion systems, pneumatic systems and hydraulic systems.
Course Outcomes	1. The students will be able to integrate mechanical, electronics, control and computer engineering in the design of Mechatronics systems. 2. The students will learn the basics of microcontrollers, sensors and actuators embedded in automated machines. 3. Design and evaluate analog signal processing systems. 4. The students will be able to apply knowledge of basic mechatronics to construct a mechatronic system

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Electric circuits and components: Basic electrical elements (resistor, capacitor, inductor), Kirchoff's laws, Voltage and current sources and meters, Thevenin and Norton equivalent circuits, Alternating current circuit analysis, Power in electrical circuits, Transformer, Impedance matching, Grounding and electrical interference
2. Semiconductor electronics: Semiconductor physics, Junction diode (Zener diode, voltage regulators, optoelectronic diodes, analysis of diode circuits), Bipolar junction transistor (common emitter transistor, bipolar transistor switch, Darlington transistor), Field-Effect transistors (behaviour, symbols, applications of MOSFETs)
3. Analog signal processing using operational amplifiers: Ideal model for the operational amplifier, inverting amplifier, non inverting amplifier, summer, difference amplifier, instrumentation amplifier, integrator, differentiator, sample and hold circuit, comparator, The real Op Amp.

Part B

4. Digital circuits: Digital representation, combinational logic and logic classes, timing diagrams, Boolean algebra, Design of logic networks, Boolean expression from a truth table, sequential logic, Flip-flops, Application of flip-flops.
5. Microcontroller programming and interfacing: Microprocessors and microcomputers, microcontrollers, The PIC16F84 microcontroller, Programming a PIC, PicBasic Pro, Using interrupts, Interfacing common PIC peripherals (keypad, LCD), interfacing to the PIC, method to design a microcontroller based system. Programmable Logic controller, Basic PLC structure, Ladder programming, Instruction lists, Sequencing, Shift registers.
6. Data acquisition: Quantizing theory, Analog-to-Digital conversion, Digital-to-Analog conversion, virtual instrumentation-data acquisition & control using Labview software.
7. Mechanical and electrical actuation systems: Kinematic chains, Cams, Gears, Ratchet & Pawl, Belt & chain drives, bearings, solenoids & relays,

DC motors, Stepper motor, examples of mechatronic systems consisting of electrical-mechanical-electronic elements.

Textbooks

Title	Author	Publisher
Mechatronics and Measurement Systems	Alciatore	McGraw Hill (2011)
Mechatronics a Multidisciplinary Approach	Bolton	Pearson (2014)

References

Title	Author	Publisher

Course Code	MEC555
Course Title	Mechatronics (P)
Course Type	Core
Course LTP	002
Course Credits	1
Course Assessment • Continuous	 50 (Practical Performance, Report writing and Viva voce)
Course Prerequisites	Introductory Electrical and Electronics Engineering,Statics and Dynamics of Rigid Bodies, Mechanics of Materials
Course Objectives	1. To enable the students to understand the interdisciplinary fundamentals of mechanical engineering, electrical engineering, control systems, computer engineering 2. Also learn their integration and apply them in practical problems.
Course Outcomes	1. Demonstrate the ability to acquire and process sensor signals using an A/D card and interface with a computer for real-time data analysis and control. 2. Apply digital-to-analog conversion (D/A) techniques to send data signals from a computer to actuators for control in automation systems. 3. Design and implement position and speed control systems for motors, including servo mechanisms and stepper motors, and analyze the impact of external loads. 4. Develop proficiency in controlling industrial systems using PID controllers and pneumatic systems, and evaluate system performance under various load conditions.

List of Experiments

1. To acquire signal from a sensor through A/D card on to a computer.

2. To send data signals from the computer to some actuator through a D/A card.
3. To carry out the position control of a geared DC motor using a servo mechanism.
4. To carry out the microprocessor based direction and speed control of a stepper motor and to observe the effect of external load.
5. To study the DC speed control system built around a permanent variable loading.
6. To perform the PID control of an oven.
7. To assemble a pneumatic sorting system by means of a single acting cylinder magnet DC motor, an optical pick-up and a slotted disk to measure the speed of the motor for feedback control.
8. To find the characteristics of the system when subjected to a set of articles.
9. Use a pneumatic double acting cylinder to open and close the lid on a container.

Textbooks

Title	Author	Publisher
Introduction to Mechatronic Design	Carryer	Pearson
Mechatronic System Design	Kolk	Cengage

References

Title	Author	Publisher

Course Code	MEC506
Course Title	Fluid Machinery
Course Type	Core
Course LTP	300
Course Credits	3
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Thermodynamics, Fluid Mechanics
Course Objectives	The objectives of the course are 1. To understand the fundamental thermo- and fluid-dynamic behavior of fluid machinery, 2. To give detailed descriptions of the main elements and applications of fluid machinery, 3. To understand the basic blade row aerodynamics and their influence on the machinery operating conditions
Course Outcomes	1. Explain principles of hydraulic machines and turbines. 2. Estimate the performance of Impulse and Reaction turbine. 3. Solve the efficiency of centrifugal and reciprocating pumps. 4. Performance analysis of hydraulic machines and Identify the various hydraulic control devices.

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Principles of Hydraulic Machines & General Study of Hydro Power Plants, classification of Hydraulic Machines, flow over moving curved and radial vanes and construction of velocity triangles,

2. Impulse Turbine :Description of Pelton impulse turbine, design of Pelton turbines such as number of jets, number of buckets, depth and width of buckets, velocity diagrams, jet ratio, power and efficiency.

3. Reaction Turbines:Design and Description of Francis and Kaplan Turbines, velocity diagrams, speed ratio, flow ratio, degree of reaction as applied to Kaplan and Francis turbines, Concept of cavitation. Governing of impulse and reaction turbines. Draft Tube: Description, function and Type.

4. Turbomachinery Noise and Performance Estimation: Sound and Noise, Fan Noise,, A Note on Pump Noise, Compressor and Turbine Noise, Cordier Diagram, Preliminary Machine Selection, Fan Selection from Vendor Data, Pump Selection from Vendor Data

Part B

5. Centrifugal Pumps: Brief description and classification of Centrifugal, Design of Centrifugal pump, work done and pressure rise, Minimum starting speed, Priming and priming devices.

6. Dimensional Analysis and Performance of Hydro Machines: Buckingham Theorem and its practical applications to turbines and pumps, Specific and unit quantities for turbines and pumps by application of Buckingham theorem. Characteristics curves of turbine and pumps.

7. Reciprocating Pumps: Slip and coefficient of discharge, Effect of acceleration on pressure in suction and delivery pipes, Air vessels (work saved by air vessel on suction and delivery pipe) Comparison with centrifugal pumps.

8. Hydraulic Devices: Construction, operation and applications of simple and differential hydraulic accumulator, intensifier, fluid coupling and torque converter, Air lift and jet pumps; gear pump, vane and piston pumps, Hydraulic Rams, Hydraulic valves,

Textbooks

Title	Author	Publisher
Fluid Mechanics	White	McGraw-Hill (2017)
Fluid Mechanics	Cengel	McGraw-Hill (2017)
Fluid Mechanics	Hibbeler	Pearson (2017)
Fluid Mechanics	Munson	Wiley (2015)
Fluid Mechanics	Fox	Wiley (2015)
Mechanics of Fluids	Potter	Cengage (2015)

References

Title	Author	Publisher
Fluid Machinery: Application, Selection, and Design	Wright	CRC Press (2009)
Fluid Mechanics and Thermodynamics of Turbomachinery	Dixon	Butterworth-Heinemann (2014)
Principles of Turbomachinery	Korpela	Wiley (2019)
Pump Characteristics and Applications	Volk	CRC Press (2013)
Handbook of Fluid Dynamics and Fluid Machinery	Fuhs, Schetz	Wiley

Course Code	MEC556
Course Title	Fluid Machinery (P)
Course Type	Core
Course LTP	002
Course Credits	1
Course Assessment • Continuous	50 (Practical Performance, Report Writing, and Viva Voce)
Course Prerequisites	
Course Objectives	
Course Outcomes	1. Analyze and determine the efficiencies of hydraulic machines, such as Hydraulic Rams, and evaluate their performance under different operating conditions. 2. Demonstrate the ability to draw and interpret the performance characteristics of turbines (Francis and Pelton turbines) and pumps (centrifugal pumps) from experimental data. 3. Understand the construction and working principles of reciprocating pumps, and perform tests to determine their performance parameters, such as flow rate, head, and efficiency. 4. Investigate the impact of vane shape and vane angle on the performance of centrifugal fans, and optimize fan design based on experimental findings.

List of Experiments

1. Determination of various efficiencies of Hydraulic Ram.
2. To draw characteristics of Francis turbine.
3. To study the constructional features of reciprocating pump and to perform test on it for determination of pump performance.
4. To draw the characteristics of Pelton Turbine.
5. To draw the various characteristics of a Centrifugal pump.
6. Determine the effect of vane shape and vane angle on the performance of centrifugal fan

Textbooks

Title	Author	Publisher

References

Title	Author	Publisher

6th Semester

Course Code	MEC601
Course Title	Design of Machine Elements 2
Course Type	Core
Course LTP	300
Course Credits	3
Course Assessment ● Continuous ● End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Calculus, Linear Algebra, Differential Equations, Statics and Dynamics of Rigid Bodies, Mechanics of Materials, Kinematics and Dynamics of Machines
Course Objectives	Student will be able to: 1. Develop the ability to analyze and evaluate the different loads and stresses acting on a machine element. 2. Understand the various failure modes of the element. 3. Apply the basic principles of mechanics to design the machine element which can meet the desired needs.
Course Outcomes	1. Ability to design and analyze different types of flexible drives (belt drive, rope drive and chain drive) and rigid drives (spur gear, helical gear, bevel gear and worm gear drive) 2. Familiarity with different types of springs and spring terminology & ability to design and analyze coil springs and leaf spring 3. Acquaintance with the working of sliding and rolling contact bearings & ability to design them. 4. Ability to design and analyze clutches and brakes.
Syllabus	

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.
Note - The use of a design data book is allowed.

Part A

1. Flexible Mechanical Elements: Introduction to belts, Flat and Round Belt Drives, V belts, Roller Chain, Wire Rope.

2. Gears : Introduction, Loading on Spur Gear, Stresses in Spur Gear, Bending Stresses, Surface Stresses, Design of Spur Gears, Helical Gear Geometry, Helical Gear Forces, Virtual Number of Teeth, Contact ratio, Stresses in Helical Gears, Bevel Gear Geometry and Nomenclature, Forces on Bevel Gears, Stresses in Bevel Gears, Wormset Geometry, Design Procedure for Wormset.

3. Mechanical Springs : Introduction, Spring Rate, Spring Configuration, Spring Materials, Helical Compression Springs, Spring Lengths, End Details, Active Coils, Spring Index, Spring Deflection, Spring Rate, Stresses in Helical Compression Spring Coils, Designing Helical Compression Spring for Static Loading, Designing Helical Compression Spring for Fatigue Loading, Design of Leaf Spring, Nipping

Part B

4. Lubrication and Journal Bearings: Introduction, Lubricants, Viscosity, Types of Lubrication, Full Film Lubrication, Boundary Lubrication, Hydrodynamic Lubrication Theory, Petroff’s Equation, Reynold’s Equation for Eccentric Journal Bearings, Design of Hydrodynamic Bearings.

5. Rolling Contact Bearing: Comparison of Rolling and Sliding Bearings, Types of Rolling Element Bearings, Failure of Rolling Element Bearings, Selection of Rolling Element Bearings, Basic Dynamic Load Rating, Basic Static Load Rating, Combined Radial and Thrust Loads

6. Clutches and Brakes: Introduction, Types of Brakes and Clutches, Clutch and Brake Materials, Disk Clutches, Uniform Pressure, Uniform Wear , Disk Brakes, Short-Shoe External Drum Brakes, Long-Shoe External Drum Brakes, Internal-Shoe Internal Drum Brakes

Textbooks

Title	Author	Publisher
Machine Design	Norton	Pearson (2018)
Shigley's Mechanical Engineering Design	Budynas	McGraw Hill (2017)

Machine Component Design	Juvinall	Wiley (2016)

References

Title	Author	Publisher
Machinery's Handbook	Oberg	Industrial Press (2020)

Course Code	MEC651
Course Title	Design of Machine Elements 2 (P)
Course Type	Core
Course LTP	002
Course Credits	1
Course Assessment ● Continuous	50 (Practical Performance, Report Writing, and Viva Voce)
Course Prerequisites	Statics and Dynamics of Rigid Bodies, Mechanics of Materials, Kinematics and Dynamics of Machines, Engineering Drawing
Course Objectives	The Design assignments aim at providing application of the basics of mechanics to design the various machine elements considering the static and dynamic strength parameters.
Course Outcomes	1. Ability to design and analyze different types of flexible drives (belt drive, rope drive and chain drive) and rigid drives (spur gear, helical gear, bevel gear and worm gear drive) 2. Familiarity with different types of springs and spring terminology & ability to design and analyze coil springs and leaf spring 3. Acquaintance with the working of sliding and rolling contact bearings & ability to design them. 4. Ability to design and analyze clutches and brakes.

List of Experiments

Design assignments covering material outlined in MEC 601

Textbooks

Title	Author	Publisher

References

Title	Author	Publisher

Course Code	MEC602
Course Title	Finite Element Methods
Course Type	Core
Course LTP	300
Course Credits	3
Course Assessment ● Continuous ● End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Mechanics of Materials
Course Objectives	1. This course aims at providing fundamental knowledge in finite element analysis. 2. The course will present systematic approaches for the derivation of various finite elements and solution of the discretized governing equations. 3. Practical aspects of finite elements analysis such as mesh generation will also be presented
Course Outcomes	1. Understand the fundamental theory and principles of the Finite Element Method (FEM). 2. Formulate and solve finite element models for different element types by applying appropriate boundary conditions. 3. Apply basic finite elements such as truss, beam, frame, and plate elements to structural analysis problems. 4. Analyze and solve dynamic problems using the Finite Element Method.

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Fundamental Concepts: Historical Background, introduction, applications. Basic concepts; direct approach, principle of minimum potential energy (PMPE), Rayleigh—Ritz Method, Galerkin's Method. Stresses and strains in 1d, 2d and 3d problems. Strain—Displacement Relations. Temperature Effects. Saint Venant's Principle. Plane stress and plane strain conditions.

2. Discretization of the Domain: Types of elements (1d,2d,3d). General consideration about placement of nodes, element size, shape and number, node numbering, quality, effect of node numbering on band size of stiffness matrix. Location of nodes, number of elements, simplification offered by physical configuration of body. Mesh refinement and convergence.

3. One dimensional problems: Introduction, local (natural) coordinate system, shape functions, element node connectivity, Global stiffness matrix, load vector, strain-displacement matrix.. Effect of temperature. Formulation of a taper bar as ID FEM problem. Quadratic shape function.
4. Trusses: Bar element in 2D, plane trusses, global stiffness matrix, load vector, Three dimensional trusses.

Part B

5. Beams, frames and CST elements: General description of 2D beam and frame elements. CST element; shape function for a triangular element, Jacobian, Strain displacement matrix. Algorithm/procedure for obtaining global stiffness matrix.

6. Axisymmetric, quadrilateral and 3D elements: General description of axisymmetric element and quadrilateral element. Procedure/algorithm to get element stiffness matrix for such elements. General description of 3D elements, tetrahedral elements. Procedure/algorithm to get stiffness matrix for static structural problem.

7. Dynamic Analysis: Formulation for solid body with distributed mass, element mass matrices for 1D bar element, Evaluation of eigenvalues and eigenvectors, Guyan's reduction, Rigid body modes.

8. FEM implementation: Pre-processing, Post processing, Design parameterization, Structural optimization, Topology optimization, Approximation techniques and Design sensitivity analysis.

Textbooks

Title	Author	Publisher
The finite element in Engineering	SS Rao	Elsevier
Introduction to FE in Engineering	Chandrupatla and Belegundu	Pearson (2015)

Textbook of finite element analysis	P Seshu	PHI
FE Method for Engineers	Huebner	Wiley (2009)
Fundamentals of FEA	Hutton	McGraw-Hill (2003)
Introduction to FEM	Reddy	McGraw-Hill (2017)
Introduction to FEM	Thompson	Wiley (2009)
FEA with ANSYS	Moaveni	Pearson (2011)
FE Procedures	Bathe	Pearson (2009)

References

Title	Author	Publisher
Introduction to FEM	Reddy	McGraw-Hill (2017)

<table>
<tr><td>Course Code</td><td>MEC652</td></tr>
<tr><td>Course Title</td><td>Finite Element Methods (P)</td></tr>
<tr><td>Course Type</td><td>Core</td></tr>
<tr><td>Course LTP</td><td>002</td></tr>
<tr><td>Course Credits</td><td>1</td></tr>
<tr><td>Course Assessment
● Continuous</td><td>
50 (Practical Performance, Report Writing, and Viva Voce)</td></tr>
<tr><td>Course Prerequisites</td><td>Mechanics of Materials</td></tr>
<tr><td>Course Objectives</td><td>The experiments aim at providing practical knowledge in finite element methods and to solve practical engineering problem using any FEM software.</td></tr>
<tr><td>Course Outcomes</td><td>1. Demonstrate understanding of FEM discretization and shape functions through visualization and MATLAB programming.
2. Develop and implement MATLAB code for solving 1D and 2D FEM problems including trusses.
3. Use ANSYS software to model and analyze static and dynamic structural problems under various boundary conditions.
4. Apply FEM-based tools for simulation, optimization, and performance evaluation of engineering components in multi-physics environments</td></tr>
<tr><td colspan="2">List of Experiments

1. Understanding the concept of FE discretization with the help of an example of a circle.
2. Program to plot and understand various shape functions used in Finite Element analysis using Matlab.
3. Program for getting FEM solution of 1D problem using Matlab.
4. Program for getting FEM solution of truss problem using Matlab.
5. Using ANSYS FEM analysis software for construction of nodes, elements and solution and post processing for 1D and 2D static structural problems under various boundary conditions. (5-6 problems)
6. Using Ansys FEM software for 3D static structural problem FE (such as L-shape, T-shape) under various boundary conditions and loading. Modify the geometry to save material etc.
7. Using Ansys FE software for modelling and analysis (Eigenvalues and mode shapes) of thin rectangular plate under one edge fixed type conditions.</td></tr>
</table>

8. Multi-physics FEM problem: Use FEM Ansys software to solve a problem for modal, thermal and structural analysis
9. Optimization using FEM: Optimize a given problem for selected parameters using FEM Ansys software
10. FEM based mini project: Each student is expected to select a suitable mini-project (programming or software based) and present the same.

Textbooks

Title	Author	Publisher
FEA with ANSYS	Moaveni	Pearson (2011)
Introduction to FE in Engineering	Chandrupatla and Belegundu	Pearson (2015)

References

Title	Author	Publisher

Course Code	MEC603
Course Title	Mechanical Vibrations
Course Type	Core
Course LTP	300
Course Credits	3
Course Assessment ● Continuous ● End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Statics & Dynamics of RIgid Bodies, Mechanics of Materials, Kinematics and Dynamics of Machinery
Course Objectives	1. To state the importance of Mechanical Vibrations 2. To make the students aware about various modeling techniques helpful in imitating a Mechanical system. 3. To give them practical exposure of Elements of a Vibrating system 4. To make students learn the harmful effects of vibrations and techniques required to make the system safe from its ill effects.
Course Outcomes	1. The principle and working of Elements of a Vibrating system 2. Formulation of Workable model of a Vibrating system 3. Formulations and solution of equations of motion for various types of vibrating systems 4. Methods to bring reduction in the levels of vibration in system to which they are harmful by learning to design vibration controlling Mechanical systems
Syllabus Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.	

Part A

1. Introduction, Primary Objective, Elements of a Vibratory System, Examples of Vibratory Motions, Simple Harmonic Motion, Vectorial Representation of Harmonic Motions

2. Systems with one degree of freedom
   Systems with one degree of freedom, Introduction, Degrees of Freedom, Equation of Motion-Energy Method, Equation of Motion-Newton's Law of Motion, General Solution, Complementary Function, Particular Integral, General Solution, Frequency Response Method, Impedance Method, Transfer Function, Resonance, Damping, and Bandwidth, Transient Vibration, Impulse Response, Convolution Integral

3. Systems with one degree of freedom - Applications
   Introduction, Undamped Free Vibration, Damped-Free Vibration, Undamped Forced Vibration-Harmonic Excitation, Damped Forced Vibration-Harmonic Excitation, Rotating and Reciprocating Unbalance, Critical Speed of Rotating Shafts, Vibration Isolation and Transmissibility, Systems Attached to Moving Support Seismic Instruments, Elastically Supported Damped Systems, Damped Forced Vibration-Periodic Excitation, Transient Vibration-Shock Spectrum, Equivalent Viscous Damping,

4. Systems with more than one degree of freedom
   Introduction, Equations of Motion: Newton's Second Law, Undamped Free Vibration: Principal Modes, Generalized and Coupling, Principal Coordinates, Modal Analysis:Transient Vibration of Undamped Systems, Forced Vibration-Harmonic Excitation, Influence Coefficients

Part B

5. Methods for finding natural frequencies
   Introduction, Rayleigh Method, Transfer Matrix Method, Myklestad-Prohl Method

6. Discrete Systems
   Introduction, Equations of Motion, Undamped Systems, Undamped Vibration Principal Modes, Orthogonality and Principal Coordinates, Expansion Theorem, Quotient Semidefinite Systems, Matrix Iteration, Undamped Forced Vibration-Modal Analysis, Systems with Proportional Orthogonality of Modes of DampedSystems, Damped Forced Vibration-Modal Analysis

7. Continuous Systems
   Introduction, Continuous System: A Simple Exposition, Separation of the Time and Space Variables, Problems Governed by the Wave Equation, Longitudinal Vibration of Rods, Torsional Vibration of Shafts, Lateral Vibration of Beams, Rotary Inertia and Other Effects, Shear Deformation and Rotary Inertia Effects, Effect of Axial Loading, The Eigenvalue Problem, Orthogonality,

Lagrange's Equations, Undamped Forced Vibration-Modal Analysis, Rayleigh's Quotient, Rayleigh-Ritz Method

Textbooks

Title	Author	Publisher
Mechanical Vibrations Theory and Applications	Tse	CBS (2004)
Theory of Vibrations with Applications	Thompson	Pearson (2008)
Engineering Vibration	Inman	Pearson (2013)

References

Title	Author	Publisher
Fundamentals of Vibration	Meirovitch	McGraw-Hill (2014)
Theory and Practise of Mechanical Vibrations	J S Rao	New Age (1999)
Mechanical Vibration	S S Rao	Pearson (2018)
Mechanical Vibration	Kelly	McGraw-Hill (2017)

Course Code	MEC653
Course Title	Mechanical Vibrations (P)
Course Type	Core
Course LTP	002
Course Credits	1
Course Assessment ● Continuous	50 (Practical Performance, Report Writing, and Viva Voce)
Course Prerequisites	Statics & Dynamics of RIgid Bodies, Mechanics of Materials, Kinematics and Dynamics of Machinery
Course Objectives	1. To state the importance Mechanical Vibrations 2. To make the students aware about various modeling techniques helpful in imitating a Mechanical system. 3. To give them practical exposure of Elements of a Vibrating system 4. To tell them about applications of Elements of a Vibrating system 5. To make students learn the harmful effects of vibrations and techniques required to make the system safe from its ill effects.
Course Outcomes	1. Perform experiments to determine vibration characteristics such as natural frequency, damping ratio, and moment of inertia using standard test setups. 2. Analyze vibration responses and identify dynamic system parameters from forced vibration experiments. 3. Simulate time responses of single and multi-degree-of-freedom systems using SIMULINK and numerical techniques like Newmark-Beta method. 4. Apply signal processing tools such as FFT to extract harmonic and natural frequencies from experimental vibration data.
List of Experiments 1. To determine the mass moment of inertia of a body by Trifilar suspension. 2. To determine the damping ratio and natural frequency of a vibrating body by rap test. 3. To find frequency response of a system through a forced vibration test. 4. To identify a system from forced vibration test data.. 5. Investigate nodes and antinodes of a centrally pivoted beam.	

6. Simulate time response of a single degree of freedom spring-mass-damper system on SIMULINK.
7. Simulate time response of a two degree of freedom spring-mass-damper system on SIMULINK.
8. Use Newmark-Beta method to simulate time response of a three degree of freedom system.
9. Find the first three natural frequencies of a body from it's time response. (using FFT algorithm of Matlab)
10. Experimentally find out different harmonic frequencies present in vibrations of an IC engine.
11. Use an instrumented impact hammer to find transfer function between two given points of a structure.

Textbooks

Title	Author	Publisher

References

Title	Author	Publisher

Course Code	MEC604
Course Title	Heat Transfer
Course Type	Core
Course LTP	300
Course Credits	3
Course Assessment ● Continuous ● End of Semester	50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Thermodynamics, Fluid Mechanics, Differential Equations
Course Objectives	1. To understand the basic concepts and different methods of Heat transfer. 2. To understand the basic concepts of conduction. 3. To understand the cross-sections of fins and their application in temperature measurement 4. To understand the principles of convection. 5. To understand the basic concepts of Heat Exchangers and its types. 6. To understand the principles of radiation and Phase change Heat transfer
Course Outcomes	1. Each student will be able to apply conservation of mass and energy to a control volume or control surface. Each student understands and can analyze conduction heat transfer in case of Cartesian, cylindrical and spherical problems and is able to solve them. 2. Each student will be able to analyze extended surfaces . 3. Each student understands the physical phenomena associated with convection, and will be able to solve convection heat transfer problems. Each student will be able to use empirical correlations to analyze external and internal, forced and free convection problems. 4. Each student understands the physical mechanisms involved in radiation heat transfer. Each student will be able to calculate total, hemispherical radiative properties of real surfaces from their spectral, directional counterparts.
Syllabus	

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Basics Of Heat Transfer:Thermodynamics And Heat Transfer Engineering, Heat Transfer, Heat And Other Forms Of Energy, The First Law Of Thermodynamics, Heat Transfer Mechanisms, Conduction, Convection , Radiation, Simultaneous Heat Transfer Mechanisms.

2. Heat Conduction Equation and Steady Heat Conduction: Introduction, One Dimensional Heat Conduction Equation: Heat Conduction Equation In A Large Plane Wall, Long Cylinder, Sphere, Combined One Dimensional Heat Conduction Equation, General Heat Conduction Equation: Rectangular Coordinates, Cylindrical Coordinates, Spherical Coordinates, Boundary And Initial Conditions, Solution Of Steady One Dimensional Heat Conduction Problems, Heat Generation In A Solid, Variable Thermal Conductivity, Steady Heat Conduction In Plane Walls: The Thermal Resistance Concept, Thermal Resistance Network, Multilayer Plane Walls, Thermal Contact Resistance, Generalized Thermal Resistance Networks, Heat Conduction In Cylinders And Spheres; Multilayered Cylinders And Spheres, Critical Radius Of Insulation, Heat Transfer From Finned Surfaces; Fin Equation, Fin Efficiency, Fin Effectiveness, Proper Length Of A Fin, Heat Transfer In Common Configurations.

3. Fundamentals Of Convection: Physical Mechanism On Convection , Classification Of Fluid Flows ; Velocity Boundary Layer; Surface Shear Stress, Thermal Boundary Layer; Prandtl Number, Laminar And Turbulent Flows; Reynolds Number, Heat And Momentum Transfer In Turbulent Flow Differential Convection Equations ; Conservation Of Mass Equation , Momentum , Energy Equation (No Derivation), Nondimensionalized Convection Equations And Similarity, Functional Forms Of Friction And Convection Coefficients , Analogies Between Momentum And Heat Transfer , Drag Force And Heat Transfer In External Flow; Friction And Pressure Drag , Parallel Flow Over Flat Plates; Friction Coefficient, Heat Transfer Coefficient , Mean Velocity And Mean Temperature, Non Dimensional Numbers And Their Physical Significance, Empirical Correlations For Flat Plate, Circular Cylinder, Circular Pipe (Horizontal Only).

Part B

4. Boiling And Condensation: Boiling Heat Transfer Pool Boiling; Boiling Regimes And The Boiling Curve, Heat Transfer Correlations In Pool Boiling, Enhancement Of Heat Transfer In Pool Boiling, Flow Boiling Condensation Heat Transfer Film Condensation; Flow Regimes, Heat Transfer Correlations

For Film Condensation, Film Condensation Inside Horizontal Tubes, Dropwise Condensation

5. Radiation Heat Transfer:Introduction, Thermal Radiation, Blackbody Radiation, Radiation Intensity; Solid Angle, Intensity Of Emitted Radiation, Incident Radiation, Radiosity, Spectral Quantities, Radiative Properties, Kirchhoff's Law , Atmospheric And Solar Radiation; The View Factor, View Factor Relations The Reciprocity Relation The Summation Rule   The Superposition Rule The Symmetry Rule View Factors Between Infinitely Long Surfaces: The Crossed   Strings Method , Radiation Heat Transfer: Black Surfaces ,   Radiation Heat Transfer: Diffuse, Gray Surfaces ; Radiosity, Net Radiation Heat Transfer To Or From A Surface, Net Radiation Heat Transfer Between Any Two Surfaces, Methods Of Solving Radiation Problems Radiation Heat Transfer In Two   Surface Enclosures, Radiation Heat Transfer In Three   Surface Enclosures , Radiation Shields.

6. Heat Exchangers: Types Of Heat Exchangers. The Overall Heat Transfer Coefficient. Fouling Factor, Analysis Of Heat Exchangers. The Log Mean Temperature Difference Method. Counter Flow Heat Exchangers. Multipass and Cross Flow Heat Exchangers: Use Of A Correction Factor The Effectiveness–NTU Method.

Textbooks

Title	Author	Publisher
Heat & Mass Transfer: Fundamentals and Application	Cengel	McGraw-Hill (2020)
Fundamentals of Heat and Mass Transfer	Incropera	Wiley (2018)
Heat Transfer	Holman	McGraw-Hill (2007)
Principles of heat transfer	Kreith	Cengage (2018)

References

Title	Author	Publisher

Course Code	MEC654
Course Title	Heat Transfer (P)
Course Type	Core
Course LTP	002
Course Credits	1
Course Assessment ● Continuous	 50 (Practical Performance, Report Writing, and Viva Voce)
Course Prerequisites	Thermodynamics
Course Objectives	1. To understand the experimental overview of conduction, and conduction related practicals, practical significance of thermal conductivity 2. To understand the experimental overview of convection, and convection related practicals, practical significance of heat transfer coefficient 3. To understand the experimental overview of radiation , and radiation related practicals, calculation Stefan Baltzmann coefficient , emissivity of surfaces.
Course Outcomes	1. Measure thermal conductivity and analyze heat conduction through different materials, including lagging materials. 2. Determine convective heat transfer coefficients for natural and forced convection scenarios and analyze influencing parameters. 3. Evaluate the performance of heat exchangers and determine overall heat transfer coefficients for various flow configurations. 4. Conduct radiation heat transfer experiments to determine emissivity and Stefan-Boltzmann constant, and compare dropwise and filmwise condensation

List of Experiments

1. To find the thermal conductivity of metal rods.
2. To determine heat transfer coefficient in natural convection.
3. To determine heat transfer coefficient in forced convection for air flowing in a tube.
4. To determine the experimental and theoretical heat transfer coefficient in drop wise and film wise condensation.
5. To determine the emissivity of a given plate at different temperatures.
6. To study and compare temperature distribution, heat transfer rate, overall heat transfer coefficient in parallel flow and counter flow heat exchanger.

7. To determine Overall Heat Transfer coefficient in Shell and tube heat exchanger.
8. To determine Stefan Boltzmann's constant in the radiation heat transfer process.
9. To determine the value of thermal conductivity of lagging material

Textbooks

Title	Author	Publisher

References

Title	Author	Publisher

Course Code	MEC605
Course Title	Mechanical Behavior of Materials
Course Type	Core
Course LTP	300
Course Credits	3
Course Assessment ● Continuous ● End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Strength of Materials or Mechanics of Materials and Materials Science
Course Objectives	This course aims to understand the behavior of material in engineering applications
Course Outcomes	1. Understand the response of material under loading during its life and analyse the scope of its failure 2. Analyse and design covering elastic and plastic deformation, fracture fatigue and creep of crystalline materials 3. Create solutions using cost effective materials for desired mechanical behaviour 4. Analyze the stress-strain behavior and deformation mechanisms in metals and anisotropic materials.

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part-A

Stress Strain Behaviour (5)

Elastic Deformation and Theoretical Strength, Inelastic Deformation, Models for Deformation Behavior, Elastic Deformation, anisotropic Materials.

Fracture (8)

Introduction, Fracture, Fundamentals of Fracture, Ductile Fracture, Brittle Fracture, Principles of Fracture Mechanics, Fracture Toughness Testing, Fatigue, Cyclic Stresses, the S–N Curve, Crack Initiation and Propagation.

Fatigue and Creep (8)

Factors That Affect Fatigue Life, Sources of Cyclic Loading, Fatigue Testing, Environmental Effects, Creep, Generalized Creep Behavior, Stress and Temperature Effects.

Part-B

Iron–Carbon System (4)

The Iron–Iron Carbide (Fe–Fe3C) Phase Diagram, Development of Microstructure in Iron–Carbon Alloys, The Influence of Other Alloying Elements

Phase Transformations: Development of Microstructure and Alteration of Mechanical Properties (9)

Introduction, Phase Transformations, Basic Concepts, The Kinetics of Phase Transformations, Metastable Versus Equilibrium States, Microstructural and Property Changes in Iron–Carbon Alloys, Isothermal Transformation Diagrams, Continuous Cooling Transformation Diagrams, Mechanical Behavior of Iron–Carbon Alloys, Tempered Martensite.

Characteristics, Applications, and Processing of Polymers (6)

Introduction, Mechanical Behavior of Polymers, Stress–Strain Behavior, Macroscopic Deformation, Viscoelastic Deformation, Fracture of Polymers, Miscellaneous Mechanical Characteristics, Mechanisms of Deformation and for Strengthening of Polymers, Deformation of Semi-crystalline, Polymers, Factors That Influence the Mechanical Properties of Semi-crystalline Polymers, Deformation of Elastomers, Crystallization, Melting, The Glass Transition

Textbooks

Title	Author	Publisher

Materials Science and Engineering	William D. Callister	Wiley (2014)
Mechanical Behavior of Materials	Norman Dowling	Pearson (2017)
Mechanical Behavior of Materials	Andre Meyers	CUP (2009)
Mechanical Behavior of Materials	Bowman	Wiley (2003)
Mechanical Behavior of Materials	Courtney	McGraw Hill (2017)
Physical Metallurgy	George E. Dieter	McGraw-Hill

References

Title	Author	Publisher

Course Code	MEC655
Course Title	Mechanical Behavior of Materials (P)
Course Type	Core
Course LTP	002
Course Credits	1
Course Assessment ● Continuous	 50 (Practical Performance, Report Writing, and Viva Voce)
Course Prerequisites	Strength of Materials or Mechanics of Materials and Materials Science
Course Objectives	The experiments aims at providing knowledge in mechanical behavior of materials
Course Outcomes	1. Understand the impact of heat treatment on mechanical properties 2. Understand the type of material failure which helps in design and material selection 3. Understand the structure and deformation under loading 4. Conduct mechanical tests (tensile, hardness, impact) on heat-treated specimens and correlate test results with microstructural changes

List of Experiments

1. To study the effects of mechanical processes namely Casting, Welding and Forging on the mechanical properties (strength, hardness, ductility/malleability, toughness, fatigue resistance, creep resistance etc) of processed materials.
2. To study microstructure of following materials before and after heat treatment:
   i. Hypo-eutectoid steel and Hyper-eutectoid steel
   ii. Hypo-eutectic and Hyper eutectic steel, Grey and White Cast iron
3. Study of microstructure and hardness of steel at different rate of cooling.
4. Heat treatment: Annealing/Normalizing/Hardening/Tempering of mild steel samples.
   i. Tensile and Hardness testing of heat treated samples
   ii. Interpretation of microstructures and comparison
5. Heat treatment: Annealing/Normalizing/Hardening/Tempering of alloy steel samples.
   i. Hardness testing (Vicker/Brinell/Rockwell Test)
   ii. Charpy Impact test/Fatigue test

Textbooks

Title	Author	Publisher
Heat Treatment: Master Control Manual	Bryson, W.	Hanser Publications
Materials Science and engineering	W D Callister	John Wiley and Sons

References

Title	Author	Publisher

Course Code	MEC 606
Course Title	Operations Research
Course Type	Core
Course LTP	300
Course Credits	3
Course Assessment ● Continuous ● End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Statistics, Manufacturing
Course Objectives	Introduce students to formulate, analyze and solve mathematical models that represent real-world problems using various techniques.
Course Outcomes	1. Understand scope, objectives, phases, models & limitations of operations research. 2. Understand the theoretical working of linear programming techniques like graphical, simplex algorithm and dual simplex technique. 3. Solve specialized linear programming problems like transportation and assignment models & model a dynamic system as queuing model and computation of its important performance measures. 4. Solve network models using PERT and CPM techniques

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. **Introduction:**

Origin & Development of Operation Research, Definition and Meaning of Operation Research, Different Phases of an Operation Research Study, Scope and Limitations of Operation Research, Operation Research Models, Solving the OR models.

2. **Modelling with Linear Programing-I:**

The Linear Programming Model, Assumptions of LP model, Two variable LP model, Graphical LP solution- Solution of Minimization and Maximization model, Selected LP applications like Urban Planning, Investment, Production planning and control, Blending, Manpower planning.

3. **Modelling with Linear Programing-II:**

Simplex method; Artificial starting solution- Big-M method and Two Phase method; Special cases in simplex like Degeneracy, Alternate optima, unbounded solution, Infeasible solution; Duality and degeneracy in simplex method, Dual simplex method.

4. **Transportation Model:**

Definition of Transportation model, Mathematical model of Transportation problem, The Transportation Algorithm, Determination of starting solution, Test for Optimality, Unbalanced Transportation model and Degeneracy in Transportation model, The Assignment Model- Hungarian Method.

Part B

5. **Network Models**

Scope and Definition of network models, Travelling Salesman's problem and its solution using Branch and Bound method

6. **Queuing Systems**

Introduction, Elements of a Queuing model, Performance Measures of a Queuing system,, Kendall's notation, Preliminary examples of Single server queuing models and Multi server queuing models.

7. **CPM AND PERT**

Introduction, Network Representation: Network Components and Precedence Relationships; Critical Path (CPM) Computations: Forward Pass method, Backward Pass method; Construction of the Time Schedule, The PERT approach: Optimistic, Pessimistic & Most likely time Estimates, Estimation of Project completion time.

Textbooks

Title	Author	Publisher
Operations Research: An Introduction	H. A. Taha	Pearson Prentice Hall
Introduction to Operations Research	Hillier	McGraw Hill Education

References

Title	Author	Publisher
Principles of Operations Research : With Applications to Management Decisions	Wagner, H.M.	Prentice-Hall of India, New Delhi
Operational Research for Managers	Stephen C. Littlechild (Editor)	P. Allan, Oxford

Course Code	MEC 656
Course Title	Operations Research (P)
Course Type	Core
Course LTP	0 0 3
Course Credits	1
Course Assessment ● · Continuous	50 (Practical Performance, Report Writing, Viva Voce)
Course Prerequisites	Basic knowledge of statistics and terminology used in production/manufacturing industry.
Course Objectives	This module aims to introduce students to formulate, analyze and solve mathematical models that represent real-world problems using various techniques.
Course Outcome	1. Understand scope, objectives, phases, models & limitations of operations research. 2. Understand the theoretical working of linear programming techniques like graphical, simplex algorithm and dual simplex technique. 3. Solve specialized linear programming problems like transportation and assignment models & model a dynamic system as queuing model and computation of its important performance measures. 4. Solve network models using PERT and CPM techniques

List of Experiments

Projects and case studies concerning the topics outlined in MEC 606 in theory.

Course Code	MEC657
Course Title	Internship 2
Course Type	Core (Mandatory internship of four week duration in a reputed Mechanical Engineering related Company or Research Organization)
Course LTP	0 0 20
Course Credits	1
Course Assessment ● Continuous ● End of Semester	50
Course Prerequisites	1. Knowledge of various manufacturing processes used in industry. 2. Knowledge of underlying principles of Solid Mechanics, Fluid Mechanics and Heat transfer.
Course Objectives	1. To give students an opportunity to apply the knowledge they have acquired on campus practically in a real-life work situation and hence sharpen their technical skills. 2. To provide an exposure to students to an industrial work environment and give them an opportunity to work on a live project and implement it. 3. To make the students industry ready and make them aware of work ethics and professional ethics. 4. To provide students with employability opportunities.
Course Outcome	1. Apply theory to practical engineering tasks. 2. Analyze and evaluate existing mechanical systems. 3. Demonstrate professional communication and teamwork. 4. Document and present internship experiences.

7th Semester

Course Code	MEC701
Course Title	Refrigeration and Air Conditioning
Course Type	Core
Course LTP	300
Course Credits	3
Course Assessment • Continuous • End of Semester	50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Basic Thermodynamics, Engineering Thermodynamics
Course Objectives	1. To understand the basic concepts and different cycles of refrigeration. 2. To understand the working and analysis of commonly used refrigeration cycles. 3. To understand about various properties and usage of refrigerants available and their selection for various applications in refrigeration and air conditioning. 4. To understand psychrometry principles and various air conditioning processes. 5. To understand the concepts of load calculation for air conditioning of different types of buildings 6. To understand the working and principles of various refrigeration and air conditioning equipment.
Course Outcomes	1. Explain the basic refrigeration concepts, including natural and mechanical refrigeration, refrigeration cycles, and their applications in different systems. 2. Analyze and compare different refrigeration systems such as air refrigeration, vapor compression, and vapor absorption systems, and determine their efficiencies and limitations. 3. Identify the properties and environmental impact of refrigerants, and select appropriate refrigerants for specific applications while considering global warming and ozone depletion potential. 4. Apply psychrometric relations and charts to analyze air conditioning processes, and perform heat load calculations to design air conditioning systems.
Syllabus	

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Basic concepts:

Natural and Mechanical refrigeration.Applications of Refrigeration using different working substances.Units of refrigeration.Coefficient of performance and Energy performance ratio.Refrigeration effect and refrigeration capacity. Heating effect and heating capacity. Reversed Carnot, cycle and its limitations. COP of refrigerator and heat pump working on reversed Carnot cycle and their relation.

2. Air refrigeration systems:

Bell Coleman cycle and its analysis.Advantages and Disadvantage of Air refrigeration systems.Necessity of cooling the Aircraft. Factors considered in selecting the refrigeration system for Aircraft. Types of Aircraft refrigeration systems: Simple cooling with Simple Evaporative, type Aircraft Air conditioning. Bootstrap and Bootstrap evaporative type Aircraft Air conditioning, Regenerative type Aircraft Air conditioning. Reduced Ambient type Aircraft Air conditioning. Effect of moisture on enthalpy calculations. Power required for pressurisation of cabin. Comparison of different Aircraft refrigeration systems,

3. Vapour compression refrigeration systems:

Vapour compression refrigeration cycles on T-s, h-s and p-h plots. Analysis of Vapour compression refrigeration system.Comparison of Actual vapour compression refrigeration cycle with Theoretical vapour compression refrigeration cycle. Comparison of Air refrigeration cycle with Vapour compression refrigeration cycle.Factors affecting C.O.P. of the vapour compression refrigeration system.Method of improving C.O.P. of vapour compression refrigeration system.Optimum inter stage pressure. Vapour compression refrigeration systems with multiple evaporators and compressors. Single load systems with multiple compressors.Multi-load systems with single compressor.Multiple evaporator and compressor systems.Dual compression system.

4. Vapour absorption refrigeration systems:

Principle and components of vapour absorption systems. Types of Vapour absorption refrigeration systems: Aqua-ammonia absorption refrigeration system. Three fluid vapour absorption refrigeration system. Lithium bromide vapour absorption refrigeration system. Comparison of Vapour absorption and Vapour compression refrigeration systems.

Part B

5. Refrigerants:

Classification of refrigerants.Required properties of an ideal refrigerant.Important refrigerants.Global warming potential, Ozone depleting potential and their effect on choice of refrigerants.Secondary refrigerants, Antifreeze solutions, Refrigerant oils.Refrigerant leakage detection methods.

6. Psychrometry:
Meaning of Air conditioning.Psychrometry and Psychrometric properties.Psychrometric relations.Psychrometric chart.Psychrometric processes.

7. Air conditioning:
Requirements of comfort air-conditioning, comfort and comfort chart. Factors governing optimum effective temperature. Design considerations. Ventilation and Ventilation standards.Summer air-conditioning and winter air-conditioning systems.Year round air-conditioning systems.

8. Load Calculations and Design of Air-conditioning systems:
Calculation of heat load from different heat sources, internal and external: Conduction load. Radiation load.Occupant load.Equipment load.Infiltration load.Ventilation load.Miscellaneous heat sources.RSHF, GSHF and ESHF. By pass factor. Design of Air-conditioning systems.Air washers.

9. Brief introduction to Refrigeration and air-conditioning equipments:
Compressors.Condensers and cooling towers.Evaporators.Expansion devices. Piping and pumps. Electric motors.Air-cleaning and air-filters.Humidifiers.Dehumidifiers.Fans and blowers.Grills.

Textbooks

Title	Author	Publisher
Principles of Refrigeration	Dossat	Pearson (2002)
Refrigeration and Air Conditioning	Stoecker	McGraw-Hill (1983)
Modern Refrigeration and Air Conditioning	Althouse	Goodheart-Wilcox (2004)
Refrigeration, Air Conditioning, and Heat Pumps	Hundy	Butterworth-Heinemann
Air Conditioning Principles and Systems: An Energy Approach	Pita	Pearson (2018)
Refrigeration and Air Conditioning Technology	Tomczyk, Silverstein, and Whitman	Cengage (2018)

References

Title	Author	Publisher
Industrial Refrigeration Handbook	Stoecker	McGraw-Hill (1998)

Course Code	MEC751
Course Title	Refrigeration and Air Conditioning (P)
Course Type	Core
Course LTP	003
Course Credits	1
Course Assessment • Continuous	 50 (Practical Performance, Report Writing, and Viva Voce)
Course Prerequisites	Basic Thermodynamics, Engineering Thermodynamics, Heat Transfer
Course Objectives	1. To understand the basic concepts and different cycles of refrigeration. 2. To understand the working and analysis of commonly used refrigeration cycles. 3. To understand about various properties and usage of refrigerants available and their selection for various applications in refrigeration and air conditioning. 4. To understand psychrometry principles and various air conditioning processes. 5. To understand the concepts of load calculation for air conditioning of different types of buildings. 6. To understand the working and principles of various refrigeration and air conditioning equipment.
Course Outcomes	1. Understand various cycles used in RAC 2. Understand various refrigerants available 3. Understand various air conditioning methods for different environment 4. Understand different equipments used in RAC and designing air conditioning systems for different applications
List of Experiments 1. Study of various elements of a mechanical refrigerator system through cut sections models / actual apparatus 2. Study and performance of domestic refrigerator, 3. Study the performance of and Electrolux refrigerator. 4. Study and performance of an Ice plant test rig. 5. 5. 5. Calculation/ Estimation of cooling load for large building	

6. Visit to a central Air conditioning plant for study of processes for winter and summer air conditioning
7. Study and performance of window type room air conditioner.
8. Study of Cooling Tower.

Textbooks

Title	Author	Publisher

References

Title	Author	Publisher

Course Code	MEC702
Course Title	Automatic Control
Course Type	Core
Course LTP	300
Course Credits	3
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Kinematics & Dynamics of Machinery, Thermodynamics
Course Objectives	To learn how to control a mechanical system : pneumatic, hydraulic, thermal etc.
Course Outcomes	1. Model and represent physical systems in terms of transfer functions and state-space equations, and analyze their time and frequency-domain responses. 2. Apply block diagram reduction, signal flow graphs, and Mason's rule to simplify complex system models for analysis and design. 3. Design and analyze control systems using root-locus and frequency-response methods, including tuning PID controllers and applying compensation techniques. 4. Analyze the stability of control systems using Routh-Hurwitz criterion, Nyquist criterion, and frequency-response methods to determine system performance.

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. System Modeling: Introduction, Laplace transform review, The transfer function, Electrical network transfer functions, Translational mechanical

systems transfer functions, Rotational mechanical system transfer function, Transfer functions for systems with gears, Electromechanical system transfer functions, Electric circuit analogs,linearization. Modeling in the time domain: Introduction, The general state-space representation, converting a transfer function to state space, converting from state space to a transfer function, linearization.

2. Reduction of multiple subsystems: Block diagrams, analysis and design of feedback systems, signal flow graphs, Mason's rule, Signal-flow graphs of state equations, alternative representations in state space, Similarity transformations.

3. Time response: Introduction, Types of control action (P, PI, PID), Ziegler Nichols rules for tuning PID controllers, Poles-zeros-system response, first order system, second order systems, system response with zeros, Routh Hurwitz criterion of Stability.

Part B

4. Control Systems Analysis and Design by the Root-Locus Method. Introduction, Root-Locus Plots , Plotting Root Loci with MATLAB, Root-Locus Plots of Positive Feedback Systems, Root-Locus Approach to Control-Systems Design, Lead Compensation, Lag Compensation, Lag–Lead Compensation, Parallel Compensation,

5. Control Systems Analysis and Design by the Frequency-Response Method Introduction, Bode Diagrams, Polar Plots, Log-Magnitude-versus-Phase Plots, Nyquist Stability Criterion, Stability Analysis, Relative Stability Analysis, Closed-Loop Frequency Response of Unity-Feedback Systems, Experimental Determination of Transfer Functions, Control Systems Design by Frequency-Response Approach, Lead Compensation, Lag Compensation, Lag–Lead Compensation.

6. Control Systems Analysis in State Space, Introduction, State-Space Representations of Transfer-Function Systems, Transformation of System Models with MATLAB, Solving the Time-Invariant State Equation, Some Useful Results in Vector-Matrix Analysis, Controllability, Observability.

Textbooks

Title	Author	Publisher
Modern Control Engineering	Ogata	Prentice Hall
Control Systems Engineering	Nise	Wiley
Automatic Control Systems	Kuo	McGraw-Hill (2018)
Modelling and control of Dynamic Systems	Macia	Cengage

References

Title	Author	Publisher

Course Code	MEC752
Course Title	Automatic Control (P)
Course Type	Core
Course LTP	003
Course Credits	1
Course Assessment • Continuous	 50 (Practical Performance, Report Writing, and Viva Voce)
Course Prerequisites	Kinematics and Dynamics of Machines, Thermodynamics
Course Objectives	To learn how to control a mechanical system : pneumatic, hydraulic, thermal etc.
Course Outcomes	1. Implement two-mode (P + I) and (P + D) controllers on real-time temperature/flow control systems and analyze their performance. 2. Implement and fine-tune a three-mode (P + I + D) control system on a temperature/flow trainer to achieve desired system stability and response. 3. Apply the Ziegler-Nichols method to tune controllers for optimal performance in real-world control systems. 4. Simulate and analyze the dynamic behavior of first-order and second-order systems using LabVIEW software, understanding system characteristics.

List of Experiments

1. Perform two mode (P + I) controls on a temperature/flow control trainer.
2. Perform two mode (P + D) controls on a temperature/flow control trainer.
3. Perform three mode (P + I + D) controls on a temperature/flow control trainer.
4. Tune the temperature/flow control trainer using Zeigler-Nichols method.
5. Simulate first order system and second order systems on Labview software.
6. Acquire data from an analog sensor using PC and Labview software.
7. Control vibrations of a cantilevered beam using negative velocity feedback.

Textbooks

Title	Author	Publisher

References

Title	Author	Publisher

Course Code	MEC703
Course Title	Automobile Engineering
Course Type	Core
Course LTP	300
Course Credits	3
Course Assessment • Continuous • End of Semester	50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Thermodynamics, Engineering Thermodynamics, Kinematics and Dynamics of Machines
Course Objectives	1. To understand the basic concepts about automobile and performance parameters. 2. To understand the working of an engine and its subsystems. 3. To understand about function, necessity and working of various types of clutches. Selection for different applications. 4. To understand power transmission from engine to tyres. Conversions at different stages, understanding working of different sub-systems in transmission to understand the power flow. 5. To understand the working of various control systems like suspension, steering and brakes. 6. To understand the environmental impacts and study various means of emission control from automobiles.
Course Outcomes	1. Basic understanding about working of automobile 2. Understanding, importance of various sub-systems in performance of automobile 3. Understand importance of control in automobile 4. Environmental friendly automobiles

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

PART-A

1. **Introduction**

Components of automobile, basic structure, classification of automobile, body styles, frame and frameless construction, power for propulsion, traction and tractive effort, relation between engine revolution and vehicle speed, road performance curves, calculation of equivalent weight, gear ratio for maximum acceleration.

2. **ICE & EV**

Automobile Engine Types and Classification, Engine Measurements wear and Performance, Superchargers and Turbochargers, Automotive Battery, Starting System, Charging System, Ignition System. Electric vehicle technology, motor drive technologies.

3. **Clutches**

Requirements of clutch, types of clutches, working of single plate, multiplate and centrifugal clutch, clutch operation, clutch plate, fluid flywheel.

4. **Transmission**

Functions of transmission, necessity, types of transmission, sliding mesh, constant mesh, synchromesh, selector mechanism, transfer box, automatic transmission, torque converter, overdrive, propeller shaft, universal joint, final drive, differential, rear axle, rear axle drive.

PART-B

5. **Suspension**

Basic classifications, types of suspension systems, leaf springs, shock absorbers, independent suspension, types of front wheel independent suspension system, air suspension.

6. **Front Axle and steering**

Front axle, wheel alignment, steering geometry, under-steer and over-steer, steering linkage, steering gears, steering ratio, reversibility, power steering.

7. **Brakes wheel and Tyres**

Brake efficiency and stopping distance, fading of brakes, wheel skidding, types of brakes, drum and disk brakes, hydraulic and pneumatic brakes, servo brakes, antilock braking system, types of wheels, wheel dimensions, types of tyres, cross ply, radial ply and belted-bias type, tyre designation.

8. **Emission control**

Automotive air pollution, emission control, crank case emission, evaporative emission control, exhaust emission control, catalytic converter.

Textbooks

Title	Author	Publisher
Automotive Mechanics	Crouse	McGraw Hill (2017)
Automotive Engines	Dempsey	
Automotive Mechanics	Heitner	CBS (2004)

References

Title	Author	Publisher

Course Code	MEC753
Course Title	Automobile Engineering (P)
Course Type	Core
Course LTP	003
Course Credits	1
Course Assessment • Continuous	50 (Practical Performance, Report Writing, and Viva Voce)
Course Prerequisites	Kinematics and Dynamics of Machines
Course Objectives	
Course Outcomes	1. Identify and explain the function of essential automotive systems such as steering, braking, and fuel systems. 2. Perform basic mechanical maintenance tasks such as tire removal, valve grinding, and piston reassembly. 3. Diagnose common engine and braking system issues using standard workshop tools. 4. Demonstrate safe and effective handling of modern components like GDI systems and battery replacements

List of Experiments

1. Study of various tools and working of various systems/components from an actual automobile/working model.
2. Removing the car tyres, repairing the tubes - their testing and fitting back.
3. Valve refacing and valve seat grinding and checking the seat for leakage.
4. Checking of cylinders for wear and finding out the next possible over-size of the
5. Piston replacing rings and studying methods of replacing piston after re-boring.
6. Study of Gasoline Direct Injection system of fuel supply used in modern automobile engines
7. Working of starting system, battery charging system and replacement of a car battery.
8. Study of Vehicle steering system and measuring steering geometry angles.

9. Replacing of car battery and casting of plate connectors, cell connectors etc.
10. Overhauling of the braking system, adjusting the brake shoes, bleeding the system and testing.

Textbooks

Title	Author	Publisher
Road Vehicle Dynamics: Fundamentals and Modeling with MATLAB®	Rill	CRC (2020)

References

Title	Author	Publisher

Course Code	MEC755
Course Title	Minor Project
Course Type	Core
Course LTP	004
Course Credits	2
Course Assessment • Continuous	 100 (Practical Performance, Report Writing, and Viva Voce)
Course Prerequisites	Machine design, Theory of Machines, Thermodynamics Fluid mechanics, Solid mechanics, Heat-transfer and Vibrations
Course Objectives	Exposure to innovation on some real-world problem
Course Outcomes	1. Ability to identify complex engineering problems and formulate technical or research gaps and project objectives. 2. Ability to propose a solution methodology to an existing problem. 3. Ability to validate the proposed solution theoretically and/or experimentally 4. Ability to communicate using project reports, paper publications and presentations.

Course Code	MEC704a
Course Title	Machine Learning
Course Type	Elective
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Discrete Structures
Course Objectives	The objective is to familiarize the students with some basic learning algorithms and techniques and their applications, as well as general issues related to analyzing and handling data.
Course Outcomes	1. Ability to apply machine learning techniques to solve regression and classification problems 2. Ability to design and implement machine learning algorithms for various applications 3. Ability to analyze and evaluate the performance of different machine learning models

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Introduction
   Overview of machine learning, related areas, applications, software tools

2. Parametric regression
   Simple linear regression, multiple linear regression, polynomial regression, nonlinear regression, gradient descent in linear regression, gradient descent in multiple regression, normal equation

3. Generative learning
   Gaussian parameter estimation, maximum likelihood estimation, bias and variance of estimators

4. Classification
   Logistic regression, decision boundary, gradient descent in logistic regression, multiclass classification, overfitting problem, cost function regularization

5. Neural networks
   The perceptron algorithm, multilayer perceptrons, backpropagation, multiclass discrimination, training procedures, localized network structure, learning curves, regularization, Support vector machines

Part B

6. Unsupervised learning
   K-means clustering, hierarchical clustering, density based clustering, latent dirichlet allocation, dendrogram, hidden markov model

7. Dimensionality reduction
   Feature selection, principal component analysis, linear discriminant analysis, factor analysis, independent component analysis, multidimensional scaling

8. Evaluation methods
   Evaluating hypotheses, classification accuracy, confusion matrix, precision, recall, F1 score, log loss, Area under curve, regression metrics, elbow method, silhouette analysis

Note: A selection of projects, from the following list, using the Python programming language are to be assigned at the instructor's discretion during the course of the semester.

1. Installing applications and creating environment
2. Reading csv into memory
3. Loading data from seaborn
4. Implement classification based on the K-nearest neighbors method, using the scikit-learn library.
5. Implement methods for linear regression (least-squares), and logistic regression
6. Implement methods for classification using a) support vector machines and b) decision trees, and investigate the use of cross-validation for model evaluation
7. Implement methods for ensembles of trees (random forests, gradient boosted trees)
8. Implement neural networks (optional deep learning) based classifiers
9. Implement methods for dimensionality reduction and unsupervised clustering

Textbooks

Title	Author	Publisher
Elements of Statistical Learning	Hastie	Springer (2001)
Machine Learning	Alpaydin	MIT Press (2010)
Pattern Recognition and Machine Learning	Bishop	Springer (2006)
Machine Learning: A Probabilistic Perspective	Murphy	MIT Press (2012)
Pattern Classification	Duda	Wiley (2000)
Machine Learning	TMitchell	McGraw HIll (1997)

References

Title	Author	Publisher

Course Code	MEC704b
Course Title	Internet of Things
Course Type	Elective
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	None
Course Objectives	1. To understand the fundamentals of the Internet of Things . 2. To learn about the basics of IOT protocols . 3. To build a small low cost embedded system using Raspberry thistle Pi. 4. To apply the concept of Internet of Things in the real world scenario.
Course Outcomes	1. Ability to understand the fundamentals of IoT and its applications 2. Ability to design and develop IoT systems using appropriate hardware and software components 3. Ability to apply IoT concepts to solve real-world problems in various domains 4. Ability to analyze and evaluate IoT technologies and their impact

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Introduction to Internet of Things (IoT):
   Internet of Things, Characteristics of IoT, Physical Design, Logical Design, Functional blocks of IoT, Communication models & APIs, IoT enabling Technologies, IoT Levels & Deployment Templates, Challenges in IoT

2. Predecessors of IOT

Introduction, Wireless sensor network, machine to machine communications, cyber-physical systems, Difference between IoT and M2M, SDNand NFV for IoT,SNMP protocol, IoT system management usingNETCONF-YANG, IoT reference model, Domain model – informationmodel, functional model, communication model.

3. IoT sensing and actuation

Introduction, sensors, sensor characteristics, sensing types, actuators, actuator types, actuator characteristics. Different types of sensors and actuators: led bulb, ultrasonic distance measurement, rain sensor, touch sensor, light sensor, DHT sensor, etc. Different types of actuators, motor, relays, etc.

4. Microcontrollers for IoT

Arduino uno, Arduino mega, Node MCU, Raspberry pi. Exercises on microcontrollers: traffic lights, distance measuring, temperature and humidity, display on led screen.

Part B

5. IoT connectivity technologies:

Introduction, IEEE 802.1.5.4, Zigbee, RFID, NFC, Z-wave, Wi-fi, Bluetooth, etc.

6. IoT Communication technologies

Introduction, infrastructure protocols, data protocols: MQTT, MQTT-SN, CoAP, AMQP, XMPP, REST

7. Cloud and fog computing

Introduction, virtualization, cloud models, cloud implementation, sensor cloud, essential characteristics of cloud fog computing. Exercise to communicate sensor output through cloud, such as temperature and humidity information through Arduino cloud. Exercise on Raspberry pi to collect sensor data and sharing through internet protocol, such as MQTT. Commercially available cloud services, such as Amazon web services.

8. IoT case studies

Agricultural IoT, vehicular IoT, Healthcare IoT. Evolution of new IoT platforms: IoT of battlefield, IoT of drones, IoT of underwater things. Introduction to data analytics and ML for IoT applications.

9. IoT live project

MQ-2 gas sensor interface for node MCU, servo motor interface with node MCU, relay interface with node MCU. Design of an IoT project for use in industry/product design, etc.

Textbooks

Title	Author	Publisher
Introduction to IoT	Sudip Misra, Anandarup Mukherjee, Arijit Roy	Cambridge University Press
IoT and its applications	Satish Jain, Shashi Singh	BPB publications

References

Title	Author	Publisher

Course Code	MEC704c
Course Title	Mechanics of Composites
Course Type	Elective
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Mechanics of Materials, Materials Science
Course Objectives	
Course Outcomes	1. Ability to select appropriate composite materials for specific engineering applications 2. Ability to predict the elastic properties, strength, and thermal properties of composite materials 3. Ability to analyze and design laminated composite structures 4. Ability to apply failure theories and characterization methods to composite materials

Syllabus

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Part A

1. Introduction (1 Lecture):
   Need for composites, Types of composites, Metal matrix, Ceramic matrix and Carbon-Carbon composites; Polymer matrix composites

2. Constituent materials and fabrication methods (6 Lectures):
   Characteristics of thermosetting and thermoplastic resins,
   Characteristics of Glass, Carbon and Kevlar Fibers, method of making and properties, types of fiber mats.
   Manufacturing of fiber composites: Hand layup, Pressure bag, Vacuum Bag and Autoclave processes, Pultrusion, Filament Winding, Bulk and Sheet molding compounds, Prepregs etc, including a video demonstration of a hand layup process.

3. Micromechanics of continuous unidirectional fiber composites (8 Lectures):

Prediction of elastic properties using strength of materials approach
Introduction to elasticity based approach for prediction of elastic constants (concentric cylinder model)
Empirical relations (Halpin-Tsai) for elastic property prediction
Comparison of different approaches with examples,
Prediction of strength and discussion on failure modes
Prediction of thermal and diffusion properties

4. Short fiber composites (3 Lectures):
   Load transfer length, Prediction of elastic properties
   Elastic property calculation for random fiber composites

Part B

5. Analysis of orthotropic lamina (8 Lectures):
   Generalized Hooke's law, Material symmetry
   Orthotropic materials and transversely isotropic materials
   Transformation of stress and strain,
   Stress-strain relations for transversely isotropic lamina under plane stress in material axis and off-axis
   Failure theories (Maximum stress, strain, Tsai-Hill and Tsai-Wu)

6. Analysis of laminated composites (12 Lectures):
   Description of laminate sequence and type of laminates (UD, Symmetric and Asymmetric, Balanced, Quasi-Isotropic) etc.
   Classical laminate theory (CLT)
   Failure analysis of laminates using CLT: First ply failure, progressive failure analysis
   Hygro-thermal stresses in laminates
   Discussion on interlaminar stresses

7. Additional topics (4 Lectures):
   Characterization methods- Test methods for determining elastic constants and strength
   Fracture oriented failure- Strength of notched composite laminates

Textbooks

Title	Author	Publisher
Engineering Mechanics of Composite Materials	Daniel	Oxford (2013)
Analysis and Performance of Fiber Composites	Agarwal	Wiley (2017)
Mechanics of Composite Materials	Kaw	CRC (2006)
Mechanics of Composites	Jones	Taylor & Francis (2015)

Principles of Composite Material Mechanics	Gibson	CRC Press (2016)

References

Title	Author	Publisher
Theory of Elasticity	Timoshenko	McGraw Hill (2013)

Course Code	MEC704d
Course Title	Work Study
Course Type	Elective
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	
Course Objectives	
Course Outcomes	1. Ability to apply work study techniques to improve productivity and efficiency 2. Ability to analyze and design work methods using various charts and diagrams 3. Ability to measure work and set time standards 4. Ability to apply ergonomic principles in workplace design

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Introduction:
   Introduction to Work Study, Productivity, Factors influencing Productivity, Productivity Index, Kinds of productivity measurements.

2. Method Study:
   Objectives of Method Study, General Problem solving procedure, Process Charts- Operation Process chart, Flow Process chart; Left-and-Right hand chart, Man-Machine Chart, Flow Diagram, String Diagram, and Travel Chart.

3. Micromotion Study
   Purpose of Micromotion study, Micromotin study as an aid in Improving Methods, Fundamental Hand Motions, Memomotion study, Cyclegraph, Chronocyclegraph, SIMO chart

4. Principles of Motion Economy:
   Introduction, Principles of Motion Economy as related to use of Human Body, Principles of Motion Economy as related to Work Place, Principles of Motion Economy as related to Design for Tools and Equipments.

Part B

5. Time Study:
   Time Study Equipment, Time Study Procedure, Number of Work Cycles to be Timed, Performance Rating, Systems of Rating, Allowances in Time Standards and Calculation of Standard Time.

6. Work Sampling and PMTS
   Introduction, Statistical Basis of Work Sampling, Procedure, Determination of sample size, Procedure for selecting random observations, Determining time standards by work sampling, Overview of Predetermined Motion Time Systems, Methods-Time Measurement (MTM), Maynard Operation Sequence Technique (MOST)

7. Wage and Wage Incentives
   Introduction, Wage incentive and its types, Piece work incentive schemes, Group Incentives schemes.

8. Ergonomics
   Introduction, areas of study under ergonomics, system approach to ergonomics model, man-machine system. Components of man-machine system and their functions – work capabilities of industrial workers, Workstation design.

Textbooks

Title	Author	Publisher
Motion and Time Study Design and Measurement of Work	Barnes	Wiley (2009)
Work Systems: The Methods, Measurement & Management of Work	Groover	Pearson (2013)
Introduction to Work Study	ILO, Geneva	Oxford

References

Title	Author	Publisher
The Handbook of Work Analysis: Methods, Systems, Applications and Science of Work Measurement in Organizations	Wilson et al.	Routledge

Course Code	MEC704e
Course Title	Structural Dynamics
Course Type	Elective
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	
Course Objectives	
Course Outcomes	1. Ability to model and analyze structural components and systems under dynamic loads 2. Ability to determine the dynamic response of SDOF and MDOF systems 3. Ability to analyze structural systems subjected to harmonic loading 4. Ability to perform structural dynamic analysis of beams

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. The science and art of structural dynamics:
   Introduction to structural dynamics; Modeling of structural components and systems; FE route of structural dynamics and its limitations; Experimental route of structural dynamics and its limitations; Understanding structural dynamics in time domain versus frequency domain.

2. Basic concepts:
   Spring-mass model; Free vibrations of SDOF, 2-DOF and MDOF system; Dynamic matrix equation; Eigenvalues; Eigenvectors; Modeshapes;

Orthogonality of normal modes; Damping ratios; Drive point and cross frequency response functions; Receptance, Mobility, Accelerance Real modes, Complex modes.

3. Undamped SDOF system:
   Degrees of freedom; Undamped system; Springs in parallel or in series; Newton's law of motion; Free body diagram; D' Alembert's principle; Solution of differential equation of motion; Frequency and period; Amplitude and motion.

4. Damped SDOF system:
   Proportional versus non-proportional damping; Equation of motion; Analysis of critically damped system; Analysis of under-damped system; Analysis of over-damped system.

Part B

5. Response of SDOF system to harmonic loading:
   Harmonic excitation for undamped and damped systems; Evaluation of damping at resonance; Bandwidth method to evaluate damping; Energy dissipated by viscous damping; Equivalent viscous damping; Response to support motion; Force transmitted to foundation; Seismic instruments; Response of SDOF system to harmonic loading.

6. Nonlinear structural response:
   Nonlinear SDOF model; Integration of the nonlinear equation of motion; Constant acceleration method; Linear acceleration step-by-step method; The Newmark beta method.

7. Structural dynamic analysis of beams:
   Shape functions for a beam segment; System stiffness matrix; Inertial-properties lumped mass; Inertial-properties consistent mass; Damping properties; External loads; Geometric stiffness; Equation of motion; Element forces at nodal coordinates; Dynamic analysis of beams using MATLAB

8. Structural dynamic analysis of systems with distributed properties:
   Flexural vibrations of uniform beams; Solution of equation of motion in free vibration; Natural frequencies and mode-shapes for uniform beams with both ends simply supported, both ends free, both ends fixed, one end fixed and other end free, one end fixed and other end simply supported; Orthogonality condition between normal modes.

Textbooks

Title	Author	Publisher
Dynamics of Structures	Chopra	Pearson (2007)

Structural Dynamics: Theory and Computation	Paz	Springer (2006)
Fundamentals of Structural Dynamics	Craig	Wiley (2006)
Dynamics of Structures	Humar	CRC (2012)
Structural Dynamics for Engineers	Buchholdt	ICE (2011)

References

Title	Author	Publisher
Structural Analysis	Hibbeler	Pearson (2014)
Fundamentals of Structural Analysis	Leet	McGraw Hill (2010)

Course Code	MEC704f
Course Title	Vehicle Dynamics
Course Type	Elective
Course LTP	300
Course Credits	3
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Kinematics and Dynamics of Machinery
Course Objectives	1. To provide an overview of important concepts of road vehicle dynamics
Course Outcomes	1. Ability to analyze the dynamics of vehicles in motion 2. Ability to model and analyze longitudinal and lateral vehicle dynamics 3. Ability to understand tire mechanics and vehicle handling characteristics 4. Ability to evaluate vehicle performance in terms of ride comfort and safety

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Introduction to Vehicle Dynamics (2):
   Dynamics of the vehicle in motion, power source, chassis, power train, sub systems, driver interaction, output requirements: safety during turn and braking, ride comfort, economics. Approach for mathematical modeling.

2. Longitudinal Dynamics (5):
   Vehicle Load Distribution – Acceleration and Braking - Brake Force Distribution, Braking Efficiency and Braking Distance - Longitudinal dynamics of a Tractor-Semi Trailer

3. Tire Mechanics – An Introduction (7):
   Mechanical Properties of Rubber - Slip, Grip and Rolling Resistance - Tire Construction and Force Development - Contact Patch and Contact Pressure Distribution

4. Simple Tire Model (8):
   Lateral Force Generation - Ply Steer and Conicity - Tire Models – Magic Formula - Classification of Tire Models and Combined Slip

Part B

5. Lateral Dynamics (7):
   Bicycle Model - Stability and Steering Conditions - Understeer Gradient and State space Approach - Handling Response of a Vehicle - Mimuro Plot for Lateral Transient Response - Parameters affecting vehicle handling characteristics

6. Vehicle Handling (4):
   Subjective and Objective Evaluation of Vehicle Handling.

7. Vertical Dynamics (3):
   Rollover Prevention, Half Car Model, Quarter Car Model

8. Noise, Vibration and Harshness (3):

Textbooks

Title	Author	Publisher
Fundamentals of Vehicle Dynamics	Gillespie	SAE
Vehicle Dynamics and Control	Rajamani	Springer (2008)
Vehicle Dynamics: Theory and Application	Jazar	Springer (2009)
Race Car Vehicle Dynamics	Milliken	SAE (1995)

References

Title	Author	Publisher
Dynamics and Optimal Control of Road Vehicles	Limebeer	Oxford (2018)
The Science of Vehicle Dynamics	Guiggiani	Springer (2019)
The Multibody Systems Approach to Vehicle Dynamics	Blundell	Butterworth-Heinemann (2014)
Vehicle Handling Dynamics	Abe	Butterworth-Heinemann (2015)

Course Code	MEC704f
Course Title	Automotive Technology
Course Type	Elective
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Thermodynamics, Engineering Thermodynamics, Kinematics and Dynamics of Machines
Course Objectives	1. To understand the basic concepts about automobile and performance parameters. 2. To understand the working of an engine and its subsystems. 3. To understand about function, necessity and working of various types of clutches. Selection for different applications. 4. To understand power transmission from engine to tyres. Conversions at different stages, understanding working of different sub-systems in transmission to understand the power flow. 5. To understand the working of various control systems like suspension, steering and brakes. 6. To understand the environmental impacts and study various means of emission control from automobiles.
Course Outcomes	1. Basic understanding about working of automobile 2. Understanding, importance of various sub-systems in performance of automobile 3. Understand importance of control in automobile 4. Environmental friendly automobiles

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Introduction : Components of automobile, basic structure, classification of automobiles, body styles, frame and frameless construction, power for propulsion, traction and tractive effort, relation between engine revolution and vehicle speed, road performance curves, calculation of equivalent weight, gear ratio for maximum acceleration.

2. Automobile Engine : Automobile Engine Types and Classifications, Engine Construction Valves, Engine Measurements wear and Performance, Superchargers and Turbochargers, Fuel-Injection System, Automotive Battery, Starting System, Charging System, Ignition System.

3. Clutches : Requirements of clutches, types of clutches, working of single plate, multiplate and centrifugal clutch, clutch operation, clutch plate, fluid flywheel.

4. Transmission : Functions of transmission, necessity, types of transmission, sliding mesh, constant mesh, synchromesh, selector mechanism, transfer box, automatic transmission, torque converter, overdrive, propeller shaft, universal joint, final drive, differential, rear axle, rear axle drive.

Part B

5. Suspension : Basic classifications, types of suspension systems, leaf springs, shock absorbers, independent suspension, types of front wheel, independent suspension system, air suspension.

6. Front Axle and steering : Front axle, wheel alignment, steering geometry, under-steer and oversteer, steering linkage, steering gears, steering ratio, reversibility, power steering.

7. Brakes wheel and Tyres : Brake efficiency and stopping distance, fading of brakes, wheel skidding, types of brakes, drum and disk brakes, hydraulic and pneumatic brakes, servo brakes, anti lock braking system, types of wheels, wheel dimensions, types of tyres, cross ply, radial ply and belted-bias type, tyre designation.

8. Emission control : Automotive air pollution, emission control, crank case emission, evaporative emission control, exhaust emission control, catalytic converter.

Textbooks

Title	Author	Publisher
Automotive Mechanics	Crouse	McGraw Hill (2017)
Automotive Engines	Dempsey	

Automotive Mechanics	Heitner	CBS (2004)

References

Title	Author	Publisher

Course Code	MEC 704g
Course Title	Industrial Engineering
Course Type	Elective
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	
Course Objectives	Introduce to Business and Management aspects related to Engineering
Course Outcomes	Ability to apply industrial engineering principles to improve productivity and efficiency Ability to design and develop products considering various factors Ability to analyze and design work systems using appropriate techniques Ability to plan and design facilities for efficient operations

Syllabus

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Part A

1. Introduction:
   Purpose and evolution of Industrial Engineering, The concept and importance of Productivity, Business process reengineering, Total productivity management, Performance management, Change management, Budgeting and planning for profits, Life cycle cost analysis, Kaizen.

2. Product Design and Development:

Principles of good product design, tolerance design; quality and cost considerations; product life cycle; standardization, simplification, diversification, value engineering and analysis, concurrent engineering; comparison of production alternatives.

Part B

3. Work System Design:
   Taylor’s scientific management, Gilbreths’s contributions
   Productivity – concepts and measurements
   Method study, micro-motion study, principles of motion economy
   Work measurement −
    a. Time study
    b. Work sampling
    c. Standard data
    d. PMTS
   Ergonomics
   Job evaluation, merit rating, incentive schemes, and wage administration

4. Facility Design:
    a. Facility location factors and evaluation of alternate locations
    b. Types of plant layout and their evaluation
    c. Computer aided layout design techniques
    d. Assembly line balancing
    e. Materials handling systems

Textbooks

Title	Author	Publisher
Maynard’s Industrial Engineering Handbook	Kjell B. Zandin	McGraw Hill

References

Title	Author	Publisher
Facilities Planning	James Tompkins	Wiley
Factory Physics	Hopp & Spearman	Waveland Press
Systematic Layout Planning	Richard Muther and Lee Hales	Management & Industrial Research Publications

Course Code	MEC704h
Course Title	Continuum Mechanics
Course Type	Elective
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Mechanics of Materials
Course Objectives	
Course Outcomes	1. Ability to apply mathematical concepts to describe the behavior of continuous media 2. Ability to analyze the kinematics of deformation and motion in solids and fluids 3. Ability to understand and apply balance laws to continuum mechanics problems 4. Ability to develop and apply constitutive relations for different materials

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Introduction: (1 Lectures)

2. Mathematical Preliminaries: (6 Lectures)
   Vector and tensor calculus.
   Tensor analysis, derivatives of functions with respect to tensors
   Fields, div, grad, curl
   Divergence theorem, transport theorem

3. Kinematics: (6 Lectures)
   Configurations of a body, displacement, velocity, motion
   Deformation gradient, rotation, stretch, strain, strain rate, spin tensor
   Assumption of small deformation and small strain

4. Balance laws: (6 Lectures)
   Balances of mass, linear momentum and angular momentum

Contact forces and the concept of stress.
Balance of energy and Clausius-Duhem inequality.

Part B

5. Constitutive relation: (12 Lectures)
   Frame indifference.
   Material symmetry
   Kinematic constraints (incompressibility, etc.)
   Thermodynamic restrictions.

6. Viscous fluid: (4 Lectures)
   Constitutive relations, non-Newtonian fluid, boundary value problem.

7. Finite elasticity: (5 Lectures)
   Hyperelasticity, isotropy, simple constitutive relations, boundary value problem

Textbooks

Title	Author	Publisher
Continuum Mechanics	Chadwick	Dover (1998)
Mechanics and Thermodynamics of Continua	Gurtin	CUP (2013)
Introduction to the Mechanics of a Continuous Medium	Malvern	Pearson
Introduction to Continuum Mechanics	Lai	Elsevier (2014)
Continuum Mechanics for Engineers	Mase	CRC (2020)
Fundamentals of Continuum Mechanics: With Applications to Mechanical, Thermomechanical, and Smart Materials	Bechtel	Academic Press (2014)

References

Title	Author	Publisher
A First Course in Rational Continuum Mechanics	Truesdell	Academic Press
Rational Thermodynamics	Truesdell	McGraw Hill
The Non-Linear Field Theories of Mechanics	Truesdell	Springer

Course Code	704i
Course Title	Probability and Statistics for Engineers
Course Type	Elective
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Calculus, Familiarity with Excel or other spreadsheet software.
Course Objectives	Recognize engineering problems requiring statistical methods and apply them.
Course Outcomes	1. Ability to apply statistical methods to analyze engineering data 2. Ability to understand and apply probability concepts and distributions 3. Ability to use statistical process control techniques for quality improvement 4. Ability to design and analyze experiments

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

(Note the capitalized terms in parentheses are EXCEL commands)

Part A

1. The Role of Statistics In Engineering: (2 lectures)
   • Collecting Engineering Data, Data Representation, Graphing and Analysis (with and without EXCEL)
   • Statistics with EXCEL: sampling, Random Number Generator, (RAND, ROUND)
   • Rank, percentile, mode, median, average, processes chart,
   • Deming's funnel
   • Retrospective Study

• Observational Study
• Designed Experiments
• Observing Engineering Processes over time
• Preliminary definitions (random variable, sample, population)
• Probability and Probability Models

2. Introduction to Probability – Basic Concepts: (4 lectures)
   • Sample space, discrete/continuous random variables, experiments with and without repetition, experiments with and without order
   • Outcome, Event, Tree Diagram, Venn Diagrams, de Morgan's Law
   • Interpretations and Axioms of Probability
   • Absolute/relative Frequency, Probability, Addition Rules
   • Conditional Probability, Multiplication and Total Probability Rule, (HISTOGRAM)
   • Independence, Bayes' theorem
   • Counting Techniques, Permutations, Combinations (COMBIN)

3. Discrete Random Variables and Probability Distributions: (5 lectures)
   • Probability Distributions, and Probability Mass Functions
   • Mean, Variance, Example: Discrete Uniform Distribution, (AVERAGE, STDEV)
   • Discrete Uniform Distribution
   • Binomial distribution, (BINOMDIST), Bernoulli experiment
   • Geometric Distribution and Negative Binomial Distribution,
   • Poisson Distribution,
   • Hypergeometric Distribution, (NEGBINOMDIST,HYPERGEOM DIST, POISSON)

4. Continuous Random Variables and Probability Distributions: (5 lectures)
   • Continuous Random Variables
   • Probability Distributions and Probability Density Functions,
   • Cumulative Distribution Functions
   • Mean and Variance of a Continuous Random Variable
   • Normal Distribution: examples, Significance, Definition, Graph, Standardization
   • Normal Distribution: Cumulative Normal Dist. Φ (z),examples (use of table, NORMDIST, NORMINV, NORMSDIST, NORMSINV))
   • Exponential Distribution,
   • Erlang and Gamma Distributions,
   • Weibull Distribution
   • Normality Criteria (normal Prob. Plot), Central Limit Theorem, Normal Distr. as Approximation (large samples, to the Binomial and Poisson Distribution), Continuity Approximation

Part B

5. Descriptive Statistics: (3 lectures)

• Linear Function. of random variables, sample mean, variance, central limit theorem
• Stem and Leaf Diagrams
• Frequency Distributions and Histograms, , sample mean and variance, range,
• Box Plots
• Time sequence plots
• Probability Plots
• Standard error of the mean
• Point estimator, bias, mean square error
• Maximum likelihood estimator

6. Introduction to Statistical Process Control (SPC): (6 lectures)
• Quality Improvement and Statistics
• Introduction to Control Charts
• Control limits, process limits, tolerance limits for X, R & S Control Charts
• Control Charts for Individual Measurements
• Process Capability Indexes Cp & Cpk
• Attribute Control Charts (P Chart & U Chart)
• Time-Weighted Charts (CUSUM Charts)
• 6-Sigma Process and SPC Black Belts in Industry

7. Design and Analysis of Single Factor Experiments: Analysis of Variance (ANOVA) : (4 lectures)
• Designing Engineering Experiments
• Completely Randomized Single Factor Experiment
• The Random Effects Model
• Randomized Complete Block Design
• Design and Statistical Analysis

Textbooks

Title	Author	Publisher
Applied Statistics and Probability for Engineer	Montgomery	Wiley (2016)
Probability and Statistics for Engineers and Scientists	Walpole	Pearson (2013)
Probability and Statistics for Engineers	Johnson, MIller, Freund	Pearson (2015)
Probability and Statistics for Engineering and the Sciences	Devore	Brooks and Cole (2011)

References

Title	Author	Publisher
A First Course in Probability	Ross	Pearson (2019)
Schaum's Outline of Probability and Statistics	Spiegel	McGraw-Hill (2017)
Data Analysis using Microsoft Excel	Middleton	Wadsworth (1997)
Engineering Statistics	Montgomery	Wiley (2013)
SPC - Practical Understanding of Capability by Implementing Statistical Process Control	Abbott	Robert Houston Smith Publishers (1999)
What is Six Sigma	Pande	McGraw Hill (2002)
Statistical Quality Control: A Modern Introduction	Montgomery	Wiley (2010)

Course Code	MEC704j
Course Title	Total Quality Management
Course Type	Elective
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Production Management, Operations Research
Course Objectives	1. The importance of Total Quality Management. 2. To make the students aware of the principles of TQM and Strategies of TQM implementations 3. To provide understanding of Statistical Process Control 4. To show the applications of TQM tools
Course Outcomes	1. Ability to understand and apply the principles of Total Quality Management 2. Ability to implement TQM practices in organizations 3. Ability to use statistical process control tools for quality improvement 4. Ability to apply various TQM tools and techniques for process optimization

Syllabus

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Part A

1. Introduction : Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs- Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation. (6)

2. TQM Principles : Customer satisfaction – Customer perception of quality – Customer complaints – Service quality – Customer retention – Employee

involvement – Motivation – Empowerment – Teams – Recognition and reward – Performance appraisal – Benefits – Continuous process improvement – Juran trilogy – PDSA cycle – 5S – Kaizen – supplier partnership – Partnering – Sourcing – Supplier selection – Supplier rating – Relationship development – Performance measures – Basic concepts – Strategy – Performance measure. (9)

Part B

3. Statistical Process Control (SPC): The seven tools of quality – Statistical fundamentals – Measures of central tendency and dispersion – Population and sample – Normal curve – Control charts for variables and attributes – Process capability – Concept of six sigma – New seven management tools. (6)

4. TQM Tools: Benchmarking – Reasons to benchmark – Benchmarking process – QualityFunction Deployment (QFD) – House of quality – QFD process – Benefits – Taguchi quality loss function— Total Productive Maintenance (TPM) – Concept – Improvement needs – FMEA – Stages of FMEA. (5)

5. Quality Systems : Need for ISO 9000 and other quality systems – ISO 9000:2000 quality system – Elements – Implementation of quality system – Documentation – Quality auditing – TS 16949 – ISO 14000 – Concept – Requirements and benefits.

Textbooks

Title	Author	Publisher
Total Quality Management	Besterfiled	Pearson
Total Quality Management	Feigenbaum	McGraw Hill
Management and Control of Quality	Evans	Thompson
Quality Management – Concepts and Tasks	Narayana	NewAge International 1996

References

Title	Author	Publisher

Course Code	MEC704k
Course Title	Fracture and Fatigue
Course Type	Elective
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Mechanics of Materials, Machine Design
Course Objectives	
Course Outcomes	1. Ability to understand the mechanisms of fracture and fatigue in materials 2. Ability to apply fracture mechanics principles to predict crack growth and failure 3. Ability to analyze and design structures to prevent fracture and fatigue 4. Ability to evaluate fracture toughness and fatigue life of materials

Syllabus

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Part A

1. Introduction (4):
Background; Griffith theory of fracture, energy release rate (ERR), conditions for stable and unstable crack growth, crack arrest

2. Linear elastic fracture mechanics (14):
Williams analysis of stress field at the tip of a crack
Solution of stress and displacement field for plane cracks using complex methods in plane elasticity (Westergaards or Kolosov-Muskhelishvili approach)
Stress intensity factor (SIF) for plane and penny shaped cracks

Equivalence of SIF and ERR, fracture toughness

3. Elasto-plastic fracture mechanics (10):
First order estimate of crack tip plastic zone using Irwin's and Dugdle's approach
Plastic zone for plane stress and plane strain situation and effect on fracture toughness
Review of small strain plasticity
Crack tip fields in an elasto-plastic material (Discussion on HRR fields)
J-integral as a fracture parameter and crack tip opening displacement

Part B

4. Mixed mode fracture (3):
Prediction of crack path and critical condition for crack extension under mixed mode loading using Maximum tensile stress, Minimum strain energy density and Maximum energy release rate criteria

5. Experimental measurement of SIF and fracture toughness (3):
SIF measurement using strain gages, optical techniques
Evaluation of fracture toughness

6. Fatigue crack growth (4):
Mechanism of crack nucleation and growth under cyclic loading
Determination of life of a cracked solid using Paris-Erdogan law and its variants

7. Advanced topics (one from the following) (4):
Computational fracture mechanics, Dynamic fracture, Bi-material fracture

Textbooks

Title	Author	Publisher
Fracture Mechanics: Fundamentals and Applications	Anderson	CRC Press (2017)
Fracture Mechanics, An Introduction	Gdoutos	Springer (2020)
Fracture Mechanics	Sun	Elsevier (2011)
Fatigue of Materials	Suresh	CUP
Deformation and Fracture Mechanics of Engineering Materials	Hertzberg	Wiley (2014)
Elementary Engineering Fracture Mechanics	Broek	Springer (2012)

References

Title	Author	Publisher

Course Code	MEC704I
Course Title	Introduction to Modern FORTRAN
Course Type	Elective
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Introduction to Programming
Course Objectives	Introduce student to scientific programming with FORTRAN
Course Outcomes	1. Ability to write and execute Fortran programs 2. Ability to use Fortran for numerical computations and engineering applications 3. Ability to implement various programming constructs in Fortran 4. Ability to develop programs using advanced Fortran features

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Introduction to Computers and The Fortran Language: The Computer * Data Representation in a Computer * Computer Languages * The History of the Fortran Language * The Evolution of Fortran

2. Basic Elements of Fortran: The Fortran Character Set * The Structure of a Fortran Statement * The Structure of a Fortran Program * Constants and Variables * Assignment Statements and Arithmetic Calculations * Intrinsic Functions * List-Directed Input and Output Statements * Initialization of Variables * The IMPLICIT NONE Statement * Debugging Fortran Programs
   * Alternate KINDS of the REAL, INTEGER, and CHARACTER Data Type * COMPLEX Data Type.

3. Program Design and Branching Structures: Introduction to Top-Down Design Techniques *Use of Pseudocode and Flowcharts * Logical Constants, Variables, and Operators * Control

4. Constructs: Branches.

5. Loops: Control Constructs: Loops.

6. Characters: Character Assignments and Character Manipulations * Character comparison operations * Intrinsic Character Functions * Passing Character Variables to Subroutines and Functions * Variable-Length Character Functions * Internal Files

7. I/O Concepts: Formats and Formatted WRITE Statements * Output Devices, Control Characters in Printer Output * Format Descriptors * Formatted READ Statements * An Introduction to Files and File Processing * Namelist I/O * Unformatted files * Direct Access Files * Stream Access Mode * Non Default I/O for derived types
(12 hours)

Part B

8. Arrays: Declaring Arrays * Using Array Elements in Fortran Statements * Using Whole Arrays and Array Subsets in Fortran Statements * Input and Output * Multidimensional Arrays * Using Intrinsic Functions with Arrays * Masked Array assignment : the WHERE construct * FORALL construct * Allocatable Arrays.

9. Procedures: Subroutines * Sharing Data Using Modules * Module Procedures * Fortran Functions * Passing Procedures as Arguments to Other Procedures. * Passing Multidimensional Arrays to Subroutines and Functions * The SAVE Attribute and Statement * Allocatable Arrays in Procedures * Automatic Arrays in Procedures * Allocatable Arrays as Dummy Arguments in Procedures* Pure and Elemental Procedures * Internal Procedures * Submodules.

10. Derived Data Types: Derived Data Types * Working with Derived Data Types * Input and Output of Derived Data Types * Declaring Derived Data Types in Modules * Returning Derived Types from Functions * Dynamic Allocation of Derived Data Types * Parameterized Derived Data Types * Type Extension * Type-Bound Procedures * The ASSOCIATE Construct Pointers and Dynamic Data Structures: Pointers and Targets * Using Pointers in Assignment Statements * Using Pointers with Arrays * Dynamic Memory Allocation with Pointers *Using Pointers as Components of Derived Data Types * Arrays of Pointers *Using Pointers in Procedures * Procedure Pointers

11. Object-Oriented Programming in Fortran: An Introduction to Object-Oriented Programming * The Structure of a Fortran Class * The CLASS Keyword * Implementing Classes and Objects in Fortran * Categories of Methods * Controlling Access to Class Members * Finalizers * Inheritance and Polymorphism * Abstract Classes.

12. Coarrays and Parallel Processing: Parallel Processing in Coarray Fortran * Coarrays * Synchronization between Images *Allocatable Coarrays and Derived Data Types

*Passing Coarrays to Procedures * Critical Sections * The Perils of parallel Programming. (12 hours)

Textbooks

Title	Author	Publisher
Modern Fortran Explained	Metcalf	Oxford (2011)
Guide to Fortran 2008 Programming	Brainerd	Springer (2016)
Fortran for Scientists and Engineers	Chapman	McGraw-Hill (2017)
Introduction to Programming with Fortran	Chivers	Springer (2018)

References

Title	Author	Publisher

Course Code	MEC704m
Course Title	Smart Materials and Structures
Course Type	Elective
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Materials Science, Mechanics of Materials
Course Objectives	1. Students will understand the coupling properties and underlying physical phenomena of different active materials. 2. Students will have the foundation to model and analyze engineering devices and systems that incorporate smart materials under static and dynamic conditions. 3. Students will be introduced to applications of active materials in sensing, actuation, control, and energy harvesting.
Course Outcomes	1. Ability to understand the properties and applications of smart materials 2. Ability to select and apply smart sensors for structural health monitoring 3. Ability to design and implement smart actuators for various applications 4. Ability to analyze and design smart composite structures

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper

will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Overview of Smart Materials:
   Introduction to Smart Materials, Principles of Piezoelectricity, Perovskite Piezoceramic Materials, Single Crystals vs Polycrystalline Systems, Piezoelectric Polymers, Principles of Magnetostriction, Rare earth Magnetostrictive materials, Giant Magnetostriction and Magneto-resistance Effect, Introduction to Electro-active Materials, Electronic Materials, Electro-active Polymers, Ionic Polymer Matrix Composite (IPMC), Shape Memory Effect, Shape Memory Alloys, Shape Memory Polymers, Electro-rheological Fluids, Magnetorheological Fluids [12]

2. High-Band Width, Low Strain Smart Sensors:
   Piezoelectric Strain Sensors, In-plane and Out-of Plane Sensing, Shear Sensing, Accelerometers, Effect of Electrode Pattern, Active Fibre Sensing, Magnetostrictive Sensing, Villari Effect, Matteucci Effect and Nagaoka-Honda Effect, Magnetic Delay Line Sensing, Application of Smart Sensors for Structural Health Monitoring (SHM), System Identification using Smart Sensors [8]

Part B

3. Smart Actuators:
   Modelling Piezoelectric Actuators, Amplified Piezo Actuation – Internal and External Amplifications, Magnetostrictive Actuation, Joule Effect, Wiedemann Effect, Magneto Volume Effect, Magnetostrictive Mini Actuators, IPMC and Polymeric Actuators, Shape Memory Actuators, Active Vibration Control, Active Shape Control, Passive Vibration Control, Hybrid Vibration Control [8]

4. Smart Composites:
   Review of Composite Materials, Micro and Macro-mechanics, Modelling Laminated Composites based on Classical Laminated Plate Theory, Effect of Shear Deformation, Dynamics of Smart Composite Beam, Governing Equation of Motion, Finite Element Modelling of Smart Composite Beams [8]

5. Advances in Smart Structures & Materials:
   Self-Sensing Piezoelectric Transducers, Energy Harvesting Materials, Autophagous Materials, Self-Healing Polymers, Intelligent System Design, Emergent System Design [6]

Textbooks

Title	Author	Publisher

Smart Structures and Materials	Culshaw	Artech House (2000)
Smart Structures	Gauenzi	Wiley (2009)
Engineering Analysis of Smart Material Systems	Leo	Wiley (2007)
Smart Materials and Structures	Gandhi	Springer (1992)
Smart Structures: Analysis and Design	Srinivasan	CUP (2000)
Adaptronics and Smart Structures: Basics, Materials, Design and Applications	Janocha	Springer (1999)

References

Title	Author	Publisher

Course Code	MEC704n
Course Title	Optimization Methods in Engineering Design
Course Type	Elective
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Machine Design, Numerical Methods, Programming
Course Objectives	This course will introduce the students to the basic fundamentals of optimization methods that can be used during a design process.
Course Outcomes	1. Ability to formulate and solve optimization problems in engineering design 2. Ability to apply various optimization techniques to find optimal solutions 3. Ability to use optimization software and tools 4. Ability to analyze and compare different optimization methods

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Introduction and overview of optimization problems including the notion of convergence and convexity. (3 lectures)

2. Basics of univariate unconstrained minimization (3 lectures)

3. Fundamentals of multivariate optimization including equation solving and least squares problem (4 lectures)

4. Discussion of applied methods for multivariate optimization (4 lectures)

5. Basics of constrained optimization (6 lectures)

Part B

6. Linear programming problems (3 lectures)

7. Quadratic programming problem (5 lectures)

8. Different family of methods for solving a constrained optimization problem (6 lectures)

9. Advanced topics - Integer and Geometric programming, genetic algorithms, simulated annealing techniques. (6 lectures)

Textbooks

Title	Author	Publisher
Optimization for Engineering Design	K Deb	PHI (2012)
Optimization concepts and applications in engineering	A. D. Belegundu and T. R. Chandrupatla.	CUP (2014)
Linear and Nonlinear programming	S. Nash and A. Sofer.	McGraw Hill (1996)

References

Title	Author	Publisher

Course Code	HSMC701
Course Title	Financial Management
Course Type	Elective
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	
Course Objectives	The main aim of this course is to make students learn different financial decisions i.e. investing, financing and dividend, required to be taken by a company and provide knowledge about the functioning of the financial system (financial markets, financial institutions, financial services and financial instruments) of the country.
Course Outcomes	1. Ability to understand the basic principles of financial management 2. Ability to analyze financial statements and make financial decisions 3. Ability to evaluate investment proposals and manage working capital 4. Ability to understand the functions of financial markets and institutions

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Introduction to Financial Management:
   Concept of Finance, Terminology Related to Finance, Financial Decisions, Factors Affecting Financial Decisions, Risk-Return Trade-Off (3 hours)

2. Financial System:
   Concept and Role of Financial System in Indian Economy (2 hours)

3. Financial Markets and Instruments:
   Concept and Relevance of Money Market and Capital Market
   Money Market Instruments: Call Money, Treasury Bills, Commercial Papers, Certificate of Deposits
   Capital Market Instruments: Equity Shares, Preference Shares and Debentures
   Hypothetical Trading in Financial Markets (8 hours)

4. Financial Services:
   Nature and Functions of Financial Services: Merchant Banking, Mutual Funds, Factoring, Forfaiting, Credit Rating
   Case Study on Financial Services (7 hours)

Part B

5. Financial Institutions:
   Nature and Functions of Financial Institutions: Reserve Bank of India (RBI), Securities and Exchange Board of India (SEBI), Discount and Finance House of India (DFHI) (6 hours)

6. Long Term Investment Decisions:
   Capital Budgeting: Concept, Importance, Factors
   Techniques/Methods with Numerical Applications (Payback Period, Accounting Rate of Return, Net Present Value, Internal Rate of Return and Profitability Index), Case Study (7 hours)

7. Short Term Investment Decisions:
   Working Capital: Nature, Type and Factors Affecting the Requirement of Working Capital, Case Study (5 hours)

8. Financing Decisions:
   Capital Structure: Essentials and Approaches of Capital Structure
   Sources of Finance (long-term and short-term), Financial Leverage: Concept and Numerical Application, Case Study (5 hours)

9. Dividend Decisions:
   Types of Dividend, Dividend Policy: Nature and Factors Affecting Dividend Policy,Case Study (2 hours)

Textbooks

Title	Author	Publisher
Financial Management	Shah	Dreamtech Press (2009)
Financial Markets and Services	Gordon	Himalaya Publishing House (2006)
Cases in Financial Management	Pandey	McGrawHill (India 2010)
Financial Management: Theory and Practice	Chandra	McGrawHill (India 2012)
Financial Institutions and Markets: Structure, Growth and Innovations	Bhole	McGrawHill (India 2009)
Financial Management	Pandey	Vikas Publishing House (2010)

References

Title	Author	Publisher

Course Code	HSMC702
Course Title	Business Laws
Course Type	Elective
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	
Course Objectives	The main aim of this course is to make students understand different types of environment influencing business decisions and to provide knowledge about different laws that needs to be followed for initiating and managing business.
Course Outcomes	1. Ability to understand the legal and regulatory framework of business 2. Ability to analyze the impact of the business environment 3. Ability to understand the principles of corporate social responsibility and governance 4. Ability to apply the basic principles of contract, partnership, and company law

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Introduction to Business (5 hours)
   Scope and Characteristics of Business, Classification of Business Activities
   Forms of Ownership of Business: Sole Proprietorship, Partnership and Company

2. Business Environment (10 hours)
   Internal Environment: Concept and Elements (Value System, Vision Mission Objectives, Management Structure, Human Resources, Company Image etc.)
   SWOT Analysis: Concept and Case Study
   External Environment: Micro Environment (Suppliers, Customers, Competitors, Market Intermediaries etc.) and Macro Environment – PESTEL Analysis (Political, Economic, Social, Technological, Ecological and Legal), Case Study on Impact of Environment on Business

3. Globalization (5 hours)
   Concept, Pros and Cons of Globalization, Impact of Global Environment on Business Globalization of Company – Case Study

Part B

4. Corporate Social Responsibility (5 hours)
   Concept, Social Responsibility towards different stakeholders, Rationale for CSR. CSR – Case Studies

5. Corporate Governance (5 hours)
   Concept, Elements and Essentials of Good Governance

6. Contract Law (5 hours)
   Concept, Types and Essentials Elements of Contract

7. Partnership Law (5 hours)
   Nature of Partnership, Provisions of Partnership Act, Issues Related to Partnership Firm, Hypothetical Formation of a Partnership Firm

8. Company Law (5 hours)
   Nature of Company, Provisions of Company Act, Issues Related to Incorporation of Company, Hypothetical Formation of a Company

Textbooks

Title	Author	Publisher
Business Environment: Text and Cases	Cherunilam	Himalaya Publications (2013)
Legal Aspects of Business	Pathak	McGraw Hill (2013)
Essential of Business Environment: Text, Cases and Exercises	Aswathappa	Himalaya Publications (2011)

Business Law Including Company Law	Gulshan	New Age (2011)
Business Law and Corporate Laws	Tulsian	S Chand (2011)
Fundamentals of Business Organization & Management	Bhushan	S Chand (2013)
Corporate Governance: Principles, Policies and Practices	Fernando	Pearson (2011)

References

Title	Author	Publisher

Course Code	HSMC703
Course Title	Human Resource Management
Course Type	Elective
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	
Course Objectives	The main aim of this course is to provide an overview of HRM, keeping the Indian business scenario in the background and to acquaint the students with the strategic role of HRM in managing an organization.
Course Outcomes	1. Ability to understand the principles and practices of human resource management 2. Ability to apply HRM functions such as planning, recruitment, and selection 3. Ability to design and implement training and development programs 4. Ability to understand performance appraisal, compensation, and employee health and safety

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Introduction to Human Resource Management (5 hours)
   HRM: Nature, Scope, Functions, HRM Practices and Problems in India with Case Studies

2. Human Resource Planning (HRP) (5 hours)
   Concept and Process of HRP, Factors Affecting HRP

3. Job Analysis and Designing (5 hours)

Uses and Process of Job Analysis, Job Description and Job Specification: Features and Hypothetical Formulation, Job Designing: Job Enrichment, Job Enlargement

4. Recruitment and Selection (6 hours)
   Recruitment: Sources and Methods
   Selection: Selection Process, Selection Tests, Types and Nature of Interviews
   Role Playing and Case Study on Selection Process, Tests and Interview

Part B

5. Induction and Internal Mobility (7 hours)
   Induction Programme, Need and Scope of Internal Mobility: Transfer, Promotion, Demotion

Training and Development (8 hours)
   Training: Need and Methods, Management Development: Need, Methods and Management Development Programme HRM Games for Development of Employees

6. Performance Appraisal and Compensation (6 hours)
   Nature and Methods of Performance Appraisal, Hypothetical Performance AppraisalCompensation: Financial and Non-Financial Benefits

7. Employee Health and Safety (3 hours)
   Concept, Issues related to Health and Safety, Workplace Health Hazards

Textbooks

Title	Author	Publisher
Human Resource Management	Dessler	Pearson (2011)
Human Resource Management: Text and Cases	Aswathappa	McGraw Hill (2013)
Human Resource Management: Text and Cases	Gupta	S Chand (2012)
Human Resource Management: Text and Cases	Bedi	Bharti (2012)

Human Resource Management Applications: Cases, Exercises, Incidents and Skill Builders	Fottler	Cengage (2013)
Human Resource Management: Text and Cases	Rao	Excel Books (2002)

References

Title	Author	Publisher

8th Semester

Course Code	MEC 801
Course Title	Advanced Machining Techniques
Course Type	Core
Course LTP	300
Course Credits	3
Course Assessment ● Continuous ● End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Manufacturing Processes and Manufacturing Technology
Course Objectives	1. To state the importance and need to develop the nontraditional machining methods. 2. To make the students aware about nontraditional machining methods 3. To give them practical exposure of nontraditional machining methods 4. To tell them about applications of various non conventional machining processes
Course Outcomes	1. The principle and working of nontraditional machining methods 2. The principle working and controlling parameters of EDM,LBM, IBM 3. The principle working and controlling parameters of AJM, WJM and AWJM 4. The principle working and controlling parameters of Chemical ,electro chemical machining and USM

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper

will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Introduction:
   Classification, Advantages & limitations of non conventional machining, Hybrid Machining, Ultrasonic machining (USM)-Principle of operation, process details, applications and advantages, limitations of USM. (8 Hours)

2. Abrasive and Water Jet Machining:
   Basic principle, mechanism of material removal, working principle of Abrasive jet machining (AJM), water jet machining (WJM), merits & demerits, application. (7 Hours)

3. Chemical Machining (CM):
   Working principle, process characteristics, procedures, advantages & disadvantages of chemical machining. (7 Hours)

Part B

4. Electrochemical Processes:
   Fundamentals, details of machining setup, materials and selection of tools, applications, Concept of others processes like ECG, Electrochemical deburring etc. (8 Hours)

5. Thermal Metal Removal Processes:
   Working principles, Mechanism of material removal, process parameters, advantages & limitations, applications of processes like electric discharge machining(EDM), Electron Beam Machining (EBM), Ion Beam Machining (IBM) Plasma Arc Machining (PAM), Laser Beam Machining (LBM) (10 Hours)

Textbooks

Title	Author	Publisher
Advanced Machining Processes	V K Jain	Allied
Non Conventional Machining	Benedict	McGraw Hill
Non Conventional Machining,"	P.K.Mishra	Narosa

References

Title	Author	Publisher
Non Conventional Machining	M. Adithan	Wiley

Course Code	MEC802
Course Title	Non-Conventional Energy Sources
Course Type	Core
Course LTP	300
Course Credits	3
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	
Course Objectives	
Course Outcomes	1. Describe the primary renewable energy resources and technologies. 2. Comprehensive understanding of current and possible future role of various renewable energy sources. 3. Access and decide the appropriate renewable energy as an alternate for conventional power in any engineering field. 4. Explain the need and significance of renewable energy sources for sustainable development.

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Introduction to Renewable Energy Sources: Introduction to Non-conventional/Renewable Energy Sources & Technologies, Their importance for Sustainable Development and Environmental Protection.

2. Solar Radiations: Introduction, Extraterrestrial solar radiations, Components of radiation, Measurement and Estimation of Solar Radiation; Characteristics of solar spectra including Wave length Distribution; Radiation Properties and spectral Characteristics Materials.

3. Solar Thermal system: Introduction, Solar Collectors: Concentrating and Non-Concentrating Collectors; Solar Water Heaters, Solar Passive Space Heating and Cooling Systems, Solar Pond; Application of Solar Energy for Water Desalination and Cooking etc.

4. Biomass: Introduction, Photosynthesis Process, Biofuels, Biomass resources, Biomass Conversion Technologies, Biomass Gasification, Types of Gasifiers, Classification of Biomass Plants, Biogas Production form Waste Biomass, Types of Biogas Digesters, Types of Bioreactors, Status of development of biomass energy resources in India

Part B

5. Wind Energy: Basic Principles; Wind Turbine Siting, Wind Turbine Types, Basic Components of Wind Energy Conversion System, Classification of Wind Energy Conversion System, Application of Wind Energy, Wind Energy Programme in India.

6. Ocean Energy: Ocean Thermal Energy Conversion (OTEC) principle, Open, Closed and Hybrid cycle OTEC system; Energy from Tides, estimation of tidal power, tidal power plants, single and double basin plants, site requirements, Advantages and Limitations;

7. Geothermal Energy: Nature of Geothermal Resources; Location & Potential Assessment; Classification & Characteristics of Geothermal Resources- Types of Geothermal Resources – Hot dry Rock; Hydrothermal- Vapour dominated, Liquid dominated and hot water resources ; Hot magma and Geo-pressured Hot Rock, comparison of geothermal power plant with conventional thermal power plants, Advantages and Limitations; Geothermal Site selection criterion, Potential of geothermal energy in India.

Textbooks

Title	Author	Publisher
Sustainable Energy: Choosing Among Options	Tester, Drake, Driscoll, Golay, and Peters	MIT Press (2005)
Renewable Energy Resources	Twidell, and Weir	Taylor and Francis (2005)
Sustainable Energy – without the hot air.	MacKay	UIT Cambridge (2008) Available free online from www.withouthotair.com

References

Title	Author	Publisher
Wiley Encyclopedia of Energy Technology and the Environment.	Attilio, and Boots	Wiley-Interscience (1996)

Course Code	MEC803
Course Title	Computational Fluid Dynamics
Course Type	Core
Course LTP	300
Course Credits	3
Course Assessment • Continuous • End of Semester	 50 (Assignments, Quizzes, Sessionals) 50 (University Exam)
Course Prerequisites	Fluid Mechanics, Numerical Analysis
Course Objectives	1. To understand basics of computational fluid dynamics 2. To learn different methods for discretization of Navier Stokes Equations 3. To implement various algorithms to solve Navier Stokes Equations for Simple Flows
Course Outcome	1. Understand and explain the governing equations of fluid dynamics and their physical significance. 2. Classify different types of PDEs and apply suitable numerical methods for solving them. 3. Implement discretization techniques such as Finite Difference and Finite Volume methods to solve flow problems. 4. Analyze and solve steady and unsteady flow problems using solution algorithms like SIMPLE and evaluate their stability and convergence.

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Introduction: Need for CDF, Comparison of the three basic approaches in engineering problem solving – Analytical, Experimental and Computational Methods, Application in different areas.
2. Governing Equation of Fluid Dynamics: Different Models of Flow, Substantial derivation, Continuity equation, Momentum equations, energy equations, transformation of conservation form of equation into non conservation form and visa-versa., Equations for viscous flow and Inviscid flow for fluid dynamics, Physical Boundary conditions, types of marching solutions in CFD.
3. Behaviour and classification of Partial Differential equation (PDE): Classification of PDE using Cramer's Rule and Eigenvalue method, discussion on behaviour of different types of PDEs and types of flows governed by PDEs.
4. Discretization of PDE by Finite Difference Method: Representation of PDE by Forward, Rear and Central Difference , Truncations Error, Difference Equations; Explicit and Implicit Approach:, Error and Analysis of stability.

PartB

5. Discretization of PDE by Finite Volume Method: Finite volume method for diffusion problems and convection-diffusion problems.
6. Discretization of PDE by Finite Volume Method: The central differencing scheme, the upwind differencing scheme, the hybrid differencing scheme, quadratic upwind differencing scheme, Properties of discretisation schemes, Properties of differencing schemes, Assessment of each scheme
7. Solution algorithms for pressure velocity coupling in steady flows: Staggered grid, the SIMPLE algorithm, SIMPLER Algorithms, application of algorithm to simple 1D flow problems, Thomas algorithm for tridiagonal matrix.

Textbooks

Title	Author	Publisher
Computational Fluid Dynamics: The Basics with Applications	Anderson	McGraw-Hill (2017)
An Introduction to Computational Fluid Dynamics: The Finite Volume Method	Versteeg and Malalasekara	Pearson (2008)

References

Title	Author	Publisher
Numerical Heat Transfer and Fluid Flow	Patankar	Taylor & Francis (2017)

Course Code	MEC853
Course Title	Computational Fluid Dynamics (P)
Course Type	Core
Course LTP	002
Course Credits	1
Course Assessment • Continuous	50 (Practical Performance, Report Writing, Viva Voce)
Course Prerequisites	Fluid Mechanics, Numerical Analysis
Course Objectives	1. Solve fluid and heat-transfer problems using computational techniques 2. To apply computational fluid dynamics to solve fluid flow over common geometries.
Course Outcome	1. Simulate and analyze 2D heat conduction and temperature distribution under different boundary conditions. 2. Solve and visualize flow fields such as lid-driven cavity and flow over external geometries (e.g., sphere, airfoil). 3. Apply numerical techniques to evaluate thermal performance of extended surfaces like fins. 4. Assess the effects of attack angle and geometry on aerodynamic performance using CFD tools

List of Experiments

1. 2D heat conduction in a rectangular geometry.
2. To solve the temperature distribution for a fin.
3. To solve two dimensional incompressible viscous flow in a lid driven cavity.
4. Temperature distribution for a heated plate subjected to insulated boundary condition on one side.
5. Temperature distribution for a heated plate subjected to fixed boundary conditions
6. Fluid flowover a spherical body .
7. Flow over an Aerofoil with a different attack angle.

Textbooks

Title	Author	Publisher

Computational Fluid Dynamics: The Basics with Applications	Anderson	McGraw-Hill
An Introduction to Computational Fluid Dynamics: The Finite Volume Method	Versteeg and Malalasekara	Pearson

References

Title	Author	Publisher
Numerical Heat Transfer and Fluid Flow	Patankar	Taylor & Francis (2017)

Course Code	MEC855
Course Title	Major Project
Course Type	Core
Course LTP	008
Course Credits	4
Course Assessment • Continuous	 150 (Practical Performance, Report Writing, and Viva Voce)
Course Prerequisites and Requisite	Mechanics, Thermodynamics,Basics of Electrical Engineering, Programming, Mechatronics, Automatic controls, Mechanical measurements, Theory of Machines and Machine Design. Problem identified for project should be real (Trivial proposal has to be rejected by the project committee).
Course Objectives	Engage student in innovation on some real-world problem
Course Outcomes	1. Identify, formulate, and analyze complex engineering problems using theoretical and practical knowledge. 2. Design and implement a system, process, or component to meet specified needs within realistic constraints. 3. Effectively communicate technical information through documentation and oral presentations. 4. Work effectively in teams and demonstrate leadership, initiative, and responsibility in executing the project.

Course Code	MEC856
Course Title	Internship 3
Course Type	Optional (Internship of one semester duration in Industry or Research Organization or UIET/CCET)
Course LTP	
Course Credits	23
Course Assessment • Continuous • End and Mid Semester	250 (Hosting Organization) 500 (Mechanical Engineering Department)
Course Prerequisites and Requisites	1. CGPA 6.5 or more upto 6th semester 2. Successful defense of Internship Proposal before a committee (Training committee). Students will have to give a formal presentation before a committee before proceeding on training. Proposal should contain objectives, Literature-Survey, Methodology, Timelines, Consent of mentor from industry, Consent of mentor from UIET/CCET and expected outcomes. 3. Desirable that the student is able to publish a paper at least in a conference out of work done in the Internship. 4. Training report should be well written and hard-bound training report submitted to the Training committee at least 15 days before final evaluation.
Course Objectives	1. To give students an opportunity to apply the knowledge they have acquired on campus practically in a real-life work situation and hence sharpen their technical skills. 2. To provide an exposure to students to industrial work environment and give them an opportunity to work on a live project and implement it 3. To make the students industry ready and make them aware of work ethics and professional ethics. 4. To provide students with employability opportunities.
Course Outcomes	1. Exposure to Industrial problems 2. Ability to solve Industrial problems

<table>
<tr><td>Course Code</td><td>MEC804a</td></tr>
<tr><td>Course Title</td><td>Tribology</td></tr>
<tr><td>Course Type</td><td>Elective</td></tr>
<tr><td>Course LTP</td><td>310</td></tr>
<tr><td>Course Credits</td><td>4</td></tr>
<tr><td>Course Assessment
• Continuous
• End of Semester</td><td>
50 (Sessionals, Assignments, Quizzes)
50 (University Examination)</td></tr>
<tr><td>Course Prerequisites</td><td></td></tr>
<tr><td>Course Objectives</td><td></td></tr>
<tr><td>Course Outcomes</td><td>1. Students will be able to describe the concepts of tribology and characterize surfaces
2. Students will be able to analyze different types of friction and wear mechanisms
3. Students will be able to apply lubrication theories to solve engineering problems
4. Students will be able to design bearings and apply tribology in manufacturing</td></tr>
<tr><td colspan="2">Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Introduction
Definition and Scope of tribology, Contact of solids, nature of surfaces, surface topography, surface interactions and characterization, micro and nanotribology, surface roughness measurement techniques.

2. Friction
Types, laws, modern theories, dry sliding friction, temperature of sliding surface, Mechanism of rolling friction, friction instabilities, measurement of friction.</td></tr>
</table>

3. Wear
   Classification, theories of adhesive, abrasive, surface fatigue and corrosives wear, erosive, cavitation and fretting wear, wear models, wear of miscellaneous machine components such as gears, plain bearings and rolling element bearings, ASTM standards for wear measurement, wear resistant materials, wear resistant components, Study of abrasion in grinding, lapping and honing. (12 hours)

Part B

4. Lubrication Theories
   Lubrication regimes: hydrodynamic lubrication, hydrostatic lubrication, elastohydrodynamic lubrication, boundary lubrication, squeeze films, turbulent lubrication. Reynold's equation, Pressure distribution, load carrying capacity, friction forces in oil film and coefficient of friction in journal bearing.

5. Bearing Design
   Clearance in journal bearing, minimum film thickness, Sommerfeld Number. Oil grooves and flow of oil in axial and circumferential grooves, cavitation and turbulence in oil bearing. Heat generation and cooling of bearing. Design of air bearing and other gas bearings.

6. Applications
   Application of tribology in manufacturing processes, Metal machining, Metal cutting, Tool wear, Action of lubricants, Friction welding, Extrusion process (12 hours)

Textbooks

Title	Author	Publisher
Basic Lubrication Theory	Cameron	Ellis Horwood (1981)
Friction, Wear, and Lubrication	Ludema	CRC Press (2018)
Engineering Tribology	Williams	CUP (2005)
Introduction to Tribology	Bhushan	Wiley (2002)
Engineering Tribology	Stachowiak	Butterworth Heinemann (2016)

References

Title	Author	Publisher

Course Code	MEC804b
Course Title	Additive Manufacturing
Course Type	Elective
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Manufacturing technology, Machine Design, Material Science
Course Objectives	The purpose of this course is to enable the students to understand about various techniques and applications of additive manufacturing techniques.
Course Outcomes	1. Students will be able to explain the basic principles and applications of additive manufacturing 2. Students will be able to analyze material selection and behavior in AM processes 3. Students will be able to classify and compare different AM technologies 4. Students will be able to develop and apply mathematical models for AM processes

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Introduction to Additive Manufacturing (AM) (05 hr)
   General overview, Introduction to reverse engineering, Traditional manufacturing vis AM, Computer aided design (CAD) and manufacturing (CAM) and AM, Different AM processes and relevant process physics AM process chain.

Application level: Direct processes - Rapid Prototyping, Rapid Tooling. Rapid Manufacturing; Indirect Processes - Indirect Prototyping. Indirect Tooling, Indirect Manufacturing

2. Materials science for AM (04 hr)
   Discussion on different materials used, Use of multiple materials, multifunctional and graded materials in AM. Role of solidification rate, Evolution of non-equilibrium structure, Structure property relationship, Grain structure and microstructure

3. AM technologies (12 hr)
   Powder-based AM processes involving sintering and melting (selective laser sintering, shaping, electron beam melting. involvement). Printing processes (drop!et based 3D)
   Solid-based AM processes - extrusion based fused deposition modeling object Stereolithography Micro- and nano-additive

Part B

4. Mathematical models for AM (13 hr)
   Transport phenomena models: temperature, fluid flow and composition, buoyancy driven tension driven free surface flow pool)
   Case studies: Numerical Modeling of AM process, Powder bed melting based process,
   Droplet based printing process Residual stress, part fabrication time, cost, optimal orientation and optimal Defect in AM and role of transport Simulations (choice of parameter, Model validation)

5. Process selection, planning, control for AM (06 hr)
   Selection of AM technologies using decision methods
   Additive manufacturing process plan: strategies and post processing. Monitoring and control of defects, transformation

Textbooks

Title	Author	Publisher
Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing,	Andreas Gebhardt	Hanser Publishers (2011)
Laser-assisted fabrication of materials,	J.D. Majumdar and I. Manna	Springer Series in Material Science
Laser-induced materials and processes for rapid prototyping	L. Lu, J. Fuh and Y.-S. Wong	Kluwer Academic (Press, 2001)
Numerical modeling of the additive manufacturing (AM)	Zhiqiang Fan and Frank Liou,	InTech (2012)

processes of titanium alloy		
Rapid prototyping: principles and applications	C.K. Chua, K.F. Leong and C.S. Lim	World Scientific (2010)
Additive manufacturing technologies: rapid prototyping to direct digital manufacturing	Ian Gibson, David W. Rosen, Brent Stucker	Springer (2010)

References

Title	Author	Publisher

Course Code	MEC804c
Course Title	Elasticity
Course Type	Elective
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Mechanics of Materials
Course Objectives	The course will provide a basic treatment of the formulation of linear elasticity theory and its application to problems of stress and displacement analysis
Course Outcomes	1. Students will be able to apply mathematical tools to analyze deformation and strain 2. Students will be able to analyze stress and equilibrium in elastic materials 3. Students will be able to utilize strain energy principles in problem-solving 4. Students will be able to solve elasticity problems in various dimensions

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Mathematical Preliminaries
2. Deformation: Displacements and Strains
3. Stress and Equilibrium
4. Material Behavior - Linear Elastic Solids
5. Formulation and Solution Strategies
6. Strain Energy and Related Principles

Part B

7. Two Dimensional Formulation
8. Two Dimensional Problem Solutions
9. Extension, Torsion and Flexure of Elastic Cylinders
10. Introduction to Three Dimensional Problems
11. Optional advanced topics - Complex Variable Methods for Two-Dimensional Problems, Anisotropic Elasticity, Thermoelasticity, Nonhomogeneous Elasticity, General Displacement Potentials and Stress Functions.

Textbooks

Title	Author	Publisher
Elasticity	Timoshenko	McGraw Hill
Elasticity: Theory, Applications & Numerics	M. H. Sadd,	Elsevier (2014)

References

Title	Author	Publisher

<table>
<tr><td>Course Code</td><td>MEC804d</td></tr>
<tr><td>Course Title</td><td>Product Design and Development</td></tr>
<tr><td>Course Type</td><td>Electives</td></tr>
<tr><td>Course LTP</td><td>310</td></tr>
<tr><td>Course Credits</td><td>4</td></tr>
<tr><td>Course Assessment
Continuous
End of Semester</td><td>50 (Sessionals, Assignments, Quizzes)
50 (University Examination)</td></tr>
<tr><td>Course Prerequisites</td><td>Basic knowledge of materials and their properties
Computer Aided Design and Manufacturing</td></tr>
<tr><td>Course Objectives</td><td>Provide knowledge of basic and important concepts used in product design
Introduce structured approach of product design and development that applies various concepts to design a new product</td></tr>
<tr><td>Course Outcomes</td><td>Students will be able to describe the design process and product life cycle management tools
Students will be able to apply value engineering and concurrent engineering principles
Students will be able to select appropriate materials and processes for product design
Students will be able to design products considering manufacturability, assembly, safety, and other factors</td></tr>
<tr><td colspan="2">

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Stages in Design Process:
Introduction to various stages of the design process: Formulation of problem, Generation of alternatives, Evaluation, Guided Redesign. Case study.(6)

2. Product Life Cycle:

</td></tr>
</table>

New product introduction: early introduction, increased product life. Life cycle management tools: System integration, QFD, House of quality, Pugh's method, Pahl and Beitz method. Case studies.(6)

3. Value Engineering:
   Introduction, nature and measurement of value. Value analysis job plan. Creativity and techniques of creativity. Value analysis test. Case studies.(6)

4. Concurrent/Reverse Engineering:
   Introduction, basic principles, components, benefits of concurrent engineering. Concept of reverse engineering. (6)

Part B

5. Material selection: (6)
   Materials in design. The evolution of engineering materials. Design tools and material data. Function, material, shape and process. Material selection strategy, attribute limits, selection process, computer aided material selection. Case studies.

6. Process selection: (6)
   Introduction. Process classification: shaping, joining and finishing. Systematic process selection. Ranking, process cost. Computer – aided process selection.

7. Design for manufacture and assembly: (4)
   Design for Manufacture and Assembly (DFMA). Reasons for not implementing DFMA. Advantages of DFMA with case studies. Design features and requirements with regard to assembly, production. Design for Manufacture in relation to any two manufacturing processes: machining and injection molding. Need, objectives.

8. Design for 'X': (4)
   Introduction. Design for: Safety, packaging and storage, quality, reliability, energy conservation, environment, aesthetics, ergonomics, maintenance, recyclability and disposal. Case studies.

9. Patents, liability and ethics: (4)
   Introduction. Protecting your design: patents, copyright, basic tools of design protection. Liability issues in product design. Ethical considerations. Examples/ case studies.

Textbooks

Title	Author	Publisher
Integrated Product and Process Development	John M. Usher, Utpal Roy and H. R. Parasaei	Tata McGraw Hill

Product Design for Manufacture and Assembly	G. Boothroyd, P. Dewhurst and W. Knight	Marcel Dekker
Product Design and Manufacture	A. K. Chitale and R. C. Gupta	PHI
Selection of Materials and Manufacturing Processes for Engineering Design Mahmoud	M. Farag	Prentice Hall
Engineering Design and Design for Manufacturing: A structured approach	John R. Dixon and Corrodo Poli	Field Stone Publishers
Material Selection in Mechanical Design	M. F. Ashby	Elsevier

References

Title	Author	Publisher
Product Design & Development	Karl T. Ulrich, Steven D. Eppinger	McGraw Hill
Concurrent Engineering	Biren Prasad	Prentice Hall

Course Code	MEC804e
Course Title	Variational Methods
Course Type	Elective
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Mechanics of Materials
Course Objectives	This course aims at providing fundamental knowledge of variational methods for formulating and solving different mechanical problems.
Course Outcomes	1. Students will be able to formulate elasticity problems using differential forms 2. Students will be able to apply virtual work principles to solve engineering problems 3. Students will be able to utilize solution methods for beam and structural analysis 4. Students will be able to apply finite element and variational methods to solve complex problems

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Formulation for Linear Problems of Elasticity (Differential Form): Vectors, Matrices, Tensors, Definitions, Strain-Displacement Equations, Material Laws, Equilibrium, Boundary conditions, Governing equations, Beam Theory, Torsion

2. Principles of Virtual Work (Integral Form): Work, Energy, Classical Variational Principles, Generalize Variational Principles, Engineering Beam Theory,

Differential and Integral forms of Governing Equations, Fundamentals of Variational Calculus

3. Solution Methods - Beam Elements: Fundamental relations for a Beam Element, Element Matrices, Stiffness Matrices.

4. Solutions Methods - Structural Systems: Displacement Method, Virtual Work, Direct Derivation, Stiffness Matrices, Trusses and Frames.

Part B

5. FInite Element Method: Trial Functions, Hamilton's principle, Virtual Work, Stiffness Matrix, Loading Vector, Displacements and Stresses, Convergence, Accuracy, h and p convergence, Numerical Integration, Isoparametric Elements.

6. Direct Variational and Weighted Residual Methods: Governing Differential Equations, Residual Methods, Variational Methods, Trial Function Methods.

7. Stability Analysis: Energy Criterion for Stability, Variationally based Stability Analysis

8. Dynamic Responses: Lagrange equations, Dynamic Response, Free Vibration Analysis.

Textbooks

Title	Author	Publisher
Mechanics of Structures: Variational and Computational Methods	Pilkey and Wunderlich	CRC Press 1994

References

Title	Author	Publisher

Course Code	MEC804f
Course Title	Nanotechnology
Course Type	Elective
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Physics, Chemistry, Mechanics of Materials, Materials Science, Manufacturing Processes
Course Objectives	1. Familiarizing students on property variations in large and small scale materials 2. Sensitization on optics and electron microscopy techniques of characterization 3. Understanding importance of nano materials in modern manufacturing and engineering applications
Course Outcomes	1. Students will be able to describe the fundamental concepts and applications of nanotechnology 2. Students will be able to explain various tools used for nano measurement and characterization 3. Students will be able to describe different nanofabrication methods 4. Students will be able to discuss the applications of nanomaterials in various fields

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Introduction to Nanotechnology:

Basics of nanofabrication and nanocharacterization techniques as well as specific applications of nanotechnology in commercial products. Light, x-rays, and electron beams to characterize objects at the nanoscale.

2. Nano Measurement and Characterization Tools:
Sample preparation and imaging techniques used in scanning electron microscopy. energy-dispersive x-ray spectroscopy can be paired with scanning electron microscopy to gain elemental information about samples.Transmission electron microscopy and cryo-transmission electron microscopy. micro-computed tomography, X-ray photoelectron spectroscopy, and optical spectroscopy.

Part B

3. Nanofabrication:
Vacuum Pumps, Vapor Deposition and Thin Film Vacuum Deposition Vacuum environment for nanofabrication, compare the operation of vacuum pumps, vacuum deposition of thin films using three different methods: sputter evaporation, e-beam evaporation and thermal evaporation.Techniques for making things with nanotechnology using thin film techniques; compare atomic layer deposition, chemical vapor deposition, and plasma-enhanced chemical vapor deposition.

4. Applications of Nanomaterials:
Nanocomposite materials for therapy and food packaging- Functional graphene- carbon nanotube and polymer composite applications in defence and aerospace. Nanomaterials for solar Cells- Nanoscale catalysts for energy and automobile industries. Rechargeable batteries based on nanomaterials- Nanomaterials for electrodes and wearable electronics- Nano based coating and paints.

Textbooks

Title	Author	Publisher
Fundamentals of Nanotechnology	Hornyak, G. Louis, Tibbals, H. F., Dutta, Joydeep	CRC Press (2019)
Nanocomposite Science and Technology	P. M. Ajayan, L. S. Schadler, P. V. Braun	Wiley (2015)
Introduction to Nanoscale Science and Technology	Massimiliano Ventra, Stephane Evoy and James R. Heflin	Springer (2009)

References

Title	Author	Publisher

Nanostructures & Nanomaterials: Synthesis, Properties & Applications	G. Cao	World Scientific (2011)

Course Code	MEC804g
Course Title	Production Operations Management
Course Type	Elective
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Manufacturing Processes
Course Objectives	1. To enable the student to understand the product and process design, inventory management, plant layout. 2. To enable the students to understand the various SQC techniques, control charts, inventory costs.
Course Outcomes	1. Students will be able to describe the functions and evolution of production and operations management 2. Students will be able to analyze product and process design methodologies 3. Students will be able to apply capacity planning and facility layout techniques 4. Students will be able to utilize demand forecasting and operation scheduling methods

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Introduction
   Operations functions in an Organization, Historical Evolution of Production and Operations Management, Jobs/Decisions of Production and Operations Management, Manufacturing v/s Service operations.

2. Product and Process Design
   Need, Stages of Product Life Cycle, Product Development process, Product Design v/s Process Design, Classification of a Production Process, Methodology for Process Design.

3. Capacity planning
   Need for capacity planning, capacity planning decisions, Strategies for modifying capacity- Long term and short term capacity strategies, capacity planning models and linear programming, Decision Tree analysis, Aggregate planning and strategies for

4. Aggregate Planning.
   Facility location and layout
   Need for facility location planning, General procedure for facility location planning; Types of layouts, Merits and Demerits, layout planning, Line balancing.

Part B

5. Demand forecasting
   Introduction, Forecasting Methods: Time series methods- Naïve method, Moving average, Weighted moving average, Exponential smoothing method and Casual methods- Linear Regression method, Forecasting Errors, Selection of the Forecasting Model.

6. Operation scheduling
   Need of operation scheduling, Factors effecting scheduling, Job Shop scheduling, Priority sequencing, Batch scheduling.

7. Inventory control
   Need of the inventory control, Inventory costs, basic EOQ model, Selective inventory controls-ABC, FSN, VED, Fixed order quantity and fixed order interval system, Material requirement planning.

8. Quality Management
   Concept of Quality, quality cost, inspection, type of inspection, statistical quality control, control charts, concept of TQM & ISO Certification

Textbooks

Title	Author	Publisher
Production and Operations Management: Manufacturing and Non-manufacturing	Dilworth	McGraw Hill
Production and Operations Management: Concepts, Models, and Behavior	Adam	Prentice Hall

References

Title	Author	Publisher

Course Code	MEC804h
Course Title	Internal Combustion Engines
Course Type	Elective
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	
Course Objectives	
Course Outcomes	1. Students will be able to describe the operation and characteristics of SI and DI engines 2. Students will be able to analyze engine combustion processes 3. Students will be able to evaluate engine performance and emissions 4. Students will be able to discuss alternative fuels and advanced engine technologies

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

Introduction to SI and DI engines, Engine operating characteristics, Ideal cycle analysis Disassembly and assembly of engines, Combustion and thermochemistry, Kinetics, equilibrium and dissociation, Gas properties and fuel - air cycle; cycle simulation, Mixture preparation in SI engines, Intake and exhaust processes, SI engine combustion, SI engine emissions

Part B

Engine performance and emissions measurements, SI engine emissions, SI engine emissions control, Emission measurements, Diesel engine characteristics, Diesel engine:

injection, ignition and combustion, Diesel engine emissions and control, Engine heat transfer, Engine friction and tribology, Turbocharging, Hydrogen, fuel cell and battery Bio fuels and hybrids

Textbooks

Title	Author	Publisher
Internal Combustion Engine Fundamentals.	J. B. Heywood	McGraw Hill

References

Title	Author	Publisher

Course Code	MEC804i
Course Title	Computational Solid Mechanics
Course Type	Elective
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Linear Finite Elements, Continuum Mechanics
Course Objectives	
Course Outcomes	1. Students will be able to apply finite element methods and continuum mechanics principles 2. Students will be able to utilize variational calculus and linearization techniques 3. Students will be able to implement Lagrangian formulations in computational mechanics 4. Students will be able to develop and apply constitutive equations in FE analysis

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Introductory lecture: review of Linear Finite Element Methods. (1 lecture)

2. Demonstration lecture on Abaqus or Calculix – installation and running the software, geometric modelling, writing user subroutine – UMAT. (1 lecture)

3. Review of continuum Mechanics: Tensor algebra & Calculus (3 lecture), Kinematics (2 lecture), Stress measures (2 lecture), Clausius Duhem

inequality (2 lecture), Objectivity with examples, objective rates used in non-linear finite element computations – comparisons using examples. (2 lectures)

4. Variational calculus: formulating linear and non-linear mechanics problems (2 lecture),

5. Introduction to Directional derivative. Variation of various stress and strain measures, Introduction to Linearization. (2 lectures)

6. Introduction to Total and Updated Lagrangian formulations: derivation of weak forms, Solution methods – Newton Raphson method and variants. (2 lecture)

7. Discretized FE equations using IsoParametric formulation. (2 lectures)

8. Constitutive Equations: Restrictions on the constitutive equations imposed by frame indifference and thermodynamics (1 lectures)

Part B

9. Constitutive equations for hyperelasticity (with and without incompressibility), rate dependent and independent plasticity in metals and Crystal plasticity. (5 lectures)

10. Linearization of constitutive equations to be used in weak forms (2 lecture)

11. Linearization of constitutive equations and FE discretisation: Example – Compressible, Neo-Hookean material (other constitutive formulations may also be taken up here), Geometric and material stiffness matrices – details of implementation, writing User subroutine UEL in Abaqus/Calculix. (5 lecture)

12. Convergence measures, rate of convergence, Patch test (2 Lectures)

13. Geometric and material stiffness matrices – discussion on rank, deficiency and implementation details. (1 lecture)

14. Discussion of techniques to deal with incompressibility condition (2 lecture)

15. Review Gauss Quadrature, Reduced integration, Locking issues. (3 lecture)

Textbooks

Title	Author	Publisher
Finite Element Procedures	Bathe	Prentice Hall (2014)

Nonlinear Finite Element Analysis (vol. 1,2)	Crisfield	Wiley
Nonlinear Finite Elements for Continua and Structures	Belytschko	Wiley (2013)
Nonlinear Solid Mechanics for Finite Element Analysis	Bonet	CUP (2016)

References

Title	Author	Publisher

Course Code	MEC804j
Course Title	Micromechanics
Course Type	Elective
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	Mechanics of Materials
Course Objectives	The course introduces the fundamental mechanics aspects required for the analysis of heterogeneous materials, and concepts required for their application in mechanical engineering. 1. Mechanics of multiphase materials such as relevant to the design and the analysis of composites, multiphase alloys, porous solids, foams, honeycomb materials, architecture materials. 2. Mechanics of material damage as this emerges from the evolution of microcracks and the growth of voids. 3. Material selection and design approaches with microstructure features. 4. Implication to the design of mechanical devices and structures with case studies.
Course Outcomes	1. Students will be able to describe defects in solids and elasticity concepts 2. Students will be able to analyze the behavior of inclusions in elastic solids 3. Students will be able to explain the elastic fields of dislocations and disclinations 4. Students will be able to analyze crack behavior, defect interactions, and homogenization techniques
Syllabus Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.	

Part A

1. Introduction: the nature of defects in solids; applications
2. Elasticity: Review; strain compatibility; stress
3. Inclusions: Eshelby solution to inclusion in an elastic solid; solution for ellipsoidal shapes; Ellipsoidal inhomogeneities; Energetics of inclusions and inhomogeneities
4. Dislocations: Elastic field of dislocations; Volterra and Somigliana dislocations; dislocation loop, continuous distribution of dislocations and its relation to strain compatibility
5. Disclinations and their elastic fields

Part B

6. Cracks
7. Interactions: Interaction of various defects; force acting on a defect; Solution to several problems, for e.g. inclusion interacting with a dislocation etc.:
8. Homogenisation: Elementary homogenisation theory; Mori-Tanaka theory; macroscopic properties of matter; Average elastic moduli of composite materials
9. Plasticity of polycrystalline metals

Textbooks

Title	Author	Publisher
Micromechanics of defects in solids	T. Mura	Springer (1987)
The Mechanics of Defects and Inhomogeneities	J. D. Eshelby (Collected works)	Springer (2006)
Introduction to the elasticity theory of crystal defects	R. W. Balluffi	CUP (2016)

References

Title	Author	Publisher

Course Code	HSMC801
Course Title	Project Management and Entrepreneurship
Course Type	Elective
Course LTP	310
Course Credits	4
Course Assessment • Continuous • End of Semester	 50 (Sessionals, Assignments, Quizzes) 50 (University Examination)
Course Prerequisites	
Course Objectives	The main aim of this course is to make prospective engineers familiar with the concept of entrepreneurship and MSMEs and to provide knowledge about different aspects to be considered while formulating the business plan for a new entrepreneurial venture. This course also intends to create awareness among students about financial and marketing functions that is required for a new venture.
Course Outcomes	1. Students will be able to describe the characteristics and functions of entrepreneurship 2. Students will be able to discuss the role of women entrepreneurs and the importance of MSMEs 3. Students will be able to conduct SWOT analysis for project identification 4. Students will be able to develop project plans and understand financial and marketing functions

Syllabus

Note - The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.

Part A

1. Introduction to Entrepreneurship
   Concept of Entrepreneurship, Characteristics and Functions of Entrepreneur
   Forms of Ownership of Business, Factors Affecting Entrepreneurship

Case Studies of Entrepreneurs (8 hours)

2. Women Entrepreneurship
   Nature of Women Entrepreneurship, Problems of Women Entrepreneurs, Institutional Initiatives for Promotion of Women Entrepreneurs (4 hours)

3. Micro, Small and Medium Enterprises (MSMEs)
   Concept of MSMEs, Schemes of MSMEs
   Functions of Entrepreneurial Development Programmes (EDPs) (3 hours)

4. Project Identification
   Idea Generation, Project Life Cycle, Concept of SWOT Analysis
   SWOT Analysis of Selected Project (3 hours)

Part B

5. Project Planning and Formulation
   Elements of Project Formulation: Product, Technical (Location, Scale, Technology, Production Process, Layout, Manpower, Resources), Market, Finance and Economic Aspects
   Feasibility Analysis: Financial Viability and Profitability, and Socio-Economic Desirability (12 hours)

6. Project Report
   Formulation of Business Plan and Project Report, Hypothetical Example of a Real-Life Project (4 hours)

7. Finance and Marketing Function
   Concept of Finance, Finance Related Terminologies, Sources of Finance, Cost Estimations
   Marketing Mix: Product, Place, Price, Promotion, People, Process and Physical Evidence
   Marketing Segmentation Targeting and Positioning (8 hours)

8. Discussions on Additional Reading (any one of the following in the semester)
   - The New Age Entrepreneurs
   - The $100 Startup: Fire your Boss, Do what you Love and Work Better to Live More
   - A Guide to Entrepreneurship
   - Dhandha: How Gujaratis Do Business
   - Rokda: How Baniyas Do Business
   - Take Me Home
   - Business Families of Ludhiana

Textbooks

Title	Author	Publisher

Dynamics of Entrepreneurial Development & Management	Desai	Himalaya Publishing House
Projects: Planning, Analysis, Selection, Financing, Implementation and Review	Chandra	McGrawHill (India 2014)

References

Title	Author	Publisher
Entrepreneur's Toolkit	Harvard Business School	Harvard University Press (2004)
Entrepreneurship	Hisrich	McGraw Hill (2006)
Entrepreneurship	Roy	Oxford University Press (2011)
Essentials of Project Management	Ramakrishna	Pearson
Entrepreneurship Development in India	Gupta	S Chand (2013)