



SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

DEPARTMENT OF MECHANICAL ENGINEERING

Program – Mechanical Engineering



2022

Scheme & Syllabus

Effective from the Academic Year 2022 - 2023



SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

B.E. IN MECHANICAL ENGINEERING

SCHEME OF TEACHING AND EVALUATION 2022
OUTCOME BASED EDUCATION (OBE) AND CHOICE BASED CREDIT SYSTEM (CBCS)
(2022 SCHEME: EFFECTIVE FROM THE ACADEMIC YEAR 2023 - 24)

III SEMESTER

Sl. No.	Course	Course Code	Course Title	Teaching Department (TD)	Question Paper Setting Board (PSB)	Teaching Hours / Week				Examination				Credits
						Theory Lecture	Tutorial	Practical / Drawing	Self-Study	Duration in hours	CIA Marks	SEE Marks	Total Marks	
						L	T	P	S					
1	BSC	MA322T1M	Transform Calculus and Special Functions	BSC	BSC	03	00	00	00	3	50	50	100	3
2	IPCC	ME322I2M	Thermodynamics-I	ME	ME	03	00	02	00	3	50	50	100	4
3	IPCC	ME322I3M	Material Science and Metallurgy	ME	ME	03	00	02	00	3	50	50	100	4
4	PCC	ME322T4M	Mechanics of Materials	ME	ME	03	00	00	00	3	50	50	100	3
5	PCCL	ME322L5M	Measurement and Metrology LAB	ME	ME	00	00	02	00	3	50	50	100	1
6	ESC/ETC/PLC	ME322T6M	Design for Manufacturing	ME	ME	03	00	00	00	3	50	50	100	3
7	UHV	HU32287X	UHV Course	BSC	BSC	01	00	00	00	1	50	50	100	1
8	AEC / SEC	ME32298MX	Ability Enhancement Course III / Skill Enhancement Course III	ME	ME	01	00	00	00	1	50	50	100	1
9	MC	N322N10X	National Service Scheme (NSS)	NSS / PED / Yoga		00	00	02	00	Registrations to any one of the courses be completed (as per the choice of the student) and activities to be carried out.				0
		P322N10X	Physical Education (PE) (Sports and Athletics)											
		Y322N10X	Yoga											
Chairperson Board of Studies											400	400	800	20

ESC/ETC/PLC																
ME322I6M	Design for Manufacturing															
ABILITY ENHANCEMENT COURSE III / SKILL ENHANCEMENT COURSE III																
ME32298MA	Python for Scientific Computing				ME32298MB	Generative design lab										
ME32298MC	Embedded Systems Lab				ME32298MD	Game Design lab										
COURSE PRESCRIBED TO LATERAL ENTRY DIPLOMA HOLDERS ADMITTED TO III SEMESTER B.E. PROGRAMS																
1			Additional Mathematics I			BSC	BSC	02	00	00	01	3	50	50	100	0
Note: BSC: Basic Science Course, IPCC: Integrated Professional Core Course, PCC: Professional Core Course, PCCL: Professional Core Course Laboratory, AEC: Ability Enhancement Courses, UHV: Universal Human Value Course, SEC: Skill Enhancement Course, ESC: Engineering Science Course, ETC: Emerging Technology Course, PLC: Programming Language Course, MC: Mandatory Course L – Lecture, T – Tutorial, P- Practical/ Drawing, S – Self -Study Component, CIA: Continuous Internal Assessment, SEE: Semester End Examination, TD- Teaching Department, PSB: Paper Setting Board.																
Integrated Professional Core Course (IPCC): Refers to Professional Theory Core Course Integrated with Practical of the same course. Credit for IPCC can be 04 and its Teaching– Learning hours (L: T: P) can be considered as (3: 0: 2) or (2: 2: 2). The theory part of the IPCC shall be evaluated both by CIA and SEE. The practical part shall be evaluated by only CIA (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper.																
National Service Scheme (NSS)/ Physical Education (PE)/ Yoga: All the students have to register for any one of the courses namely NSS/ PE/ Yoga with the concerned coordinator of the course during the first week of the III semester. Activities shall be carried out between the III semester and VI semester (for Four Semesters). The events shall be appropriately scheduled and the same shall be reflected in the Institute Academic and Activity Calendar. The course will be evaluated only for the CIA marks and will not have SEE component. The students who successfully complete the registered course will be awarded with “PP” grade and the students not completing the same will be awarded with “NP” grade. The marks and the grade obtained by the student will be included in the SIXTH semester grade card. The course will not be considered for the SGPA and CGPA calculations and Vertical Progression, however, completion of the course is mandatory for the award of the Degree.																
Non–Credit Mandatory Courses (NCMC): (A) Additional Mathematics I: 1) This course is prescribed in the III semester to the lateral entry Diploma holders admitted to the second year of the B.E., programs. They shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the Continuous Internal Assessment (CIA). These courses are slated for both CIA and SEE. 2) Additional Mathematics I shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the courses shall be mandatory for the award of degree. 3) Successful completion of the courses Additional Mathematics I shall be indicated with Pass (PP) grade in the grade card. Non-completion of the courses will lead to the award of Not Pass (NP) Grade. 4) In case, any student fails to register for the said course/fails to secure the minimum 40% of the prescribed CIA marks and 40% of the prescribed SEE marks, shall be deemed to have secured an NP grade. In such a case, the student has to fulfill the course requirements during subsequent semester/s.																

(B) National Service Scheme (NSS)/Physical Education (Sport and Athletics) (PED)/ Yoga:

- 1) Securing 40% or more in CIA, 40% or more marks in SEE and 40% or more in the sum total of CIA + SEE leads to successful completion of the registered course.
- 2) In case, students fail to secure 40 % marks in SEE, they have to appear for SEE during the subsequent examinations and obtain the minimum requirement.
- 3) In case, any student fails to register for NSS, PE or Yoga/fails to secure the minimum requirements as mentioned in (B).1, they shall be awarded with NP Grade. In such a case, the student has to fulfill the course requirements during subsequent semester/s.
- 4) Successful completion of the course shall be indicated with a PP Grade in the grade card.
- 5) These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the courses shall be mandatory for the award of degree.

BoS SPECIFIED NPTEL COURSES**(APPLICABLE ONLY TO THE STUDENTS WHO FAIL IN A COURSE MORE THAN FOUR TIMES)**

Course Code	Course Name	Alternative NPTEL Courses*
A		

subjected to change depending on the courses offered by the NPTEL.*Note:**

- The student has to provide the evidences for registering to the course, assignment submission, attending the examination and the certificate provided by NPTEL indicating the clearance of the Course by the candidate.
- Only on submitting the valid documents, the student will be awarded with the credits mentioned against the course(s)



B.E. IN MECHANICAL ENGINEERING
SCHEME OF TEACHING AND EVALUATION 2022
OUTCOME BASED EDUCATION (OBE) AND CHOICE BASED CREDIT SYSTEM (CBCS)
(2022 SCHEME: EFFECTIVE FROM THE ACADEMIC YEAR 2023 - 24)

IV SEMESTER

Sl. No.	Course	Course Code	Course Title	Teaching Department (TD)	Question Paper Setting Board (PSB)	Teaching Hours / Week				Examination				Credits
						Theory Lecture	Tutorial	Practical / Drawing	Self -Study	Duration in hours	CIA Marks	SEE Marks	Total Marks	
						L	T	P	S					
1	IPCC	ME422I1M	Thermodynamics-II	ME	ME	03	00	02	00	3	50	50	100	4
2	IPCC	ME422I2M	Machining Science and Jigs & Fixtures	ME	ME	03	00	02	00	3	50	50	100	4
3	PCC	ME422T3M	Kinematics of Machines	ME	ME	03	00	00	00	3	50	50	100	3
4	PCC	ME422T4M	Fluid Mechanics	ME	ME	03	00	00	00	3	50	50	100	3
5	PCCL	ME422L5M	Machine Drawing and GD & T	ME	ME	00	00	02	00	3	50	50	100	1
6	ESC/ETC/PLC	MA422T6M (A)	Functions of Complex Variables and Statistical Methods	BSC	BSC	03	00	00	00	3	50	50	100	3
7	AEC / SEC	ME42297MX	Ability Enhancement Course IV / Skill Enhancement Course IV	ME	ME	01	00	00	00	1	50	50	100	1
8	BSC	BS422T8X	Biology for Engineers	BSC	BSC	02	00	00	00	2	50	50	100	2
9	UHV	HU42289X	UHV Course	BSC	BSC	01	00	00	00	1	50	50	100	1
10	MC	N422N10X	National Service Scheme (NSS)	NSS / PED / Yoga		00	00	02	00	Activities to be carried out by the student in the registered course				0
		P422N10X	Physical Education (PE) (Sports and Athletics)											
		Y422N10X	Yoga											
Chairperson Board of Studies											450	450	900	22

ESC/ETC/PLC

MA422T6M	Functions of Complex Variables and Statistics for Engineers		

ABILITY ENHANCEMENT COURSE IV / SKILL ENHANCEMENT COURSE IV

ME42297MA	Data Wrangling, Analysis and Visualization	ME42297MB	Prototype fabrication lab
ME42297MC	Sensors and actuators lab	ME42297MD	Animation Lab

COURSE PRESCRIBED TO LATERAL ENTRY DIPLOMA HOLDERS ADMITTED TO III SEMESTER B.E. PROGRAMS

1			Additional Mathematics II	BSC	BSC	02	00	00	01	3	50	50	100	0
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Note: **BSC:** Basic Science Course, **IPCC:** Integrated Professional Core Course, **PCC:** Professional Core Course, **PCCL:** Professional Core Course Laboratory, **AEC:** Ability Enhancement Courses, **UHV:** Universal Human Value Course, **SEC:** Skill Enhancement Course, **ESC:** Engineering Science Course, **ETC:** Emerging Technology Course, **PLC:** Programming Language Course, **MC:** Mandatory Course

L – Lecture, **T** – Tutorial, **P**- Practical/ Drawing, **S** – Self -Study Component, **CIA:** Continuous Internal Assessment, **SEE:** Semester End Examination, **TD-** Teaching Department, **PSB:** Paper Setting Board.

Integrated Professional Core Course (IPCC): Refers to Professional Theory Core Course Integrated with Practical of the same course. Credit for IPCC can be 04 and its Teaching– Learning hours (L: T: P) can be considered as (3: 0: 2) or (2: 2: 2). The theory part of the IPCC shall be evaluated both by CIA and SEE. The practical part shall be evaluated by only the CIA (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper.

National Service Scheme (NSS)/ Physical Education (PE)/ Yoga: All the students have to register for any one of the courses namely NSS/ PE/ Yoga with the concerned coordinator of the course during the first week of the III semester. Activities shall be carried out between the III semester and VI semester (for Four Semesters). The events shall be appropriately scheduled and the same shall be reflected in the Institute Academic and Activity Calendar. The course will be evaluated only for the CIA marks and will not have SEE component. The students who successfully complete the registered course will be awarded with “PP” grade and the students not completing the same will be awarded with “NP” grade. The marks and the grade obtained by the student will be included in the SIXTH semester grade card. The course will not be considered for the SGPA and CGPA calculations and Vertical Progression, however, completion of the course is mandatory for the award of the Degree.

Non–Credit Mandatory Courses (NCMC):

(A) Additional Mathematics I:

- 1) This course is prescribed in the III semester to the lateral entry Diploma holders admitted to the second year of the B.E., programs. They shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the Continuous Internal Assessment (CIA). These courses are slated for both CIA and SEE.
- 2) Additional Mathematics I shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the courses shall be mandatory for the award of degree.
- 3) Successful completion of the courses Additional Mathematics I shall be indicated with Pass (PP) grade in the grade card. Non-completion of the courses will lead to the award of Not Pass (NP) Grade.
- 4) In case, any student fails to register for the said course/fails to secure the minimum 40% of the prescribed CIA marks and 40% of the prescribed SEE marks, shall be deemed to have secured an NP grade. In such a case, the student has to fulfill the course requirements during subsequent semester/s.

National Service Scheme (NSS)/Physical Education (Sport and Athletics) (PED)/ Yoga:

- 1) Securing 40% or more in CIA, 40% or more marks in SEE and 40% or more in the sum total of CIA + SEE leads to successful completion of the registered course.
- 2) In case, students fail to secure 40 % marks in SEE, they have to appear for SEE during the subsequent examinations and obtain the minimum requirement.
- 3) In case, any student fails to register for NSS, PE or Yoga/fails to secure the minimum requirements as mentioned in (B).1, they shall be awarded with NP Grade. In such a case, the student has to fulfill the course requirements during subsequent semester/s.
- 4) Successful completion of the course shall be indicated with a PP Grade in the grade card.
- 5) These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the courses shall be mandatory for the award of degree.

BoS SPECIFIED NPTEL COURSES**(APPLICABLE ONLY TO THE STUDENTS WHO FAIL IN A COURSE MORE THAN FOUR TIMES)**

Course Code	Course Name	Alternative NPTEL Courses*
A	Functions of Complex Variables and Statistics for Engineers	—

subjected to change depending on the courses offered by the NPTEL.*Note:**

- The student has to provide the evidences for registering to the course, assignment submission, attending the examination and the certificate provided by NPTEL indicating the clearance of the Course by the candidate.
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B.E. IN MECHANICAL ENGINEERING

SCHEME OF TEACHING AND EVALUATION 2022
OUTCOME BASED EDUCATION (OBE) AND CHOICE BASED CREDIT SYSTEM (CBCS)
(2022 SCHEME: EFFECTIVE FROM THE ACADEMIC YEAR 2024 - 25)

V SEMESTER

Sl. No.	Course	Course Code	Course Title	Teaching Department (TD)	Question Paper Setting Board (PSB)	Teaching Hours / Week				Examination				Credits
						Theory Lecture	Tutorial	Practical / Drawing	Self -Study	Duration in hours	CIA Marks	SEE Marks	Total Marks	
						L	T	P	S					
1	IPCC	ME522I1M	Finite Element Method	ME	ME	03	00	02	00	3	50	50	100	4
2	IPCC	ME522I2M	Dynamics of Machines	ME	ME	03	00	02	00	3	50	50	100	4
3	PCC	ME522T3M	Advanced Manufacturing Technology	ME	ME	03	00	00	00	3	50	50	100	3
4	PCC	ME522T4M	Turbomachines	ME	ME	03	00	00	00	3	50	50	100	3
5	PCCL	ME522L5M	Fluid Mechanics and Machinery Lab	ME	ME	00	00	02	00	3	50	50	100	1
6	PEC	ME52216MX	Professional Elective I	ME	ME	03	00	00	00	3	50	50	100	3
7	PROJ	ME522L7M	Mini-Project Work	ME	ME	00	00	04	00	3	50	---	50	2
8	AEC	ME52298X	Research Methodology and IPR	ME	ME	01	00	00	00	1	50	50	100	1
9	MC	BS52289X	Environmental Studies	BSC	BSC	01	00	00	00	1	50	50	100	1
10	MC	N522N9X	National Service Scheme (NSS)	NSS / PED / Yoga		00	00	02	00	Activities to be carried out by the student in the registered course				0
		P522N9X	Physical Education (PE) (Sports and Athletics)											
		Y522N9X	Yoga											
Chairperson Board of Studies											450	400	850	22

PROFESSIONAL ELECTIVE COURSES

ME52216MA	Smart Materials	ME52216MB	Technologies for Clean Energy
ME52216MC	Industrial Robotics	ME52216MD	Operations Research

Note: **HSMC:** Humanities Science & Management Course, **IPCC:** Integrated Professional Core Course, **PCC:** Professional Core Course, **PCCL:** Professional Core Course Laboratory, **AEC:** Ability Enhancement Courses, **PEC:** Professional Elective Course, **MC:** Mandatory Course, **PROJ:** Project Work

L – Lecture, **T** – Tutorial, **P**- Practical/ Drawing, **S** – Self -Study Component, **CIA:** Continuous Internal Assessment, **SEE:** Semester End Examination, **TD-** Teaching Department, **PSB:** Paper Setting Board.

Integrated Professional Core Course (IPCC): Refers to Professional Theory Core Course Integrated with Practical of the same course. Credit for IPCC can be 04 and its Teaching– Learning hours (L: T: P) can be considered as (3: 0: 2) or (2: 2: 2). The theory part of the IPCC shall be evaluated both by CIA and SEE. The practical part shall be evaluated by only CIA (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper.

National Service Scheme (NSS)/ Physical Education (PE)/ Yoga: All the students have to register for any one of the courses namely NSS/ PE/ Yoga with the concerned coordinator of the course during the first week of the III semester. Activities shall be carried out between the III semester and VI semester (for Four Semesters). The events shall be appropriately scheduled and the same shall be reflected in the Institute Academic and Activity Calendar. The course will be evaluated only for the CIA marks and will not have SEE component. The students who successfully complete the registered course will be awarded with “PP” grade and the students not completing the same will be awarded with “NP” grade. The marks and the grade obtained by the student will be included in the SIXTH semester grade card. The course will not be considered for the SGPA and CGPA calculations and Vertical Progression, however, completion of the course is mandatory for the award of the Degree.

Non–Credit Mandatory Courses (NCMC):

National Service Scheme (NSS)/Physical Education (Sport and Athletics) (PED)/ Yoga:

- 1) Securing 40% or more in CIA, 40% or more marks in SEE and 40% or more in the sum total of CIA + SEE leads to successful completion of the registered course.
- 2) In case, students fail to secure 40 % marks in SEE, they have to appear for SEE during the subsequent examinations and obtain the minimum requirement.
- 3) In case, any student fails to register for NSS, PE or Yoga/fails to secure the minimum requirements as mentioned in (B).1, they shall be awarded with NP Grade. In such a case, the student has to fulfill the course requirements during subsequent semester/s.
- 4) Successful completion of the course shall be indicated with a PP Grade in the grade card.
- 5) These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the courses shall be mandatory for the award of degree.





B.E. IN MECHANICAL ENGINEERING

SCHEME OF TEACHING AND EVALUATION 2022
OUTCOME BASED EDUCATION (OBE) AND CHOICE BASED CREDIT SYSTEM (CBCS)
(2022 SCHEME: EFFECTIVE FROM THE ACADEMIC YEAR 2024 - 25)

VI SEMESTER

Sl. No.	Course	Course Code	Course Title	Teaching Department (TD)	Question Paper Setting Board (PSB)	Teaching Hours / Week				Examination				Credits
						Theory Lecture	Tutorial	Practical / Drawing	Self -Study	Duration in hours	CIA Marks	SEE Marks	Total Marks	
						L	T	P	S					
1	HSMC	ME622T1M	Technology Entrepreneurship and Business Economics	ME	ME	03	00	00	00	3	50	50	100	3
2	IPCC	ME622I2M	Heat Transfer	ME	ME	03	00	02	00	3	50	50	100	4
3	PCC	ME622T3M	Design of Machine Elements – I	ME	ME	03	00	00	00	3	50	50	100	3
4	PEC	ME62214MX	Professional Elective II	ME	ME	03	00	00	00	3	50	50	100	3
5	OEC	ME62225MX	Open Elective Course I	ME	ME	03	00	00	00	3	50	50	100	3
6	PROJ	ME622P6M	Project Work Phase I	ME	ME	00	00	08	00	3	100	---	100	4
7	PCCL	ME622L7M	3D Printing Lab	ME	ME	00	00	02	00	3	50	50	100	1
8	AEC / SEC	ME62298MX	Ability Enhancement Course V / Skill Enhancement Course V	ME	ME	01	00	00	00	1	50	50	100	1
9	MC	N62289X	National Service Scheme (NSS)	Completed during the intervening period of III and VI Semester							50	---	50	0
		P622N9X	Physical Education (PE) (Sports and Athletics)											
		Y622N9X	Yoga											
														22



ABILITY ENHANCEMENT COURSE V/ SKILL ENHANCEMENT COURSE V			
ME62298MA	Machine Learning using tensor flow	ME62298MB	PLM lab
ME62298MC	SoC lab	ME62298MD	VR app development
PROFESSIONAL ELECTIVE COURSE			
ME62214MA	Product Life Cycle Management	ME62214MB	Rocket Propulsion
ME62214MC	Industrial Automation and Control	ME62214MD	Industrial Internet of Things
OPEN ELECTIVE COURSE			
ME62225MA	Non-Conventional Energy Sources	ME62225MB	Introduction to Automobile Engineering
ME62225MC	Hybrid and Electric Vehicles	ME62225MD	Introduction to Computer Integrated Manufacturing
Note: BSC: Basic Science Course, IPCC: Integrated Professional Core Course, PCC: Professional Core Course, PCCL: Professional Core Course Laboratory, AEC: Ability Enhancement Courses. UHV: Universal Human Value Course, SEC: Skill Enhancement Course, ESC: Engineering Science Course, ETC: Emerging Technology Course, PLC: Programming Language Course L – Lecture, T – Tutorial, P- Practical/ Drawing, S – Self -Study Component, CIA: Continuous Internal Assessment, SEE: Semester End Examination, TD- Teaching Department, PSB: Paper Setting Board.			
Integrated Professional Core Course (IPCC): Refers to Professional Theory Core Course Integrated with Practical of the same course. Credit for IPCC can be 04 and its Teaching– Learning hours (L: T: P) can be considered as (3: 0: 2) or (2: 2: 2). The theory part of the IPCC shall be evaluated both by CIA and SEE. The practical part shall be evaluated by only CIA (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper.			
Professional Elective Course (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students’ strengths for offering professional electives is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.			
Open Elective Courses (OEC): Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor. Selection of an Open Elective shall not be allowed if, - The candidate has studied the same course during the previous semesters of the program. - The syllabus content of open electives is similar to that of the Departmental core courses or Professional Elective courses. - A similar course, under any category, is prescribed in the higher semesters of the program. - In case, if any department is interested in offering courses from streams such as Law, Business (MBA), Medicine, Arts, Commerce etc. need to get the necessary approval from the respective Board of Studies and the Academic Council. - The minimum numbers of students’ strength for offering Open Elective Course is 10. However, this condition shall not be applicable to class where the admission to the program is less than 10.			

Non-Credit Mandatory Courses (NMC):**National Service Scheme/Physical Education (Sport and Athletics)/ Yoga:**

- 1) Securing 40% or more in CIA, 40% or more marks in SEE and 40% or more in the sum total of CIA + SEE leads to successful completion of the registered course.
- 2) In case, students fail to secure 40 % marks in SEE, they have to appear for SEE during the subsequent examinations and obtain the minimum requirement.
- 3) In case, any student fails to register for NSS, PE or Yoga/fails to secure the minimum requirements as mentioned in (B).1, they shall be awarded with NP Grade. In such a case, the student has to fulfill the course requirements during subsequent semester/s.
- 4) Successful completion of the course shall be indicated with a PP Grade in the grade card.
- 5) These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the courses shall be mandatory for the award of degree.

Project Work Phase I: Students have to discuss with their mentors/guides and with their help has to complete the Literature Review, define the problem statement for the Project Work, and submit an appropriate report. The guidelines and the evaluation process will be defined by the Board of Studies in line with the requirements of VTU and approved by the Academic Council of SCEM.



Chairperson
Board of Studies
Mechanical Engineering & Allied Program



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SCHEME OF TEACHING AND EVALUATION 2022
OUTCOME BASED EDUCATION (OBE) AND CHOICE BASED CREDIT SYSTEM (CBCS)
(2022 SCHEME: EFFECTIVE FROM THE ACADEMIC YEAR 2025 - 26)

VII SEMESTER

Sl. No.	Course	Course Code	Course Title	Teaching Department (TD)	Question Paper Setting Board (PSB)	Teaching Hours / Week				Examination				Credits
						Theory Lecture	Tutorial	Practical / Drawing	Self -Study	Duration in hours	CIA Marks	SEE Marks	Total Marks	
						L	T	P	S					
1	IPCC	ME722I1M	Industrial Control and Instrumentation	ME	ME	03	00	02	00	3	50	50	100	4
2	PCC	ME722T2M	Design of Machine Elements – II	ME	ME	03	00	00	00	3	50	50	100	3
3	PEC	ME72213MX	Professional Elective Course III	ME	ME	03	00	00	00	3	50	50	100	3
4	OEC	ME72224MX	Open Elective Course II	ME	ME	03	00	00	00	3	50	50	100	3
5	PCCL	ME722L5M	Computer Integrated Manufacturing Lab	ME	ME	00	00	02	00	3	50	50	100	1
6	PROJ	ME722P6M	Project Work Phase II	ME	ME	00	00	16	00	03	100	100	200	8
														22
PROFESSIONAL ELECTIVE COURSE														
ME72213MA		Operations and Supply Chain Management			ME72213MB		Refrigeration and Air Conditioning							
ME72213MC		Automotive Engineering			ME72213MD		Future Mobility Systems							
OPEN ELECTIVE COURSE														
ME72224MA		Energy and Environment			ME72224MB		Product Design and Manufacturing							
ME72224MC		Business Planning and Project Management			ME72224MD		Introduction to Hydraulics and Pneumatics							



Chairperson
Board of Studies
Mechanical Engineering & Allied Program

Note: PCC: Professional Core Course, **PEC**–Professional Elective Course. **OEC:** Open Elective Course, **PROJ:** Project Work

L – Lecture, **T** – Tutorial, **P**- Practical/ Drawing, **S** – Self -Study Component, **CIA:** Continuous Internal Assessment, **SEE:** Semester End Examination, **TD-** Teaching Department, **PSB:** Paper Setting department.

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

Open Elective Courses (OEC): Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor.

Selection of an Open Elective shall not be allowed if,

- i. The candidate has studied the same course during the previous semesters of the program.
- ii. The syllabus content of open electives is similar to that of the Departmental core courses or Professional Elective courses.
- iii. A similar course, under any category, is prescribed in the higher semesters of the program.
- iv. In case, if any department is interested in offering courses from streams such as Law, Business (MBA), Medicine, Arts, Commerce etc. need to get the necessary approval from the respective Board of Studies and the Academic Council.
- v. The minimum numbers of students' strength for offering Open Elective Course is 10. However, this condition shall not be applicable to class where the admission to the program is less than 10.

Project Work:

The objective of the Project Work is to

- i. Encourage independent learning and the innovative attitude of the students
- ii. Develop interactive attitude, communication skills, Organization, Time Management and Presentation Skills.
- iii. Impart Flexibility and Adaptability
- iv. Inspire Team working
- v. Expand Intellectual capacity, credibility, judgement and intuition
- vi. Adhere to Punctuality, setting and meeting deadlines
- vii. Install responsibilities to oneself and others
- viii. Train students to present the topic of Project work without any fear, face the audience confidently, enhance communication skills, involve in group discussions to present and exchange ideas.

The CIA and SEE evaluation procedure for the Project work will be as provided by the Board of Studies in line with VTU Regulations and approved by the Academic Council of SCEM.



SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

B.E. IN MECHANICAL ENGINEERING

SCHEME OF TEACHING AND EVALUATION 2022
OUTCOME BASED EDUCATION (OBE) AND CHOICE BASED CREDIT SYSTEM (CBCS)
(2022 SCHEME: EFFECTIVE FROM THE ACADEMIC YEAR 2025 – 26)

VIII SEMESTER

Sl. No.	Course	Course Code	Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours / Week				Examination				Credits
					Theory Lecture	Tutorial	Practical / Drawing	Self -Study	Duration in hours	CIA Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	INT	ME82231M	Internship (14-20 Weeks) [Research Internship/ Rural Internship/ Industry Internship]	ME	00	00	20	00	3	100	100	200	10
2	SEM	ME822S2M	Research oriented Technical Seminar	ME	00	00	04	00	3	100	---	100	2
													12

Note: INT: Internship

L – Lecture, **T** – Tutorial, **P**- Practical/ Drawing, **S** – Self -Study Component, **CIA**: Continuous Internal Assessment, **SEE**: Semester End Examination, **TD**- Teaching Department, **PSB**: Paper Setting department.



Chairperson
Board of Studies
Mechanical Engineering & Allied Program

Research Internship/Industry Internship/Rural Internship

- **Research Internship:** This is intended to offer the flavor of current research happening in the Research fields. It helps students to get familiarize with the field and imparts the skill required for carrying out research.
- **Industry Internship:** An extended period of work experience undertaken by the students to supplement their degree for professional development. It also helps them learn to overcome unexpected obstacles and successfully navigate the organizations, perspectives and cultures. Dealing with contingencies helps the students recognize, appreciate and adapt to the organizational realities by tempering their knowledge with practical constraints.
- **Rural Internship:** A long term goal, as proposed under the AICTE rural internship programme, shall be counted as rural internship activity.
- The student may take up Interdisciplinary Research Internship or Industry Internship.
- The Faculty Mentor need to monitor the student's internship progress and interact with them to guide them for the successful completion of the internship requirements
- The students are permitted to carry out internship anywhere in India or Abroad. However, the institute will not bear any expenses incurred with respect to the internship.

Research Oriented Technical Seminar: In order to make the student aware of the technological and research application in various domains of the society, a comprehensive presentation need to be provided with all the supporting evidences for the claims in the presentation.

- The objective of the Technical Seminar is to inculcate self-learning, present the seminar topic confidently, enhance communication skill, involve in group discussion for exchange of ideas.
- Each student, under the guidance of a Faculty, shall choose a topic, preferably a recent topic in their interested specializations.
- The student has to
 - i. Carry out a detailed Literature survey, systematically organize the content
 - ii. Prepare the report as per their own intuition, without cut-paste activities.
 - iii. Use tools for writing equations, drawings etc. and gain proficiency of the tools used.
 - iv. Present the topics effectively through appropriate digital media.
 - v. Answer the queries posed and involve in healthy debates/discussions
 - vi. Submit a report in an error-free and professional way
 - vii. Present the findings of the seminar in the reputed Conferences/Journals for possible publications (desirable).

The evaluation procedure for the Research oriented Technical Seminar will be as provided by the Board of Studies and approved by the Academic Council of SCEM.



Transform Calculus and Special functions

(Effective from the Academic Year 2023 - 2024)

SEMESTER - III

Course Code	MA322T1M	CIA Marks	50
Number of Contact Hours/Week (L:T:P:S)	3:0:0:1	SEE Marks	50
Total Hours of Pedagogy	50 L	Exam Hours	3 Hours

CREDITS – 3

Prerequisites:

Applied Mathematics-I, Applied Mathematics-II

Course Objectives:

- Enable the students to use the concepts of Fourier series and transform to solve engineering problems.
- Study the various methods of Transform Calculus of continuous and discrete variables.
- Develop accurate solutions for initial value problems and Partial Differential Equations using various Numerical Techniques.
- Study the basic concepts of functionals and Variational problems related to engineering.

Teaching - Learning Strategy:

These are some sample strategies, which course faculty members can incorporate in the Teaching Learning Process:

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses

COURSE CONTENTS

MODULE - I

Fourier series: Periodic functions, Dirichlet's condition. Fourier series of periodic functions of 2π and arbitrary period. Half-range Fourier series. Practical Harmonic Analysis and applications. Textbook : Chapter 10 (10.1-7,10.11)	10 Hours
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MODULE - II

Fourier transforms: Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transforms. Application of Fourier Transforms. Z-Transforms: Difference equations and Z-transforms: Difference equations, basic definition, z-transform-definition, standard z-transforms, damping and shifting rules, initial value and final value theorems (without proof) and problems. Inverse z-transform and Applications to the solution of difference equations. Textbook : Chapter 22 (22.1-5), Chapter 23 (23.1-12,23.16).	10 Hours
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MODULE - III

Numerical solution of ODEs of first order and first degree- Taylor's series method, Modified Euler's method. Runge -Kutta method of fourth order, Milne's and Adam-Bashforth predictor and corrector method. Numerical Solution of Second Order ODE's: Runge-Kutta method and Milne's predictor and corrector method. (No derivations of formulae). <i>Textbook : Chapter 32 (32.1,3,5,7,8,9,10,12,)</i>	10 Hours
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MODULE - IV

Numerical Solution of Partial Differential Equations: Classifications of second-order partial differential equations, finite difference approximations to derivatives. Solution of Laplace's equation using standard five-point formula. Solution of heat equation by Schmidt explicit formula and Crank- Nicholson method, Solution of the Wave equation. <i>Textbook : Chapter 33 (33.1-5,7-10)</i>	10 Hours
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MODULE - V

Special Functions : Bessel's Equation (problems), Recurrence formula and problems, generating function for $P_n(x)$ problems. Calculus of Variations: Variation of function and functional, Variational Problems, Euler's Equation, Geodesics, Hanging chain.	10 Hours
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COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Illustrate to the behavior of Fourier series and their applications in communication system.	CL3
CO2	To use the Z transform to solve the difference equations and illustrate the behavior of the Fourier transform and its applications in communication systems.	CL3
CO3	Solve first and second order ordinary differential equations using single-step and multistep numerical methods engineering problems	CL3
CO4	Solve partial differential equation initial or boundary value problems utilizing mathematical models.	CL3
CO5	Apply advanced mathematical techniques to solve complex engineering problems using special functions and calculus of variations.	CL3

CO-PO-PSO MAPPING

Programme Outcomes (PO)	Programme Outcomes (PO)												Programme Outcomes (PO)		
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3
CO1	3	3	2						1		1	1	1		
CO2	2	2	1					1			1		1		
CO3	3	2	2					1							1



CO4	3	3	1							1		1		1	
CO5	3	3	1									1			
3: Substantial (High)			2: Moderate (Medium)							1: Poor (Low)					

CO - Assessment Mapping:

Course Outcomes	Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE)(50%)
	Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities	
	I	II	III		
	Syllabus Coverage				
	40%	30%	30%		
CO1	X			X	X
CO2	X	X		X	X
CO3		X		X	X
CO4			X	X	X
CO5			X	X	X

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignment	40 %	20
2	Semester End Examination (SEE)	100 %	50
Assignment Types			
	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	5
2	Quiz	25 %	5
3	Case Studies	25 %	5
4	Seminar/Presentation	15 %	3
5	Peer - to -Peer Learning	10 %	2

NOTE:

- Assessment will be both CIA and SEE.
- The practical sessions of the IPCC shall be for CIE only.
- The Theory component of the IPCC shall be for both CIA and SEE respectively.

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

1. The question paper will have **TEN** full questions from **FIVE** Modules
2. There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
3. Each full question may have a maximum of four sub-questions covering all the topics under a module.
4. The students will have to answer **FIVE** full questions, selecting one full question from each module.
- 5.

TEXT BOOKS:

1. B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, 44th Ed., 2017, May.
2. N.P Bali and Manish Goyal: "A Textbook of Engineering Mathematics" Laxmi Publications, 10th Ed., 2022

Reference Books:

1. B.V. Ramana: "Higher Engineering Mathematics" McGraw-Hill Education, 11th Ed., 2017
2. C. Ray Wylie, Louis C. Barrett: "Advanced Engineering Mathematics" McGraw – Hill Book Co., New York, 6th Ed., 2017.
3. E.Kreyszig: "Advanced Engineering Mathematics", John Wiley and Sons, 10thEd.(Reprint), 2016.
4. Dr. K Chandrashekar, "Transform Calculus and Numerical Techniques" Sudha Publications, 2019.

Reference Web Links and Video Lectures (e - Resources):

1. [http://www.class-central.com/subject/math\(MOOCs\)](http://www.class-central.com/subject/math(MOOCs))
2. <http://academicearth.org/>
3. <http://www.bookstreet.in>.
4. VTU e-Shikshana Program
5. <https://youtu.be/6HeQc7CSkZs>
1. <https://youtu.be/B4IyRw1zvva>

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. <http://nptel.ac.in/courses.php?disciplineID=111>
2. [http://www.class-central.com/subject/math\(MOOCs\)](http://www.class-central.com/subject/math(MOOCs))
3. <http://academicearth.org/>
4. <http://www.bookstreet.in>.
5. VTU e-Shikshana Program.
6. <https://www.youtube.com/watch?v=8Kg21jBCm-k>
7. <https://www.youtube.com/watch?v=Wa6kaCwyYRk>



REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. https://onlinecourses.nptel.ac.in/noc22_cs93/unit?unit=17&lesson=18
2. https://onlinecourses.nptel.ac.in/noc22_cs93/unit?unit=26&lesson=27
3. https://onlinecourses.nptel.ac.in/noc22_cs93/unit?unit=43&lesson=44
4. https://onlinecourses.nptel.ac.in/noc22_cs93/unit?unit=52&lesson=53
5. https://onlinecourses.nptel.ac.in/noc22_cs93/unit?unit=75&lesson=76



THERMODYNAMICS – I

(Effective from the Academic Year 2023 - 2024)

III SEMESTER

Course Code	ME322I2M	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40L + 20P	Exam Hours	03

CREDITS – 4

COURSE PREREQUISITES:

- Knowledge of Mathematics and Elements of Mechanical Engineering.

COURSE OBJECTIVES:

- Learn about thermodynamic system and its equilibrium.
- Understand various forms of energy – heat and work transfer.
- Study the laws of thermodynamics including, zeroth law, first law and second law.
- Interpret the behaviour of pure substances and its application in practical problems.
- Study of Ideal and real gases and evaluation of thermodynamic properties.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Fundamental Concepts & Definitions: Thermodynamics definition, Microscopic and Macroscopic approaches, thermodynamic system, boundary and control surface, examples. Thermodynamic properties; intensive and extensive properties, Thermodynamic state, path and process, quasi-static process, cyclic and non-cyclic processes, Thermodynamic equilibrium; definition, mechanical equilibrium, thermal equilibrium, chemical equilibrium, Zeroth law of thermodynamics, temperature scales, international fixed points and measurement of temperature. Constant volume gas thermometer, constant pressure gas thermometer, mercury in glass thermometer. Numericals on temperature scales.

8 Hours

MODULE - II

Work and Heat: work according to Mechanics, Thermodynamic definition of work; examples, sign convention. Displacement work; expressions for displacement work in various processes through PV diagrams. Shaft work; Electrical work. Other types of work. Heat; definition, units and sign convention. Numericals on different displacement works.

8 Hours

First Law of Thermodynamics: Joules experiment, Statement of the First law of thermodynamics, extension of the First law to non-cyclic processes, energy, energy as a property, modes of energy, Availability (Exergy), Unavailable energy, Extension of the First law to control volume; steady flow energy equation (SFEE), important applications. Numericals on first law applicable to both Non-flow and flow processes.

MODULE - III

Second Law of Thermodynamics: Limitations of first law of thermodynamics, Thermal reservoir, heat engine and heat pumps: Schematic representation, efficiency and COP. Kelvin-Planck statement of the Second law of Thermodynamics; PMM-I and PMM-II kind, Clausius statement of Second law of

8 Hours

Thermodynamics, Equivalence of the two statements; Carnot cycle, Carnot principles, Numericals.			
Third Law of Thermodynamics: Definition of Entropy and mathematical expression, definition and mathematical explanation of the Third Law of Thermodynamics.			
MODULE - IV			
Pure Substances: P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapor, saturated vapor and superheated vapor states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (Quality), T-S and H-S diagrams, representation of various processes on these diagrams. Steam tables and its use. Throttling calorimeter, separating and throttling calorimeter. Numericals.			8 Hours
MODULE - V			
Ideal gases: Ideal gas mixtures, Daltons law of partial pressures, Amagat’s law of additive volumes, evaluation of properties of perfect and ideal gases, Air- Water mixtures and related properties. Numericals.			8 Hours
Real gases: Introduction, Van-der Waal’s Equation of state, Van-der Waal’s constants in terms of critical properties, Beattie-Bridgeman equation, Law of corresponding states, compressibility factor; compressibility chart. Difference between Ideal and real gases. Numericals.			
COURSE OUTCOMES			
Upon completion of this course, the students will be able to:			
CO No.	Course Outcome Description	Bloom’s Taxonomy Level	
CO1	Explain the energy interactions across the boundary of thermodynamic systems.	CL4	
CO2	Analyze the energy transfers and change in properties of closed and open systems using 1 st law of thermodynamics.	CL4	
CO3	Analyze the energy interactions in power producing and power absorbing systems using 2 nd law of thermodynamics.	CL4	
CO4	Examine the behavior of pure substances and its application in practical problems.	CL4	
CO5	Determine the thermodynamic properties of ideal and real gases using various relations.	CL4	
LABORATORY COMPONENTS			
Exp. No.	Experiment Description	CO No.	Bloom’s Taxonomy Level
1.	Measurement of temperature using mercury in glass thermometer and thermocouple to evaluate international fixed points and scales.	CO1	CL4
2.	Experimentation on power producing thermodynamic system (IC Engine) to evaluate the energy interactions and sign conventions.	CO2	CL4
3.	Experimentation on power absorbing thermodynamic system (Vapour compression Refrigerator) to evaluate the energy interactions and sign conventions.	CO2	CL4
4.	Demonstration on flow processes in power producing thermodynamic systems – I C Engine, Hydraulic turbines.	CO2	CL2
5.	Demonstration on flow processes in power absorbing thermodynamic systems – Pumps, Blower.	CO2	CL2
6.	Demonstration on flow processes in non-power producing and non-power absorbing thermodynamic systems – Heat exchanger, nozzle.	CO2	CL2
7.	Determine the Calorific value of the fuel by using Bomb Calorimeter.	CO2	CL4
8.	Demonstration on Performance parameters of Power producing and Power absorbing devices.	CO3	CL2
9.	Experimentation on boiling heat transfer to understand stages of steam formation.	CO4	CL2
10.	Demonstration on application of Ideal and Real Gases	CO5	CL2



CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	1							1		1			3
CO2	3	3	1							1		1			3
CO3	3	3	1							1		1			3
CO4	3	3	1							1		1			3
CO5	3	3	1							1		1			3
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Practical Session (Laboratory Component)	40 %	20
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)	
Continuous Internal Evaluation (CIE) (60%)			Practical Sessions (40%)		
I	II	III			
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage	
40%	30%	30%	100%	100%	
MI			MI	MI	
MII	MIII		MII	MII	
	MIII		MIII	MIII	
		MIV	MIV	MIV	
		MV	MV	MV	

NOTE:

- Assessment will be both CIA and SEE.
- The practical sessions of the IPCC shall be for CIE only.
- The Theory component of the IPCC shall be for both CIA and SEE respectively.
- The questions from the practical sessions shall be included in Theory SEE.

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

SEE QUESTION PAPER PATTERN:

1. The question paper will have **TEN** full questions from **FIVE** Modules
2. There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
3. Each full question may have a maximum of four sub-questions covering all the topics under a module.
4. The students will have to answer FIVE full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Engineering Thermodynamics, P K Nag, Tata McGraw Hill Pub, 6th Edition, 2018.
2. Thermodynamics, Yunus A Cengel, Michael A Boles, Tata McGraw Hill, 7th Edition, 2017.



3. Applications of Thermodynamics, V.Kadambi, T.R. Seetharam, K. B. Subramanya Kumar, Wiley Indian Private Ltd, 1st Edition, 2019.
4. Basic Thermodynamics, B.K Venkanna, Swati B. Wadavadagi, PHI, New Delhi, 2010.
5. Fundamental of Classical Thermodynamics, G.J. Van Wylen and R.E. Sontang, Wiley eastern, 5th edition, 2004.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. https://onlinecourses.nptel.ac.in/noc21_ch27/preview
2. https://onlinecourses.nptel.ac.in/noc21_me119/preview
3. <https://nptel.ac.in/courses/112105266>



MATERIAL SCIENCE AND METALLURGY

(Effective from the Academic Year 2023 - 2024)

III SEMESTER

Course Code	ME322I3M	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40L + 20P	Exam Hours	03

CREDITS – 4

COURSE PREREQUISITES:

- Elements of Mechanical Engineering, Engineering Mathematics, Engineering chemistry

COURSE OBJECTIVES:

- Understand the behavior of materials common in mechanical engineering.
- Explore the mechanical properties of metals and their alloys, polymers, ceramics, composites
- Construct and interpret phase diagrams for binary alloy systems
- Understand modifications of material properties by heat treatment processes
- Gain exposure to the concept of corrosion and its methods of prevention
- Understand techniques such as powder metallurgy and its applications

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction: Classification of materials, crystalline and non-crystalline solids, Crystal Structure – Coordination number, atomic packing factor of simple Cubic, BCC, FCC and HCP Structures, Crystal imperfections – point, line, surface and volume imperfections, Atomic Diffusion: Phenomenon, Fick's laws of diffusion; Factors affecting diffusion. Mechanical Behavior: Stress strain diagrams showing ductile and brittle behavior of materials, Mechanical properties in plastic range. Fracture: Type I, Type II and Type III, Fatigue: Mechanism of fatigue, Fatigue properties, S-N diagram, Fatigue testing. Creep: Description of the phenomenon with examples, three stages of creep, creep properties

8 Hours

MODULE - II

Solidification and Concept of formation of alloys: Types of alloys, solid solutions, factors affecting solid solubility (Hume Rothery rules), phase diagrams: Isomorphous, Eutectic, and Eutectoid systems, Lever rule, Intermediate phases, Gibbs phase rule, Iron-Carbon (Cementite) diagram: description of phases, Solidification: Mechanism of solidification, Homogenous and Heterogeneous nucleation.

8 Hours

MODULE - III

Heat Treatment, Ferrous and Non-Ferrous Alloys Heat treating of metals: Time-Temperature Transformation (TTT) curves, Annealing: Types of annealing, Normalizing, Hardening, Tempering, Martempering, Austempering, Concept of hardenability, Factors affecting it hardenability, surface hardening methods: carburizing, cyaniding, nitriding, flame hardening and induction hardening, Age hardening of aluminum-copper alloys Ferrous materials: Properties, Compositions and uses of grey cast iron and steel.

8 Hours



MODULE - IV

Corrosion and its prevention: Galvanic cells, the electrode potentials, polarization, passivation, general methods of corrosion prevention by alloying, stress corrosion cracking.	8 Hours
Powder Metallurgy: Definition and concepts, applications, powder metallurgy process, production of metal powders; Different Mechanical methods: Chopping or Cutting, Abrasion methods, Machining methods, Ball Milling and Chemical method: Chemical reduction method	

MODULE - V

Plastics: Various types of polymers/plastics and their applications. Mechanical behaviour and processing of plastics, Failure of plastics.	8 Hours
Ceramics: Structure type and properties and applications of ceramics Mechanical/ Electrical behaviour and processing of Ceramics.	
Composite Materials: Definition, applications and properties of MMCs, ceramic composites and FRPs Production of Metal Matrix Composites (Squeeze casting, powder metallurgy, stir casting) Production of FRPs (Hand layup, spray layup, pultrusion, filament winding, SMC	

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Understand the concept of atomic packing factor and be able to describe mechanical behavior of materials	CL3
CO2	Construct phase diagrams of eutectic systems and be able to interpret Iron-Iron carbide diagram	CL3
CO3	Construct TTT diagram and understand various heat treatment process in properties	CL3
CO4	Understand the principles of corrosion and gain insights about powder metallurgy, its process and application	CL3
CO5	Know about polymers, ceramics, composite materials and their processing as well as applications	CL2

LABORATORY COMPONENTS

Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	Evaluate hardness of untreated and heat-treated specimens using Brinell, Rockwell and Vickers's Hardness testing machine	CO1	CL3
2.	Evaluate modulus of rigidity, torsional yield strength of steels using Torsion testing machine	CO1	CL3
3.	Izod and charpy test for of untreated and heat-treated specimens	CO1	CL3
4.	Evaluate mechanical properties of engineering materials using Universal Testing Machine	CO1	CL3
5.	Preparation of specimen for Metallographic examination of different engineering materials. To report microstructures of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze & composites (Demonstration)	CO3	CL3
6.	Annealing, normalizing, hardening and tempering of steel. Metallographic specimens of heat-treated components to be supplied and students should report microstructures of furnace cooled, water cooled, air cooled, tempered steel. Students should be able to distinguish the phase changes in a heat-treated specimen compared to untreated specimen (DEMO)	CO3	CL3
7	Study the chemical corrosion and its protection (Demonstration)	CO4	CL3
8	Study the properties of various types of plastics (Demonstration)	CO4	CL3
9	Fabrication of Fibre reinforced composites using land lay-up methods (Demonstration)	CO5	CL3

CO-PO-PSO MAPPING



CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	3							2		2		2	
CO2	3	3	3							2		2		2	
CO3	3	3	3	2	2				2	2		2		2	
CO4	3	3	3	2	2				2	2		2		2	
CO5	3	3	3							2		2		2	
3: Substantial (High)				2: Moderate (Medium)						1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Practical Session (Laboratory Component)	40 %	20
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)	
Continuous Internal Evaluation (CIE) (60%)			Practical Sessions (40%)		
I	II	III			
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage	
40%	30%	30%	100%	100%	
MI			MI	MI	
MII	MII		MII	MII	
	MIII		MIII	MIII	
		MIV	MIV	MIV	
		MV	MV	MV	

NOTE:

- Assessment will be both CIA and SEE.
- The practical sessions of the IPCC shall be for CIE only.
- The Theory component of the IPCC shall be for both CIA and SEE respectively.
- The questions from the practical sessions shall be included in Theory SEE.

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

SEE QUESTION PAPER PATTERN:

The question paper will have TEN full questions from FIVE Modules

There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.

Each full question may have a maximum of four sub-questions covering all the topics under a module.

The students will have to answer FIVE full questions, selecting one full question from each module.

REFERENCE BOOKS:

- V.Raghavan, Materials Science and Engineering, , PHI, 2002
- Donald R. Asklund and Pradeep.P. Phule, The Science and Engineering of Materials, Cengage Learning, 4th Ed., 2003.
- Foundations of Material Science and Engineering by Smith,Mcgrawhill, 4th edition 2009



4. Material science and Engineering Introduction by William D Callister, Wiley, 2006
5. Plastics Engineering- RJ Crawford, 3rd Edition, Butterworth Heinemann 1998



SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

Chairperson
Board of Studies
Mechanical Engineering & Allied Program



MECHANICS OF MATERIALS

(Effective from the Academic Year 2023 - 2024)

SEMESTER - III

Course Code	ME322T4M	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Knowledge of engineering mechanics.

COURSE OBJECTIVES:

- Classify the stresses into various categories and define elastic properties of materials and compute stress and strain intensities caused by applied loads in simple and compound sections and temperature changes.
- Derive the equations for principal stress and maximum in-plane shear stress and calculate their magnitude and direction. Draw Mohr circle for plane stress system and interpret this circle.
- Determine the shear force, bending moment and draw shear force and bending moment diagrams, describe behavior of beams under lateral loads.
- Explain the structural behavior of members subjected to torque, calculate twist and stress induced in shafts subjected to bending and torsion
- Understand the concept of stability and derive crippling loads for columns.
- Understand the concept of strain energy and compute strain energy for applied loads.

TEACHING - LEARNING STRATEGY:

These are some sample strategies, which course faculty members can incorporate in the Teaching Learning Process:

- Chalk and Talk Method/Blended Mode Method
- PowerPoint Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- MOOC/NPTEL Courses

COURSE CONTENTS

MODULE - I

Stress and Strain: Introduction, Hooke's law, Mechanical Properties of Engineering Materials, Stress strain diagram for Engineering Materials, Calculation of stresses in straight, Stepped and tapered sections, Super position principles, Composite sections, Stresses due to temperature change, Shear stress and strain, Lateral strain and Poisson's Ratio, Generalized Hooke's law, Bulk modulus, Relationship between elastic constants.

08 Hours

MODULE - II

Analysis of Stress and Strain: Plane stress, Stresses on inclined planes, Principal stresses and maximum shear stress, Principal angles, Shear stresses on principal planes, Maximum shear stress, Mohr circle for plane stress conditions.

08 Hours

Cylinders: Thin cylinder: Hoop's stress, maximum shear stress, Circumferential and longitudinal strains, Thick cylinders: Lame's equations.

MODULE - III

Shear Forces and Bending Moments: Type of beams, Loads and reactions, Relationship between loads, shear forces and bending moments, Shear force and bending moments of cantilever beams, Pin support and roller supported beams subjected to concentrated loads and uniformly distributed constant / varying loads.

08 Hours

Stress in Beams: Pure bending, Curvature of a beam, Longitudinal strains in beams, Normal stresses in Beams with rectangular, circular, 'I' and 'T' cross sections, Flexure Formula, Bending Stresses.



MODULE - IV															
Torsion: Circular solid and hallow shafts, Torsional moment of resistance, Power transmission of straight and stepped shafts, Twist in shaft sections.														08 Hours	
Columns: Buckling and stability, Critical load, Columns with pinned ends, Columns with other support conditions, Effective length of columns.															
MODULE - V															
Strain Energy: Castigliano's theorem I and II, Load deformation diagrams, strain energy due to normal stresses, Shear stresses, Modulus of resilience, Strain energy due to bending and torsion.														08 Hours	
Theories of Failure: Maximum Principal stress theory, Maximum shear stress theory.															
COURSE OUTCOMES															
Upon completion of this course, the students will be able to:															
CO No.	Course Outcome Description													Bloom's Taxonomy Level	
CO1	Analyze stresses and strains developed in the member subjected to axial, bending, shear, torsion & thermal loads.													CL4	
CO2	Analyze the graphical representation of stresses and strains and understand the concept of stress developed in the thick and thin cylinders.													CL4	
CO3	Analyze the shear force and bending moment diagrams in beams subjected to different loading conditions and bending stress and shear stress developed for different types of beams.													CL4	
CO4	Analyze the torsional stress, angle of twist and power transmitted for shafts subjected to pure torsion and the buckling of Columns subjected to different load and end conditions.													CL4	
CO5	Analyze the concept of Strain energy and theories of failure for the efficient design of engineering materials.													CL4	
CO-PO-PSO MAPPING															
CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2					2	2	2		2	2		
CO2	3	3	2					1		1		2	2		
CO3	3	3	2		2			2	2	2		2	2		
CO4	3	3	2					1		1		2	2		
CO5	3	3	2					1		1		2	2		
3: Substantial (High)				2: Moderate (Medium)						1: Poor (Low)					
ASSESSMENT STRATEGY															
Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:															
Sl. No.	Assessment Description							Weightage (%)				Max. Marks			
1	Continuous Internal Assessment (CIA)							100 %				50			
	Continuous Internal Evaluation (CIE)							60 %				30			
	Assignments							40 %				20			
2	Semester End Examination (SEE)							100 %				50			
CO - ASSESSMENT MAPPING															
Course Outcomes		Continuous Internal Assessment (CIA) (50%)										Semester End Exam (SEE) (50%)			
		Continuous Internal Evaluation (CIE) (60%)					Assignment/ Activities (40%)								
		I	II	III											
		Syllabus Coverage					Syllabus Coverage					Syllabus Coverage			
		40%		30%		30%		100%					100%		



CO1	x			x	x
CO2	x	x		x	x
CO3		x		x	x
CO4			x	x	x
CO5			x	x	x

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to -Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer **FIVE** full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. J M Gere, B J Goodno, "Mechanics of Materials" Cengage, Eighth edition 2013.
2. P N Chandramouli "Fundamentals of Strength of Materials" PHI Learning Pvt. Ltd, 2013.
3. R K Rajput "Strength of Materials" s. Chand and Company Pvt. Ltd, 2014.
4. R. Subramanian "Strength of Materials" Oxford, 2005.
5. S. S. Ratan "Strength of Materials" Tata McGraw Hill 2nd Edition, 2008.
6. S C Pilli and N Balasubramanya "Mechanics of materials Strength of Materials" Cengage 2019.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. https://onlinecourses.nptel.ac.in/noc22_ce54/
2. <https://nptel.ac.in/courses/105104160>



MEASUREMENT AND METROLOGY LABORATORY

(Effective from the Academic Year 2023 - 2024)

SEMESTER - III

Course Code	ME322L5M	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:1	SEE Marks	50
Total Hours of Pedagogy	24P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Knowledge of least count, scale reading techniques.
- Knowledge on basic measurement instruments.

COURSE OBJECTIVES:

- To illustrate the theoretical concepts taught in Mechanical Measurements & Metrology through experiments.
- To illustrate the use of various measuring tools & measuring techniques.
- To understand calibration techniques of various measuring devices.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Demonstration
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Exp. No.	Description
1	Calibration of micrometer and vernier caliper using slip gauges.
2	Calibration of pressure Gauge.
3	Calibration of LVDT.
4	Calibration of load cell.
5	Calibration of thermocouple.
6	Measurement of angle using sine centre, sine bar and bevel protractor.
7	Measurements using optical projector and tool makers' microscope.
8	Measurement of major diameter, minor diameter, pitch, angle and effective diameter of screw threads by 2- wire and 3-wire methods, Sheet and wire gauge.
9	Gear tooth measurement using gear tooth vernier and gear tooth micrometer.
10	Determination of modulus of elasticity of a mild steel specimen using strain gauge.
11	Surface topology measurement using surface roughness tester.
12	Demonstration of measurement using coordinate measuring machine (CMM).

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Demonstrate the calibration of various measuring gauges.	CL3
CO2	Choose appropriate measuring instruments to discover angular measurement of a given object.	CL3



CO3	Analyze the application of optical and manual instruments to measure the profile of threaded parts.	CL4
CO4	Analyze the application of gear tooth vernier and gear tooth micrometer to measure the profile of the gears.	CL4
CO5	Explain the applications of strain gauge, surface roughness tester and coordinate measuring machines.	CL4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2		3			2	2	1		2		3	2
CO2	3	3	2		3			2	2	1		2		3	
CO3	3	3	2		3			2	2	1		2	2	3	
CO4	3	3	2		3			2	2	1		2	2	3	
CO5	3	3	2		3			2	2	1		2	2	3	

3: Substantial (High)

2: Moderate (Medium)

1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT STRATEGY:

- I. In Laboratory Courses where (B) and (C) are not the components of the assessment pattern, then (A) will have 100% weightage (50 Marks).

Assessment Mode: Weekly Assessment of Laboratory Work (50 Marks) - the marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment, each of 25 marks) of the students in each laboratory session. The average of all the marks obtained across the sessions will be the Final CIA marks.

- II. In Laboratory Courses where (C) is not a component of the assessment pattern, then (A) will have 50% weightage (25 Marks), and (B) will have 50% weightage (25 Marks).

Assessment Mode: The marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment) (A) and One Laboratory Test (B).

- In Weekly Assessment, the student will be evaluated in each laboratory session for 25 marks. The average marks obtained across all the experiments will be the marks obtained for (A).
- A Laboratory Test, similar to the SEE exam is conducted towards the end of the Semester/Course, whichever is earlier. The obtained marks are scaled down to 25 Marks (B)

The Sum of marks obtained across (A) and (B) will be the Final CIA marks.

- III. In Laboratory Courses where (C) is a component of the assessment pattern, then assessment will be done by considering the weightages given above, i.e. (A) – 25 Marks (Weekly Assessment), (B) – 15 Marks (Laboratory Examination), (C) – 10 marks (Open Ended Experiments/Mini Projects)

- The respective course instructor will design the assessment criteria for the said assessment components.
- The assessment components will be made known to the students by the respective Course Coordinators prior to the commencement of the Laboratory Work.

In all the cases, the assessments will be done based on the criteria designed by the Course Coordinator.



SEE QUESTION PAPER PATTERN:

1. All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
2. SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
3. General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
4. Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. Engineering Metrology and Measurements, N.V. Raghavendra and L. Krishnamurthy, Oxford University Press, 2013.
2. Mechanical, Measurements and Instrumentation, R.K Rajput, S.K. Kataria & Sons, 3rd Edition.
3. <http://vlabs.iitb.ac.in/vlabs->
4. <https://www.digimat.in/nptel/courses/video/112106138/L01.html>



DESIGN FOR MANUFACTURING

(Effective from the Academic Year 2023 - 2024)

III SEMESTER

Course Code	ME322T6M	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Basic knowledge of different manufacturing process.

COURSE OBJECTIVES:

- Describe the different types of manufacturing systems and compare their suitability for economic production of various components and products.
- Identify factors and causing mechanisms of the defects likely to occur with different manufacturing processes in producing mechanical products and the relevant design approaches to rectify them.
- Select proper materials and manufacturing processes for designing products/components by applying the relevant principles for ease and economic production.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction to manufacturing process: Concept of manufacturing process, its importance, classification of manufacturing processes.

Introduction to design for manufacturability: Major phases of design, effect of material properties on design, effect of manufacturing processes on design. Material selection process - cost per unit property, weighted properties and limits on properties methods, guidelines for design for manufacturability.

8 Hours

MODULE - II

Introduction to Casting: Casting process (sand casting) & steps involved. Varieties of components produced by casting process. Advantages & Limitations of casting process. Patterns: Definition, functions, Materials used for pattern, various pattern allowances and their importance. Classification of patterns. Cores, concept of runner riser and gates.

Design of components with casting considerations: Pattern, mould, and parting line. Cored holes and machined holes. Identifying the possible and probable parting lines. Castings requiring special sand cores.

8 Hours

MODULE - III

Welding process: Definition, Principles, classification, application, advantages & limitations of welding. Arc welding: Principle, Metal arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW), Inert Gas Welding (TIG & MIG) Submerged Arc Welding (SAW) and Atomic Hydrogen Welding (AHW).

Design of components for welding considerations: Requirements and rules, redesign of components for welding.

8 Hours

MODULE - IV



Introduction to forging: Classification of forging processes. Forging machines & equipment, Die-design parameters. Material flow lines in forging. Forging defects, Residual stresses in forging. Design of components for forging considerations: Requirements and rules-redesign of components for forging. Powder Metallurgy: Basic steps in Powder metallurgy brief description of methods of production of metal powders, conditioning and blending powders, compaction and sintering application of powder metallurgy components, advantages and limitations. Design of components for powder metallurgy: Requirements and rules-case studies.	8 Hours
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MODULE - V

Design for Assembly: Compliance analysis and interference analysis for the design of assembly, design and development of features for automatic assembly, liaison diagrams. Design for Environment: Motivations for principles of environment- eco-efficiency, product life cycle perspective, environment tools and processes, environment design guidelines.	8 Hours
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COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Describe basic principles of design for manufacturability concepts.	CL2
CO2	Explain general design rules and recommendations to be used in manufacturing a component through casting process.	CL2
CO3	Explain general design rules and recommendations to be used in manufacturing a component through welding process.	CL2
CO4	Discuss the design rules to be used in manufacturing of components through forging and powder metallurgy process.	CL2
CO5	Demonstrate design rules to be used in assembly of components and environmental safety.	CL2

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2					2		2		3		3	
CO2	3	3	2					2		2		3		3	
CO3	3	3	2					2		2		3		3	
CO4	3	3	2					2		2		3		3	
CO5	3	3	2					2		2		3		3	
3: Substantial (High)				2: Moderate (Medium)				1: Poor (Low)							

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT DETAILS



Continuous Internal Assessment (CIA) (50%)			Semester End Exam (SEE) (50%)	
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII		MIII	MIII
		MIV	MIV	MIV
		MV	MV	MV

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Dieter, G.E. "Engineering Design: A Materials and processing Approach", McGrawHill, 2002.
2. Eggert, R.J. "Engineering Design" Pearson Education, Inc., New Jersey, 2005.
3. Peck, H. "Designing for Manufacture", Pitman Publications, London, 1983.
4. Bralla, James G., "Handbook of Products Designfor Manufacturing: A Practical Guide to Low-cost Production", McGraw Hill, New York, 1986.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. <https://archive.nptel.ac.in/courses/112/101/112101005/>
2. <https://nptel.ac.in/courses/107103012>



UHV -1: SOCIAL CONNECT & RESPONSIBILITIES

(Effective from the Academic Year 2023 - 2024)

SEMESTER III

Course Code	HU32287X	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Have/Develop the critical analysis of the day today happenings.

COURSE OBJECTIVES:

This course will enable students to:

- Enable the student to do a deep drive into societal challenges being addressed by NGO(s), social enterprises & The government and build solutions to alleviate these complex social problems through immersion, design & technology.
- Provide a formal platform for students to communicate and connect to their surroundings.
- Enable to create a responsible connection with society

TEACHING - LEARNING STRATEGY:

These are some sample strategies, which course faculty members can incorporate in the Teaching Learning Process:

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies

COURSE CONTENTS

MODULE - I

Connectivity with Nature: Importance of plants, Plantation process, **Plant Development:** Sequence of Plant Development, Factors affecting Plant Development, Practice Problems.

Activity: Self-study on selected plant's origin, its usage in daily life and its appearance in folklore and literature.

3 Hours

MODULE - II

Heritage walk and Regional Crafts: An overview of Heritage, Awareness on Indian Cultural Heritages, Crafts & Heritage, Protective measures for the survival of handicrafts.

Activity: Self-study on selected Heritage and its Inheritance.

3 Hours

MODULE - III

Organic farming and waste management: Introduction of organic farming, study on wet waste management, Effects of organic farming on crop productivity.

3 Hours

MODULE - IV

Water Conservation: Necessity of water conservation, study on water reuse, an overview on rainwater harvesting.

Activity: Documentary or photo blog presenting the current practices.

3 Hours

MODULE - V



Food Practices: Fast foods - nutritional value, food lore and indigenous materials of the region used in cooking.	3 Hours
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COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	To understand the social responsibility of individual-Adaptation and Plantation of Tree	CL3
CO2	To know the heritage and holistic places - Heritage walk and crafts corner	CL3
CO3	To understand the importance of Organic farming and waste management	CL3
CO4	To know the importance and necessity of Water Conservation	CL3
CO5	To understand diverse food practices of the region.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1			1			1	2	1	2			1		
CO2			1			1	1	1	1			1		
CO3			1			1	2	1				1		
CO4			1			1	2	1				1		
CO5						1	1	1				1		
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)				

ASSESSMENT STRATEGY

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	Semester End Examination (SEE)	100 %	50

CO - ASSESSMENT MAPPING

Course Outcomes	Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)	
	Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)		
	I	II	III			
	Syllabus Coverage			Syllabus Coverage	Syllabus Coverage	
	40%	30%	30%	100%	100%	
CO1	MI			MI	MI	
CO2	MII	MII		MII	MII	
CO3		MIII		MIII	MIII	
CO4			MIV	MIV	MIV	
CO5			MV	MV	MV	

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.



ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Case Studies	25 %	05
3	Seminar/Presentation	25 %	05
4	Peer - to - Peer Learning	25 %	05

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE Question Paper Pattern:

- The question paper will have **seventy MCQ** questions and **six** main questions.
- Each MCQ questions consisting of 1mark; and main questions of 5 marks.
- Main questions will be asked from all FIVE modules.

TEXT BOOKS:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

REFERENCE BOOKS:

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

<https://www.aicteindia.org/sites/default/files/Vol.%20II%20%20AICTE%20UG%20%20Curriculum.>



PYTHON FOR SCIENTIFIC COMPUTING

(Effective from the Academic Year 2023 - 2024)

III SEMESTER

Course Code	ME32298MA	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	20P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Basic knowledge of mathematics
- Basic Knowledge of programming and control loop concepts studied in C Programming of 1ST year BE.

COURSE OBJECTIVES:

- To apply Python for computational problems in engineering.
- To capture data, process data and interpret the results using graphs in Python.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Sl. No.	Description
1	Demonstrate Python , IDEs of Python environment, mathematical expressions with numbers, Variables, symbolic constants, functions and help writing a basic program and elements. (1hr) Students develop and execute a basic program in a Python IDE,Additional features of Ipython Interpreter (1hr)
2	Demonstrate and conduct plotting scientific graphs using Matplotlib library and different plotting functions. Students plot different graphs using Matplotlib library (2hrs)
3	Demonstrate and conduct Loading data from files, plotting charts (2hrs)
4	Demonstrate and conduct For loop, lists and String functions (2hrs)
5	Demonstrate and conduct file handling functions, parsing data and statistical functions (2hrs)
6	Demonstrate and conduct Array Operations ,Image manipulation with arrays (2hrs)
7	Demonstrate Basic matrix operations. (1hr) Students develop and execute the basic matrix operations in a Python IDE. (1hr)
8	Demonstrate advanced matrix operations (1hr) Students develop and execute the advanced matrix operations in a Python IDE.(1hr)
9	Demonstrate control loops - if, else, elif, select, for loop, while loop with suitable examples(1hr) Students develop and execute the control loop operations in a Python IDE. (1hr)
10	Demonstrate script and function programming concepts with suitable examples(1hr) Students develop a script and function program to perform a particular given task(1hr)
11	Demonstrate Generating a Least Square fit line Generating L vs t square loadtxt function ,Usage of numpy library



	Plotting L vs t square Steps for least square fit line Matrix formulation . (1hr) Students to solve a least square fit line and plot . (1hr)
12	Capstone Project on implementation of Python programming concepts –Students has to develop miniature software/program using python for an engineering problem.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Understand and execute basic python commands using different IDEs and python libraries and their use	CL 4
CO2	Plot scientific graphs for data visualization using python libraries	CL 4
CO3	Execute file handling functions, arrays and matrix operations for scientific computing	CL 4
CO4	Execute control loops, function programming and script programming	CL 4
CO5	Build a miniature software/program using python to solve an engineering problem	CL 6

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	3		2							1		3	
CO2	3	2	3		2							1		3	
CO3	3	2	3		2							1		3	
CO4	3	2	3		2							1		3	
CO5	3	2	3		2							1		3	

3: Substantial (High)

2: Moderate (Medium)

1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT STRATEGY:

- I. In Laboratory Courses where (B) and (C) are not the components of the assessment pattern, then (A) will have 100% weightage (50 Marks).

Assessment Mode: Weekly Assessment of Laboratory Work (50 Marks) - the marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment, each of 25 marks) of the students in each laboratory session. The average of all the marks obtained across the sessions will be the Final CIA marks.

- II. In Laboratory Courses where (C) is not a component of the assessment pattern, then (A) will have 50% weightage (25 Marks), and (B) will have 50% weightage (25 Marks).

Assessment Mode: The marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment) (A) and One Laboratory Test (B).

- In Weekly Assessment, the student will be evaluated in each laboratory session for 25 marks. The average marks obtained across all the experiments will be the marks obtained for (A).
- A Laboratory Test, similar to the SEE exam is conducted towards the end of the Semester/Course, whichever is earlier. The obtained marks are scaled down to 25 Marks (B)

The Sum of marks obtained across (A) and (B) will be the Final CIA marks.

III. In Laboratory Courses where (C) is a component of the assessment pattern, then assessment will be done by considering the weightages given above, i.e. (A) – 25 Marks (Weekly Assessment), (B) – 15 Marks (Laboratory Examination), (C) – 10 marks (Open Ended Experiments/Mini Projects)

- The respective course instructor will design the assessment criteria for the said assessment components.
- The assessment components will be made known to the students by the respective Course Coordinators prior to the commencement of the Laboratory Work.

In all the cases, the assessments will be done based on the criteria designed by the Course Coordinator.

SEE QUESTION PAPER PATTERN:

1. All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
2. SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
3. General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
4. Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE WEB LINKS AND VIDEO LECTURES (E – RESOURCES):

1. Spoken Tutorials Python programming -. https://spoken-tutorial.org/tutorialsearch/?search_foss=Python%203.4.3&search_language=English&page=1
2. Let Us Python , Y .Kanetkar and A.Kanetkar , BPB Publications ,4th Edition ,2021.



GENERATIVE DESIGN LAB

(Effective from the Academic Year 2023 - 2024)

III SEMESTER

Course Code	ME32298MB	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	20P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Basic knowledge of parametric 3D CAD tool, preferably Fusion 360
- Basic knowledge of Engineering drawings

COURSE OBJECTIVES:

- To familiarise and enable student to learn generative design and its applications.
- To enable students learn the CAD software for Generative design.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Sl. No.	Description
1	Construct, set up, and complete a Shape Optimization study. Promote a Shape Optimization result. Incorporate Shape Optimization result features using design workspace tools. Open the Motorcycle Triple Clamp provided dataset after uploading it.f3d. Setting up, solving, and reviewing the results of a Shape Optimization research are the objectives of this task.
2	Use Edit Model to create obstacles while maintaining geometry. Create geometry to be utilized in the Design workspace or the Generative Design workspace as preserve regions. Create a new Generative Design study that categorizes the produced geometry as preserve regions.
3	Apply a load and constraint, duplicate a load scenario, choose a material, and choose a generative design production technique. Challenge: Creating a motorcycle brake lever from scratch
4	Establish a simulation study, alter a form, create a distributed design, and examine the outcomes of the simulation. Post-process a generative design as a challenge.
5	Examine additional forms-based tools that can be used to alter the results of generative design. Use Fill, Smooth, Cylindrify, and erase. Make a Form cylinder primitive, experiment with the modification tools in the Form toolset, then extrude edges using Edit Form. Challenge: Investigate the editing features in the generating frame.f3d
6	Complete the development of a generative motorcycle swing arm.
7	Examine the topology optimization setup procedure and compare the outcomes to conventional parametric optimization techniques for a cantilevered bracket.
8	Generative design with AI in 3D modeling - Write blender code with ChatGPT and use blender software to execute.
9	Capstone Project 1 in Generative Design

10	Capstone Project 2 in Generative Design
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COURSE OUTCOMES															
Upon completion of this course, the students will be able to:															
CO No.	Course Outcome Description												Bloom's Taxonomy Level		
CO1	Explain generative design technology and Edit sculpted bodies using T-splines using Autodesk Fusion 360.												CL3		
CO2	Create basic assemblies using Autodesk Fusion 360.												CL5		
CO3	Use generative design using Autodesk Fusion 360.												CL4		
CO4	Explore generative design outcomes using Autodesk Fusion 360.												CL4		
CO5	Finalize advanced designs using Autodesk Fusion 360												CL4		
CO-PO-PSO MAPPING															
CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1	3	2	3		2							1	3		
CO2	3	2	3		2							1	3		
CO3	3	2	3		2							1	3		
CO4	3	2	3		2							1	3		
CO5	3	2	3		2							1	3		
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					
ASSESSMENT STRATEGY															
Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:															
Sl. No.	Assessment Description					Weightage (%)					Max. Marks				
1	Continuous Internal Assessment (CIA)					100 %					50				
	Laboratory Work (A)					50 %					25				
	Laboratory Test (B)					30 %					15				
	Open Ended Experiments /Mini Projects (C)					20 %					10				
2	Semester End Examination (SEE)					100 %					50				
ASSESSMENT STRATEGY:															
I. In Laboratory Courses where (B) and (C) are not the components of the assessment pattern, then (A) will have 100% weightage (50 Marks). Assessment Mode: Weekly Assessment of Laboratory Work (50 Marks) - the marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment, each of 25 marks) of the students in each laboratory session. The average of all the marks obtained across the sessions will be the Final CIA marks.															
II. In Laboratory Courses where (C) is not a component of the assessment pattern, then (A) will have 50% weightage (25 Marks), and (B) will have 50% weightage (25 Marks). Assessment Mode: The marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment) (A) and One Laboratory Test (B). In Weekly Assessment, the student will be evaluated in each laboratory session for 25 marks. The average marks obtained across all the experiments will be the marks obtained for (A).															

- A Laboratory Test, similar to the SEE exam is conducted towards the end of the Semester/Course, whichever is earlier. The obtained marks are scaled down to 25 Marks (B)
- The Sum of marks obtained across (A) and (B) will be the Final CIA marks.

III. In Laboratory Courses where (C) is a component of the assessment pattern, then assessment will be done by considering the weightages given above, i.e. (A) – 25 Marks (Weekly Assessment), (B) – 15 Marks (Laboratory Examination), (C) – 10 marks (Open Ended Experiments/Mini Projects)

- The respective course instructor will design the assessment criteria for the said assessment components.
- The assessment components will be made known to the students by the respective Course Coordinators prior to the commencement of the Laboratory Work.

In all the cases, the assessments will be done based on the criteria designed by the Course Coordinator.

SEE QUESTION PAPER PATTERN:

1. All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
2. SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
3. General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
4. Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE WEB LINKS AND VIDEO LECTURES (E – RESOURCES):

1. Introduction to Generative Design for Manufacturing
2. <https://www.autodesk.com/certification/learn/course/fusion360-generative-design-intro-expert>



EMBEDDED SYSTEMS LAB

(Effective from the Academic Year 2023 - 2024)

III SEMESTER

Course Code	ME32298MC	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	20P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Basic Knowledge of Mathematics and Embedded Systems, C PROGRAMMING, Microcontrollers, microprocessor.

COURSE OBJECTIVES:

- To introduce the Building Blocks of Embedded System
- To Educate in Various Embedded Development Strategies
- To Introduce Bus Communication in processors, Input/output interfacing.
- To impart knowledge in various processor scheduling algorithms.
- To introduce Basics of Real time operating system and example tutorials to discuss on one real time operating system tool

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Sl. No.	Description
1	ALP to multiply two 16 bit binary numbers.
2	ALP to find the sum of the first 10 integer numbers.
3	ALP to find the number of 0's and 1's in a 32 bit data
4	ALP to find determine whether the given 16 bit is even or odd
5	ALP to write data to RAM
6	Display "Hello world" message using internal UART
7	Interface and Control the speed of a DC Motor.
8	Interface a Stepper motor and rotate it in clockwise and anti-clockwise direction.
9	Interface a DAC and generate Triangular and Square waveforms.
10	Interface a 4x4 keyboard and display the key code on an LCD.
11	Demonstrate the use of an external interrupt to toggle an LED On/Off
12	Display the Hex digits 0 to F on a 7-segment LED interface, with an appropriate delay.



COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Understand the instruction set of 32 bit microcontroller ARM Cortex M3, and the software tool required for programming in Assembly and C language.	CL2
CO2	Develop assembly language programs using ARM Cortex M3 for different applications.	CL2
CO3	Interface external devices and VOW with ARM Cortex M3.	CL2
CO4	Develop C language programs and library functions for embedded system applications.	CL2
CO5	Analyze the functions of various peripherals, peripheral registers and power saving modes of ARM Cortex M3	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	3		2							2		2	
CO2	3	2	3		2							2		2	
CO3	3	2	3		2							2		2	
CO4	3	2	3		2							2		2	
CO5	3	2	3		2							2		2	
3: Substantial (High)				2: Moderate (Medium)						1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT STRATEGY:

- I. In Laboratory Courses where (B) and (C) are not the components of the assessment pattern, then (A) will have 100% weightage (50 Marks).

Assessment Mode: Weekly Assessment of Laboratory Work (50 Marks) - the marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment, each of 25 marks) of the students in each laboratory session. The average of all the marks obtained across the sessions will be the Final CIA marks.

- II. In Laboratory Courses where (C) is not a component of the assessment pattern, then (A) will have 50% weightage (25 Marks), and (B) will have 50% weightage (25 Marks).

Assessment Mode: The marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment) (A) and One Laboratory Test (B).

- In Weekly Assessment, the student will be evaluated in each laboratory session for 25 marks. The average marks obtained across all the experiments will be the marks obtained for (A).
- A Laboratory Test, similar to the SEE exam is conducted towards the end of the Semester/Course, whichever is earlier. The obtained marks are scaled down to 25 Marks (B)

The Sum of marks obtained across (A) and (B) will be the Final CIA marks.





III. In Laboratory Courses where (C) is a component of the assessment pattern, then assessment will be done by considering the weightages given above, i.e. (A) – 25 Marks (Weekly Assessment), (B) – 15 Marks (Laboratory Examination), (C) – 10 marks (Open Ended Experiments/Mini Projects)

- The respective course instructor will design the assessment criteria for the said assessment components.
- The assessment components will be made known to the students by the respective Course Coordinators prior to the commencement of the Laboratory Work.

In all the cases, the assessments will be done based on the criteria designed by the Course Coordinator.

SEE QUESTION PAPER PATTERN:

1. All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
2. SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
3. General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
4. Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.



GAME DESIGN LAB

(Effective from the Academic Year 2023 - 2024)

III SEMESTER

Course Code	ME32298MD	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	20P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Basic Knowledge of Mathematics and Embedded Systems.

COURSE OBJECTIVES:

- To know the basics of 2D and 3D graphics for game development.
- To know the stages of game development.
- To understand the basics of game engine.
- To survey the gaming development environment and toolkits.
- To learn and develop simple games using Pygame environment.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Sl. No.	Description
1	Installation of a game engine, familiarization of the GUI. Conceptualize the theme for a 2D game.
2	Character design, sprites, movement and character control.
3	Level design: design of the world in the form of tiles along with interactive and collectible objects.
4	Design of interaction between the player and the world, optionally using the physics engine.
5	Developing a 2D interactive game.
6	Developing a Puzzle game.
7	Developing a Board game.
8	Design of menus and user interaction in mobile platforms.
9	Developing a 3D Game using unity.
10	Developing a Multiplayer game using unity.



COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Understand the concepts of 2D and 3D graphics.	CL2
CO2	Know about games and their genres with their origin and history.	CL2
CO3	Prepare game design documents.	CL3
CO4	Demonstrate the implementation of gaming engines.	CL3
CO5	Develop a 2D/3D game using unity game engine.	CL4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2			2					2		2	3		
CO2	3	2			2					2		2	3		
CO3	3	2			2					2		2	3		
CO4	3	2			2					2		2	3		
CO5	3	2			2					2		2	3		
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT STRATEGY:

- I. In Laboratory Courses where (B) and (C) are not the components of the assessment pattern, then (A) will have 100% weightage (50 Marks).

Assessment Mode: Weekly Assessment of Laboratory Work (50 Marks) - the marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment, each of 25 marks) of the students in each laboratory session. The average of all the marks obtained across the sessions will be the Final CIA marks.

- II. In Laboratory Courses where (C) is not a component of the assessment pattern, then (A) will have 50% weightage (25 Marks), and (B) will have 50% weightage (25 Marks).

Assessment Mode: The marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment) (A) and One Laboratory Test (B).

- In Weekly Assessment, the student will be evaluated in each laboratory session for 25 marks. The average marks obtained across all the experiments will be the marks obtained for (A).
- A Laboratory Test, similar to the SEE exam is conducted towards the end of the Semester/Course, whichever is earlier. The obtained marks are scaled down to 25 Marks (B)

The Sum of marks obtained across (A) and (B) will be the Final CIA marks.

- III. In Laboratory Courses where (C) is a component of the assessment pattern, then assessment will be done by considering the weightages given above, i.e. (A) – 25 Marks (Weekly Assessment), (B) – 15 Marks (Laboratory Examination), (C) – 10 marks (Open Ended Experiments/Mini Projects)



- The respective course instructor will design the assessment criteria for the said assessment components.
- The assessment components will be made known to the students by the respective Course Coordinators prior to the commencement of the Laboratory Work.

In all the cases, the assessments will be done based on the criteria designed by the Course Coordinator.

SEE QUESTION PAPER PATTERN:

1. All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
2. SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
3. General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
4. Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE WEB LINKS AND VIDEO LECTURES (E – RESOURCES):

1. Nystrom Robert, Game Programming Patterns, 3rd edition, Genever Benning, 2014.
2. Paris Buttfield Addison et al., Unity Game Development Cookbook: Essentials for Every Game, 1st Edition, O'Reilly Media, 2019.
3. David H. Eberly, "3D Game Engine Design: A Practical Approach to Real-Time Computer Graphics", Second Edition, CRC Press, 2006.
4. Jung Hyun Han, "3D Graphics for Game Programming", Chapman and Hall/CRC, 2011.



THERMODYNAMICS – II

(Effective from the Academic Year 2023 - 2024)

IV SEMESTER

Course Code	ME42211M	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40L + 20P	Exam Hours	03

CREDITS – 4

COURSE PREREQUISITES:

- Knowledge of Mathematics and Thermodynamics – I.

COURSE OBJECTIVES:

- To understand fundamentals of I.C. Engines, Construction and working Principle of an Engine and Compare Actual, Fuel-Air and Air standard cycle Performance.
- To understand the applications of the first and second laws of Thermodynamics to various gas processes and cycles.
- To study Combustion in SI and CI engines and its controlling factor in order to extract maximum power.
- To understand the concepts related to Air conditioning to get conversant with Psychrometric Charts, Psychrometric processes, human comfort conditions.
- To understand theory and performance Calculation of Positive displacement compressor.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

I.C. Engines: Detonation and factors affecting detonation, IC Engine fuels and Ratings, Alternate Fuels. Air standard cycles: Carnot, Otto, Diesel, Dual combustion cycles, P-V and T-S diagrams, description, efficiencies and mean effective pressures. Comparison of Otto and Diesel cycles. Numericals on cycles.	8 Hours
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MODULE - II

Gas power Cycles: Brayton cycle; description and analysis. Regenerative gas turbine cycle. Intercooling and reheating in gas turbine cycles. Introduction to Jet Propulsion cycles. Numericals.	8 Hours
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MODULE - III

Vapour Power Cycles: Carnot vapour power cycle, drawbacks as a reference cycle. Simple Rankine cycle; description, T-S diagram, analysis for performance. Comparison of Carnot and Rankine cycles. Effects of pressure and temperature on Rankine cycle performance. Actual vapour power cycles. Ideal and practical regenerative Rankine cycles, open and closed feed water heaters. Reheat Rankine cycle. Characteristics of an Ideal working fluid in vapour power cycles. Numericals.	8 Hours
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MODULE - IV

Psychometrics and Air-conditioning Systems: Psychometric properties of Air, Psychometric Chart, Analyzing Air-conditioning Processes; Heating, Cooling, Dehumidification and Humidification, Evaporative Cooling. Adiabatic mixing of two moist air streams. Numericals.	8 Hours
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MODULE - V



Reciprocating Compressors: Operation of a single stage reciprocating compressors. Work input through P-V diagram and steady state steady flow analysis. Effect of Clearance and Volumetric efficiency. Adiabatic, Isothermal and Mechanical efficiencies. Multi-stage compressor, optimizing power consumption, methods of Optimum intermediate pressure, Inter-cooling, Minimum work for compression. Numericals.	8 Hours
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COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Examine the performance of Air-standard cycles.	CL4
CO2	Analyze the performance of gas turbine cycles.	CL4
CO3	Analyze the performance of Vapour power cycles.	CL4
CO4	Determine the performance parameters of Air conditioning systems.	CL4
CO5	Analyze the performance of reciprocating air compressors.	CL4

LABORATORY COMPONENTS

Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	Performance test and heat balance sheet on single cylinder 4-stroke diesel engine.	CO1	CL4
2.	Performance test on 4-stroke petrol engine.	CO1	CL4
3.	Performance test on 2-stroke single cylinder petrol engine.	CO1	CL4
4.	Morse test on multi cylinder petrol engine.	CO1	CL4
5.	Performance test on variable compression ratio petrol engine.	CO1	CL4
6.	Virtual – Demonstration on gas turbines and gas turbine engines.	CO2	CL4
7.	Visit to nearby steam power plant to understand the power generation	CO3	CL4
8.	Experimentation on COP of Vapor Compression Refrigeration system.	CO4	CL4
9.	Experimentation on COP of Air-Conditioning system.	CO4	CL4
10.	Experimentation on single and double stage reciprocating compressors.	CO5	CL4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	1					1	1	1		1			3
CO2	3	3	1			1		1	1	1		1			3
CO3	3	3	1			1	2	1	1	1		1			3
CO4	3	3	1				2	1	1	1		1			3
CO5	3	3	1					1	1	1		1			3
3: Substantial (High)				2: Moderate (Medium)				1: Poor (Low)							

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Practical Session (Laboratory Component)	40 %	20
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT DETAILS



Continuous Internal Assessment (CIA) (50%)			Semester End Exam (SEE) (50%)	
Continuous Internal Evaluation (CIE) (60%)		Practical Sessions (40%)		
I	II		III	
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII		MIII	MIII
		MIV	MIV	MIV
		MV	MV	MV

NOTE:

- Assessment will be both CIA and SEE.
- The practical sessions of the IPCC shall be for CIE only.
- The Theory component of the IPCC shall be for both CIA and SEE respectively.
- The questions from the practical sessions shall be included in Theory SEE.

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

SEE QUESTION PAPER PATTERN:

1. The question paper will have **TEN** full questions from **FIVE** Modules
2. There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
3. Each full question may have a maximum of four sub-questions covering all the topics under a module.
4. The students will have to answer FIVE full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Engineering Thermodynamics, P K Nag, Tata McGraw Hill Pub, 6th Edition, 2018.
2. Thermodynamics, Yunus A Cengel, Michael A Boles, Tata McGraw Hill, 7th Edition, 2017.
3. Applications of Thermodynamics, V.Kadambi, T.R. Seetharam, K. B. Subramanya Kumar, Wiley Indian Private Ltd, 1st Edition, 2019.
4. Applied Thermodynamics, B.K Venkanna, Swati B. Wadavadagi, PHI, New Delhi, 2010.
5. Fundamental of Classical Thermodynamics, G.J. Van Wylen and R.E. Sontang, Wiley eastern, 5th edition.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. https://onlinecourses.nptel.ac.in/noc21_ch27/preview
2. https://onlinecourses.nptel.ac.in/noc21_me119/preview
3. <https://nptel.ac.in/courses/112105266>



MACHINING SCIENCE AND JIGS & FIXTURES

(Effective from the Academic Year 2023 - 2024)

IV SEMESTER

Course Code	ME422I2M	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40L + 20P	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Knowledge on strength of materials, tooling and machine tools.

COURSE OBJECTIVES:

This course will enable students to:

- Know the various machining processes used in industries.
- Determine the various forces involved in the machining operations.
- Understand the various tool wear mechanism and determination of cutting tool life.
- Know various non-conventional machining processes.
- Know the design of Jigs and Fixtures for various industrial/ machining members.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction to Machining Processes and Machine tools: Need and classification of machining processes; Configuration, Specification and Classification of machine tools - Lathe, Milling Machine, Drilling Machine, Shaping Machine, Planer Machine, Slotting Machine.

8 Hours

Introduction to CNC machines: CNC lathe, CNC Milling, CNC drilling.

MODULE - II

Mechanics of Metal Cutting: Geometry of single point cutting tools; Mechanism of chip formation; Orthogonal and oblique cutting. Force and power analysis in machining: Causes, effects of cutting temperature on the machining process.

8 Hours

MODULE - III

Machinability and tool life: Machinability concept; Tool Wear; Failure of cutting tools and tool life; Cutting Tool Materials; Economics of metal cutting, choice of cutting speed and feed, tool life for minimum cost and production time. Numerical problems on cutting tool life.
Surface finish: Effect of machining parameters on surface finish.

8 Hours



Finishing and Super-Finishing Processes: Purpose and application of grinding; Selection of grinding wheels and their conditioning methods; Specific energy and power requirement in grinding; Super-finishing processes such as Honing, Lapping.			
MODULE - IV			
Non-conventional methods of machining Mechanical Processes: Working Principle, process parameters, advantages, limitations and applications in Abrasive Jet Machining (AJM) Process, Water Jet Machining (WJM) process, Abrasive Water Jet Machining (AWJM) process, Ultrasonic Machining (USM). Thermo-electric Processes: Working Principle, process parameters, advantages, limitations and applications in Electric Discharge Machining (EDM), Laser Beam Machining (LBM), Electron Beam Machining (EBM) and Plasma Machining (PM). Electrochemical Processes: Working Principle, process parameters, advantages, limitations and applications in Electroplating and reverse-electroplating, Electro Chemical Machining (ECM).		8 Hours	
MODULE - V			
Jigs and Fixtures: Introduction: Functions and differences between jigs and fixtures, advantages in mass production, design principles, economics of jigs and fixtures. Location: 3-2-1 Principle of location, different types of locating elements. Clamping: Principles of clamping, types of clamping devices, and power clamping. Drill bushes. Drill jigs: Different types, exercises of designing jigs for simple components. Fixture Design: Turning fixtures, milling fixtures, grinding fixtures, and modular fixtures. Design exercises on fixtures for turning and milling for simple components.		8 Hours	
COURSE OUTCOMES			
Upon completion of this course, the students will be able to:			
CO No.	Course Outcome Description	Bloom's Taxonomy Level	
CO1	Utilize the subtractive machining process in manufacturing industries.	CL3	
CO2	Identify forces involved in machining operations.	CL3	
CO3	Solve numerical problems in tool wear and tool life of machining processes	CL3	
CO4	Understand the Non-Conventional machining processes	CL2	
CO5	Design and develop jigs & Fixtures for industrial applications	CL3	
LABORATORY COMPONENTS			
Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	Simple machining (Turning, facing, taper turning) of Mild steel and Copper using High Speed Steel (HSS) tool and Tungsten carbide tipped tool.	CO1	CL3
2.	Perform thread turning operation to analyze various parameters involved in thread profiles	CO1	CL3
3.	Performing different slot cutting using Shaper machine	CO1	CL3
4.	Experiment to manufacture spur gear using simple indexing mechanism	CO1	CL3
5.	Cutting force measurement with Lathe tool dynamometers for turning operation.	CO2	CL3
6.	Cutting force measurement with Drill tool dynamometers for drilling operation.	CO2	CL3
7.	Effect of process parameters on machinability and surface characteristics of machined components	CO3	CL3
8.	Modeling and simulation of Laser Beam machining process using Ansys software.	CO4	CL4



9.	Modeling and simulation of the Ultrasonic machining process using Ansys software.	CO4	CL4
10.	Design of Jigs and Fixture for different components using a CAD Software (Solid works/Solid Edge/Catia)	CO5	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	3	2	2	2				2			2	1	2	1
CO2	2	3	2	2	2				2			2	1	2	1
CO3	2	3	2	2	2				2			2	1	2	1
CO4	2	2	2	1	2				2			2	1	2	1
CO5	2	2	3	2	2				2			2	1	2	1
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Practical Session (Laboratory Component)	40 %	20
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)	
Continuous Internal Evaluation (CIE) (60%)			Practical Sessions (40%)		
I	II	III			
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage	
40%	30%	30%	100%	100%	
MI			MI	MI	
MII	MII		MII	MII	
	MIII		MIII	MIII	
		MIV	MIV	MIV	
		MV	MV	MV	

NOTE:

- Assessment will be both CIA and SEE.
- The practical sessions of the IPCC shall be for CIE only.
- The Theory component of the IPCC shall be for both CIA and SEE respectively.
- The questions from the practical sessions shall be included in Theory SEE.

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting one full question from each module.



REFERENCE BOOKS:

1. V. K. Jain, Advanced Machining Processes, NPTEL Course Department of Mechanical Engineering, IIT Kanpur, Link: <http://nptel.ac.in/courses/112104028/>.
2. U. S. Dixit, Mechanics of Machining, NPTEL Course Department of Mechanical Engineering Guwahati, Link: <http://nptel.ac.in/courses/112103248/>.
3. A. B. Chattopadhyay, Manufacturing Processes II, NPTEL Course of Department of Mechanical Engineering, IIT Kharagpur, <https://nptel.ac.in/courses/112/105/112105126/>.
4. Mikell P. Groover, (2019), Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Wiley Publications.
5. Rao P. N., Manufacturing Technology II, Tata McGraw Hill
6. Shaw, M C, (2014), Metal Cutting Principles, Oxford University Press.
7. McGeough, J A, (1988), Advanced Methods of Machining, Springer.
8. Boothroyd, G., and Knight, W. A., Fundamentals of Machining and Machine Tools, CRC Press.
9. Chattopadhyay, A B, (2013), Machining and Machine Tools, Wiley India.



REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. https://onlinecourses.nptel.ac.in/noc22_cs93/unit?unit=17&lesson=18
2. https://onlinecourses.nptel.ac.in/noc22_cs93/unit?unit=26&lesson=27
3. https://onlinecourses.nptel.ac.in/noc22_cs93/unit?unit=43&lesson=44
4. https://onlinecourses.nptel.ac.in/noc22_cs93/unit?unit=52&lesson=53
5. https://onlinecourses.nptel.ac.in/noc22_cs93/unit?unit=75&lesson=76



KINEMATICS OF MACHINES

(Effective from the Academic Year 2023 - 2024)

IV SEMESTER

Course Code	ME422T3M	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Knowledge of Gears and Gear Trains from Elements of Mechanical Engineering.

COURSE OBJECTIVES:

This course will enable students to:

- To understand the concept of machines, mechanisms and related terminologies.
- To expose the students to various mechanisms and motion transmission elements used in Mechanical Engineering.
- To analyze a mechanism for displacement, velocity and acceleration at any point in a moving link.
- To understand the theory of cams, gears and gear trains

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Definitions: Link, types of links, joint, types of joints kinematic pairs, Constrained motion, Kinematic chain, Mechanism and types, Degrees of freedom of planar mechanisms, Equivalent mechanisms, Grashoff's criteria and types of four bar Mechanisms, Inversions of four bar chain, Slider crank chain, Double slider crank chain and its inversions, Grashoff's chain.

Mechanisms: Quick return motion mechanisms- Drag link mechanism, Whitworth mechanism and Crank and slotted lever Mechanism. Straight line motion mechanisms, Peaucellier's mechanism and Robert's mechanism. Intermittent Motion mechanisms: Geneva wheel mechanism, Ratchet and Pawl mechanism.

8 Hours

MODULE - II

Velocity and Acceleration Analysis of Mechanisms (Graphical Method): Velocity and acceleration analysis of four bar mechanism, slider crank mechanism. Angular velocity and angular acceleration of links.

Velocity Analysis by Instantaneous Center Method: Definition, Kennedy's theorem, Determination of linear and angular velocity using instantaneous center method.

8 Hours

MODULE - III

Velocity and Acceleration Analysis of Mechanisms (Analytical Method): Loop Closure equation, Velocity and acceleration analysis of four bar mechanism, slider crank mechanism using complex algebra method. Analytical expression for the determination of velocity and acceleration of piston of a reciprocating engine. Simple Numerical Problems. Freudenstein's equation for slider crank mechanism.

8 Hours



MODULE - IV															
Cams: Classification of cams, Types of followers, Cam nomenclature, Follower motions and motion analysis of SHM, Motion with uniform acceleration and deceleration, Cycloidal motion, Cam profile with offset knife edge follower, Roller follower.														8 Hours	
MODULE - V															
Spur Gears: Gear terminology, law of gearing, path of contact, arc of contact, contact ratio of spur gear. Interference in involute gears, methods of avoiding interference, condition and expressions for minimum number of teeth to avoid interference.														8 Hours	
Gear Trains: Simple gear trains, compound gear trains. Epicyclic gear trains: Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains, torque calculation in epicyclic gear trains.															
COURSE OUTCOMES															
Upon completion of this course, the students will be able to:															
CO No.	Course Outcome Description													Bloom's Taxonomy Level	
CO1	Understand the working of Kinematic mechanisms and its inversions.													CL2	
CO2	Analyze graphically the velocity and acceleration of the planar mechanisms.													CL4	
CO3	Analyze the velocity and acceleration of the planar mechanisms analytically.													CL4	
CO4	Develop CAM Profile using SHM, UARM and Cycloidal motions of the follower.													CL4	
CO5	Inspect gear parameters such as length of path of contact, Contact ratio, Minimum number of teeth to avoid interference and examine the gear trains.													CL4	
CO-PO-PSO MAPPING															
CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2		2			2	2	2		2	3		
CO2	3	2	2					2	2	2		2	3		
CO3	3	2	2					2	2	2		2	3		
CO4	2	2	2					2	2	2		2	3		
CO5	3	2	2					2	2	2		2	3		
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					
ASSESSMENT STRATEGY															
Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:															
Sl. No.	Assessment Description							Weightage (%)				Max. Marks			
1	Continuous Internal Assessment (CIA)							100 %				50			
	Continuous Internal Evaluation (CIE)							60 %				30			
	Assignments							40 %				20			
2	Semester End Examination (SEE)							100 %				50			
ASSESSMENT DETAILS															
Continuous Internal Assessment (CIA) (50%)										Semester End Exam (SEE) (50%)					
Continuous Internal Evaluation (CIE) (60%)							Assignment/ Activities (40%)								
I		II		III											
Syllabus Coverage							Syllabus Coverage				Syllabus Coverage				



40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII		MIII	MIII
		MIV	MIV	MIV
		MV	MV	MV

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer **FIVE** full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Mechanisms and Machines Kinematics, Dynamics and Synthesis by Michael M Stanisc, Cengage Learning, 2016
2. Theory of Machines by R S Khurmi&J.K Gupta, S Chand Publishing, 14th revised edition, 2015
3. Theory of Machines by Rattan S.S Tata, McGraw-Hill publishing company, 2014
4. Theory of Machines Kinematics and Dynamics by Sadhu Singh, Pearson Education, 3rd edition, 2019
5. Mechanism and Machine Theory by G Ambedkar, PHI 2009

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. <https://youtu.be/yDEJxYGAoso>
2. <https://youtu.be/e1n-7Wz8dhg>
3. <https://youtu.be/N0hTFnvIE7A>
4. <https://youtu.be/MJeRFzs4oRU>



FLUID MECHANICS

(Effective from the Academic Year 2023 - 2024)

IV SEMESTER

Course Code	ME422T4M	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fundamental knowledge of Engineering Mathematics and Applied Physics.

COURSE OBJECTIVES:

- To possess a functional understanding of the fundamental characteristics of fluids and grasp the concept of the continuum approximation.
- To compute the forces applied by a stationary fluid on submerged surfaces and comprehend the concept of buoyant force.
- To understand the flow behavior and dynamics within flow fields in diverse engineering applications.
- To comprehend the velocity variations, energy transfers in fluid flows, and their correlation with forces and torques, as well as to appreciate the significance of designing for minimal energy loss in fluid systems.
- To discuss the main properties of laminar and turbulent pipe flow and appreciate their differences and the concept of boundary layer theory.
- Understand the concept of dynamic similarity and how to apply it to experimental modeling.
- To appreciate the consequences of compressibility in gas flow and understand the effects of friction and heat transfer on compressible flows.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Basics: The concept a fluid. General Properties of fluids- dimensions and units. Newton's law of Viscosity- Newtonian and Non-Newtonian fluids- Classification. Viscous flow between fixed and moving plates. Surface tension and Pressure difference across an interface due to Surface Tension. Pressure distribution in a hydrostatic fluid. Pascal's law. Application to manometry.

8 Hours

Fluid Statics: Hydrostatic forces on an arbitrary plane surface. Buoyancy and stability.

MODULE - II

Fluid Kinematics: Differential formulation for fluid flow. Types of Flow-steady, unsteady, uniform, non-uniform, laminar, turbulent, one, two and three dimensional, compressible, incompressible, rotational, irrotational, stream lines, path lines, streak lines, velocity components, convective and local acceleration, velocity potential, stream function, continuity equation in Cartesian co-ordinates. Rotation, vorticity and circulation, Laplace equation in velocity potential and Poisson equation in stream function, flow net, Problems.

8 Hours



Laminar and Turbulent flow: Flow through circular pipe, between parallel plates, Power absorbed in viscous flow in bearings, Poiseuille equation.	
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MODULE - III

Fluid Dynamics: Integral or Control Volume formulation for fluid flow. System and Control volume. Reynolds Transport Theorem- application to arbitrary fixed control volume as well as control volume moving at constant velocity. Relations for Arbitrary moving and Deformable control volume. Momentum equation, Impact of jets- force on fixed and moving vanes, flat and curved. Numerical. Euler's equation, Integration of Euler's equation to obtain Bernoulli's equation, Bernoulli's theorem, Application of Bernoulli's theorem such as venture meter, orifice meter, rectangular and triangular notch, pitot tube, orifices etc., related numerical. Loss of head due to friction in pipes, Major and minor losses, pipe connection in series and parallel.	8 Hours
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MODULE - IV

Flow over bodies: Development of boundary layer, Lift and Drag, Flow around circular cylinders, spheres, aerofoils and flat plates, Streamlined and bluff bodies, boundary layer separation and its control. Dimensional Analysis: Dimensional analysis and similarity. Dimensional homogeneity concept. the Raleigh's method and Buckingham Pi theorem for non-dimensional analysis of a physical phenomenon. Similitude, and types of similitude. The geometric, kinematic and dynamic similarity considerations for model and prototype.	8 Hours
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MODULE - V

Compressible flows: Speed of sound, adiabatic and isentropic steady flow, Isentropic flow with area change stagnation and sonic properties, normal and oblique shocks, flow through nozzles. Introduction to CFD: Necessity, limitations, philosophy behind CFD, applications.	8 Hours
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COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Understand and apply the basic principles of fluid mechanics and fluid statics for the fluid flow.	CL3
CO2	Understand and apply the principles of buoyancy, floatation, and fluid kinematics for the flow field.	CL3
CO3	Understand and apply the basic knowledge of fluid dynamics to the vanes, and pipes to predict relevant forces, velocity, and pressures.	CL3
CO4	Illustrate the concept of boundary layer in fluid flow and apply principles of dimensional analysis and similitude to form dimensionless numbers in terms of input-output variables.	CL3
CO5	Apply the basic concept of compressible flow and CFD to analyze the fluid behavior.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	1				2				2			2
CO2	3	3	2					2				2			2
CO3	3	3	3					2				2			2
CO4	3	3	3					2				2			2
CO5	3	3	3					2				2			2



3: Substantial (High)			2: Moderate (Medium)			1: Poor (Low)		
ASSESSMENT STRATEGY								
Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:								
Sl. No.	Assessment Description			Weightage (%)		Max. Marks		
1	Continuous Internal Assessment (CIA)			100 %		50		
	Continuous Internal Evaluation (CIE)			60 %		30		
	Assignments			40 %		20		
2	Semester End Examination (SEE)			100 %		50		
ASSESSMENT DETAILS								
Continuous Internal Assessment (CIA) (50%)					Semester End Exam (SEE) (50%)			
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)					
I		II		III				
Syllabus Coverage				Syllabus Coverage		Syllabus Coverage		
40%		30%		30%		100%		100%
MI						MI		MI
MII		MII				MII		MII
		MIII				MIII		MIII
				MIV		MIV		MIV
				MV		MV		MV
Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom’s Level. Any COs mapped with higher cognitive Bloom’s Level may also be assessed through the assignments.								
ASSIGNMENT TYPES WITH WEIGHTAGES								
Sl. No.	Assignment Description				Max. Weightage (%)		Max. Marks	
1	Written Assignments				25 %		05	
2	Quiz				10 %		02	
3	Case Studies				25 %		05	
4	Seminar/Presentation				15 %		03	
5	Peer - to - Peer Learning				10 %		02	
6	Activity Based Learning				50 %		10	
7	Project Based Learning				50 %		10	
8	Field Work + Report				50 %		10	
9	Industry Visit + Report				50 %		10	
10	NPTEL/MOOC Courses – Registration and Assignment Submissions				50 %		10	
	NPTEL Certification				75 %		15	
11	Any other Innovative Assignments (CL4 and above)				50 %		10	
Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands								
SEE QUESTION PAPER PATTERN:								
• The question paper will have TEN full questions from FIVE Modules • There will be 2 full questions from each module. Every question will carry a maximum of 20 marks. • Each full question may have a maximum of four sub-questions covering all the topics under a module. • The students will have to answer FIVE full questions, selecting one full question from each module.								
REFERENCE BOOKS:								
1. Introduction to Fluid Mechanics, Fox, R. W., Pitchard, P.J., and McDonald, A. T., (2010), 7th Edition, John Wiley & Sons Inc. 2. Fluid Mechanics: Fundamentals and Applications, Cimbala, J.M., Cengel, Y. A. (2010), McGraw-Hill								



3. Fluid Mechanics, Frank M White., (2016), 8th Edition , McGraw-Hill
4. A textbook of Fluid Mechanics and Hydraulic Machines, Dr. R K Bansal, Laxmi publishers
5. Fundamentals of Fluid Mechanics, Munson, Young, Okiishi &Hebsch, John Wiley Publications, 7th Edition

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. https://www.youtube.com/watch?v=gY0MwGLq9W8&list=PLyqSpQzTE6M9DKhN7z2fOpKTJWu-639_P
2. <https://www.youtube.com/watch?v=5Y8Lfsreeck&list=PL7DC83C6B3312DF1E>
3. https://www.youtube.com/watch?v=S47aSEqm_0I&list=PLgj_V-ZKxRRxgFyOutPJpoLFBaQMOpK-



MACHINE DRAWING AND GD&T

(Effective from the Academic Year 2023 - 2024)

SEMESTER - IV

Course Code	ME422L5M	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:1	SEE Marks	50
Total Hours of Pedagogy	24P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Concepts of engineering visualization.
- Usage of basic engineering drawing tools.

COURSE OBJECTIVES:

- Identify the various types of limits, tolerance and fits on machine drawings.
- Understand the concept of orthographic projections and the importance of sectional views.
- Acquire the knowledge of thread forms, fasteners, keys, joints and couplings.
- Interpret drawing details of machine components and to prepare of assembly using CAD packages.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

PRE-REQUISITE EXPERIMENTS

1. Drawing orthographic views of a machine part.
2. Creating 3D model of simple solid parts.

COURSE CONTENTS

PART A

Basic review of conventional representation of details in machine drawing (Materials, machine components, dimensioning practices & principles of drawing).

Geometrical Dimensioning and Tolerances (GD&T): Introduction, terminology, basic Rules and features of GD&T. Introduction to and material conditions, maximum material condition, least material condition. types of fits with symbols and applications.

Geometrical tolerances on drawings: Form tolerances - straightness, flatness, circularity & cylindricity, **Orientation tolerances** - parallelism, perpendicularity & angularity, **Profile tolerances** - profile of a surface & profile of a line.

Location tolerances - true position, concentricity, symmetry, **Runout tolerances** - Runout/circular runout, total runout, Standards followed in industry.

Part modelling and assembly using Solidworks software for the following machine components and obtaining BOM, production drawings as per GD&T standards.

1. Joints: Cotter joint (socket and spigot), Knuckle joint
2. Couplings: Protected type flanged coupling, Universal coupling
3. C Clamp



4. Cross head
5. IC engine connecting rod
6. Crane hook
7. Lifting devices
8. Lever safety valve

PART B

1. Sheet metal modelling and assembly (Exercise Problems)
2. 3D surface modelling (Exercise Problems)

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Apply suitable GD&T symbols to the machine part drawings.	CL3
CO2	Analyze 2D part drawings and generate 3D assembly of machine components using CAD software.	CL4
CO3	Develop production drawing of a machine component as per GD&T standards.	CL3
CO4	Model sheet metal drawings using CAD software.	CL3
CO5	Develop 3D surface models using CAD software.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2		3			2		3		3	3	3	
CO2	3	2	2		3			2		3		3	3	3	
CO3	3	2	2		3			2		3		3	3	3	
CO4	3	2	2		3			2		3		3	3	3	
CO5	3	2	2		3			2		3		3	3	3	
3: Substantial (High)				2: Moderate (Medium)						1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Laboratory Report (A)	50 %	25
	Laboratory Test (B)	50 %	25
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT STRATEGY:

- CIA shall be evaluated for max marks 100. Marks obtained shall be accounted for CIA final marks, reducing it by 50%.
- CIA component should comprise of **continuous evaluation of printouts** as and when the topics are covered and one **closed book test** covering all the topics with the ratio of 50:50.
- Marks distribution for test is PART A + PART B = 60 + 40

SEE QUESTION PAPER PATTERN:

- SEE shall be conducted and evaluated for maximum marks 100. Marks obtained shall be accounted for SEE final marks, reducing it to 50 marks.
- The question paper will include two questions from each part i.e from Part A and Part B. Student has to



answer one question each from part.

- Marks distribution: PART A + PART B = 60 + 40
- The duration of SEE is 03 hours.

REFERENCE BOOKS:

1. K L Narayana, P Kannaiah, K Venkata Reddy, “Machine Drawing”, New Age International, 3rd Edition, 2006.
2. N D Bhatt, “Machine Drawing”, Charotar Publishing House Pvt. Ltd., 50th Edition, 2014.
3. James D. Meadows, “WORKBOOK AND ANSWERBOOK for Geometric Dimensioning and Tolerancing”, [As per ASME Y14.5-2009], 2009.
4. K R Gopalakrishna, “Machine Drawing”, Subhash publications, 20th edition, 2007.
5. P S Gill, “Geometric Dimensioning & Tolerancing”, S.K. Kataria & Sons, 3rd edition, 2019.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. <https://www.youtube.com/@solidworks>



Functions of Complex Variables and Statistical Methods

(Effective from the Academic Year 2022 - 2023)

SEMESTER - IV

Course Code	MA422T6M	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:1	SEE Marks	50
Total Hours of Pedagogy	50L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

Applied Mathematics-I, Applied Mathematics-II, Basics of Statistics and Complex Numbers

Course Objectives:

- Study the techniques of complex variables and functions together with their derivatives, Contour integration and transformations.
- Enable the students to apply basic concepts Testing Hypothesis.
- Understand the concept of probability distributions and enable the students to predict the outcome of simple random experiments

Teaching - Learning Strategy:

These are some sample strategies, which course faculty members can incorporate in the Teaching Learning Process:

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses

COURSE CONTENTS

MODULE - I

Calculus of Complex functions & Construction of Analytic functions: Review of a function of a complex variable, limits, continuity, differentiability.

Construction of analytic functions: Cauchy-Riemann equations in Cartesian and polar forms. Properties and construction of analytic functions. Milne-Thompson Method. Application of analytic functions.

Textbook : Chapter 20(sections :20.1,20.2,20.3,20.4,20.5)

10 Hours

MODULE - II

Conformal Transformations and Complex integration: Conformal transformations: Introduction. Discussion of transformations: $w = z^2$, $w = e^z$, $w = z + 1/z$, $z \neq 0$. Bilinear transformations- Problems. Line integral of a complex function, Cauchy's theorem and Cauchy's integral formula. Cauchy's Residue theorem problems.

Textbook : Chapter 20(20.7,20.8,20.9,20.10,20.12,20.13,20.14)

10 Hours

MODULE - III

Probability Distribution Functions: Random variables (discrete and continuous), probability mass/density functions, Binomial, Poisson distributions-problems. Exponential and Normal distributions-problems, Joint Probability distribution for two discrete random variables, expectation and

10 Hours



covariance,															
Textbook : Chapter 26 (26.7,26.8,26.9,26.10,26.14,26.15,26.16,26.19(section-6))															
MODULE - IV															
Linear system of equations : consistent and inconsistent systems and its solution sets; LU decomposition. Symmetric Matrices and Quadratic Forms: Inner products, inner product spaces , orthogonal sets , orthogonal projections, Gram- Schmidt Orthogonalization procedure, QR Factorization. Textbook : Chapter 3(sections :3.15, 3.45)														10 Hours	
MODULE - V															
Curve Fitting and Statistical Methods: Curve fitting by the method of least squares- fitting the curves of the form $y = ax + b$, $y = ax^b$, $y = ae^{bx}$ and $y = ax^2 + bx + c$. Correlation-Karl Pearson's coefficient of correlation regression analysis-lines of regression, Rank Correlation. Optimization Technique: Mathematical Modeling of LPP, Graphical method, Simplex Method. Textbook : Chapter 24 (24.5,24.6,), Chapter 25(25.12,25.13,25.14), Chapter 34(34.3,34.7)														10 Hours	
COURSE OUTCOMES															
Upon completion of this course, the students will be able to:															
CO No.	Course Outcome Description													Bloom's Taxonomy Level	
CO1	Demonstrate the ability to analyze, differentiate, and construct complex analytic functions.													CL3	
CO2	Utilize conformal transformation and complex integral in fluid flow visualization and image processing.													CL3	
CO3	Utilize Discrete and Continuous random variables and Probability distribution functions to use for the probability models in engineering field.													CL3	
CO4														CL3	
CO5	Apply statistical methods to analyze data and utilize curve fitting techniques for practical problem-solving in mechanics.													CL3	
CO-PO-PSO MAPPING															
CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2					1				1	1		
CO2	2	2	1									1			
CO3	3	2	2						1						1
CO4	3	3	1					1				1	1		
CO5	3	3	1						1			1	1		
3: Substantial (High)				2: Moderate (Medium)						1: Poor (Low)					
ASSESSMENT STRATEGY															



Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignment	40 %	20
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
30%	30%	40%	100%	100%
MI			MI	MI
MII	MIII		MII	MII
	MIII		MIII	MIII
		MIV	MIV	MIV
		MV	MV	MV

NOTE:

- Assessment will be both CIA and SEE.
- The practical sessions of the IPCC shall be for CIE only.
- The Theory component of the IPCC shall be for both CIA and SEE respectively.

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

1. The question paper will have **TEN** full questions from **FIVE** Modules
2. There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
3. Each full question may have a maximum of four sub-questions covering all the topics under a module.
4. The students will have to answer **FIVE** full questions, selecting one full question from each module.

TEXT BOOKS:

1. N.P Bali & Dr. Manish Goyal: " Engineering Mathematics" 9th Edition, Laxmi Publications.
2. B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, 43rd Ed., 2015.

REFERENCE BOOKS:

1. C Ray Wylie, Louis C Barrett: "Advanced Engineering Mathematics", 6th Edition,
2. Dr. K. Chandrashekar: " Complex analysis, Probability and Statistical Methods" Sudha Publications, 2021



REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. <http://nptel.ac.in/courses.php?disciplineID=111>
2. [http://www.class-central.com/subject/math\(MOOCs\)](http://www.class-central.com/subject/math(MOOCs))
3. <http://academicearth.org/>
4. <http://www.bookstreet.in>.
5. VTU e-Shikshana Program.
6. <https://www.youtube.com/watch?v=8Kg21jBCm-k>
7. <https://www.youtube.com/watch?v=Wa6kaCwyYRk>



REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. https://onlinecourses.nptel.ac.in/noc22_cs93/unit?unit=17&lesson=18
2. https://onlinecourses.nptel.ac.in/noc22_cs93/unit?unit=26&lesson=27
3. https://onlinecourses.nptel.ac.in/noc22_cs93/unit?unit=43&lesson=44
4. https://onlinecourses.nptel.ac.in/noc22_cs93/unit?unit=52&lesson=53
5. https://onlinecourses.nptel.ac.in/noc22_cs93/unit?unit=75&lesson=76



Data Wrangling, Analysis and Visualization

(Effective from the Academic Year 2023 - 2024)

IV SEMESTER

Course Code	ME42297MA	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	20P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Basic knowledge of Python as covered in AEC - Python for Scientific Computing.
- Basic knowledge of statistics, graphs and linear algebra

COURSE OBJECTIVES:

- To become familiar in the utilisation of python data science libraries such as Pandas, Seaborn, Scipy, Numpy, Matplotlib, Plotly and special libraries such as Geopandas.
- To learn the techniques of using python libraries for data preprocessing, data analysis and data visualization.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Sl. No.	Description
1	Pandas Basics and Data Cleaning: Use Pandas library to load, clean, and preprocess data. Read various data formats, handling missing values, and basic data manipulation. Tutorial Link: [Pandas Basics](https://pandas.pydata.org/docs/getting_started/intro_tutorials/index.html)
2	Data Transformation with Pandas: Explore more advanced data transformation techniques using Pandas. Perform merging, grouping, pivoting, and reshaping data for analysis. Tutorial Link: [Data Transformation with Pandas](https://pandas.pydata.org/pandas-docs/stable/getting_started/intro_tutorials/06_calculate_statistics.html)
3	Data Cleaning with Regular Expressions: Use regular expressions in Python to clean and preprocess text data effectively. Use the `re` module for pattern matching and text manipulation. Tutorial Link: [Data Cleaning with Regular Expressions](https://www.datacamp.com/community/tutorials/python-regular-expression-tutorial)
4	Handling and Cleaning Messy Data with OpenRefine: Use OpenRefine, a powerful tool for data cleaning and transformation to clean and preprocess data with a user-friendly interface. Tutorial Link: [OpenRefine Tutorial](https://programminghistorian.org/en/lessons/cleaning-data-with-openrefine)
5	Exploratory Data Analysis (EDA) with Seaborn and Matplotlib: Perform exploratory data analysis using Seaborn and Matplotlib libraries. Create different types of plots and visualizations to understand data distribution and relationships. Tutorial Link: [EDA with Seaborn and Matplotlib](https://seaborn.pydata.org/tutorial.html)
6	Statistical Data Analysis with SciPy: Perform statistical analysis using the SciPy library. Demonstrate basic statistical tests, hypothesis testing, and summary statistics to analyze datasets. Tutorial Link: [Statistical Data Analysis with SciPy](https://docs.scipy.org/doc/scipy/reference/tutorial/stats.html)



7	Time Series Analysis with Pandas: Analyze time series data using Pandas. Use techniques for resampling, rolling statistics, and plotting time-based data. Tutorial Link: [Time Series Analysis with Pandas](https://pandas.pydata.org/pandas-docs/stable/user_guide/timeseries.html)
8	Machine Learning for Data Analysis with Scikit-Learn: Explore basic machine learning techniques for data analysis using the Scikit-Learn library. Conduct classification, regression, and clustering algorithms for various datasets. Tutorial Link: [Scikit-Learn Tutorial](https://scikit-learn.org/stable/tutorial/index.html)
9	Data Visualization with Matplotlib: Learn the fundamentals of data visualization using the Matplotlib library. Create different types of plots and customizing visualizations. Tutorial Link: [Matplotlib Tutorial](https://matplotlib.org/stable/tutorials/introductory/pyplot.html)
10	Interactive Data Visualization with Plotly: Explore interactive and web-based data visualization using Plotly. Create dynamic visualizations that can be embedded in web applications. Tutorial Link: [Plotly Python Tutorial](https://plotly.com/python/)
11	Data Visualization with Seaborn: Explore the advanced data visualization using the Seaborn library. Create attractive and informative statistical visualizations. Tutorial Link: [Seaborn Tutorial](https://seaborn.pydata.org/tutorial.html)
12	Geospatial Data Visualization with Geopandas: Use geospatial data and create maps using the Geopandas library. Load geographic data, performing spatial analysis, and generating maps. Tutorial Link: [Geopandas Documentation](https://geopandas.org/docs/user_guide.html)

COURSE OUTCOMES															
Upon completion of this course, the students will be able to:															
CO No.	Course Outcome Description												Bloom's Taxonomy Level		
CO1	Apply Pandas for data manipulation and analysis- be able to load, clean, transform, and summarize data using Pandas												CL2		
CO2	Apply data cleaning tools like Openrefine to handle messy and unstructured data effectively, ensuring data quality and consistency in real-world datasets.												CL2		
CO3	Create Data visualisation using Exploratory Data Analysis (EDA) Skills using Seaborn and Matplotlib.												CL2		
CO4	Analyse Statistical parameters of data using Scipy - perform hypothesis testing, statistical modeling, and advanced statistical analyses suing SciPy												CL2		
CO5	Create geospatial visualizations using Geopandas, as covered in the Geopandas Documentation.												CL3		
CO-PO-PSO MAPPING															
CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	3		2							1		3	
CO2	3	2	3		2							1		3	
CO3	3	2	3		2							1		3	
CO4	3	2	3		2							1		3	
CO5	3	2	3		2							1		3	
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT STRATEGY:

- I. In Laboratory Courses where (B) and (C) are not the components of the assessment pattern, then (A) will have 100% weightage (50 Marks).

Assessment Mode: Weekly Assessment of Laboratory Work (50 Marks) - the marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment, each of 25 marks) of the students in each laboratory session. The average of all the marks obtained across the sessions will be the Final CIA marks.

- II. In Laboratory Courses where (C) is not a component of the assessment pattern, then (A) will have 50% weightage (25 Marks), and (B) will have 50% weightage (25 Marks).

Assessment Mode: The marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment) (A) and One Laboratory Test (B).

- In Weekly Assessment, the student will be evaluated in each laboratory session for 25 marks. The average marks obtained across all the experiments will be the marks obtained for (A).
- A Laboratory Test, similar to the SEE exam is conducted towards the end of the Semester/Course, whichever is earlier. The obtained marks are scaled down to 25 Marks (B)

The Sum of marks obtained across (A) and (B) will be the Final CIA marks.

- III. In Laboratory Courses where (C) is a component of the assessment pattern, then assessment will be done by considering the weightages given above, i.e. (A) – 25 Marks (Weekly Assessment), (B) – 15 Marks (Laboratory Examination), (C) – 10 marks (Open Ended Experiments/Mini Projects)

- The respective course instructor will design the assessment criteria for the said assessment components.
- The assessment components will be made known to the students by the respective Course Coordinators prior to the commencement of the Laboratory Work.

In all the cases, the assessments will be done based on the criteria designed by the Course Coordinator.

SEE QUESTION PAPER PATTERN:

1. All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
2. SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
3. General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
4. Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE WEB LINKS AND VIDEO LECTURES (E – RESOURCES):

1. Pandas Basics- https://pandas.pydata.org/docs/getting_started/intro_tutorials/index.html
2. Data Transformation with Pandas- https://pandas.pydata.org/pandas-docs/stable/getting_started/intro_tutorials/06_calculate_statistics.html
3. Data Cleaning with Regular Expressions-<https://www.datacamp.com/community/tutorials/python-regular-expression-tutorial>
4. Handling and Cleaning Messy Data with OpenRefine- <https://programminghistorian.org/en/lessons/cleaning-data-with-openrefine>
5. Exploratory Data Analysis (EDA) with Seaborn and Matplotlib- <https://seaborn.pydata.org/tutorial.html>
6. Statistical Data Analysis with SciPy-<https://docs.scipy.org/doc/scipy/reference/tutorial/stats.html>



7. Time Series Analysis with Pandas- https://pandas.pydata.org/pandas-docs/stable/user_guide/timeseries.html
8. Machine Learning for Data Analysis with Scikit-Learn- <https://scikit-learn.org/stable/tutorial/index.html>
9. Data Visualization with Matplotlib: Learn the fundamentals of data visualization using the Matplotlib library. Create different types of plots and customizing visualizations- <https://matplotlib.org/stable/tutorials/introductory/pyplot.html>
10. Plotly Python Tutorial- <https://plotly.com/python/>
11. Seaborn Tutorial- <https://seaborn.pydata.org/tutorial.html>
12. Geopandas Documentation- https://geopandas.org/docs/user_guide.html



PROTOTYPE FABRICATION LAB

(Effective from the Academic Year 2022 - 2023)

IV SEMESTER

Course Code	ME42297MB	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	20P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Basic Knowledge of Mathematics and Embedded Systems.

COURSE OBJECTIVES:

- To understand the design standards of fabrication of industrial components.
- To fabricate the robot components.
- To fabricate the machine components.
- To design the electronic circuits.
- To fabricate the electronic circuits used in various industries.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Sl. No.	Description
1	Design thinking and communication: Problem identification and rational thinking CAD drawings and standards, Safety standards.
2	Design thinking and communication: Problem identification and rational thinking CAM packages- CNC Turning and CNC milling part program generation.
3	Design for Fabrication: Learning designing standards for Robo components.
4	Design for Fabrication: Learning designing standards for automotive components.
5	Design for Fabrication: Learning designing standards for machine members.
6	Design for Fabrication: Learning designing standards for weld joints.
7	Design, plan and create technically sound and conceptually- related screen printed images using Adobe photoshop and other softwares for 3D printing objects
8	Learning programming for virtual prototyping for non conventional machining processes
9	Design and fabrication of Eletronic circuits -rectifiers, Simple Temperature Monitor
10	Design and fabrication of Eletronic circuits -Touch Sensor Circuit.
11	Design and fabrication of Eletronic circuits -Invisible Burglar Alarm
12	Design and fabrication of Eletronic circuits -Rain Alarm



COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	To understand the design standards of fabrication of industrial components.	CL2
CO2	To fabricate the robot components.	CL4
CO3	To make the machine components.	CL4
CO4	To design the electronic circuits.	CL4
CO5	To fabricate the electronic circuits used in various industries.	CL4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	3		2							1			
CO2	3	2	3		2							1			
CO3	3	2	3		2							1			
CO4	3	2	3		2							1			
CO5	3	2	3		2							1			
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT STRATEGY:

- I. In Laboratory Courses where (B) and (C) are not the components of the assessment pattern, then (A) will have 100% weightage (50 Marks).

Assessment Mode: Weekly Assessment of Laboratory Work (50 Marks) - the marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment, each of 25 marks) of the students in each laboratory session. The average of all the marks obtained across the sessions will be the Final CIA marks.

- II. In Laboratory Courses where (C) is not a component of the assessment pattern, then (A) will have 50% weightage (25 Marks), and (B) will have 50% weightage (25 Marks).

Assessment Mode: The marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment) (A) and One Laboratory Test (B).

- In Weekly Assessment, the student will be evaluated in each laboratory session for 25 marks. The average marks obtained across all the experiments will be the marks obtained for (A).
- A Laboratory Test, similar to the SEE exam is conducted towards the end of the Semester/Course, whichever is earlier. The obtained marks are scaled down to 25 Marks (B)

The Sum of marks obtained across (A) and (B) will be the Final CIA marks.

- III. In Laboratory Courses where (C) is a component of the assessment pattern, then assessment will be done by considering the weightages given above, i.e. (A) – 25 Marks (Weekly Assessment) (B) – 15 Marks (Laboratory



Examination), (C) – 10 marks (Open Ended Experiments/Mini Projects)

- The respective course instructor will design the assessment criteria for the said assessment components.
- The assessment components will be made known to the students by the respective Course Coordinators prior to the commencement of the Laboratory Work.

In all the cases, the assessments will be done based on the criteria designed by the Course Coordinator.

SEE QUESTION PAPER PATTERN:

1. All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
2. SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
3. General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
4. Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE WEB LINKS AND VIDEO LECTURES (E – RESOURCES):

1. <https://spu.ac.in/fabrication-laboratory/https://www.comasso.org/>
2. <https://dl.acm.org/doi/10.1145/3335055.3335074>



SENSORS AND ACTUATORS LAB

(Effective from the Academic Year 2023 - 2024)

IV SEMESTER

Course Code	ME42297MC	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	20P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Mechatronics
- Basics of IOT

COURSE OBJECTIVES:

- To understand the basic working principle and operation of different types of sensors and actuators and their real time applications.
- To know the characteristics performance of mechanical sensors like- high stiffness, high resolution over a wide measurement range.
- To understand different industrial sensors and actuators and their real time applications with Arduino and Raspberry-Pi.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Sl. No.	Description
1	To sense the Available Networks Using Arduino.
2	Measure the Distance Using Ultrasonic Sensor and Make Led Blink Using Arduino
3	To detect the Vibration of an Object Using Arduino.
4	Connect with the Available Wi-Fi Using Arduino.
5	Sense a Finger When it is Placed on Board Using Arduino.
6	Temperature Notification Using Arduino.
7	LDR to Vary the Light Intensity of LED Using Arduino.
8	MySQL Database Installation in Raspberry Pi.
9	SQL Queries by Fetching Data from Database in Raspberry Pi.
10	Switch Light On and Off Based on the Input of user using Raspberry Pi.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Able to understand the types, working and characteristics of different sensors, actuators and Transducers	CL2

CO2	Analyze different sensors and Actuators on Arduino-UNO board	CL4
CO3	Analyze different sensors and Actuators on Raspberry-Pi	CL4
CO4	Analyze the Fetching data in Raspberry Pi	CL4
CO5	Analyze the intensity of LED Using Arduino.	CL4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	3	2				1	1	2	2	2		
CO2	2	2	3	3	2				1	1	3	2	2		
CO3	2	1	2	2	3				1	2	2	2	2		
CO4	2	1	2	2	3				1	1	3	2	2		
CO5	2	1	2	2	3				1	1	3	2	2		
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT STRATEGY:

- I. In Laboratory Courses where (B) and (C) are not the components of the assessment pattern, then (A) will have 100% weightage (50 Marks).

Assessment Mode: Weekly Assessment of Laboratory Work (50 Marks) - the marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment, each of 25 marks) of the students in each laboratory session. The average of all the marks obtained across the sessions will be the Final CIA marks.

- II. In Laboratory Courses where (C) is not a component of the assessment pattern, then (A) will have 50% weightage (25 Marks), and (B) will have 50% weightage (25 Marks).

Assessment Mode: The marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment) (A) and One Laboratory Test (B).

- In Weekly Assessment, the student will be evaluated in each laboratory session for 25 marks. The average marks obtained across all the experiments will be the marks obtained for (A).
- A Laboratory Test, similar to the SEE exam is conducted towards the end of the Semester/Course, whichever is earlier. The obtained marks are scaled down to 25 Marks (B)

The Sum of marks obtained across (A) and (B) will be the Final CIA marks.

- III. In Laboratory Courses where (C) is a component of the assessment pattern, then assessment will be done by considering the weightages given above, i.e. (A) – 25 Marks (Weekly Assessment), (B) – 15 Marks (Laboratory Examination), (C) – 10 marks (Open Ended Experiments/Mini Projects)

- The respective course instructor will design the assessment criteria for the said assessment components.
- The assessment components will be made known to the students by the respective Course Coordinators prior to the commencement of the Laboratory Work.

In all the cases, the assessments will be done based on the criteria designed by the Course Coordinator.



SEE QUESTION PAPER PATTERN:

1. All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
2. SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
3. General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
4. Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE WEB LINKS AND VIDEO LECTURES (E – RESOURCES):

1. https://onlinecourses.nptel.ac.in/noc21_ee32/preview
2. <https://youtu.be/t0mCp-RzxVU>



ANIMATION LAB

(Effective from the Academic Year 2023 - 2024)

IV SEMESTER

Course Code	ME42297MD	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	20P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Basic Knowledge of Mathematics and Embedded Systems.

COURSE OBJECTIVES:

- To skill the students in the Animation concepts.
- To make the students to design and animate the given process.
- To make students simulate the real-time technical environments of the various aspects of industries.
- To design and develop the virtual robotic environment.
- To design and develop the short movies using animation skills.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Sl. No.	Description
1	Introduction to Animation basics and knowledge on animation softwares such as MAYA, ANIMAKER, BLENDER, ADOBE CHARACTER ANIMATOR
2	Interface, Graphics, navigating in 3D space, and working with basic objects.
3	Animation Tools: Insert Edge, Extrude, and Append
4	Animation Tools: Bevel & Normals, Booleans, Knob Motion Path, Front, Merge Vertices, Topology
5	Animation Tools: Knob Motion Path-Front and back
6	Animation Tools: Merge Vertices, Topology, Constraints
7	Animation of Squirrels rig for performing a bouncy jump.
8	Character Animation -advanced animation shot using a mechanical robot arm
9	Character Animation -advanced animation shot using a mechanical robot end effector
10	Character Animation - Bouncing Ball, Graph Editor, Finishing Generic Ball Bounce
11	Character Animation -Squash and Stretch, Animation Scene Setup, Follow Through Polish
12	Character Animation -Walk cycle, walk cycle body, Walk Cycle Polish, Walk Cycle off the spot.



COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	To skill the students in the Animation concepts.	CL4
CO2	To make the students to design and animate the given process.	CL4
CO3	To make students simulate the real-time technical environments of the various aspects of industries.	CL4
CO4	To design and develop the virtual robotic environment.	CL4
CO5	To design and develop the short movies using animation skills.	CL4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	3		2							1			
CO2	3	2	3		2							1			
CO3	3	2	3		2							1			
CO4	3	2	3		2							1			
CO5	3	2	3		2							1			

3: Substantial (High)

2: Moderate (Medium)

1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT STRATEGY:

- I. In Laboratory Courses where (B) and (C) are not the components of the assessment pattern, then (A) will have 100% weightage (50 Marks).

Assessment Mode: Weekly Assessment of Laboratory Work (50 Marks) - the marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment, each of 25 marks) of the students in each laboratory session. The average of all the marks obtained across the sessions will be the Final CIA marks.

- II. In Laboratory Courses where (C) is not a component of the assessment pattern, then (A) will have 50% weightage (25 Marks), and (B) will have 50% weightage (25 Marks).

Assessment Mode: The marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment) (A) and One Laboratory Test (B).

- In Weekly Assessment, the student will be evaluated in each laboratory session for 25 marks. The average marks obtained across all the experiments will be the marks obtained for (A).
- A Laboratory Test, similar to the SEE exam is conducted towards the end of the Semester/Course, whichever is earlier. The obtained marks are scaled down to 25 Marks (B)

The Sum of marks obtained across (A) and (B) will be the Final CIA marks.

- III. In Laboratory Courses where (C) is a component of the assessment pattern, then assessment will be done by



considering the weightages given above, i.e. (A) – 25 Marks (Weekly Assessment), (B) – 15 Marks (Laboratory Examination), (C) – 10 marks (Open Ended Experiments/Mini Projects)

- The respective course instructor will design the assessment criteria for the said assessment components.
- The assessment components will be made known to the students by the respective Course Coordinators prior to the commencement of the Laboratory Work.

In all the cases, the assessments will be done based on the criteria designed by the Course Coordinator.

SEE QUESTION PAPER PATTERN:

1. All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
2. SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
3. General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
4. Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE WEB LINKS AND VIDEO LECTURES (E – RESOURCES):

1. <https://www.youtube.com/watch?v=CBJp82tlR3M>
2. <https://www.youtube.com/watch?v=nIoXOplUvAw>
3. <https://www.youtube.com/watch?v=v3NrfXaJW6c>



BIOLOGY FOR ENGINEERS

(Effective from the Academic Year 2023 - 2024)

IV SEMESTER

Course Code	BS422T8X	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	2:0:0:0	SEE Marks	50
Total Hours of Pedagogy	30L	Exam Hours	03

CREDITS – 2

COURSE PREREQUISITES:

- Basic Concepts of Biology

COURSE OBJECTIVES:

- Implementation of new technology in medical Science.
- Use modern technical skills to bring out innovations in medical field.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Basic Cell Biology- Introduction to Biology, Cell-The unit of life, Cell Theory, Cell structure and Function- Plant cell and Animal cell.

Human Organ System-Brain as a CPU system - architecture, CNS and Peripheral Nervous System, signal transmission, EEG, Heart as the pump system- Double circulation of human heart, ECG.

6 Hours

MODULE - II

Common Diseases and Vaccination - Allergies, Colds and Flu - causes and precautions. First vaccine in the world, Vaccine for Rabies and RNA vaccines for COVID. Heart disease and its types. Modern technologies to detect heart diseases. Engineering solutions for Parkinson's disease. DNA fingerprinting.

6 Hours

MODULE - III

Biosensors: Various components of biosensors, Transducers in Biosensors: Various types of transducers; principles and applications, applications of biosensors.

Telemedicine: Block diagram of telemedicine system, origin and development of Telemedicine, Benefits and limitations of Telemedicine.

6 Hours

MODULE - IV

Biomechanics of Joints: Skeletal Joints, Skeletal Muscles, Joint Function, forces and stresses in human joints, Mechanics of the Elbow, Shoulder, Spinal Column, Hip, Knee and Ankle, Applications of prosthetics.

Bio-fluid Mechanics: Circulatory System in the Human Body, Modeling of Flow in Blood Vessels, Blood Flow Theory.

Biomaterials: Definition and classification of biomaterials, biocompatibility and biodegradability,

6 Hours



Biomedical Implants.														
MODULE - V														
Artificial intelligence for Medical Application:Introduction to Artificial intelligence and machine learning in medical Science. Application of AI in Imaging and Computer-aided Diagnosis, Neuroscience and drug discovery, Genetic algorithms.													6 Hours	
COURSE OUTCOMES														
Upon completion of this course, the students will be able to:														
CO No.	Course Outcome Description												Bloom's Taxonomy Level	
CO1	Interpret the basics of cell biology and brain functions.												CL2	
CO2	Understand effect of common diseases, types of vaccination and general forensics.												CL2	
CO3	Summarize the application of biosensors and telemedicine in medical science.												CL2	
CO4	Visualize biomechanical joints, biofluid mechanics and bio materials in medical science.												CL2	
CO5	Contrast innovative methods of information technology in computer aided medical diagnosis.												CL2	
CO-PO-PSO MAPPING														
CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	1	1			1			1	1		1		
CO2	1	1	1			2			1	1		1		
CO3	1	2	2			1			1	1		1		
CO4	1	2	2			2			1	1		1		
CO5	1	2	2			1			1	1		1		
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)				
ASSESSMENT STRATEGY														
Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:														
Sl. No.	Assessment Description					Weightage (%)				Max. Marks				
1	Continuous Internal Assessment (CIA)					100 %				50				
	Continuous Internal Evaluation (CIE)					60 %				30				
	Assignments					40 %				20				
2	Semester End Examination (SEE)					100 %				50				
ASSESSMENT DETAILS														
Continuous Internal Assessment (CIA) (50%)										Semester End Exam (SEE) (50%)				
Continuous Internal Evaluation (CIE) (60%)						Assignment/ Activities (40%)								
I		II		III										
Syllabus Coverage														
40%		30%		30%		100%				100%				
MI						MI				MI				
MII		MII				MII				MII				
		MIII				MIII				MIII				
				MIV		MIV				MIV				
				MV		MV				MV				
Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the														



assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Case Studies	25 %	05
3	Seminar/Presentation	25 %	05
4	Peer - to - Peer Learning	25 %	05

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

1. The question paper will have TEN full questions.
2. Each full question consists of 20 marks.
3. There will be 2 full questions from all the FIVE modules.
4. Each full question will have a maximum of three sub-questions covering all the topics under a module.
5. The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. Biology for Engineers, Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M.K., Tata McGraw-Hill, New Delhi, 2012
2. Human Physiology, Stuart Fox, Krista Rompolksi, McGraw-Hill eBook. 16th Edition, 2022.
3. Brian R Eggins - Biosensors an Introduction, First edition, John Wiley & Sons Publishers, 1996.
4. R S Khandpur, "Telemedicine technology and applications", PHI Learning Pvt. Ltd, New Delhi, 2017.
5. N. Ozkaya and M. Nordin: Fundamentals of Biomechanics-Equilibrium, Motion and Deformation, Springer-Verlag, 2nd Edition, 1999.

REFERENCE BOOKS:

1. Biomaterials Science and Tissue Engineering: Principles and Methods, by Bikramjit Basu, Cambridge IISc Series.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. <https://www.youtube.com/watch?v=96-u9s6D16k>
2. https://www.youtube.com/watch?v=4_emccqgYMs
3. https://onlinecourses.nptel.ac.in/noc22_cs56/preview
4. https://onlinecourses.nptel.ac.in/noc22_cs29/preview



UHV -2: UNDERSTANDING HARMONY and ETHICAL HUMAN CONDUCT

(Effective from the Academic Year 2023 - 2024)

SEMESTER - IV

Course Code	HU42289X	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Have/Develop the critical analysis of the day today happenings.

COURSE OBJECTIVES:

This course will enable students to:

- To make the students to understand, the essential complementarity between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
- To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
- To highlight possible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.

TEACHING - LEARNING STRATEGY:

These are some sample strategies, which course faculty members can incorporate in the Teaching Learning Process:

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies

COURSE CONTENTS

The course is mainly activity-based that will offer a set of activities for the student that enables them to connect with fellow human beings, nature, society, and the world at large. The course will engage students in interactive sessions, open mic, reading groups, storytelling sessions, and semester-long activities conducted by faculty mentors. In the following a set of activities planned for the course have been listed :

MODULE - I

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 fulfill the Basic Human Aspirations.

3 Hours

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MODULE - II														
Harmony in the Human Being :													3 Hours	
Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the 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.														
MODULE - III														
Harmony in the Family and Society :													3 Hours	
Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship, 'Respect' – as the Right Evaluation, Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order.														
MODULE - IV														
Harmony in the Nature/Existence:													3 Hours	
Understanding Harmony in the Nature, Inter-connectedness, 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														
MODULE - V														
Implications of the Holistic Understanding – a Look at Professional Ethics :													3 Hours	
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.														
COURSE OUTCOMES														
Upon completion of this course, the students will be able to:														
CO No.	Course Outcome Description												Bloom's Taxonomy Level	
CO1	Understand value education to develop basic human aspirations through a holistic approach												CL2	
CO2	Relate to the needs of self and body to establish co-existence leading to harmony in the human being.												CL2	
CO3	Recognize the importance of trust and respect to promote harmony in the family and society.												CL2	
CO4	Realize the existence as coexistence to establish harmony through mutual fulfillment among four orders of nature.												CL2	
CO5	Recognize the needs for a holistic understanding of human values to develop ethical and professional conduct.												CL2	
CO-PO-PSO MAPPING														
CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1								1				2		
CO2						1		1	1			2		

CO3						2		1	1			2		
CO4							2	1	1			2		
CO5							1	1				2		
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)				

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	Semester End Examination (SEE)	100 %	50

CO - ASSESSMENT MAPPING

Course Outcomes	Continuous Internal Assessment (CIA) (50%)			Semester End Exam (SEE) (50%)
	Continuous Internal Evaluation (CIE) (60%)		Assignment/ Activities (40%)	
	I	II	III	
	Syllabus Coverage			Syllabus Coverage
	40%	30%	30%	100%
CO1	MI			MI
CO2	MII	MII		MII
CO3		MIII		MIII
CO4			MIV	MIV
CO5			MV	MV

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Case Studies	25 %	05
3	Seminar/Presentation	25 %	05
4	Peer - to - Peer Learning	25 %	05

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

Theory SEE will be conducted, with common question papers for the subject (**duration 01 hours**)

- The question paper will have 50 questions. Each question is set for 01 marks.
- The students have to answer all the questions, selecting one full question from each module

TEXT BOOKS:

- a. The Textbook A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034- 47-1
- The Teacher's Manual Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G

REFERENCE BOOKS:

- Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
- Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
- The Story of Stuff (Book).



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4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Gandhi - Romain Rolland (English)

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. <https://www.aicteindia.org/sites/default/files/Vol.%20II%20%20AICTE%20UG%20%20Curriculum.>
2. https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw
3. https://fdp-si.aicte-india.org/8dayUHV_download.php
4. <https://www.youtube.com/watch?v=8ovkLRYXIjE>





FINITE ELEMENT METHOD

(Effective from the Academic Year 2023 - 2024)

SEMESTER – V

Course Code	ME522I1M	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Knowledge of Mathematics, Mechanics of Materials, Heat Transfer, Dynamics of Machines.

COURSE OBJECTIVES:

- To learn the basic principles of finite element analysis procedure
- To formulate and solve for displacement, stress and strain on bar, truss, beams and torsion of shaft using Finite Element Analysis approach.
- To Formulate and solve the problems on heat transfer and dynamic consideration using Finite Element Analysis approach.

TEACHING - LEARNING STRATEGY:

- Following are some sample strategies that can be incorporate for the Course Delivery
- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction to Finite Element Method: General steps of the finite element method. Engineering applications of finite element method. Advantages of the Finite Element Method. Potential energy method, Displacement method of finite element formulation. Convergence criteria, Discretization process. Rayleigh Ritz method.

8 Hours

Types of elements: 1D, 2D and 3D, Node numbering, Location of nodes. Strain- displacement relations, Stress-strain relations, Plain stress and Plain strain conditions.

MODULE –II

Interpolation models: Simplex, complex and multiplex elements, linear interpolation polynomials in terms of global coordinates 1D, 2D, 3D Simplex Elements.

8 Hours

Stiffness method: Introduction, Linear interpolation polynomials in terms of Global, natural and local coordinate's for 1D, 2D elements. Higher order interpolation functions for 1D quadratic and cubic elements in natural coordinates, Constant strain triangle, Four-Noded Tetrahedral Element (TET 4), Eight-Noded Hexahedral Element (HEXA 3 8), 2D iso-parametric element.

MODULE –III

Bars: One-Dimensional Elements-Analysis of Bars and Solution for displacement, stress and strain in 1D straight bar, stepped bars and tapered bars using elimination approach and penalty approach.

8 Hours

Trusses: Analysis of trusses and Solution for displacement, stress and strain in trusses.



MODULE –IV			
Beams: Boundary conditions, Load vector, Hermite shape functions, Beam stiffness matrix based on Euler Bernoulli beam theory, Numerical problems on simply supported, fixed straight and cantilever beams, cantilever beams with concentrated and uniformly distributed load.			8 Hours
Shafts: Analysis of shafts, determination of shear stresses and twists in circular shafts.			
MODULE –V			
Heat Transfer: Basic equations of heat transfer: Energy balance equation, Rate equation: conduction, convection, radiation, 1D finite element formulation using variational method, Problems with temperature gradient and heat fluxes, heat transfer in composite sections, straight fins.			8 Hours
Dynamic Considerations: Formulation for point mass and distributed masses, Consistent element mass matrix of one-dimensional bar element, truss element, triangular element, beam element. Lumped mass matrix of bar element, truss element, Evaluation of eigen values and eigen vectors, Applications to bars, stepped bars, and beams.			
COURSE OUTCOMES			
Upon completion of this course, the students will be able to:			
CO No.	Course Outcome Description	Bloom's Taxonomy Level	
CO1	Analyze the concepts behind Finite element formulation.	CL4	
CO2	Analyze the interpolation models of various 1D, 2D and 3D elements.	CL4	
CO3	Analyze the finite element formulation of bars and trusses	CL4	
CO4	Analyze the finite element formulation of beams and shafts	CL4	
CO5	Analyze the finite element formulation of heat transfer and dynamic consideration.	CL4	
LABORATORY COMPONENTS			
Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	Stress analysis of a rectangular plate with a circular hole.	CO2	CL4
2.	Stress analysis of Bars with constant cross section area.	CO3	CL4
3.	Stress analysis of Bars with tapered cross section area.	CO3	CL4
4.	Stress analysis of a stepped Bar.	CO3	CL4
5.	Stress analysis of Truss.	CO3	CL4
6.	SFD and BMD of cantilever Beam with point loads.	CO4	CL4
7.	SFD and BMD of cantilever Beam with point loads and UDL.	CO4	CL4
8.	SFD and BMD of simply supported Beam with point load , UDL, and UVL	CO4	CL4
9.	Heat transfer analysis with conduction and convection boundary condition.	CO5	CL4
10.	Dynamic Analysis to find Natural frequency of beam with both ends fixed.	CO5	CL4
CO-PO-PSO MAPPING			



CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2					2	2	2		2	2		
CO2	3	2	2		2			2	2	2		2	2		
CO3	3	2	2		2			2	2	2		2	2		
CO4	3	2	2		2			2	2	2		2	2		
CO5	3	2	2		2			2	2	2		2	2	2	
3: Substantial (High)				2: Moderate (Medium)						1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	Semester End Examination (SEE)	100 %	50

CO - ASSESSMENT MAPPING

Course Outcomes	Continuous Internal Assessment (CIA) (50%)			Assignment/ Activities (40%)	Semester End Exam (SEE)(50%)
	Continuous Internal Evaluation (CIE) (60%)				
	I	II	III		
	Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
	40%	30%	30%	100%	100%
CO1	x			x	X
CO2	x			x	X
CO3		x		x	X
CO4		x	x	x	X
CO5			x	x	X

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	5
2	Quiz	25 %	5
3	Field Visits/Survey/Case Studies	50 %	10
4	Model / Prototype Development	100 %	20
5	Project Based Learning		
6	Seminar/Presentation	25 %	5
7	Peer - to -Peer Learning	25 %	5

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions.
- Each full question consisting of 20 marks.
- There will be 2 full questions from all the FIVE modules.
- Each full question will have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.



REFERENCE BOOKS:

1. Logan, D. L., A first course in the finite element method, 6th Edition, Cengage Learning, 2016.
2. Rao, S. S., Finite element method in engineering, 5th Edition, Pergaman Int. Library of Science, 2010.
3. Chandrupatla T. R., Finite Elements in engineering, 2nd Edition, PHI, 2013.
1. Logan, D. L., A first course in the finite element method, 6th Edition, Cengage Learning, 2016.
2. Rao S. S., Finite element method in engineering, 5th Edition, Pergaman Int. Library of Science, 2010.
3. Chandrupatla T. R., Finite Elements in engineering, 2nd Edition, PHI, 2013.
4. J.N.Reddy, —Finite Element Method— McGraw -Hill International Edition. Bathe K. J. Finite Elements Procedures, PHI.
5. Cook R. D., et al. —Concepts and Application of Finite Elements Analysis— 4th Edition, Wiley & Sons, 2003.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. Finite Element Method https://onlinecourses.nptel.ac.in/noc22_me43/preview
2. Basics of Finite Element Analysis-I <https://archive.nptel.ac.in/courses/112/104/112104193/>
2. Basics of Finite Element Analysis -II <https://nptel.ac.in/courses/112104205>



DYNAMICS OF MACHINES

(Effective from the Academic Year 2023 - 2024)

SEMESTER - V

Course Code	ME522I1M	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40L + 24P	Exam Hours	03

CREDITS – 4

COURSE PREREQUISITES:

- Kinematics of Machines.

COURSE OBJECTIVES:

- To understand the force-motion relationship in components subjected to external forces and analysis of standard mechanisms.
- To understand the undesirable effects of unbalances resulting from prescribed motions in mechanism.
- To understand the principles in mechanisms used for speed control and stability control.
- To compute the natural and damped frequencies of free 1-DOF mechanical systems.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Static force analysis: Static equilibrium, Equilibrium condition of a body subjected to two force, three force, two force and a couple. Analysis of four bar mechanism.

**8
Hours**

Dynamic force analysis: D-Alembert's principle, analysis of four bar and slider crank mechanism.

MODULE - II

Balancing of Rotating Masses: Static and Dynamic Balancing, Balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing of several rotating masses by balancing masses in same plane and in different planes.

**8
Hours**

Balancing of Reciprocating Masses: Inertia Effect of crank and connecting rod, Single cylinder Engine, Balancing in multi cylinder-inline engine (primary and secondary forces), V-type engine, Radial engine – direct and reverse crank method.

MODULE - III

Governors: Types of Governors; Force Analysis of Porter and Hartnell Governors. Controlling Force, Stability, Sensitiveness, Isochronism, Effort and Power.

**8
Hours**

Gyroscope: Vectorial representation of angular motion, Gyroscopic couple. Effect of gyroscopic Couple on plane disc, ship, aeroplane.

MODULE - IV

Introduction & Undamped free Vibrations (Single Degree of Freedom): Types of vibrations, Definitions, Simple Harmonic Motion (SHM), Work done by harmonic force, Principle of super position applied to SHM(Addition of SHM).

**8
Hours**





Methods of analysis: Newton's, Energy & Rayleigh's methods, Torsional and transverse vibrations, Springs in series and parallel, Effect of mass of spring, Natural frequencies of simple systems.			
MODULE - V			
Damped free Vibrations (Single Degree of Freedom): Types of damping, Analysis with viscous damping - Derivations for over, critical and under damped systems, Logarithmic decrement and numerical problems. Forced vibrations: Damped forced vibration of spring mass system, Magnification factor (M.F.), Vibration isolation - Transmissibility ratio, Numerical problems. Critical speed.			8 Hours
COURSE OUTCOMES			
Upon completion of this course, the students will be able to:			
CO No.	Course Outcome Description	Bloom's Taxonomy Level	
CO1	Analyze the forces and couples for Static and dynamic conditions for four bar and slider crank mechanism.	CL4	
CO2	Examine Static and dynamic balancing of forces of rotating and reciprocating masses.	CL4	
CO3	Inspect the forces, sensitivity, effort and power of Porter and Hartnel governor and examine the gyroscopic effect on Ship and Aeroplane.	CL4	
CO4	Analyze the natural frequency of single degree of freedom Undamped free vibrations.	CL4	
CO5	Categorize and examine system with damped and forced Vibrating conditions.	CL4	
LABORATORY COMPONENTS			
Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	Virtual Lab on Position analysis of Grashof and Non Grashof four bar Mechanism.	CO1	CL4
2.	Virtual Lab on Position and Velocity analysis of Slider Crank Mechanism.	CO1	CL4
3.	Balancing of rotating masses.	CO2	CL4
4.	Determination of equilibrium speed, sensitiveness, power and effort of Porter governor.	CO3	CL4
5.	Demonstration on the working of Gyroscope.	CO3	CL4
6.	Determination of natural frequency in a undamped single degree of freedom vibrating systems (longitudinal).	CO4	CL4
7.	Determination of natural frequency in a undamped single degree of freedom vibrating systems (Torsional).	CO4	CL4
8.	Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (longitudinal).	CO5	CL4
9.	Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (Torsional).	CO5	CL4
10.	Determination of critical speed of a rotating shaft.	CO5	CL4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	3						2	2		2	3		
CO2	3	3	3	1					2	2		2	3		
CO3	3	3	3	1					2	2		2	3		
CO4	3	3	3	1								2	3		
CO5	3	3	3	1								2	3		
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Practical Session (Laboratory Component)	40 %	20
2	Semester End Examination (SEE)	100 %	50

CO - ASSESSMENT MAPPING

Course Outcomes	Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
	Continuous Internal Evaluation (CIE) (60%)			Practical Sessions (40%)	
	I	II	III		
	Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
	40%	30%	30%	100%	100%
CO1	x			x	x
CO2	x	x		x	x
CO3		x		x	x
CO4			x	x	x
CO5			x	x	x

NOTE

- Assessment will be both CIA and SEE.
- The practical sessions of the IPCC shall be for CIE only.
- The Theory component of the IPCC shall be for both CIA and SEE respectively.
- The questions from the practical sessions shall be included in Theory SEE.

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.



SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer **FIVE** full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Theory of Machines by S S Rattan.
2. Mechanisms and Machines-Kinematics, Dynamics and Synthesis by Michael M Stanisic.
3. Dynamics of Machines by J B K Das.
4. Theory of Machines: Kinematics and Dynamics by Sadhu Singh.
5. Mechanism and Machine Theory by G. Ambekar.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. <https://www.youtube.com/watch?v=-ZR73-49RsY> – NPTEL video on Undamped free Vibration
2. <https://www.youtube.com/watch?v=R7pF2WC4hXQ> – Free and Forced Vibration Analysis.



ADVANCED MANUFACTURING TECHNOLOGY

(Effective from the Academic Year 2023 - 2024)

V SEMESTER

Course Code	ME522T3M	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fundamentals of Material Science, metal forming

COURSE OBJECTIVES:

- To learn various concepts related to modern machining processes & their applications.
- To appreciate the differences between conventional and non-conventional machining processes.
- To acquire a functional understanding of non-traditional manufacturing equipment.
- To know about various process parameters and their influence on performance and their applications.
- To impart knowledge on various types of energy involved in non-traditional machining processes.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction to Non-traditional machining: Need for Non-traditional machining process, Comparison between traditional and non-traditional machining, general classification Non-traditional machining processes, classification based on nature of energy employed in machining, selection of non-traditional machining processes, Specific advantages, limitations and applications of non-traditional machining processes

8 Hours

MODULE - II

Ultrasonic Machining (USM): Introduction, Equipment and material process, Effect of process parameters: Effect of amplitude and frequency, Effect of abrasive grain diameter, effect of slurry, tool & work material. Process characteristics: Material removal rate, tool wear, accuracy, surface finish, applications, advantages & limitations of USM.

8 Hours

Abrasive Jet Machining (AJM): Introduction, Equipment and process of material removal, process variables: carrier gas, type of abrasive, work material, stand-off distance (SOD). Process characteristics-Material removal rate, Nozzle wear, accuracy & surface finish. Applications, advantages & limitations of AJM

MODULE - III

ELECTROCHEMICAL MACHINING (ECM): Introduction, Principle of electro chemical machining, ECM equipment, elements of ECM operation, Chemistry of ECM. ECM Process characteristics: Material removal rate, accuracy, surface finish. Process parameters: Current density, Tool feed rate, Gap between tool & work piece, velocity of electrolyte flow, type of electrolyte, its concentration temperature, and choice of electrolytes. ECM Tooling: ECM tooling technique & example, Tool & insulation materials. Applications ECM: Electrochemical grinding and electrochemical honing process. Advantages, disadvantages and application of ECM, ECH.

8 Hours

CHEMICAL MACHINING (CHM): Elements of the process, Resists (maskants), Etchants. Types of chemical



machining process-chemical blanking process, chemical milling process. Process characteristics of CHM: material removal rate, accuracy, surface finish, advantages, limitations and applications of chemical machining process	
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MODULE - IV

ELECTRICAL DISCHARGE MACHINING (EDM): Introduction, mechanism of metal removal, EDM equipment: spark erosion generator (relaxation type), dielectric medium-its functions & desirable properties, electrode feed control system. Flushing types; pressure flushing, suction flushing, side flushing, pulsed flushing. EDM process parameters: Spark frequency, current & spark gap, surface finish, Heat Affected Zone. Advantages, limitations & applications of EDM, Electrical discharge grinding, Traveling wire EDM. PLASMA ARC MACHINING (PAM): Introduction, non-thermal generation of plasma, equipment mechanism of metal removal, Plasma torch, process parameters, process characteristics. Safety precautions. Safety precautions, applications, advantages and limitations	8 Hours
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MODULE - V

LASER BEAM MACHINING (LBM): Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM parameters and characteristics, Applications, Advantages & limitations. ELECTRON BEAM MACHINING (EBM): Introduction, Principle, equipment and mechanism of metal removal, applications, advantages and limitations	8 Hours
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COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Understand the compare traditional and non-traditional machining process and recognize the need for non-traditional machining process.	CL3
CO2	Understand the constructional features, performance parameters, process characteristics, applications, advantages and limitations of USM, AJM and WJM	CL3
CO3	Identify the need of Chemical and electro-chemical machining process along with the constructional features, process parameters, process characteristics, applications, advantages and limitations	CL3
CO4	Understand the constructional feature of the equipment, process parameters, process characteristics, applications, advantages and limitations EDM & PAM	CL3
CO5	Understand the LBM equipment, LBM parameters, and characteristics. EBM equipment and mechanism of metal removal, applications, advantages and limitations LBM & EBM	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	2				2				2		2	
CO2	3	3	2					2				2		2	
CO3	3	3	3					2				2		2	
CO4	3	3	3					2				2		2	
CO5	3	3	3					2				2		2	
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50



	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)			Semester End Exam (SEE) (50%)	
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII		MIII	MIII
		MIV	MIV	MIV
		MV	MV	MV

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. New Technology Dr. Amitabha Bhattacharyya The Institute of Engineers (India) 2000
2. Modern Machining process Aditya 2002
3. Modern Machining Process by P.C Pandey and H S Shah McGraw Hill Education India Pvt. Ltd 2000
4. Production technology HMT McGraw Hill Education India Pvt. Ltd 2001



TURBO MACHINES

(Effective from the Academic Year 2023 - 2024)

V SEMESTER

Course Code	ME522T4M	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fundamental knowledge of Trigonometry and Fluid Mechanics.

COURSE OBJECTIVES:

- Understand typical design of Turbo machine, their working principle, application and thermodynamics process involved.
- Study the conversion of fluid energy to mechanical energy in Turbo machine with utilization factor and degree of reaction.
- Analyse various designs of steam turbine and their working principle.
- Study the various designs of hydraulic turbine based on the working principle.
- Understand the various aspects in design of power absorbing machine.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction: Definition of turbo machine, parts of turbo machines, Comparison with positive displacement machines, Classification, Dimensionless parameters and their significance, Unit and specific quantities, model studies and its numerical. (Note: Since dimensional analysis is covered in Fluid Mechanics subject, questions on dimensional analysis may not be given. However, dimensional parameters and model studies may be given more weightage.)

Thermodynamics of fluid flow: Application of first and second law of thermodynamics to turbo machines, Efficiencies of turbo machines, Static and Stagnation states, overall isentropic efficiency, stage efficiency (their comparison) and polytropic efficiency for both compression and expansion processes. Reheat factor for expansion process. Simple Numerical on-stage efficiency and polytropic efficiency.

8 Hours

MODULE - II

Energy exchange in Turbo machines: Euler's turbine equation, Alternate form of Euler's turbine equation, Velocity triangles for different values of degree of reaction, Components of energy transfer, Degree of Reaction, utilization factor, Relation between degree of reaction and Utilization factor, Problems.

General Analysis of Turbo machines: Radial flow compressors and pumps – general analysis, Expression for degree of reaction, velocity triangles, Effect of blade discharge angle on energy transfer and degree of reaction, Effect of blade discharge angle on performance, General analysis of axial flow pumps and compressors, degree of reaction, velocity triangles, Numerical Problems.

8 Hours



MODULE - III															
Steam Turbines: Classification, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need and methods of compounding, Multi-stage impulse turbine, expression for maximum utilization factor, Numerical Problems.														8 Hours	
Reaction turbine – Parsons’s turbine, condition for maximum utilization factor, reaction staging. Numerical Problems															
MODULE - IV															
Hydraulic Turbines: Classification, various efficiencies.														8 Hours	
Pelton Wheel – Principle of working, velocity triangles, design parameters, maximum efficiency, and numerical problems.															
Francis Turbine – Principle of working, velocity triangles, design parameters, and numerical problems.															
Kaplan and Propeller Turbines - Principle of working, velocity triangles, design parameters and Numerical Problems. Theory and types of Draft tubes.															
MODULE - V															
Centrifugal Pumps: Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, Theoretical head – capacity relationship, Minimum speed for starting the flow, Maximum suction lift, Net positive suction head, Cavitation, Need for priming, Pumps in series and parallel. Problems.														8 Hours	
Centrifugal Compressors: Stage velocity triangles, slip factor, power input factor, Stage work, Pressure developed, stage efficiency and surging and problems.															
COURSE OUTCOMES															
Upon completion of this course, the students will be able to:															
CO No.	Course Outcome Description												Bloom’s Taxonomy Level		
CO1	Analyze various problems on specific speed, unit quantities and similitudes with respect to turbo machines and applications of thermodynamics in fluid flow.												CL4		
CO2	Analyse velocity triangles for different degrees of Reaction under turbines, compressors and pumps.												CL4		
CO3	Analyse single stage, multi stage impulse steam turbine and Parson’s reaction turbine.												CL4		
CO4	Draw velocity triangles and design parameters for Pelton turbine, Francis turbine and Kaplan turbine.												CL4		
CO5	Draw velocity triangle and analyze centrifugal and axial flow compressors and centrifugal pumps.												CL4		
CO-PO-PSO MAPPING															
CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	3	2				1				1			3
CO2	3	3	3	2	1			1				1			3
CO3	3	3	3	2	1		1	1				1			3
CO4	3	3	3	2	1	1	1	1				1			3
CO5	3	3	3	2	1	1		1				1			3
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					



ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII		MIII	MIII
		MIV	MIV	MIV
		MV	MV	MV

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer **FIVE** full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. An Introduction to Energy Conversion, Volume III, Turbo machinery, V. Kadambi and Manohar Prasad, New Age International Publishers, reprint 2008.
2. Turbo Machines, B. U. Pai, Wiley India Pvt, Ltd, 1st Edition.
3. Turbo machines, M. S. Govindgowda and A. M. Nagaraj, M. M. Publications, 7th Ed, 2012.



4. Fundamentals of Turbo Machinery, B.K Venkanna, PHI Publishers.
5. Turbines, Compressors & Fans, S. M. Yahya, Tata McGraw Hill Co. Ltd, 2nd edition, 2002.
6. Principals of Turbo machines, D. G. Shepherd, The Macmillan Company, 1964.
7. Fluid Mechanics & Thermodynamics of Turbo machines, S. L. Dixon, Elsevier, 2005.



FLUID MECHANICS AND MACHINERY LAB

(Effective from the Academic Year 2023 - 2024)

V SEMESTER

Course Code	ME522L5M	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	20P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Basic Knowledge of Fluid Mechanics and Machines

COURSE OBJECTIVES:

- To skill the students in the flow measurements using various types of flow measuring devices, calibration and losses associated with these devices.
- To skill the students to understand the energy conversion in hydraulic turbines and pumps.
- To enable the students to conduct the performance analysis of hydraulic machines.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Sl.No.	Description
1	To determine the coefficient of Friction in pipes (major losses)
2	To determine the coefficient of Friction in pipe fittings (minor losses)
3	To determine the Coefficient of discharge of Orifice meter
4	To determine the Coefficient of discharge of Venturimeter
5	To determine the Coefficient of discharge of Flow nozzle
6	To determine the Coefficient of discharge of Notches apparatus
7	To determine the Impact of jet on vane apparatus
8	To determine the performance characteristics of Pelton turbine
9	To determine the performance characteristics of Kaplan turbine
10	To determine the performance characteristics of Francis turbine
11	To determine the performance characteristics of Multistage centrifugal pump
12	To determine the performance characteristics of Single stage centrifugal pump
13	To determine the performance characteristics of Reciprocating pump
14	To determine the performance characteristics of Reciprocating air compressor
15	To determine the performance characteristics of Centrifugal air blower test rig

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Investigate applications of the Bernoulli's equation and momentum equations experimentally.	CL3
CO2	Investigate the various losses of fluid flow through the pipes and fittings.	CL3
CO3	Experimentally determine performance parameters on Hydraulic Turbines.	CL3
CO4	Perform experiments on Hydraulic Pumps and draw characteristic curve	CL3
CO5	Determine the performance parameters on Compressor and Blower through experimentally.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	3		2							1			2
CO2	3	2	3		2							1			2
CO3	3	2	3		2							1			2
CO4	3	2	3		2							1			2
CO5	3	2	3		2							1			2
3: Substantial (High)				2: Moderate (Medium)						1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT STRATEGY:

- I. In Laboratory Courses where (B) and (C) are not the components of the assessment pattern, then (A) will have 100% weightage (50 Marks).

Assessment Mode: Weekly Assessment of Laboratory Work (50 Marks) - the marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment, each of 25 marks) of the students in each laboratory session. The average of all the marks obtained across the sessions will be the Final CIA marks.

- II. In Laboratory Courses where (C) is not a component of the assessment pattern, then (A) will have 50% weightage (25 Marks), and (B) will have 50% weightage (25 Marks).

Assessment Mode: The marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment) (A) and One Laboratory Test (B).

- In Weekly Assessment, the student will be evaluated in each laboratory session for 25 marks. The average marks obtained across all the experiments will be the marks obtained for (A).
- A Laboratory Test, similar to the SEE exam is conducted towards the end of the Semester/Course, whichever is earlier. The obtained marks are scaled down to 25 Marks (B)

The Sum of marks obtained across (A) and (B) will be the Final CIA marks.

- III. In Laboratory Courses where (C) is a component of the assessment pattern, then assessment will be done by considering the weightages given above, i.e. (A) – 25 Marks (Weekly Assessment), (B) – 15 Marks (Laboratory Examination), (C) – 10 marks (Open Ended Experiments/Mini Projects)



- The respective course instructor will design the assessment criteria for the said assessment components.
- The assessment components will be made known to the students by the respective Course Coordinators prior to the commencement of the Laboratory Work.

In all the cases, the assessments will be done based on the criteria designed by the Course Coordinator.

SEE QUESTION PAPER PATTERN:

1. All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
2. SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
3. General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
4. Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE WEB LINKS AND VIDEO LECTURES (E – RESOURCES):

1. <https://archive.nptel.ac.in/courses/112/103/112103249/>
2. <https://archive.nptel.ac.in/courses/112/104/112104118/>



SMART MATERIALS

(Effective from the Academic Year 2023 - 2024)

V SEMESTER

Course Code	ME52216MA	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Materials Science

COURSE OBJECTIVES:

- To describe the methods of controlling vibration using smart systems.
- To explain the working principle and concepts of shape memory alloys, smart materials, structures, fibre optics, ER & MR fluids.
- To analyse the applications and properties of smart structures and select the suitable procedure for fabrication.
- To Summarize the methods and uses of Micro fabrications, Fibre optics, piezoelectric sensing and actuation.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction: Closed loop and Open loop Smart Structures. Applications of Smart structures, Piezoelectric properties. Inchworm Linear motor, Shape memory alloys, Shape memory effect-Application, Processing and characteristics.	8 Hours
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MODULE - II

Shape Memory Alloys: Introduction, Phenomenology, Influence of stress on characteristic temperatures, Modelling of shape memory effect. Vibration control through shape memory alloys. Design considerations, multiplexing embedded NiTiNOL actuators.	8 Hours
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MODULE - III

Electro rheological (ER) and Magneto rheological (MR) Fluids: Mechanisms and Properties, Characteristics, Fluid composition and behavior, Discovery and Early developments, Summary of material properties. Applications of ER and MR fluids (Clutches, Dampers, others).	8 Hours
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MODULE - IV

Fiber Optics: Introduction, Physical Phenomenon, Characteristics, Fiber optic strain sensors, Twisted and Braided Fiber Optic sensors, Optical fibers as load bearing elements, Crack detection applications, Integration of Fiber optic sensors and shape memory elements.	8 Hours
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MODULE - V

Vibration Absorbers: Introduction, Parallel Damped Vibration Absorber, Analysis, Gyroscopic Vibration absorbers, analysis & experimental set up and observations, Active Vibration absorbers. Control of Structures: Introduction, Structures as control plants, Modelling structures for control, Control strategies and Limitations.	8 Hours
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COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Describe the methods of controlling vibration using smart systems.	CL2
CO2	Explain the working principle and concepts of shape memory alloys, smart materials, structures, fibre optics, ER & MR fluids.	CL2
CO3	Analyse the applications and properties of smart structures and select the suitable procedure for fabrication.	CL2
CO4	Summarize the methods and uses of Micro fabrications, Fibre optics, piezoelectric sensing and actuation.	CL2

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	1				2				2			
CO2	3	3	2					2				2			
CO3	3	3	3					2				2			
CO4	3	3	3					2				2			
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)	
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)		
I	II	III			
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage	
40%	30%	30%	100%	100%	
MI			MI	MI	
MII	MII		MII	MII	
	MIII		MIII	MIII	
		MIV	MIV	MIV	
		MV	MV	MV	

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02



3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. “Smart Structures –Analysis and Design”, A.V.Srinivasan, Cambridge University Press, New York, 2001, (ISBN:0521650267).
2. “Smart Materials and Structures”, M.V.Gandhi and B.S.Thompson Chapman & Hall, London, 1992 (ISBN:0412370107)
3. Brian Culshaw, Smart Structures and Materials, Artech House, 2000
4. Gauenzi, P., Smart Structures, Wiley, 2009
5. Cady, W. G., Piezoelectricity, Dover Publication

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. <https://www.youtube.com/watch?v=GAKwYtDbn6M&t=1s>
2. <https://www.youtube.com/watch?v=yXHIIowQntk>



TECHNOLOGIES FOR CLEAN ENERGY
(Effective from the Academic Year 2023 - 2024)
V SEMESTER

Course Code	ME52216MB	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Elements of Mechanical Engineering
- Thermodynamics
- Heat transfer

COURSE OBJECTIVES:

- Learn about the solar energy and its conversion methods.
- Study the principles of wind, biomass and ocean energy conversion systems.
- Study the principles of energy harnessing in the hydroelectric power generation.
- Become knowledgeable about nuclear reactions, energy conversion techniques, nuclear risks, and disposal.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Solar Energy: Introduction, Solar radiation at the earth's surface, beam, diffuse and global radiation. Measurement of Solar Radiation: Schematic diagrams and principle of working of Pyrometer, Pyrheliometer, sunshine recorder. Solar Thermal Conversion: Liquid flat plate collectors, concentrating collectors (cylindrical, parabolic, paraboloid), sensible heat storage, latent heat storage. Application of Solar Energy: Water heating. Space heating and cooling, active and passive systems, distillation, solar pond. Photovoltaic Conversion: Description, principle of working and characteristics, applications.	8 Hours
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MODULE - II

Wind Energy: Availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power. Wind machines: Types of wind machines, horizontal and vertical axis wind mills, coefficient of performance of a wind mill rotor, aerodynamic considerations of wind mill design.	8 Hours
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Biomass Energy: Photosynthesis, photosynthetic oxygen production, energy plantation. Bio Chemical Route: Biogas production from organic wastes by anaerobic fermentation, Bio gas plants-KVIC, Janta, Deenbhandu models, factors affecting bio gas generation. Thermal gasification of biomass, updraft and downdraft.															
MODULE - III															
Tidal Power: Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, harnessing tidal energy, limitations. Ocean Thermal Energy Conversion: Principle of working, Rankine cycle, OTEC power stations in the world, problems associated with OTEC. Geothermal Energy Conversion: Principle of working, types of geothermal station with schematic diagram, geothermal plants in the world, problems associated with geothermal conversion, scope of geothermal energy.													8 Hours		
MODULE - IV															
Hydroelectric Plants: Advantages & disadvantages of water power, detailed classification of hydroelectric plants, General layout of hydel power plants - components such as Penstock, surge tanks, spillway and draft tube and their applications, pumped storage plants, storage and pondage, water hammer. Hydrographs and flow duration curves. Numericals.													8 Hours		
MODULE - V															
Energy Conservation: Methods of energy conservation and energy efficiency for buildings, air conditioning, heat recovery and thermal energy storage systems. Energy Management: Principles of Energy Management, Energy demand estimation, Organizing and Managing Energy Management Programs, Energy pricing.													8 Hours		
COURSE OUTCOMES															
Upon completion of this course, the students will be able to:															
CO No.	Course Outcome Description												Bloom's Taxonomy Level		
CO1	Understand the measurement of radiation flux, principles of solar-thermal and photovoltaic energy conversion.												CL2		
CO2	Categorizing the methods of energy harnessing from Wind and Biomass.												CL2		
CO3	Understand the principles of energy conversion from Ocean and Geothermal sources.												CL2		
CO4	Explaining the components and principles involved in Hydroelectric power generation.												CL2		
CO5	Classifying the methods of energy conservation and energy management.												CL2		
CO-PO-PSO MAPPING															
CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	1			1	1	1				1			3
CO2	3	3	1			1	1	1				1			3
CO3	3	3	1			1	1	1				1			3
CO4	3	3	2			1	1	1				1			3
CO5	3	3	1			1	1	1				1			3
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					



ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)			Semester End Exam (SEE) (50%)	
Continuous Internal Evaluation (CIE) (60%)		Assignment/ Activities (40%)		
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII		MIII	MIII
		MIV	MIV	MIV
		MV	MV	MV

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.



- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Solar Energy, by Subhas P Sukhatme – Tata McGraw Hill, 2nd Edition, 1996.
2. Non-Conventional Energy Sources by G.D Rai K, Khanna Publishers, 2003.
3. Power Plant Engineering P. K. Nag Tata McGraw Hill, Education Private, Limited, New Delhi, Third Edition, 2012.
4. Power Plant Engineering, Arora and Domkundwar, Dhanpat Rai & Co. (P) Ltd. Sixth Edition, 2012.
5. Non-conventional energy resources, B H Khan McGraw Hill Education 3rd Edition.
6. Power Plant Engineering, R. K. Rajput, Laxmi publication, New Delhi, 5th Edition. 2016.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. https://onlinecourses.nptel.ac.in/noc22_ch27/preview
2. https://onlinecourses.nptel.ac.in/noc21_ge04/preview



INDUSTRIAL ROBOTICS

(Effective from the Academic Year 2023 - 2024)

V SEMESTER

Course Code	ME52216MC	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fundamental knowledge of automation systems.

COURSE OBJECTIVES:

- To introduce the fundamentals of robotics and its components.
- To provide knowledge about the sensors and actuators used in robotics
- To discuss different industrial applications of robots.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction: History, basic concepts of robotics such as definition, three laws, anatomy of a robotic manipulator, classification of robots, robot configurations, degrees of freedom, workspace of manipulators, characteristics of robots, specifications of robots, four Ds of robotics, economic analysis.

8 Hours

End Effectors: Mechanical grippers, magnetic grippers, vacuum grippers, adhesive grippers, active and passive grippers, special tools as end effectors, selection and design considerations of grippers in robot.

MODULE - II

Sensors and Actuators: Sensor classification - Proprioceptive and Exteroceptive sensors, active and passive sensors, characteristics of sensors, Internal sensors - linear and rotary position sensors, velocity sensors, acceleration sensors, External sensors - force, touch, range, proximity, vision, optic, selection of sensors.

8 Hours

Actuators for Robots: Classification - Electric, Hydraulic, Pneumatic actuators, their advantages and disadvantages; Electric actuators- Stepper motors, DC motors, DC servo motors and their drivers, AC motors, selection of motors; Hydraulic actuators - Components and typical circuit, advantages, and disadvantages; Pneumatic actuators - Components and typical circuit, advantages and disadvantages.

MODULE - III

Robots programming: Introduction to robot programming, methods of robot programming, WAIT, SIGNAL and DELAY commands, subroutines, Programming Languages: Generations of Robotic Languages, Introduction to various types such as VAL, RAIL, AML, Python, ROS.

8 Hours

MODULE - IV

Robots for material handling: Types of industrial robots, Load handling capacity, general considerations in Robotic material handling, material transfer, machine loading and unloading, CNC machine tool loading, Robot centred cell.

8 Hours



Robots for Inspection: Robotic vision systems, image representation, object recognition and categorization, depth measurement, image data compression, visual inspection, software considerations.	
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MODULE - V

Other Applications: Application of Robots in continuous arc welding, Spot welding, Spray painting, assembly operation, cleaning, robot for underwater applications.	8 Hours
Selection of Robots: Factors influencing the choice of a robot, robot performance testing, economics of robotization, Impact of robot on industry and society.	

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Identify the components of robots and their classification.	CL2
CO2	Describe the applications of sensors and actuators in robotics.	CL2
CO3	Explain the robot programming techniques.	CL2
CO4	Discuss the use of robots in material handling and inspection applications.	CL2
CO5	Summarize the industrial use of robots and its selection criteria.	CL2

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2					2		2		3	3		
CO2	3	3	2					2		2		3	3		
CO3	3	3	2					2		2		3	3		
CO4	3	3	2					2		2		3		3	
CO5	3	3	2					2		2		3		3	
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)	
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)		
I	II	III			
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage	
40%	30%	30%	100%	100%	
MI			MI	MI	
MII	MII		MII	MII	
	MIII		MIII	MIII	
		MIV	MIV	MIV	
		MV	MV	MV	

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the



assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer **FIVE** full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. R. K. Mittal, I. J. Nagrath, Robotics and Control, TATA McGraw Hill Publishing Co Ltd, NewDelhi (2003).
2. Mikell. P. Groover, “Industrial Robotics Technology”, Programming and Applications, McGraw Hill Co, 1995.
3. S. K. Saha, Introduction to Robotics 2e, TATA McGraw Hills Education (2014)
4. Dilip Kumar Pratihar, Fundamentals of Robotics, Narosa Publishing House, (2019).

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. <https://nptel.ac.in/courses/112105249>



OPERATIONS RESEARCH
(Effective from the Academic Year 2023 - 2024)
V SEMESTER

Course Code	ME522A6MD	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fundamentals of operations management.

COURSE OBJECTIVES:

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

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction: Evolution of OR, Definitions of OR, Scope of OR, Applications of OR, Phases in OR study. Characteristics and limitations of OR, models used in OR, Linear Programming Problem (LPP), Generalized LPP- Formulation of problems as L.P.P. Solutions to LPP by graphical method (Two Variables).	8 Hours
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MODULE - II

LPP: Simplex method, Canonical and Standard form of LP problem, slack, surplus and artificial variables, Solutions to LPP by Simplex method, Big-M Method and two-phase Simplex Method, Degeneracy in LPP. Concept of Duality, writing Dual of given LPP. Solutions to L.P.P by Dual Simplex Method.	8 Hours
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MODULE - III

Transportation Problem: Formulation of transportation problem, types, initial basic feasible solution using North-West Corner rule, Vogel's Approximation method. Optimality in Transportation problem by Modified Distribution (MODI) method. Unbalanced T.P. Maximization T.P. Degeneracy in transportation problems, application of transportation problem. Assignment Problem-Formulation, Solutions to assignment problems by Hungarian method, Special cases in assignment problems, unbalanced, Maximization assignment	8 Hours
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problems. Travelling Salesman Problem (TSP). Difference between assignment and T.S.P, Finding best route by Little's method. Numerical Problems.	
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MODULE - IV

Network analysis: Introduction, Construction of networks, Fulkerson's rule for numbering the nodes, AON and AOA diagrams; Critical path method to find the expected completion time of a project, determination of floats in networks, PERT networks, determining the probability of completing a project, predicting the completion time of project; Cost analysis in networks. Crashing of networks- Problems. Queuing Theory: Queuing systems and their characteristics, Pure-birth and Pure-death models (only equations), Kendall & Lee's notation of Queuing, empirical queuing models – Numerical on M/M/1 and M/M/C Queuing models.	8 Hours
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MODULE - V

Game Theory: Definition, Pure Strategy problems, Saddle point, Max-Min and Min-Max criteria, Principle of Dominance, Solution of games with Saddle point. Mixed Strategy problems. Solution of 2X2 games by Arithmetic method, Solution of 2Xn m and mX2 games by graphical method. Formulation of games. Sequencing: Basic assumptions, Johnson's algorithm, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. Sequencing of 2 jobs on 'm' machines using graphical method.	8 Hours
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COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Understand the meaning, definitions, scope, need, phases and techniques of operations research. Formulate linear programming problems (LPP) and derive optimal solutions using the graphical method.	CL3
CO2	Formulate and derive optimal solutions to linear programming problems by Simplex method, Big-M method, Two-phase simplex method and Dual Simplex method.	CL3
CO3	Formulate as Transportation and Assignment problems and derive optimum solutions for transportation, Assignment and travelling salesman problems.	CL3
CO4	Construct network diagrams and determine critical path, floats for deterministic and PERT networks including crashing of Networks. Solve waiting line problems for M/M/1 and M/M/K queuing models.	CL3
CO5	Determine minimum processing times for sequencing of n jobs-2 machines, n jobs-3 machines, n jobs-m machines and 2 jobs-n machines using Johnson's algorithm. Solve problems on game theory for pure and mixed strategy under competitive environment.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3



CO1	3	2	1								2		2	
CO2	3	2	1								2		2	
CO3	3	2	1								2		2	
CO4	3	2	1								2		2	
CO5	3	2	1								2		2	

3: Substantial (High)

2: Moderate (Medium)

1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII		MIII	MIII
		MIV	MIV	MIV
		MV	MV	MV

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10





10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: *The assignments mentioned above may be provided appropriately to the students belonging to different bands*

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Operations Research P K Gupta and D S Hira S. Chand and Company LTD. Publications, New Delhi 2007
2. Operations Research, An Introduction Hamdy A. Taha PHI Private Limited Seventh Edition, 2006.
3. Operations Research, Theory and Applications J K Sharma Trinity Press, Laxmi Publications Pvt.Ltd. Sixth Edition, 2016
4. Operations Research Paneerselva n PHI
5. Operations Research A M Natarajan, P Balasubram ani Pearson Education, 2005
6. Introduction to Operations Research Hillier and Lieberman McGraw Hill 8th Ed

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. <https://nptel.ac.in/courses/110106062>

RESEARCH METHODOLOGY & INTELLECTUAL PROPERTY RIGHTS

(Effective from the Academic Year 2023- 2024)

SEMESTER – V

Course Code	ME522E8X	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	1:2:0:0	SEE Marks	50
Total Hours of Pedagogy	30L	Exam Hours	03

CREDITS – 2

COURSE PREREQUISITES:

- A foundational understanding of research and knowledge of research problem formulation, familiarity with academic ethics, a basic understanding of statistics and data analysis, ability to search and evaluate academic sources, basic writing and communication skills, critical thinking skills, time management skills and awareness of ethical considerations in research.

COURSE OBJECTIVES:

- Understand the basic concepts, principles, and types of research methodologies
- Collect, analyze, and interpret data using relevant techniques.
- Ethically conduct research and adhere to academic integrity.
- Communicate research findings effectively through written and oral presentations.
- Understand the intellectual property rights and the types of IPR.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporated into the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- PowerPoint Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem-Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction to Research Methodology and Literature Review

Introduction to Research Methodology: Meaning of research, Objectives of research, Types of research, Importance of scientific research in decision making, Defining the research problem, techniques involved in defining a problem. Research Design: Meaning of research design, need for research design, Features of good design.

Literature Review: Significance of literature review, Sources for literature: Books, Journals, Proceedings, Thesis and Dissertations. Online databases: Web of Science, Google and Google Scholar. Quality research papers. Research metrics: Citation, Citation Index, Impact Factor, H-index, i10-index, Google index and their significance.

Text books: 1, 2.

**6
Hours**

MODULE - II

Data Collection, Analysis and Report Writing

Data Collection: Introduction, collection of primary data: observation method, questionnaires

6

and case study method, collection of secondary data, Selection of an appropriate method for data collection. Data Analysis: Introduction, Data analysis process, Types of data analysis, Methods of data analysis: Qualitative analysis, Quantitative analysis. Tools for data analysis. Report Writing: Effective technical writing, Steps for writing a report, structure of the research report, method of writing a research article (manuscript)/ research report, crafting effective project proposals, Paper writing for National and international journals, Submitting papers to journals (Scopus Indexed Journals, Science Citation Indexed journals), preparation of effective slides, pictures, and graphs for presentation. Text books: 1, 2.	Hours
MODULE - III	
Ethics in Research Ethics with respect to research, ethical principles, the importance of adhering to ethical norms in research, research misconducts, plagiarism, penalties for plagiarism, publication ethics, conflict of interest, publication misconduct, violation of publication ethics and authorships, identification of publication misconduct, complaints and appeals (examples) and Open Access Publishing. Text books: 3.	6 Hours
MODULE - IV	
Intellectual Property Rights, Patents and Industrial Designs: Intellectual Property Rights: Introduction to intellectual property and intellectual property rights, objectives of IPR, History of IPR in India, Role of WIPO and WTO in IPR establishments, Types of Intellectual property rights. Patents: Introduction to patent, need and importance of a patent, requirements of patent, types of patents, few famous examples of patent, patentable and non-patentable items, Duration, limitations of a patent, the Indian Patent Act-1970, Rights associated with patents, Enforcement of patent rights, Patent infringements. Case Studies on Patents: Case study of Curcuma (Turmeric) Patent, Case study of Neem Patent, Case study of Basmati patent Industrial Designs: Design introduction, Features of Design, Design law 2000, Registration of Design, Need for registration of Design, Procedure for registration of Design, Infringement of Design. Famous Case Law: Apple Inc. vs. Samsung Electronics Co. Text books: 4, 5.	6 Hours
MODULE - V	
Copyrights, Trademarks and Geographical Indications: Copyrights: Introduction to copyright, characteristics of copyright, copyright-National Vs international, Indian copyright Act-1957, Indian perspective on copyright, Term/duration of copyright, registration of copyright, copyright symbol, procedure of copyright certification, benefits of copyright registration, copyright infringement, limitations of copyright. Trademarks: Introduction to Trademark, signs which may serve as Trademarks, functions of Trademark, Essential features of Trademark, Types of Trademark, the validity of the trademark, Unfair competition, Trademark Act 1999, Infringement of Trademark, Famous case law: Coca-Cola Company vs. Bisleri International Pvt. Ltd. Geographical Indications: Introduction to G.I, History of G.I, G.I Act 1999, Registration of	6 Hours

G.I, Registration process of G.I, Duration of G.I Tag, Infringement of G.I, Some important G.I Tags. Text books: 4, 5.	
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COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Comprehend the process of research methodology to define a research problem.	CL2
CO2	Understand the analytical tools for the analysis and interpretation of data.	CL2
CO3	Understand the research ethics and adhere to ethical norms in the research process.	CL2
CO4	Illustrate the significance of Intellectual property rights and of research projects for economic growth and social benefits.	CL2
CO5	Demonstrate the copyright laws, subject matters of copyrights and Trademarks.	CL2

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	1	1			1		1	1		2			
CO2	3	2	1	1	1	1		1	1		2			
CO3	3	1	1			2		3	1	1	1	2		
CO4	3	2	2	2	1	2		3	1	1	1	2		
CO5	3	2	2	2	1	2		3	1	1	1	2		
3: Substantial (High)				2: Moderate (Medium)				1: Poor (Low)						

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignment	40 %	20
2	Semester End Examination (SEE)	100 %	50

CO - ASSESSMENT MAPPING

Continuous Internal Assessment (CIA) (50%)		Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)	Assignment (40%)	

I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII		MIII	MIII
		MIV	MIV	MIV
		MV	MV	MV

NOTE

- Assessment will be both CIA and SEE.
- The assignment of the IPCC shall be for CIE only.
- The Theory component of the IPCC shall be for both CIA and SEE respectively.

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

SEE QUESTION PAPER PATTERN:

1. The question paper will have TEN full questions from FIVE Modules
2. There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
3. Each full question may have a maximum of four sub-questions covering all the topics under a module.
4. The students will have to answer FIVE full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. David V. Thiel "Research Methods for Engineers" Cambridge University Press, 978-1-107-03488-4.
2. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
3. Acharya N K, Intellectual Property Rights, Asia Law House 6th Edition. ISBN: 978-93-81849-30-9
4. Kothari C R and Gaurav Garg, Research Methodology Methods and Techniques, Fourth Edition by, New Age International, 2019.
5. Ranjit Kumar, Research Methodology- A step by step guide for beginners, Pearson Education, Australia, 2005.
6. Pratim Ray, Partha "A Guide to Research and Publication Ethics" First edition, New Delhi Publishers c2022.
7. Deborah E Bouchoux, Intellectual Property Rights by CENGAGE Learning.
8. Rupinder Tewari and Mamta Bhardwa, Intellectual Property A Primer for Academia.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. <https://nptel.ac.in/courses/106/105/106105077/>
2. <https://youtu.be/oPXyj3mAEKg>
3. <https://youtu.be/E2gGF1rburw>
4. https://www.youtube.com/watch?v=VzIgPAd0Fs&list=RDCMUCLV4Vq_9CKVYNv4tDZhX

Assignments:

1. **Case Study:** Conduct a literature survey on a suitable research topic and prepare a report with a minimum of 10 references that adheres to standard journal specifications.
2. **Case Study:** Download 5 quality research papers published within the last five years from reputed journals on the topic of your choice and provide your analysis and perspective on the chosen topic
3. **Case Study:** Conduct a prior art search using free online databases and prepare a report.



ENVIRONMENTAL STUDIES

(Effective from the Academic Year 2023 - 2024)

V SEMESTER

Course Code	BS52289X	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	16L	Exam Hours	01

CREDITS – 1

COURSE PREREQUISITES:

- Fundamental knowledge of Ecosystems, Environment Pollution and its effects.

COURSE OBJECTIVES:

- To create environmental and sustainability awareness among the students.
- To educate the students to understand the various environmental pollutants, waste management techniques, and the legal framework governing environmental protection.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Ecosystem and Sustainability:

Structure and Function of ecosystems in Forest, Desert, Wetlands, River, Oceanic and Lakes. Sustainability: 17 SDGs- History, targets, implementation, Capacity Development.
Success stories - Best practices related to urban ecosystem conservation and sustainable innovations in Mechanical Engineering.

3 Hours

MODULE - II

Advances in Energy Systems and Sustainable Practices: Exploration of advanced energy systems: Hydrogen, Solar, OTEC, Tidal, and Wind energy. Evaluation of the merits and demerits of energy systems. Global status and applications of sustainable energy technologies. Case studies in disaster management relevant to mechanical engineering. Sustainable mining practices and their role in responsible resource extraction.
Bioenergy - Use of biomass, biogas, and biofuels in the context of renewable energy - their environmental impacts, sustainability, and applications.

3 Hours

MODULE - III

Environmental Pollution & Waste Management: Sources, Impacts and Preventive measures of Surface and Ground Water Pollutants, Soil Pollutants, Air pollutants.
Waste Management: Solid waste- sources, characteristics health hazards due to exposure & the disposal methods of municipal & Industrial waste, e-waste & biomedical waste.

4 Hours

MODULE - IV

Global Environmental Issues & Conservation

Global environmental challenges like climate change, acid rain, and ozone depletion. Radon and fluoride concentration in drinking water and their effects on public health. Environmental toxicology - causes and control measures. Sustainable agriculture practices and green technologies from Mechanical Engineering perspective.

3 Hours



Strategies for plastic pollution control and marine conservation.		
MODULE - V		
Environmental Legislation: Water Act 1974, Air Act 1981, Environmental Protection Act 1984, Solid Waste Management Rules-2016, E- Waste management Rule - 2022, Biomedical Waste management- 2016 and The Biological Diversity Act, 2002.		3 Hours
COURSE OUTCOMES		
Upon completion of this course, the students will be able to:		
CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Summarize the role of Mechanical Engineers in maintaining the ecosystem functionalities and sustainable development in the field of environmental science.	CL2
CO2	Understand the advances in energy systems and approaches relevant to natural resource management.	CL2
CO3	Illustrate the sources, impacts & control of environmental pollution and understand the process involved in solid waste management.	CL2
CO4	Extend the issues related to global environment and means for its conservation through sustainable approaches.	CL2
CO5	Categorize the environmental legislation and policies in line with waste management, environmental protection and preservation of biological diversity.	CL2
SEE QUESTION PAPER PATTERN: • The Question paper will have FIFTY multiple choice questions covering the entire five module syllabus. • Each question may have a maximum of four sub-questions and each question will be for 01 mark. • Examination will be ONLINE and students will have to answer all the questions. • The Duration of the Exam will be 01 hour.		
Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning Field work: Visit to Zero Waste Management Plant / Solid waste management plant/Biogas production plant.		



TECHNOLOGY ENTREPRENEURSHIP AND BUSINESS ECONOMICS

(Effective from the Academic Year 2023 - 2024)

VI SEMESTER

Course Code	ME622T1M	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fundamental concepts of Management, economics, costing, finance and marketing.

COURSE OBJECTIVES:

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

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Management: Introduction - Meaning - nature and characteristics of Management, Scope and Functional areas of management, Management & Administration - Roles of Management, Levels of Management, Scientific Management, Planning: Nature, importance and purpose of planning process, Organizing and Staffing: Nature and purpose of organization, Principles of organization, Nature and importance of staffing, Process of Selection & Recruitment (in brief). Directing & Controlling: Meaning and nature of directing Leadership styles, Motivational Theories- only Maslow's theory, Communication - Meaning and importance - coordination, meaning and importance and steps in controlling - Essentials of a sound control system.

8 Hours

MODULE - II

Entrepreneurship: Role of entrepreneurship in economic development; Entrepreneurial mindset, motivation and competencies; Market pull and technology push factors; New product development lifecycle; Technology readiness levels; Product-market fit validation; Commercialization pathways; Business vision & leadership; Team composition & management, Financial Institutions and Small-scale Industries, Govt. Policies for SSIs. Case studies on Indian Start-ups. Innovation in science, technology and industry: Six Sigma, 5S Techniques.

8 Hours

MODULE - III

Marketing: Market segmentation & market sizing; Customer persona & value proposition; Marketing (Go-to-market) strategy; Distribution channels and sales network; Funding requirement (based on stage); Source of funding for startup ventures.

8 Hours

Venture Creation: Sustainable business options & pathways; Business model & business canvas; Startup team & business partners; Startup ecosystem and stakeholders; Technology business incubators & parks; Proposal pitching & agreements; Startup company incorporation; Social impact & responsibility.



MODULE - IV

Introduction: Economics, Laws of demand and supply, Difference between Microeconomics & Macroeconomics, equilibrium between demand & supply, elasticity of demand, price elasticity, income elasticity. Time value of money, Interest and interest factors, simple and compound interest, Cash flow diagrams, personal loans and EMI payment calculation with flexible interest rates, Discussion and problems. Present, future and annual worth: Basic present worth comparisons, Present worth equivalence, Assets with unequal lives and infinites lives, future worth comparisons, Equivalent annual worth comparisons, Discussions and problems.

8 Hours

MODULE - V

Costing and Depreciation: Components of costs, estimation of selling price, marginal cost, first cost, types of overheads, indirect cost estimation, estimation of material cost, cost estimation of mechanical process, idling time. causes of depreciation, methods of computing depreciation charges, straight line method, declining balance method, sum of years method, sinking fund method, service output methods, taxation concepts, personal income taxes and corporate taxes, Discussions and problems.

8 Hours

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Comprehensive Understanding of Management Principles and its functions.	CL2
CO2	Develop entrepreneurial competencies by analyzing the role of entrepreneurship in economic development	CL2
CO3	Understand the importance of Marketing and Venture development	CL2
CO4	Understand the various interest rate methods and select the best alternative by using appropriate Economic Models.	CL3
CO5	Apply Cost Estimation techniques and Estimate various Depreciation values of Commodities	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1										2		2			
CO2										2		2			
CO3										2		2			
CO4	3	2										2		2	
CO5	3	2										2		2	

3: Substantial (High)

2: Moderate (Medium)

1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	Semester End Examination (SEE)	100 %	50



ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)			Semester End Exam (SEE) (50%)	
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII		MIII	MIII
		MIV	MIV	MIV
		MV	MV	MV

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer **FIVE** full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Mechanical estimation and costing T.R. Banga & S.C. Sharma Khanna Publishers 17th edition
2. Engineering Economy Riggs J.L McGraw Hill 24th edition
3. Engineering Economy Thuesen H.G PHI 22000022
4. Principles of Management Tripathy and Reddy Tata McGraw Hill 3rd edition 2006
5. Mechanical estimation T.R. Banga & S.C. Sharma Khanna Publishers 17th edition
6. Engineering Economy Riggs J.L McGraw Hill 4th edition
7. Byers, Dorf, and Nelson, Technology Ventures: From Ideas to Enterprise, McGraw Hill, 2010
8. Steve Blank, "The Startup Owner's Manual"
9. T.V. Rao, "Entrepreneurship - A South Asian Perspective."

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. https://onlinecourses.nptel.ac.in/noc22_ge03/preview



2. https://onlinecourses.nptel.ac.in/noc23_ec06/preview
3. <https://archive.nptel.ac.in/courses/110/105/110105067/>



HEAT TRANSFER

(Effective from the Academic Year 2023 - 2024)

SEMESTER - VI

Course Code	ME622I2M	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40L + 24P	Exam Hours	03

CREDITS – 4

COURSE PREREQUISITES:

- Engineering Physics

COURSE OBJECTIVES:

Student will be able to learn

- Principles of heat transfer.
- Steady and transient heat transfer, obtain the differential equation of heat conduction in various coordinate system.
- Physical mechanism of convection and visualize the development of velocity and thermal boundary layers during flow over a surface.
- Radiation heat transfer mechanism.
- The mechanisms of boiling and condensation and understand performance parameters of heat exchangers.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introductory Concepts and definition: Review of basics of Modes of Heat Transfer.

8 Hours

Conduction-Basic Equations: General form of one-dimensional heat conduction equation. Boundary conditions of first, second and third kinds.

One dimensional Steady state conduction with and without heat generation: Steady state conduction in slab, cylinder and sphere with engineering applications.

Steady state conduction: Overall heat transfer coefficient for a composite medium; thermal contact resistance; critical thickness of insulation, Discussion on engineering applications.

MODULE - II

Extended surfaces: Steady state conduction in fins of uniform cross section long fin, fin with insulated tip and fin with convection at the tip; fin efficiency & effectiveness, Discussion on engineering applications.

8 Hours

One dimensional Transient conduction: Conduction in solids with negligible internal temperature gradients (lumped system analysis) Use of transient temperature charts (Heisler's charts) for Transient conduction in slab, long cylinder and sphere; concept of semi-infinite solids, Discussion on engineering applications.

MODULE - III

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

8 Hours



Radiation Heat transfer: (Review of basic laws of thermal radiation) Intensity of radiation and solid angle; Concept of thermal radiation resistance, Radiation network, view factor, Radiation heat exchange between two parallel infinite black surfaces, between two parallel infinite gray surfaces; Effect of radiation shield; Discussion on engineering applications.			
MODULE - IV			
Concepts and Basic Relations in Boundary layers: Flow over a flat plate -Velocity boundary layer, Thermal boundary layer; Prandtl number; general expression for local heat transfer coefficient; Average heat transfer coefficient. Forced Convection: Physical significance of Dimensionless numbers. Use of various Correlations for hydro dynamically and thermally developed flows; Use of correlations for flow over a flat plate, cylinder, sphere and flow inside the duct. Free or Natural Convection: Physical significance of dimensionless numbers. Use of correlations for free convection from or to vertical, horizontal and inclined flat plates, vertical and inclined cylinder.			8 Hours
MODULE - V			
Boiling and Condensation: Film, dropwise condensation theory, Pool boiling regimes, Use of correlations for film and dropwise condensation on tubes. Heat Exchangers: Classification of heat exchangers; Overall heat transfer coefficient, Fouling, Scaling factors; LMTD and NTU methods of analysis of heat exchangers, Compact heat exchangers.			8 Hours
COURSE OUTCOMES			
Upon completion of this course, the students will be able to:			
CO No.	Course Outcome Description	Bloom's Taxonomy Level	
CO1	Describe the basic modes of heat transfer, boundary conditions and solve problems on 1D conduction equation in cartesian, cylindrical and spherical co-ordinate systems.	CL4	
CO2	Explain the concept of fins and its applications and solve problems on critical thickness of insulation, Analyze the Transient heat conduction by using Heisler and Grober charts.	CL4	
CO3	Analyse the system of steady and unsteady heat conduction in 1D & 2D co-ordinates and explain the basic concepts of radiation heat transfer.	CL4	
CO4	Analyze and Solve the problems on forced convection, velocity and thermal boundary layers, applications of navier stokes and energy equations, free convection on various geometries.	CL4	
CO5	Design various types of heat exchangers, boiling & condensation equipment's.	CL4	
LABORATORY COMPONENTS			
Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	Determination of Thermal Conductivity of a Metal Rod.	CO1	CL4
2.	Determination of Overall Heat Transfer Coefficient of a Composite wall.	CO1	CL4
3.	Experiment on Transient Conduction Heat Transfer.	CO2	CL4
4.	Determination of Effectiveness on a Metallic fin.	CO2	CL4
5.	Determination of Emissivity of a Surface and Determination of Stefan Boltzmann Constant.	CO3	CL4
6.	Determination of Heat Transfer Coefficient in free Convection.	CO4	CL4
7.	Determination of Heat Transfer Coefficient in a Forced Convention.	CO4	CL4



8.	Determination of LMDT and Effectiveness in a Parallel Flow and Counter Flow Heat Exchangers.	CO5	CL4
9.	Experiments on Boiling of Liquid and Condensation of Vapour.	CO5	CL4
10.	Use of CFD for demonstrating heat transfer mechanism considering practical applications, Minimum two exercises.	CO3	CL4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	1		1	1	1				1			3
CO2	3	3	2	1		1	1	1				1			3
CO3	3	3	2	1		1	1	1				1			3
CO4	3	3	2	1		1	1	1				1			3
CO5	3	3	2	1		1	1	1				1			3
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Practical Session (Laboratory Component)	40 %	20
2	Semester End Examination (SEE)	100 %	50

CO - ASSESSMENT MAPPING

Course Outcomes	Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
	Continuous Internal Evaluation (CIE) (60%)			Practical Sessions (40%)	
	I	II	III		
	Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
	40%	30%	30%	100%	100%
CO1	x			x	x
CO2	x	x		x	x
CO3		x		x	x
CO4			x	x	x
CO5			x	x	x

NOTE

- Assessment will be both CIA and SEE.
- The practical sessions of the IPCC shall be for CIE only.
- The Theory component of the IPCC shall be for both CIA and SEE respectively.
- The questions from the practical sessions shall be included in Theory SEE.

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.



- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Principals of heat transfer Frank Kreith, Raj M. Manglik, Mark S. Bohn Cengage learning Seventh Edition 2011.
2. Heat transfer, a practical approach Yunus A. Cengel Tata Mc Graw Hill Fifth edition
3. Heat and mass transfer Kurt C, Rolfe Cengage learning second edition.
4. Heat Transfer A Basic Approach M. Necati Ozisik McGraw Hill, New York 2005.
5. Fundamentals of Heat and Mass Transfer Incropera, F. P. and De Witt, D. P John Wiley and Sons, New York 5th Edition 2006.
6. Heat Transfer Holman, J. P. Tata McGraw Hill, New York 9th Edition 2008.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. CFD Analysis of Shell and Tube Heat Exchanger- <https://youtu.be/jwdNeW690MI>
2. NPTEL video on Conduction and Convection Heat Transfer- <https://youtu.be/IedD23t5jI4>
3. NPTEL video on Importance of Thermal Radiation- <https://youtu.be/aLwJKZ1Gf3g>
4. NPTEL video on Boiling and Condensation- <https://youtu.be/6OGnB9tywtI>



DESIGN OF MACHINE ELEMENTS I

(Effective from the Academic Year 2023 - 2024)

SEMESTER - VI

Course Code	ME622T3M	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Knowledge of Engineering Mechanics, Mechanics of Materials, Engineering Machine Drawing.

COURSE OBJECTIVES:

- To understand the various steps involved in the Design Process.
- To understand the principles involved in design of machine elements, subjected to different kinds of forces, considerations of strength, rigidity, functional and manufacturing requirements.
- To understand the concept of impact strength and fatigue strength in the design.
- To develop the capability to design elements like shafts, couplings, welded joints, screwed joints, and power screws.

TEACHING - LEARNING STRATEGY:

- Following are some sample strategies that can be incorporate for the Course Delivery
- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction: Design Process: Definition of design, phases of design, and review of engineering materials and their properties and manufacturing processes; use of codes and standards, selection of preferred sizes.

Design of machine members under axial, bending, shear and torsion loading.

Design of Curved beams: Crane hook, punching presses and clamps, closed rings.

8 Hours

MODULE –II

Impact Strength: Introduction, Impact stresses due to axial, bending and torsion loads.

Fatigue loading: Introduction to fatigue failure, types of fatigue loading, S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit, size effect, surface effect, Stress concentration effects Notch sensitivity, Soderberg and Goodman relationships, stresses due to combined loading

8 Hours

MODULE –III

Design of shafts: Torsion of shafts, solid and hollow shaft design with steady loading based on strength and rigidity, design of shafts subjected to combined bending, torsion and axial loading. Design of shafts subjected to fluctuating loads.

Design of keys and couplings: **Keys:** Types of keys and their applications, design considerations in parallel and tapered sunk keys, Design of square and rectangular sunk keys. **Couplings:** Rigid and flexible coupling-types and applications, design of Flange coupling.

8 Hours

MODULE –IV





Permanent Joints: Design of Welded joints, Types, strength of butt and fillet welds, eccentrically loaded welded joints. Temporary Joints: Types of temporary joints- cotter joints, knuckle joint and fasteners. Design of Cotter and Knuckle Joint.	8 Hours
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MODULE –V

Power screws: Mechanics of power screw, stresses in power screws, efficiency and self-locking, design of power screws. Theories of failure: maximum principal stress theory, maximum shear stress theory, strain energy theory, distortion energy theory, Maximum principal strain theory.	8 Hours
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COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Analyze the design of machine elements subjected to axial, bending, shear and torsion loading.	CL4
CO2	Analyze the design of machine element subjected to impact and fatigue loading.	CL4
CO3	Analyze the design procedure involved in shafts, keys and couplings.	CL4
CO4	Analyze the design procedure of welded joint, cotter and knuckle joint.	CL4
CO5	Analyze the design procedure involved in power screws and selection of suitable diameter and FoS under theories of failure.	CL4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2		2			1	1	2		2	2		
CO2	3	2	2		2			1	1	2		2	2		
CO3	3	2	2		2			1	1	2		2	2		
CO4	3	2	2		2			1	1	2		2	2		
CO5	3	2	2		2			1	1	2		2	2		
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	Semester End Examination (SEE)	100 %	50

CO - ASSESSMENT MAPPING

Course Outcomes	Continuous Internal Assessment (CIA) (50%)						Semester End Exam (SEE)(50%)		
	Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)					
	I	II	III						
	Syllabus Coverage			Syllabus Coverage			Syllabus Coverage		
	40%	30%	30%	100%			100%		
CO1	x			x			X		
CO2	x	x		x			X		



CO3		x		x	X
CO4			x	x	X
CO5			x	x	X

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	5
2	Quiz	25 %	5
3	Field Visits/Survey/Case Studies	50 %	10
4	Model / Prototype Development	100 %	20
5	Project Based Learning		
6	Seminar/Presentation	25 %	5
7	Peer - to -Peer Learning	25 %	5

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions.
- Each full question consisting of 20 marks.
- There will be 2 full questions from all the FIVE modules.
- Each full question will have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Richard G. Budynas, and J. Keith Nisbett, "Shigley's Mechanical Engineering Design" McGraw-Hill Education, 10th edition, 2015.
2. V B Bhandari "Design of Machine Elements" Tata McGraw Hill, 4th Ed., 2016.
3. Juvinall R.C, and Marshek K.M., "Fundamentals of Machine Component Design" Juvinall R.C, and Marshek K.M., John Wiley & Son, Third Edition, 2007.
4. Dr.M H Annaiah Dr. J Suresh Kumar., "Design of Machine Elements" New Age International, First Edition, 2016.
5. Robert L. Norton "Machine Design" Pearson Education, Second Edition.
6. H.G.Patil, S.C.Pilli, R.R.Malagi, M.S.Patil., "Elements of Machine Design" IK International, First Edition, 2019.

DESIGN DATA HAND BOOK:

1. Design Data Hand Book by K. Mahadevan and Balaveera Reddy, CBS Publication, 4th Revised edition.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. Design of Machine Elements <https://nptel.ac.in/courses/112/105/112105125/>
2. Design of Machine Elements <https://nptel.ac.in/courses/112/105/112105124/>
3. Design of Machine Elements <https://nptel.ac.in/courses/112/106/112106137/>



PRODUCT LIFE CYCLE MANAGEMENT

(Effective from the Academic Year 2023 - 2024)

VI SEMESTER

Course Code	ME62214MA	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Elements of mechanical engineering

COURSE OBJECTIVES:

- Familiarize with various strategies of PLM .
- Understand the concept of product design and simulation.
- Develop New product development , product structure and supporting systems
- Interpret the technology forecasting and product innovation and development in business processes.
- Understand product building and Product Configuration.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction to PLM,Need for PLM, opportunities and benefits of PLM, different views of PLM, components of PLM, phases of PLM, PLM feasibility study. PLM Strategies, strategy elements, its identification, selection and implementation. Product Data Management, implementation of PDM systems.	8 Hours
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MODULE - II

Engineering design, organization and decomposition in product design, product design process, methodical evolution in product design, concurrent engineering, design for 'X' and design central development model. Strategies for recovery at end of life, recycling, human factors in product design. Modelling and simulation in product	8 Hours
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MODULE - III

New Product Development, Structuring new product development, building decision support system, Estimating market opportunities for new product, new product financial control, implementing new product development, market entry decision, launching and tracking new product program. Concept of redesign of product.	8 Hours
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MODULE - IV

Technological change, methods of technology forecasting, relevance trees, morphological methods, flow diagram and combining forecast of technologies Integration of technological product innovation and product development in business processes within enterprises, methods and tools in the innovation process according to the situation, methods and tools in the innovation process according to the situation	8 Hours
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MODULE - V



Virtual product development tools for components, machines, and manufacturing plants: 3D CAD systems, digital mock-up, model building, model analysis, production (process) planning, and product data technology, Product structures: Variant management, product configuration, material master data, product description data, Data models, Life cycles of individual items, status of items.	8 Hours
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COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Explain the various strategies of PLM and Product Data Management	CL3
CO2	Describe decomposition of product design and model simulation	CL3
CO3	Apply the concept of New Product Development and its structuring	CL3
CO4	Analyze the technological forecasting and the tools in the innovation.	CL3
CO5	Apply the virtual product development and model analysis	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	1				2				2		2	
CO2	3	3	2					2				2		2	
CO3	3	3	3					2				2		2	
CO4	3	3	3					2				2		2	
CO5	3	3	3					2				2		2	

3: Substantial (High)

2: Moderate (Medium)

1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)	
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)		
I	II	III			
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage	
40%	30%	30%	100%	100%	
MI			MI	MI	
MII	MII		MII	MII	
	MIII		MIII	MIII	
		MIV	MIV	MIV	



		MV	MV	MV
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Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer **FIVE** full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realisation, Springer-Verlag, 2004. ISBN 1852338105.
2. Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor & Francis 2006
3. Saaksvuori Antti / Immonen Anselmie, product Life Cycle Management Springer, Dreamtech, 3-540-25731-4
4. Product Lifecycle Management, Michael Grieves, Tata McGraw Hill

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):



ROCKET PROPULSION

(Effective from the Academic Year 2023 - 2024)

VI SEMESTER

Course Code	ME62214MB	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fluid Dynamics
- Thermodynamics
- Heat transfer

COURSE OBJECTIVES:

- Study the basic definition, ASHRAE nomenclature for refrigerating systems.
- Understand the working principles and applications of different types of refrigeration systems.
- Study the working of air conditioning systems and their applications.
- Identify the performance parameters and their relations of an air conditioning system.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction: Classification of power plants, Methods of aircraft propulsion, Propulsive efficiency, Specific fuel consumption, Thrust and power, Factors affecting thrust and power.

Illustration of working of Gas turbine engine: Characteristics of turboprop, turbofan and turbojet, Ram jet, Scram jet, Methods of Thrust augmentation.

8 Hours

MODULE - II

Introduction to rocket propulsion: Classification and applications of rockets, Reaction principle, Thrust equation, Classification of rockets based on propellants used, solid, liquid and hybrid, Comparison of these engines with special reference to rocket performance, electric propulsion, classification: electro thermal – electro static – electromagnetic thrusters- geometries of Ion thrusters- beam/plume characteristics – hall thrusters.

Fundamentals and Definitions: Thrust, Exhaust Velocity, Energy and efficiencies, multiple propulsion systems, typical performance values, variable thrust and simple problems.

8 Hours

MODULE - III

Solid Propellant Rocket engine: Basic relations and propellant burning rate, performance issues, propellant grain and grain configuration, propellant grain stress and strain, altitude control and side man oeuvres with solid propellant rocket motors

Solid Propellants: Classification, propellant characteristics, hazards, propellant ingredients, other propellant categories

8 Hours

MODULE - IV

Liquid Propellant rocket engine: Types of propellants, propellant tanks, propellant feed systems, gas pressure feed systems, tank pressurization, turbopump feed system, rocket engines for maneuvering and orbit adjustments.

8 Hours



Liquid Propellants: propellant properties, liquid oxidizers, liquid fuels, liquid monopropellants, gaseous propellant, safety and environment concern. Combustion process and instability.	
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MODULE - V

Nozzle Theory and Thermodynamics Relations: review of thermodynamics relations, ideal rocket propulsion systems, isentropic flow through nozzles, nozzle configuration, real nozzles, nozzle alignment, over expanded, under expanded nozzles and optimum expansion in nozzles Thrust Chambers: Injectors, flow characteristics, factors influencing injection behavior, heat transfer analysis, starting and ignition, life of thrust chambers, random variable thrust, sample thrust chamber design analysis, Thrust Vector Control with single nozzle and multiple nozzles. Integration with vehicle.	8 Hours
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COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Illustrate the principles, construction and operation of various Gas turbine engines.	CL3
CO2	Classify the rocket propulsion.	CL3
CO3	Explain the performance of Solid Propellant Rocket engine and solid propellants.	CL3
CO4	Describe the performance of Liquid Propellant Rocket engine and liquid propellants.	CL3
CO5	Illustrate the principles and effect of Nozzles and thrust chambers on rocket propulsion.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	1			1	1	1				1			3
CO2	3	3	2			1	1	1				1			3
CO3	3	3	1			1	1	1				1			3
CO4	3	3	1			1	1	1				1			3
CO5	3	3	2			1	1	1				1			3

3: Substantial (High)

2: Moderate (Medium)

1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)	
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)		
I	II	III			
Syllabus Coverage			Syllabus Coverage		
40%	30%	30%	100%	100%	
MI			MI	MI	





MII	MII		MII	MII
	MIII		MIII	MIII
		MIV	MIV	MIV
		MV	MV	MV

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Rocket Propulsion Elements G. P. Sutton Wiley India Pvt Ltd 7th Edition, 2010
2. Gas Turbine Theory Cohen, H. Rogers, G.F.C. and Saravana muttoo H.I.H DORLING KINDERSLEY 5th edition, 2002
3. Introduction to Rocket Propulsion James R Church of Care 2018
4. Rocket and Spacecraft Propulsion Martin J I Turner Springer Third Edition

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. <https://archive.nptel.ac.in/courses/101/104/101104078/>



INDUSTRIAL AUTOMATION AND CONTROL

(Effective from the Academic Year 2023 - 2024)

VI SEMESTER

Course Code	ME62214MC	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Basic knowledge of automation and control systems
- Basic knowledge about industrial processes.

COURSE OBJECTIVES:

- Study the basics of Industrial Automation and Control.
- Understand about measurement systems and their different types.
- Study the working of different controlling processes.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction to Industrial Automation and Control: Architecture of Industrial Automation Systems. Architectural levels of Industrial controls. Actuators & sensors: Servomotors, Stepper motors, Process I/O systems. Local & remote I/O systems.	8 Hours
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MODULE - II

Introduction to measurement systems. Temperature measurement, pressure and force measurement, Displacement and speed measurement, flow measurement, measurement of levels, humidity, pH, etc. Signal Conditioning and processing, Estimation of errors and calibration.	8 Hours
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MODULE - III

Process Control: Introduction to Process Control P I D Control, Controller Tuning. Implementation of PID Controllers. Special Control Structures: Feed forward and Ratio Control. Predictive Control, Control of Systems with Inverse Response, Cascade Control, Overriding Control, Selective Control, Split Range Control	8 Hours
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MODULE - IV

Sequence Control: Introduction to Sequence Control PLCs and Relay Ladder Logic Sequence Control, Scan Cycle, RLL Syntax Sequence Control, Structured Design Approach Sequence Control, Advanced RLL Programming Sequence Control : The Hardware environment. Supervisory Controllers: Functionally of Supervisory Control Level, Process Optimization, Recipe Management Material. Tracking. Man-machine interfaces	8 Hours
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MODULE - V



Pneumatic Control Systems: System Components Pneumatic Control Systems, Controllers and Integrated Control Systems. Networking of Sensors, Actuators and Controllers: The Fieldbus, The Fieldbus Communication Protocol, Introduction to Production Control Systems. Control of Machine tools - Introduction to CNC machine, Control of Machine tools, Analysis of a control loop. Flow control valves, Pumps, motors and servo valves.	8 Hours
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COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Understand the Architecture of Industrial Automation Systems, Actuators & sensors.	CL2
CO2	Identify the measurement systems and Signal Conditioning and processing	CL3
CO3	Describe Process Control, Controller Tuning, Special Control Structures and Control of Systems with Inverse Response.	CL2
CO4	Illustrate Sequence Control and Supervisory Controllers.	CL3
CO5	Understand Pneumatic Control Systems and Control of Machine tools.	CL2

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	3	2	2	2			1	2			2	1	2	1
CO2	2	3	2	2	2			1	2			2	1	2	1
CO3	2	3	2	2	2			1	2			2	1	2	1
CO4	2	2	2	1	2			1	2			2	1	2	1
CO5	2	2	3	2	2			1	2			2	1	2	1
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)	
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)		
I	II	III			
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage	
40%	30%	30%	100%	100%	
MI			MI	MI	
MII	MII		MII	MII	
	MIII		MIII	MIII	
		MIV	MIV	MIV	



		MV	MV	MV
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Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer **FIVE** full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. L.A. Bryan and E. A. Bryan, "Programmable Controllers – Theory and implementation," Second edition, An Industrial text company publication, USA, 1997.
2. Richard L. Shell and Ernest L. Hall, "Handbook of industrial automation," CRC press 2000.
3. Industrial Instrumentation and Control By. S.K. Singh The McGraw Hill Companies.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):





INDUSTRIAL INTERNET OF THINGS

(Effective from the Academic Year 2023 - 2024)

VI SEMESTER

Course Code	ME62214MD	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fundamental knowledge of

COURSE OBJECTIVES:

- To impart knowledge on the infrastructure, sensor technologies and networking technologies of IoT.
- To analyse, design and develop IoT solutions.
- To apply the concept of Internet of Things in the real world scenarios
- To introduce students the criteria for selecting the devices required for IoT.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction to IoT, IoT Vs. IIoT, Components of IIoT -Sensors, Interface, Networks, People &Process, Hype cycle, IOT Market, Trends& future Real life examples, Key terms of IoT–IoT Platform, Interfaces, API, clouds, Data Management Analytics, Mining &Manipulation;
Role of IIoT in Manufacturing Processes Use of IIoT in plant maintenance practices, Sustainability through Business excellence tools Challenges and Benefits in implementing IIoT.

8 Hours

MODULE - II

ARCHITECTURE: Overview of IoT components: Various Architectures of IoT and IIoT, Advantages & disadvantages, Industrial Internet -Reference Architecture; IIoT System components: Sensors, Gateways, Routers, Modem, Cloud brokers, servers and its integration, WSN, WSN network design for IoT. **SENSORS AND INTERFACING:** Introduction to sensors, Transducers, Classification, Roles of sensors in IIoT, Various types of sensors, Design of sensors, sensor architecture, special requirements for IIoT sensors, Role of actuators, types of actuators. Hardwire the sensors with different protocols such as HART, MODBUS-Serial & Parallel, Ethernet, BACnet, Current, M2M

8 Hours

MODULE - III

IIoT Data Monitoring & Control: IoT Gate way, IoT Edge Systems and It's Programming, Cloud computing, Real Time Dashboard for Data Monitoring, Data Analytics and Predictive Maintenance with IIoT technology.

8 Hours

MODULE - IV

Security & Safety: Introduction to system security, network security, generic application security, application process security and safety, design of reliable and secure IoT applications, Run-time Monitoring, The ARMET approach, privacy and dependability.

8 Hours



MODULE - V

IoT Solutions: IoT use case development, Need and Goals for IoT solution, Adoption of IoT solutions, Planning for IoT Solution: Evaluate costs, competition, technology challenges and internal resource considerations.

8 Hours

Scalability of IoT Solutions: Roadmap for developing complete IoT solutions, Strategies for implementation, key Milestone, Scalability of IoT Solutions, Methods, platforms and tools. Web and Mobile Interfaces

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Understand IoT and IIoT, components, key terms, real-life examples, and the role of IIoT in manufacturing processes as well as insights into challenges and benefits associated with IIoT implementation.	CL2
CO2	Understand IIoT architectures, components of IIoT system, sensor types, and interfacing protocols.	CL2
CO3	Proficient in IIoT data monitoring and control, the use of IoT gateways, edge systems programming, cloud computing, real-time dashboard creation, and data analytics for predictive maintenance using IIoT technology.	CL2
CO4	Understand IoT security and safety system and the design of reliable and secure IoT applications, as well as knowledge of privacy and dependability considerations in IoT systems.	CL2
CO5	Assess the need and goals for IoT solutions, and roadmap for scalable IoT solutions.	CL2

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2					2				2		2	
CO2	3	3	2					2				2		2	
CO3	3	3	3					2				2		2	
CO4	3	3	3					2				2		2	
CO5	3	3	3					2				2		2	
3: Substantial (High)				2: Moderate (Medium)						1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)	
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)		
I	II	III			
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage	
40%	30%	30%	100%	100%	
MI			MI	MI	
MII	MII		MII	MII	



	MIII		MIII	MIII
		MIV	MIV	MIV
		MV	MV	MV

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Rethinking the Internet of things: A Scalable Approach to Connecting Everything by Francis daCosta, Apress, 2014
2. Learning Internet of Things by Peter Waher, Packt Publishing, 2015
3. Designing the Internet of Things, by Adrian McEwen, Hakim Cassimally, Wiley India Private Limited
4. Arshdeep Bahga, Vijay Madisetti, "Internet of Things: A hands-on Approach", University Press, 2015.
5. Adrian McEwen & Hakim Cassimally, "Designing the Internet of Things", Wiley, Nov 2013, (1 st edition)

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. <https://www.youtube.com/watch?v=TXzACi8Rs4>
2. <https://www.youtube.com/watch?v=WSHzjARRZDg>
3. https://onlinecourses.nptel.ac.in/noc20_cs69/preview



NON CONVENTIONAL ENERGY SOURCES

(Effective from the Academic Year 2023 - 2024)

VI SEMESTER

Course Code	ME62225MA	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- ENGINEERING PHYSICS

COURSE OBJECTIVES:

- To introduce the concepts of solar energy, its radiation, collection, storage and application.
- To introduce the concepts and applications of Wind energy, Biomass energy, Geothermal energy and Ocean energy as alternative energy sources.
- To explore society's present needs and future energy demands.
- To examine energy sources and systems, including fossil fuels and nuclear energy, and then focus on alternate, renewable energy sources such as solar, biomass (conversions), wind power, geothermal, etc.
- To get exposed to energy conservation methods.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Energy source, India's production and reserves of commercial energy sources, need for nonconventional energy sources, energy alternatives, solar, thermal, photovoltaic. Water power, wind biomass, ocean temperature difference, tidal and waves, geothermal, tar sands and oil shale, nuclear (Brief descriptions); advantages and disadvantages

8 Hours

Solar Radiation: Extra-Terrestrial radiation, spectral distribution of extra-terrestrial radiation, solar constant, solar radiation at the earth's surface, beam, diffuse and global radiation, solar radiation data. Measurement of Solar Radiation: Pyrometer, shading ring pyrheliometer, sunshine recorder, schematic diagrams and principle of working.

MODULE - II

Measurement of Solar Radiation: Pyrometer, shading ring pyrheliometer, sunshine recorder, schematic diagrams and principle of working.

8 Hours

Solar Thermal Conversion: Collection and storage, thermal collection devices, liquid flat plate collectors, solar air heaters concentrating collectors (cylindrical, parabolic, paraboloid), sensible heat storage, latent heat storage, application of solar energy water heating. Space heating and cooling, active and passive systems, Principles of solar pond

MODULE - III

Performance Analysis of Liquid Flat Plate Collectors: General description, collector geometry, selective surface (qualitative discussion) basic energy-balance equation, stagnation temperature, transmissivity of the cover system, transmissivity – absorptivity product, numerical examples. The overall loss coefficient, correlation for the top loss coefficient, bottom and side loss coefficient, problems (all correlations to be provided). Temperature distribution between the collector tubes, collector heat removal factor, collector efficiency factor and collector

8 Hours



flow factor, mean plate temperature, instantaneous efficiency (all expressions to be provided). Effect of various parameters on the collector performance; collector orientation, selective surface, fluid inlet temperature, number covers, dust. Photovoltaic Conversion: Description, principle of working and characteristics, application															
MODULE - IV															
Wind Energy : Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, wind machines; Types of wind machines and their characteristics, horizontal and vertical axis wind mills, elementary design principles; coefficient of performance of a wind mill rotor, aerodynamic considerations of wind mill design, numerical examples. Tidal Power: Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, harnessing tidal energy, limitations. Ocean Thermal Energy Conversion: Principle of working, Rankine cycle, OTEC power stations in the world, problems associated with OTEC													8 Hours		
MODULE - V															
Geothermal Energy Conversion: Principle of working, types of geothermal station with schematic diagram, geothermal plants in the world, problems associated with geothermal conversion, scope of geothermal energy. Energy from Bio Mass: Photosynthesis, photosynthetic oxygen production, energy plantation, bio gas production from organic wastes by anaerobic fermentation, description of bio-gas plants, transportation of bio-gas, problems involved with bio-gas production, application of bio-gas, application of bio-gas in engines, advantages. Hydrogen Energy: Properties of Hydrogen with respected to its utilization as a renewable form of energy, sources of hydrogen, production of hydrogen, electrolysis of water, thermal decomposition of water, thermo chemical production bio-chemical production													8 Hours		
COURSE OUTCOMES															
Upon completion of this course, the students will be able to:															
CO No.	Course Outcome Description													Bloom's Taxonomy Level	
CO1	To introduce the concepts of solar energy, its radiation, collection, storage and application.													CL2	
CO2	To introduce the concepts and applications of Wind energy, Biomass energy, Geothermal energy and Ocean energy as alternative energy sources													CL2	
CO3	To explore society's present needs and future energy demands													CL2	
CO4	To examine energy sources and systems, including fossil fuels and nuclear energy, and then focus on alternate, renewable energy sources such as solar, biomass (conversions), wind power, geothermal, etc.													CL2	
CO5	To get exposed to energy conservation methods													CL2	
CO-PO-PSO MAPPING															
CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2					2				2		2	
CO2	3	3	2					2				2		2	
CO3	3	3	3					2				2		2	
CO4	3	3	3					2				2		2	
CO5	3	3	3					2				2		2	
3: Substantial (High)				2: Moderate (Medium)					1: Poor (Low)						
ASSESSMENT STRATEGY															
Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:															



Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)	
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)		
I	II	III			
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage	
40%	30%	30%	100%	100%	
MI			MI	MI	
MII	MII		MII	MII	
	MIII		MIII	MIII	
		MIV	MIV	MIV	
		MV	MV	MV	

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer **FIVE** full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Non-Convention Energy Resources, B H Khan, McGraw Hill Education (India) Pvt. Ltd. 3 rd Edition
2. Solar energy Subhas P, Sukhatme Tata McGraw Hill, 2 nd Edition, 1996
3. Non-Conventional Energy Sources, G.D Rai, Khanna Publishers 2003



REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):



INTRODUCTION TO AUTOMOBILE ENGINEERING

(Effective from the Academic Year 2023 - 2024)

VI SEMESTER

Course Code	ME62225MB	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fundamental knowledge of Mathematics, Data Structures.

COURSE OBJECTIVES:

- To understand the different chassis design & main components of an engine
- To understand the working of transmission and control system employed in automobiles
- □To understand the automotive pollution and alternative automotive technologies under trail
- To understand the upcoming electric vehicle technology

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

ENGINE COMPONENTS AND IT'S PRINCIPLE PARTS:

8 Hours

Spark Ignition (SI) & Compression Ignition (CI) engines, cylinder – arrangements and their relatives merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams, Types of combustion chambers for S.I. Engine and C.I. Engines, methods of a Swirl generation, engine positioning. Concept of HCCI engines, Hybrid engines, Twin spark engine, Electric car.

COOLING AND LUBRICATION:

Cooling requirements, Types of cooling- Thermo siphon system, forced circulation water cooling system, water pump, Radiator, Significance of lubrication, Splash and Forced feed system.

MODULE - II

TRANSMISSION SYSTEMS:

8 Hours

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

BRAKES:

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



MODULE - III		
STEERING AND SUSPENSION SYSTEMS: Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Suspension, Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel, Air suspension system. IGNITION SYSTEM: Battery Ignition system, Magneto Ignition system, electronic Ignition system.		8 Hours
MODULE - IV		
UPERCHARGERS AND TURBOCHARGERS: Naturally aspirated engines, Forced Induction, Types of superchargers, Turbocharger construction and operation, Intercooler, Turbocharger lag. FUELS, FUEL SUPPLY SYSTEMS FOR SI AND CI ENGINES: Conventional fuels, Alternative fuels, Normal and Abnormal combustion, Cetane and Octane numbers, Fuel mixture requirements for SI engines, Types of carburetors, C.D.& C.C. carburetors, Multi point and Single point fuel injection systems, fuel transfer pumps, Fuel filters, fuel injection pumps and injectors. Electronic Injection system, Common Rail Direct Injection System.		8 Hours
MODULE - V		
AUTOMOTIVE EMISSION CONTROL SYSTEMS: Different air pollutants, formation of photochemical smog and causes. Automotive emission controls, Controlling crankcase emissions, Controlling evaporative emissions, Cleaning the exhaust gas, Controlling the air-fuel mixture, Controlling the combustion process, Exhaust gas recirculation, Treating the exhaust gas, Air-injection system, Air-aspirator system, Catalytic converter. EMISSION STANDARDS: Euro I, II, III and IV norms, Bharat Stage II, III, IV norms. Motor Vehicle Act.		8 Hours
COURSE OUTCOMES		
Upon completion of this course, the students will be able to:		
CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Identify the different parts of an automobile and it's working.	CL3
CO2	Understand the working of transmission and braking systems..	CL3
CO3	Understand the working of steering and suspension systems and their applications.	CL3
CO4	Selection and applications of various types of fuels and injection systems.	CL3



CO5	Analyse the cause of automobile emissions, its effects on environment and methods to reduce the emissions.	CL3
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CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	2	1				2				2		
CO2	3	3	2					2				2		
CO3	3	3	3					2				2		
CO4	3	3	3					2				2		
CO5	3	3	3					2				2		
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)				

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)	
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)		
I	II	III			
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage	
40%	30%	30%	100%	100%	
MI			MI	MI	
MII	MII		MII	MII	
	MIII		MIII	MIII	
		MIV	MIV	MIV	
		MV	MV	MV	

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10



	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting one full question from each module.

TEXT BOOKS:

1. Automobile engineering Vol I and II Kirpal Singh Standard Publishers 12th Edition 2011
2. Automotive Mechanics S. Srinivasan Tata McGraw Hill 2003 2nd Edition

REFERENCE BOOKS:

1. Automotive Mechanics William H Crouse & Donald L Anglin Tata McGraw Hill Publishing Company Ltd 10th Edition 2007
2. Automotive Mechanics: Principles and Practices, Joseph Heitner D Van Nostrand Company, Inc
3. Automobile Engineering R. B. Gupta Satya Prakashan 4th edition 1984.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):



HYBRID AND ELECTRIC VEHICLES

(Effective from the Academic Year 2023 - 2024)

VI SEMESTER

Course Code	ME62225MC	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fundamental knowledge of Automotive Engineering, Mechanical Engineering and Basic electrical and electronics engineering.

COURSE OBJECTIVES:

- Select an appropriate drive strategy for the creation of an electric hybrid vehicle based on available resources.
- Create and formulate fundamental designs for electric vehicles and hybrid electric vehicles.
- Select suitable energy storage systems for use in vehicle applications.
- Recognize different communication protocols and technologies employed in automotive networks.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction of Electric vehicles: Past, Present & Feature of EV, Current Major Issues, Recent Development Trends, EV Concept, Key EV Technology, State-of-the Art EVs & HEVs. Components, vehicle mechanics – Roadway fundamentals, vehicle kinetics, Dynamics of vehicle motion - Propulsion System Design. Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.

8 Hours

HEV: Configuration of HEV (Series, Parallel, Series-parallel & Complex), Power Flow control, Examples. Power flow control in all HEV configurations, Examples of HEV system performance.

MODULE - II

Energy Sources: Different Batteries, Battery characteristics (Discharging & Charging)

Battery Chargers: Conductive (Basic charger circuits, Microprocessor based charger circuit. Arrangement of an off-board conductive charger, Standard power levels of conductive chargers, Inductive (Principle of inductive charging, Soft-switching power converter for inductive charging), Battery indication methods Charging Infrastructure: Domestic Charging Infrastructure, Public Charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move and charge zone. EV and EV charging standards, V2G, G2V, V2B, V2H.

8 Hours

MODULE - III

DC Motor: Type of wound-field DC Motor, Torque speed characteristics, DC-DC Converter, Two quadrant DC Chopper, two quadrant zero voltage transition converter-fed dc motor drive, speed control of DC Motor.

8 Hours



Induction Motor Drive: Three Phase Inverter Based Induction Motor Drive, Equal Area PWM, Three Phase Auxiliary resonant snubber (ARS) Inverter Type (ZVC & ZCS), Single Phase ARS Inverter Topology, Speed Control of Induction Motor, FOC, Adaptive Control, Model Reference Adaptive Control (MARS), Sliding mode Control	
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MODULE - IV

Electric vehicle drive train: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis Hybrid electric drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis	8 Hours
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MODULE - V

Sizing the drive system: the propulsion motor, sizing the power electronics, selecting the energy storage technology. Communications, supporting subsystems: In vehicle networks- CAN, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies. Case Studies: Design of Battery electric vehicle (BEV).	8 Hours
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COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Understand the electric and hybrid vehicle configuration and its components	CL2
CO2	Understand the energy source, properties and types of Batteries	CL2
CO3	Understand the working and different types of motors	CL2
CO4	Compare electric and hybrid-electric gear train	CL2
CO5	Identify and compare the different energy management strategies	CL2

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	1				2				2			2
CO2	3	3	2					2				2			2
CO3	3	3	3					2				2			2
CO4	3	3	3					2				2			2
CO5	3	3	3					2				2			2
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30



	Assignments	40 %	20
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)			Semester End Exam (SEE) (50%)	
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII		MIII	MIII
		MIV	MIV	MIV
		MV	MV	MV

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting one full question from each module.

TEXT BOOKS:

1. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001
2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
3. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004
4. Sandeep Dhameja, "Electric Vehicle Battery Systems", Newnes, 2000
5. A. E. Fuhs, Hybrid Vehicles and the Future of Personal Transportation , CRC Press, 2009

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. <https://nptel.ac.in/courses/108103009>
2. https://www.youtube.com/watch?v=rK6Bey_loiw



SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

Chairperson
Board of Studies
Mechanical Engineering & Allied Program



INTRODUCTION TO COMPUTER INTEGRATED MANUFACTURING

(Effective from the Academic Year 2023 - 2024)

VI SEMESTER

Course Code	ME62225MD	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Manufacturing Operations, Basics of Computers.

COURSE OBJECTIVES:

- To impart knowledge of CIM and Automation and different concepts of automation by developing mathematical models.
- To make students to understand the Computer Applications in Design and Manufacturing (CAD / CAM) leading to Computer integrated systems. Enable them to perform various transformations of entities on display devices.
- To expose students to automated flow lines, assembly lines, Line Balancing Techniques, and Flexible Manufacturing Systems.
- To expose students to computer aided process planning, material requirement planning, capacity planning etc.
- To expose the students to CNC Machine Tools, CNC part programming, and industrial robots.
- To introduce the students to concepts of Additive Manufacturing, Internet of Things, and Industry 4.0 leading to Smart Factory

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction to CIM and Automation: Automation in Production Systems, automated manufacturing systems- types of automation, reasons for automating, Computer Integrated Manufacturing, computerized elements of a CIM system, CAD/CAM and CIM. Mathematical models and matrices: production rate, production capacity, utilization and availability, manufacturing lead time, work-in- process, numerical problems.

8 Hours

MODULE - II

CAD and Computer Graphics Software: The design process, applications of computers in design, software configuration, functions of graphics package, constructing the geometry. Transformations: 2D transformations, translation, rotation and scaling, homogeneous transformation matrix, concatenation, numerical problems on transformations.

8 Hours

MODULE - III

Flexible Manufacturing Systems: Fundamentals of Group Technology and Flexible Manufacturing Systems, types of FMS, FMS components, Material handling and storage system, applications, benefits, computer control systems, FMS planning and design issues, Automated Storage and Retrieval Systems, AS/RS and Automatic parts identification systems and data capture.

8 Hours

MODULE - IV



Computer Numerical Control: Introduction, components of CNC, CNC programming, manual part programming, G Codes, M Codes, programming of simple components in turning, drilling and milling systems, programming with canned cycles. Cutter radius compensations.	8 Hours
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MODULE - V

Robot Technology: Robot anatomy, joints and links, common robot configurations, robot control systems, accuracy and repeatability, end effectors, sensors in robotics. Robot programming methods: on-line and offline methods. Robot industrial applications: material handling, processing and assembly and inspection.	8 Hours
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COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Define Automation, CIM, CAD, CAM and explain the differences between these concepts. Solve simple problems of transformations of entities on computer screen.	CL2
CO2	Explain the basics of automated manufacturing industries through mathematical models and analyse different types of automated flow lines.	CL2
CO3	Analyse the automated flow lines to reduce time and enhance productivity.	CL2
CO4	Explain the use of different computer applications in manufacturing, and able to prepare part Programs for simple jobs on CNC machine tools and robot programming.	CL2
CO5	Explain the robot and robot characteristics and its applications.	CL2

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	1				2				2		2	
CO2	3	3	2					2				2		2	
CO3	3	3	3					2				2		2	
CO4	3	3	3					2				2		2	

3: Substantial (High)

2: Moderate (Medium)

1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)	
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)		
I	II	III			
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage	
40%	30%	30%	100%	100%	
MI			MI	MI	
MII	MII		MII	MII	
	MIII		MIII	MIII	



		MIV	MIV	MIV
		MV	MV	MV

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Automation, Production Systems and Computer-Integrated Manufacturing, Mikell P Groover, Pearson Learning, 4th edition, 2015.
2. CAD / CAM Principles and Applications, P N Rao, Tata McGraw-Hill, 3rd Edition 2015.
3. CAD / CAM Principles and Applications, P N Rao, Tata McGraw-Hill, 3rd Edition.
4. Principles of Computer Integrated Manufacturing, S Kant Vajapayee, Prentice Hall of India, 1999.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. https://www.youtube.com/watch?v=49RET0NITY&list=PLFW6lRTa1g808_CfYhZKdv2eXplAQiAwS
2. https://www.youtube.com/watch?v=eFU7tSld7Yc&list=PLFW6lRTa1g808_CfYhZKdv2eXplAQiAwS&index=2



3D Printing Lab

(Effective from the Academic Year 2023 - 2024)

VI SEMESTER

Course Code	ME622L7M	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	24P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Knowledge of Rapid Prototyping.

COURSE OBJECTIVES:

- Develop the prototype using 3D printing or Additive Manufacturing (AM) machine.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Sl. No.	Description
1	Introduction to 3D Printing and Safety: Overview of 3D printing technologies, Safety precautions in the 3D printing lab, Introduction to lab equipment and software.
2	FDM calibration and Printer setup: Calibrating the FDM printer, Setting up the print bed, Printing a basic FDM object.
3	Designing for FDM: Introduction to CAD software (e.g., Tinkercad, Fusion 360), Designing a simple FDM object, Exporting and preparing the design for printing
4	Advanced FDM Printing: Printing complex geometries with FDM, Understanding support structures, Post-processing techniques for FDM prints
5	FDM Material Exploration: Exploring different FDM materials (PLA, ABS, PETG, etc.), Comparing material properties, Printing with specialized filaments (flexible, composite, etc.)
6	SLA Printer Setup and Calibration: Calibrating the SLA printer, Handling resin materials, Printing a basic SLA object.
7	Designing for SLA: Design considerations for SLA printing, Creating supports for SLA objects, Exporting and preparing a design for SLA printing.
8	SLA Post-Processing Techniques: Cleaning and curing SLA prints, Surface finishing techniques (sanding, painting, etc.), Assembling complex SLA-printed parts
9	SLA Material Exploration: Exploring different SLA resin materials (standard, flexible, castable, etc.), Understanding material properties and applications.
10	Creating intricate and functional designs.
11	Troubleshooting and Maintenance: Common 3D printing issues and solutions, Routine maintenance of FDM and SLA printers. Final project consultation and troubleshooting.



12	Students will work on individual or group projects using both FDM and SLA printers, Presentation of final projects and portfolio, Course review, Q&A, and future prospects in 3D printing.
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COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Understand the operations of FDM and SLA 3D printers, and also their respective mechanisms, software interfaces, and calibration processes to produce precise and accurate prints.	CL3
CO2	Create and modify 3D models optimized for FDM and SLA printing, applying design principles to ensure structural integrity and appropriate resolution for different applications.	CL3
CO3	Acquire troubleshooting skills to diagnose and address common printing issues, as well as the ability to fine-tune print parameters to enhance efficiency, print quality, and material usage.	CL3
CO4	Analyze the properties and behaviors of various printing materials used in FDM and SLA technologies, as well as the post-processing techniques necessary to refine and finish printed objects.	CL3
CO5	Explore innovative applications of 3D printing, experimenting with complex geometries, multi-material prints, and design enhancements to expand their understanding of the technology's potential in various industries.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2			2							2	2	2	2
CO2	3	2	2		2							2	2	2	
CO3	3	2	2		2							2	2	2	2
CO4	3	2			2							2		2	2
CO5	3	2	2		2							2	2	2	2
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT STRATEGY:

- I. In Laboratory Courses where (B) and (C) are not the components of the assessment pattern, then (A) will have 100% weightage (50 Marks).

Assessment Mode: Weekly Assessment of Laboratory Work (50 Marks) - the marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment, each of 25 marks) of the students in each laboratory session. The average of all the marks obtained across the sessions will be the Final CIA marks.

- II. In Laboratory Courses where (C) is not a component of the assessment pattern, then (A) will have 50% weightage (25 Marks), and (B) will have 50% weightage (25 Marks).

Assessment Mode: The marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment) (A) and One Laboratory Test (B).

- In Weekly Assessment, the student will be evaluated in each laboratory session for 25 marks. The average marks obtained across all the experiments will be the marks obtained for (A).
- A Laboratory Test, similar to the SEE exam is conducted towards the end of the Semester/Course, whichever is earlier. The obtained marks are scaled down to 25 Marks (B)

The Sum of marks obtained across (A) and (B) will be the Final CIA marks.

III. In Laboratory Courses where (C) is a component of the assessment pattern, then assessment will be done by considering the weightages given above, i.e. (A) – 25 Marks (Weekly Assessment), (B) – 15 Marks (Laboratory Examination), (C) – 10 marks (Open Ended Experiments/Mini Projects)

- The respective course instructor will design the assessment criteria for the said assessment components.
- The assessment components will be made known to the students by the respective Course Coordinators prior to the commencement of the Laboratory Work.

In all the cases, the assessments will be done based on the criteria designed by the Course Coordinator.

SEE QUESTION PAPER PATTERN:

1. All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
2. SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
3. General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
4. Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE WEB LINKS AND VIDEO LECTURES (E – RESOURCES):

1. <https://3dp-dei.vlabs.ac.in/>
2. <https://nptel.ac.in/courses/112103306>
3. <https://3dp-dei.vlabs.ac.in/exp/simulation-stereolithography-process/>
4. <https://3dp-dei.vlabs.ac.in/exp/simulation-modelling-process/>
5. <https://3dp-dei.vlabs.ac.in/exp/simulation-laser-sintering-nonmetal/>
6. <https://3dp-dei.vlabs.ac.in/exp/simulation-laser-sintering-metal/>
7. <https://3dp-dei.vlabs.ac.in/exp/simulation-post-processing/>
8. <https://3dp-dei.vlabs.ac.in/exp/simulation-additive-manufacturing/>



ML Using Scikit, Pytorch and Tensorflow

(Effective from the Academic Year 2023 - 2024)

VI SEMESTER

Course Code	ME62298MA	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	24P	Exam Hours	02

CREDITS – 1

COURSE PREREQUISITES:

- Basic Knowledge of PUC Mathematics and Python
- Must have completed the previous AEC course “Data wrangling, Analysis and Visualization”
- Preparatory knowledge of Pytorch, Scikit and Tensorflow.

COURSE OBJECTIVES:

This course will enable students to (i) Understand and implement the concepts of Artificial Intelligence and Machine Learning. (ii) Write basic AI/ML programs using Tensorflow.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Demonstration
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Design, develop, and implement the specified algorithms using Google Collab under LINUX/Windows environment.

Exp. No.	Description	COs	CSL
1	Linear Regression with Scikit-Learn: Implement linear regression on a simple dataset (like Boston Housing) using Scikit-Learn. Focus on data preprocessing, model fitting, and evaluation of the model.	CO1	CL4
2	Image Classification with TensorFlow: Use TensorFlow to build a convolutional neural network (CNN) for classifying images from a dataset like CIFAR-10. Explore different architectures and hyperparameters.	CO1	CL4
3	PyTorch Basics: Create a simple neural network in PyTorch. Learn to define a model, loss function, and optimizer. Train the model on a basic dataset like MNIST.	CO2	CL4
4	K-Means Clustering with Scikit-Learn: Implement K-means clustering on a dataset to understand unsupervised learning. Analyze the results and visualize the clusters.	CO2	CL4
5	Text Classification with TensorFlow: Use TensorFlow to build a recurrent neural network (RNN) for classifying text data, such as movie reviews. Explore word embeddings and LSTM/GRU layers.	CO3	CL4
6	Transfer Learning in PyTorch: Utilize a pre-trained model (like ResNet) in PyTorch for a classification task on a new dataset. Learn about fine-tuning and feature extraction approaches.	CO3	CL4



7	Decision Trees with Scikit-Learn: Build and visualize decision trees for classification or regression tasks. Understand tree parameters and how to prevent overfitting.	CO3	CL4
8	Autoencoders with TensorFlow: Create an autoencoder for dimensionality reduction or denoising on image datasets. Explore the architecture of autoencoders and their applications.	CO4	CL4
9	PyTorch Custom Dataset and DataLoader: Learn to create a custom dataset class in PyTorch. Implement a DataLoader for efficient data handling and batching during training.	CO5	CL6
10	Hyperparameter Tuning with Scikit-Learn: Use Scikit-Learn's Grid Search CV or Randomized Search CV to perform hyperparameter tuning on a machine learning model. Analyze the impact of different hyperparameters on model performance.	CO5	CL6

Note: Installation procedure of the required software must be demonstrated, carried out in groups and documented in the journal.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Build, train, and deploy various machine learning models efficiently utilizing major machine learning frameworks such as TensorFlow, PyTorch, and Scikit-Learn.	CL4
CO2	Apply core machine learning algorithms, including supervised and unsupervised learning methods, enabling them to choose and apply the appropriate algorithm for different types of data and problems.	CL4
CO3	Apply essential skills in data preprocessing, manipulation, and visualization, learning to effectively prepare data for machine learning models using tools like NumPy, pandas, and matplotlib.	CL4
CO4	Evaluate complex problems in areas such as image and text analysis using comprehensive knowledge in deep learning, including the construction and training of neural networks.	CL4
CO5	Evaluate the performance of machine learning models using various metrics and techniques, gaining expertise in tuning models for improved accuracy and efficiency, preparing them for real-world machine learning challenges.	CL6

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	3		3			2	2	1		2	1	2	2
CO2	3	3	3		3			2	2	1		2	1	2	2
CO3	3	3	3		3			2	2	1		2	1	2	2
CO4	3	3	3		3			2	2	1		2	1	2	2
CO5	3	3	3		3			2	2	1		2	1	2	2

3: Substantial (High)

2: Moderate (Medium)

1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT STRATEGY:

- In Laboratory Courses where (B) and (C) are not the components of the assessment pattern, then (A) will

have 100% weightage (50 Marks).

Assessment Mode: Weekly Assessment of Laboratory Work (50 Marks) - the marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment, each of 25 marks) of the students in each laboratory session. The average of all the marks obtained across the sessions will be the Final CIA marks.

- II. In Laboratory Courses where (C) is not a component of the assessment pattern, then (A) will have 50% weightage (25 Marks), and (B) will have 50% weightage (25 Marks).

Assessment Mode: The marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment) (A) and One Laboratory Test (B).

- In Weekly Assessment, the student will be evaluated in each laboratory session for 25 marks. The average marks obtained across all the experiments will be the marks obtained for (A).
- A Laboratory Test, similar to the SEE exam is conducted towards the end of the Semester/Course, whichever is earlier. The obtained marks are scaled down to 25 Marks (B)

The Sum of marks obtained across (A) and (B) will be the Final CIA marks.

- III. In Laboratory Courses where (C) is a component of the assessment pattern, then assessment will be done by considering the weightages given above, i.e. (A) – 25 Marks (Weekly Assessment), (B) – 15 Marks (Laboratory Examination), (C) – 10 marks (Open Ended Experiments/Mini Projects)

- The respective course instructor will design the assessment criteria for the said assessment components.
- The assessment components will be made known to the students by the respective Course Coordinators prior to the commencement of the Laboratory Work.

In all the cases, the assessments will be done based on the criteria designed by the Course Coordinator.

SEE QUESTION PAPER PATTERN:

1. All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
2. SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
3. General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
4. Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE WEB LINKS AND VIDEO LECTURES (E-RESOURCES):

1. <https://developers.google.com/machine-learning/crash-course>
2. <https://developers.google.com/machine-learning/practica/image-classification>
3. <https://developers.google.com/machine-learning/intro-to-ml>
4. "Python Machine Learning" by Sebastian Raschka and Vahid Mirjalili
5. "Deep Learning with Python" by François Chollet
6. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron
7. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville
8. "PyTorch Deep Learning Hands-On" by Sherin Thomas and Sudhanshu Passi
9. "Learning TensorFlow: A Guide to Building Deep Learning Systems" by Tom Hope, Yehezkel S. Resheff, and Itay Lieder



PLM Lab

(Effective from the Academic Year 2023 - 2024)

VI SEMESTER

Course Code	ME62298MB	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	20P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Basic Knowledge of Mathematics and Embedded Systems.

COURSE OBJECTIVES:

- Demonstrate prerequisites of PLM
- Make able to understand implementation procedures of PLM tools.
- Build confidence in using CAD /CAE software along with PLM software.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Sl. No.	Description
1	Introduction to PLM lab, Installation of Various software's Oracle / SQL Server / DB2, PLM Server, CAD Software, MS Office, Rich client, Web client, Application server, Software/ Hardware/ Network issues resolutions.
2	CAD: Modeling (at least 5 parts) and Assembly using any High-End CAD Software Assembly should include top down and bottom-up approaches, Drafting (at least 1 assembly)
3	CAD File/data exchange amongst the various CAD software and software for CMM, CAE, CNC, CAM.
4	FEA: Analysis (structural, thermal and both) of at least two parts, Introduction to nonlinear analysis.
5	PLM: Exhibiting use of following modules of any PLM software through at least six assignments Organization. · Workflow · Product Structure · Access Manager · Query Builder · Change Management · Schedule Manager · Manufacturing Process Planner



COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Graduate can demonstrate practical uses of various PLM technologies.	CL2
CO2	Configure the various CAD/CAE and PLM tools.	CL2
CO3	Build the various CAD/CAE models to use in PLM applications.	CL2

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	3		2					2		3	2		
CO2	3	2	3		2					2		3	2		
CO3	3	2	3		2					2		3	2		
3: Substantial (High)				2: Moderate (Medium)						1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT STRATEGY:

- I. In Laboratory Courses where (B) and (C) are not the components of the assessment pattern, then (A) will have 100% weightage (50 Marks).

Assessment Mode: Weekly Assessment of Laboratory Work (50 Marks) - the marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment, each of 25 marks) of the students in each laboratory session. The average of all the marks obtained across the sessions will be the Final CIA marks.

- II. In Laboratory Courses where (C) is not a component of the assessment pattern, then (A) will have 50% weightage (25 Marks), and (B) will have 50% weightage (25 Marks).

Assessment Mode: The marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment) (A) and One Laboratory Test (B).

- In Weekly Assessment, the student will be evaluated in each laboratory session for 25 marks. The average marks obtained across all the experiments will be the marks obtained for (A).
- A Laboratory Test, similar to the SEE exam is conducted towards the end of the Semester/Course, whichever is earlier. The obtained marks are scaled down to 25 Marks (B)

The Sum of marks obtained across (A) and (B) will be the Final CIA marks.

- III. In Laboratory Courses where (C) is a component of the assessment pattern, then assessment will be done by considering the weightages given above, i.e. (A) – 25 Marks (Weekly Assessment), (B) – 15 Marks (Laboratory Examination), (C) – 10 marks (Open Ended Experiments/Mini Projects)

- The respective course instructor will design the assessment criteria for the said assessment components.
- The assessment components will be made known to the students by the respective Course Coordinators prior to the commencement of the Laboratory Work.

In all the cases, the assessments will be done based on the criteria designed by the Course Coordinator.



SEE QUESTION PAPER PATTERN:

1. All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
2. SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
3. General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
4. Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE WEB LINKS AND VIDEO LECTURES (E – RESOURCES):

1. <https://www.AUTOSAR.org/standards/>
2. <https://www.comasso.org/>
3. AUTOSAR Architecture (Learn from Scratch with Demo) - <https://www.udemy.com/course/AUTOSAR-architecture/>



SoC Lab

(Effective from the Academic Year 2023 - 2024)

VI SEMESTER

Course Code	ME62298MC	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	20P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Working knowledge of C and C++, including software development and debugging (e.g., EE322C Data Structures, or equivalent);
- Embedded real-time system design and hardware/software interfacing (e.g., EE445M Embedded & Real-Time Operating Systems, or equivalent);
- Digital hardware design and hardware description languages (e.g., EE460M Digital System Design using Verilog, or equivalent);
- It is helpful to have some basic knowledge of linear algebra and machine/deep learning algorithms.

COURSE OBJECTIVES:

- Analyze the functional and nonfunctional performance of the system early in the design process to support design decisions.
- Analyze hardware/software tradeoffs, algorithms, and architectures to optimize the system based on requirements and implementation constraints.
- Analyze tradeoffs and explore architecture and micro-architecture design spaces to develop and synthesize custom hardware accelerators
- Understand hardware, software, and interface synthesis.
- Understand issues in interface design.
- Use co-simulation to validate system functionality.
- Describe examples of applications and systems developed using a co-design approach.
- Appreciate issues in system-on-chip design associated with co-design, such as intellectual property, reuse, and verification.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Sl. No.	Description
1	Introduction to FPGA and SoC Platforms: Blink an LED using both FPGA logic and embedded processor.
2	HDL Design and Simulation: Design, simulate, and implement basic digital circuits, such as adders or multiplexers.
3	Embedded Software Development: Write, compile, and run a simple program on the embedded processor.
4	Interfacing External Memory: Read/write operations to the memory and performance evaluation.



5	Designing Custom IP Cores: Design a simple custom peripheral (like a PWM controller), integrate it into the SoC, and control it via software.
6	Communication Protocols: Implement and test protocols like UART, SPI, I2C, etc., and establish communication between the SoC and an external device.
7	RTOS on SoC: Deploy an RTOS (like FreeRTOS) on the embedded processor and develop multitasking applications.
8	Power and Performance Optimization: Measure power consumption under different workloads and implement power-saving techniques.
9	Hardware/Software Co-design: Develop a system where a specific task is partitioned between the FPGA logic and the embedded processor.
10	Advanced Project - Complete SoC System Design: Design and implement an SoC-based project, such as a simple IoT device, a media player, or a robot controller.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Design and manipulate FPGA and SoC platforms, as well as simulate and implement foundational digital circuits using HDL	CL2
CO2	Develop embedded software and effectively interfacing with external memory systems.	CL2
CO3	Design custom IP cores and understand the intricacies of various communication protocols	CL2
CO4	Implement RTOS on SoC platforms and master techniques for power and performance optimization.	CL2
CO5	Perform hardware/software co-design and undertake advanced SoC system design projects from concept to completion.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	3		2							1		
CO2	3	2	3		2							1		
CO3	3	2	3		2							1		
CO4	3	2	3		2							1		
CO5	3	2	3		2							1		
3: Substantial (High)				2: Moderate (Medium)						1: Poor (Low)				

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT STRATEGY:

- I. In Laboratory Courses where (B) and (C) are not the components of the assessment pattern, then (A) will have 100% weightage (50 Marks).

Assessment Mode: Weekly Assessment of Laboratory Work (50 Marks) - the marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment, each of 25 marks) of the students in each laboratory session. The average of all the marks obtained across the sessions will be the Final CIA marks.

- II. In Laboratory Courses where (C) is not a component of the assessment pattern, then (A) will have 50% weightage (25 Marks), and (B) will have 50% weightage (25 Marks).

Assessment Mode: The marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment) (A) and One Laboratory Test (B).

- In Weekly Assessment, the student will be evaluated in each laboratory session for 25 marks. The average marks obtained across all the experiments will be the marks obtained for (A).
- A Laboratory Test, similar to the SEE exam is conducted towards the end of the Semester/Course, whichever is earlier. The obtained marks are scaled down to 25 Marks (B)

The Sum of marks obtained across (A) and (B) will be the Final CIA marks.

- III. In Laboratory Courses where (C) is a component of the assessment pattern, then assessment will be done by

considering the weightages given above, i.e. (A) – 25 Marks (Weekly Assessment), (B) – 15 Marks (Laboratory Examination), (C) – 10 marks (Open Ended Experiments/Mini Projects)

- The respective course instructor will design the assessment criteria for the said assessment components.
- The assessment components will be made known to the students by the respective Course Coordinators prior to the commencement of the Laboratory Work.

In all the cases, the assessments will be done based on the criteria designed by the Course Coordinator.

SEE QUESTION PAPER PATTERN:

1. All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
2. SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
3. General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
4. Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE WEB LINKS AND VIDEO LECTURES (E – RESOURCES):

1. P. Marwedel, Embedded System Design: Embedded Systems Foundations of Cyber-Physical Systems, Third Edition, Springer, 2018. (author's website)
2. D. C. Black, J. Donovan, B. Bunton, A. Keist, SystemC: From the Ground Up, Second Edition, Springer, 2010.
3. G. De Micheli, Synthesis and Optimization of Digital Circuits, McGraw-Hill, 1994.



VR App Development

(Effective from the Academic Year 2023 - 2024)

VI SEMESTER

Course Code	ME62298MD	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	24P	Exam Hours	02

CREDITS – 1

COURSE PREREQUISITES:

- Basic 3D Modeling Skills with software like Blender or other 3D modeling tools.
- Programming concepts, especially in languages commonly used in game development and VR, such as C# or JavaScript, can be advantageous (but not essential).

COURSE OBJECTIVES:

- To proficiently use Blender, including installation, interface navigation, and basic 3D modeling techniques, setting a strong foundation for virtual reality (VR) app development.
- To gain expertise in applying textures, materials, shaders, and reflections to 3D objects, enhancing their ability to create visually compelling VR environments.
- To acquire the skills needed to model VR objects, compose VR scenes, apply lighting and shading, and implement interactions, ultimately culminating in the creation of a complete VR app using both Blender and Unity.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Demonstration
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Exp. No.	Description	COs	CSL
1	Blender Basics- Install Blender and get familiar with its interface. Create basic 3D shapes, manipulate them, and navigate the 3D viewport.	CO1	CL4
2	Texturing and Materials-Learn how to apply textures to objects. Experiment with basic materials, shaders, and reflections	CO1	CL4
3	Modeling VR Objects - Model simple VR objects like a table and a chair. Ensure proper scale and proportions for VR.	CO2	CL4
4	UV Mapping and Unwrapping - Understand UV mapping and unwrap objects. Apply textures to objects using UV mapping.	CO2	CL4



5	Scene Composition - Create a VR room with the modelled objects. Arrange the scene and set up a camera for VR viewing.	CO3	CL4
6	Lighting and Shading - Add lighting sources to the scene for realism. Experiment with different lighting setups and shading options.	CO3	CL4
7	Adding Interaction - Learn about Blender's built-in game engine for interactions. Implement basic interactions like object picking and dropping.	CO3	CL4
8	Simple Animations - Create animations for objects in the VR environment. Animate object movement, rotation, and scaling.	CO4	CL4
9	Exporting to Web VR - Learn about exporting to Web VR formats using platforms like A-Frame. Convert your Blender scene into a Web VR experience.	CO5	CL4
10	Exporting to Unity - Export your Blender assets to Unity for further VR development. Set up the VR environment and import your assets.	CO5	CL6
11	VR Interaction in Unity - Implement VR interactions using Unity's VR toolkit. Add gaze-based interaction and simple VR interactions.	CO5	CL6
12	Captstone VR App Project - Combine all your skills to create a simple VR app. Develop a VR environment with interactive objects and animations	CO5	CL6

Note: Installation procedure of the required software must be demonstrated, carried out in groups and documented in the journal.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Apply Blender and Unity for VR app development, as evidenced by their ability to navigate the software interfaces, model objects, apply textures, and implement VR interactions.	CL4
CO2	Create 3D models of VR objects with correct scale and proportions, with the skills to compose immersive VR scenes, including setting up cameras and lighting for realistic experiences.	CL4
CO3	Apply and create texture mapping, UV unwrapping, and material application techniques, enabling them to enhance the visual appeal and realism of VR environments.	CL4
CO4	Create interactive elements within VR environments using both Blender's built-in game engine and Unity's VR toolkit. They will be proficient in creating interactions such as object picking, dropping, and gaze-based interaction.	CL4
CO5	Create VR App by export asseting from Blender to Unity, integrate them into a VR environment, and create a complete VR app. This culminating outcome will showcase their skills in developing VR experiences from concept to execution.	CL6

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2



CO1	3	3	3		3			2	2	1		2	2	2
CO2	3	3	3		3			2	2	1		2	2	2
CO3	3	3	3		3			2	2	1		2	2	2
CO4	3	3	3		3			2	2	1		2	2	2
CO5	3	3	3		3			2	2	1		2	2	2

3: Substantial (High)

2: Moderate (Medium)

1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT STRATEGY:

- I. In Laboratory Courses where (B) and (C) are not the components of the assessment pattern, then (A) will have 100% weightage (50 Marks).

Assessment Mode: Weekly Assessment of Laboratory Work (50 Marks) - the marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment, each of 25 marks) of the students in each laboratory session. The average of all the marks obtained across the sessions will be the Final CIA marks.

- II. In Laboratory Courses where (C) is not a component of the assessment pattern, then (A) will have 50% weightage (25 Marks), and (B) will have 50% weightage (25 Marks).

Assessment Mode: The marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment) (A) and One Laboratory Test (B).

- In Weekly Assessment, the student will be evaluated in each laboratory session for 25 marks. The average marks obtained across all the experiments will be the marks obtained for (A).
- A Laboratory Test, similar to the SEE exam is conducted towards the end of the Semester/Course, whichever is earlier. The obtained marks are scaled down to 25 Marks (B)

The Sum of marks obtained across (A) and (B) will be the Final CIA marks.

- III. In Laboratory Courses where (C) is a component of the assessment pattern, then assessment will be done by considering the weightages given above, i.e. (A) – 25 Marks (Weekly Assessment), (B) – 15 Marks (Laboratory Examination), (C) – 10 marks (Open Ended Experiments/Mini Projects)

- The respective course instructor will design the assessment criteria for the said assessment components.
- The assessment components will be made known to the students by the respective Course Coordinators prior to the commencement of the Laboratory Work.

In all the cases, the assessments will be done based on the criteria designed by the Course Coordinator.

SEE QUESTION PAPER PATTERN:

- All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
- SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
- General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
- Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE WEB LINKS AND VIDEO LECTURES (E-RESOURCES):

- <https://www.blender.org/support/tutorials/>



2. <https://learn.unity.com/>



INDUSTRIAL CONTROL AND INSTRUMENTATION

(Effective from the Academic Year 2023 - 2024)

VII SEMESTER

Course Code	ME722I1M	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40L + 20P	Exam Hours	03

CREDITS – 4

COURSE PREREQUISITES:

- Fundamental knowledge of Electronic engineering.

COURSE OBJECTIVES:

- To acquire a thorough grasp of contemporary control theory, industrial automation, and systems analysis.
- To create models for mechanical, hydraulic, pneumatic, and electrical systems.
- To represent system elements by blocks and its reduction techniques.
- To understand transient and steady state response analysis of a system.
- To carry out frequency response analysis using polar plot, Bode plot.
- To analyse a system using root locus plots.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction: Components of a control system, Open loop and closed loop systems. Types of controllers: Proportional, Integral, Differential, Proportional-Integral, and Proportional- Integral- Differential controllers.

8 Hours

Modelling of Physical Systems: Mathematical Models of Mechanical, Electrical, Thermal, Hydraulic Systems

MODULE - II

Time domain performance of control systems: Typical test signal, Unit step response and time domain specifications of first order, second order system. Steady state error, error constants.

8 Hours

Block diagram algebra: Reduction of block diagram, Signal flow graphs, Gain formula for signal flow graphs, State diagram from differential equations.

MODULE - III

Stability of linear control systems: Routh's criterion, Root locus, Determination of phase margin and gain margin using root locus.

8 Hours

MODULE - IV

Stability analysis using Polar plot, Nyquist plot, Bode plot, Determination of phase margin and gain margin using Bode plot.

8 Hours

MODULE - V





Data Acquisition Systems: A/D and D/A converters, Plug-in Analog Input / Output cards – Digital Input and Output Cards, Opto-isolation – Performing analog input and analog output – Scanning multiple analog channels – Issues involved in selection of Data acquisition cards – Data acquisition modules with serial communication. Virtual Instrumentation: Block diagram and Architecture for Virtual Instruments versus Traditional Instruments Instrumentation -VI Programming techniques - VI, sub VI, Loop and Charts, Arrays, Clusters and Graphs, Case and Sequence Structures, Formula nodes, String and File Input / Output	8 Hours
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COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Distinguish the open and closed type of controllers and time domain control systems.	CL3
CO2	Analyze the control systems with the aid of block diagram reduction, signal flow graphs, and frequency response diagrams.	CL3
CO3	Analyze the control systems with the aid of Root locus.	CL3
CO4	Analyze the stability of control systems with the help of Polar plot, Nyquist plot, Bode plot	CL3
CO5	Organize the DAQ systems and analyze the Virtual instrumentation using in VI software.	CL2

LABORATORY COMPONENTS

Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	Case study of PID Controller.	CO1	CL2
2.	Performance characteristics of an analog PID controller using simulated systems.	CO1	CL3
3.	Temperature controller using PID	CO1	CL3
4.	Demonstration of Graphical modelling of physical system	CO1	CL3
5.	Demonstration of block diagram reduction	CO2	CL3
6.	Stability analysis of linear time invariant systems – Root locus	CO3	CL3
7.	Stability analysis of linear time invariant systems – Bode plot	CO4	CL3
8.	Sum of 'n' numbers using FOR loop	CO5	CL3
9.	Factorial of a give number using FOR loop	CO5	CL3
10.	Sorting even numbers using WHILE loop in an array	CO5	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	3							1		1	2		
CO2	3	3	3							1		1	2		
CO3	3	3	3	1	2				1	1		1	2		
CO4	3	3	3	1	2				1	1		1	2		
CO5	3	3	3							1		1	2		
3: Substantial (High)				2: Moderate (Medium)						1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
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1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Practical Session (Laboratory Component)	40 %	20
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)			Semester End Exam (SEE) (50%)	
Continuous Internal Evaluation (CIE) (60%)			Practical Sessions (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII		MIII	MIII
		MIV	MIV	MIV
		MV	MV	MV

NOTE:

- Assessment will be both CIA and SEE.
- The practical sessions of the IPCC shall be for CIE only.
- The Theory component of the IPCC shall be for both CIA and SEE respectively.
- The questions from the practical sessions shall be included in Theory SEE.

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

SEE QUESTION PAPER PATTERN:

1. The question paper will have **TEN** full questions from **FIVE** Modules
2. There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
3. Each full question may have a maximum of four sub-questions covering all the topics under a module.
4. The students will have to answer FIVE full questions, selecting one full question from each module.

TEXT BOOKS:

1. Automatic Control Systems Farid G., Kuo B. C McGraw Hill Education 10th Edition, 2018
2. Control Systems Engineering IjNagrath, M Gopal New Age International (P) Ltd 2018
3. Control systems Manik D. N Cengage 2017

REFERENCE BOOKS:

1. Modern control Engineering K. Ogata Pearson 5th Edition, 2010
2. Control Systems Engineering Norman S Nice Fourth Edition, 2007
3. Modern control Systems Richard C Dorf Pearson 2017
4. Control Systems Engineering S Palani Tata McGraw Hill Publishing Co Ltd ISBN-13 9780070671935



REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. https://onlinecourses.nptel.ac.in/noc22_cs93/unit?unit=17&lesson=18
2. https://onlinecourses.nptel.ac.in/noc22_cs93/unit?unit=26&lesson=27
3. https://onlinecourses.nptel.ac.in/noc22_cs93/unit?unit=43&lesson=44
4. https://onlinecourses.nptel.ac.in/noc22_cs93/unit?unit=52&lesson=53
5. https://onlinecourses.nptel.ac.in/noc22_cs93/unit?unit=75&lesson=76



DESIGN OF MACHINE ELEMENTS II

(Effective from the Academic Year 2023 - 2024)

SEMESTER - VII

Course Code	ME722T2M	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Knowledge of Mechanics of Materials, Kinematics and dynamics of machines, design of Machine Elements I

COURSE OBJECTIVES:

- To understand the design formulation of springs, belts and ropes.
- To understand the design formulation of spur, helical, bevel and worm gears.
- To understand the design formulation of clutches, brakes and bearings

TEACHING - LEARNING STRATEGY:

- Following are some sample strategies that can be incorporate for the Course Delivery
- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Springs: Types of springs, spring materials, stresses in helical coil springs of circular and non-circular cross sections. Concentric springs; springs under fluctuating loads. **Leaf Springs:** Stresses in leaf springs, equalized stresses, and nipping of leaf springs. Belleville springs.

Belts: Materials of construction of flat and V belts, power rating of belts, concept of slip and creep, initial tension, effect of centrifugal tension, maximum power condition. Selection of flat and V belts-length & cross section. **Wire ropes:** Construction of wire ropes, stresses in wire ropes, and selection of wire ropes.

8 Hours

MODULE –II

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

Helical Gears: Definitions, transverse and normal module, formative number of teeth, design based on strength, dynamic load and wear.

8 Hours

MODULE –III

Bevel Gears: Definitions, formative number of teeth, design based on strength, dynamic load and wear.

Worm Gears: Definitions, types of worm and worm gears, and materials for worm and worm wheel. Design based on strength, dynamic, wear loads and efficiency of worm gear drives.

8 Hours

MODULE –IV

Design of Clutches: Necessity of a clutch in automobile, types of clutch, friction materials and its properties. Design of single plate, multi-plate and cone clutches based on uniform pressure and uniform wear theories.

Design of Brakes: Different types of brakes, Concept of self-energizing and self-locking of brakes.

8 Hours



Design of band brakes, block brakes.																	
MODULE –V																	
Journal bearings: Lubricants and their properties, bearing materials and properties; mechanisms of lubrication, hydrodynamic lubrication, pressure development in oil film, bearing modulus, coefficient of friction, minimum oil film thickness, heat generated, and heat dissipated. Numerical examples on journal bearing.													8 Hours				
Antifriction bearings: Types of rolling contact bearings and their applications, static and dynamic load carrying capacities, equivalent bearing load, load life relationship; selection of deep grove ball bearings from the manufacturers’ catalogue; selection of bearings subjected to cyclic loads and speeds.																	
COURSE OUTCOMES																	
Upon completion of this course, the students will be able to:																	
CO No.	Course Outcome Description												Bloom’s Taxonomy Level				
CO1	Analyze the design and selection of power transmission elements like belts &ropes, suspension systems like springs.												CL4				
CO2	Analyze the design formulation of spur and helical gears.												CL4				
CO3	Analyze the design formulation of bevel and worm gears.												CL4				
CO4	Analyze the design formulation of clutches and brakes.												CL4				
CO5	Analyze the design formulations of Journal and antifriction bearing.												CL4				
CO-PO-PSO MAPPING																	
CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)				
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3		
CO1	3	2	2		2			1	1	2		2	2				
CO2	3	2	2		2			1	1	2		2	2				
CO3	3	2	2;		2			1	1	2		2	2				
CO4	3	2	2		2			1	1	2		2	2				
CO5	3	2	2					1	1	2		2	2				
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)							
ASSESSMENT STRATEGY																	
Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:																	
Sl. No.	Assessment Description							Weightage (%)				Max. Marks					
1	Continuous Internal Assessment (CIA)							100 %				50					
	Continuous Internal Evaluation (CIE)							60 %				30					
	Assignments							40 %				20					
2	Semester End Examination (SEE)							100 %				50					
CO - ASSESSMENT MAPPING																	
Course Outcomes	Continuous Internal Assessment (CIA) (50%)								Semester End Exam (SEE)(50%)								
	Continuous Internal Evaluation (CIE) (60%)						Assignment/ Activities (40%)										
	I	II	III														
	Syllabus Coverage						Syllabus Coverage		Syllabus Coverage								
	40%						30%		30%		100%		100%				
CO1		x						x		X							
CO2		x		x				x		X							
CO3				x				x		X							



CO4			X	X	X
CO5			X	X	X

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	5
2	Quiz	25 %	5
3	Field Visits/Survey/Case Studies	50 %	10
4	Model / Prototype Development	100 %	20
5	Project Based Learning		
6	Seminar/Presentation	25 %	5
7	Peer - to -Peer Learning	25 %	5

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions.
- Each full question consisting of 20 marks.
- There will be 2 full questions from all the FIVE modules.
- Each full question will have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Richard G. Budynas, and J. Keith Nisbett, "Shigley's Mechanical Engineering Design" McGraw-Hill Education, 10th edition, 2015.
2. V B Bhandari "Design of Machine Elements" Tata McGraw Hill, 4th Ed., 2016.
3. Juvinall R.C, and Marshek K.M., "Fundamentals of Machine Component Design" Juvinall R.C, and Marshek K.M., John Wiley & Son, Third Edition, 2007.
4. Dr.M H Annaiah Dr. J Suresh Kumar., " Design of Machine Elements" New Age International, First Edition, 2016.
5. Robert L. Norton "Machine Design" Pearson Education, Second Edition.
6. H.G.Patil, S.C.Pilli, R.R.Malagi, M.S.Patil., "Elements of Machine Design" IK International, First Edition, 2019.

DESIGN DATA HAND BOOK:

1. Design Data Hand Book by K. Mahadevan and Balaveera Reddy, CBS Publication, 4th Revised edition.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. Design of Machine Elements <https://nptel.ac.in/courses/112/105/112105125/>
2. Design of Machine Elements <https://nptel.ac.in/courses/112/105/112105124/>
3. Design of Machine Elements <https://nptel.ac.in/courses/112/106/112106137/>



OPERATIONS & SUPPLY CHAIN MANAGEMENT

(Effective from the Academic Year 2023 - 2024)

VII SEMESTER

Course Code	ME72213MA	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fundamentals of Management and Mathematics.

COURSE OBJECTIVES:

- The course focuses on the basic concepts, issues, and techniques adopted worldwide for efficient and effective operations.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Production and Operations Management: Introduction, Functions within business organizations, the operation management function, Classification of production systems, Productivity, factors affecting productivity.

8 Hours

Decision Making: The decision process, characteristics of operations decisions, use of models - B.E.P and Transportation models, decision making environments. Decision trees.

MODULE - II

Forecasting: Steps in forecasting process, approaches to forecasting, forecasts based on judgment and opinion, analysis of time series data, Regression and Correlation methods, accuracy and control of forecasts, Choosing a forecasting technique, Elements of a good forecast.

8 Hours

MODULE - III

Capacity, Location and Layout Planning: Importance of capacity decisions, defining and measuring capacity, determinants of effective capacity, determining capacity requirement, developing capacity alternatives, evaluating alternatives. Design, System an actual capacity. System efficiency and utilization. Determination of Equipment requirement for a single stage production processes. Numerical problems on the above. Need for location decisions, nature of locations decisions, general procedure for making locations decisions, evaluating locations decisions. Use of Breakeven analysis and Transportation algorithms for making location decisions. Facilities layout - Need for layout decisions. Minimizing material handling cost in process layout using Load distance analysis, Simple line balancing problems in product layouts

8 Hours

MODULE - IV

Aggregate Planning & Master Scheduling: Aggregate planning - Nature and scope of aggregate planning, strategies of aggregate planning, techniques for aggregate planning - graphical and charting techniques, Mathematical techniques. The master production schedule, Master scheduling process, Master

8 Hours



scheduling methods.	
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MODULE - V

Material Requirement Planning (MRP): Dependent versus independent demand, an overview of MRP - MRP inputs and outputs, MRP processing; An overview of MRP-II, JIT manufacturing, Kanban System and ERP, benefits and limitations of MRP. Capacity requirement planning. Purchasing and Supply Chain Management (SCM): Introduction, Importance of purchasing and SCM, the procurement process, Concept of tenders, Approaches to SCM, Vendor development.	8 Hours
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COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Explain the concept and scope of operations management in a business context	CL3
CO2	Recognize the role of Operations management among various business functions and its role in the organizations strategic planning and gaining competitive advantage.	CL3
CO3	Analyze the appropriateness and applicability of a range of operations management systems/models in decision making.	CL3
CO4	Assess a range of strategies for improving the efficiency and effectiveness of organizational operations.	CL3
CO5	Evaluate a selection of frameworks used in the design and delivery of operations	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2										2		2	
CO2	3	2										2		2	
CO3	3	2										2		2	
CO4	3	2										2		2	
CO5	3	2										2		2	
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)	
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)		
I	II	III			
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage	
40%	30%	30%	100%	100%	
MI			MI	MI	
MII	MII		MII	MII	



	MIII		MIII	MIII
		MIV	MIV	MIV
		MV	MV	MV

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Production and Operation Management Chary S. N. TataMcGraw Hill 3rd edition.
2. Production and Operations Management, Everett E. Adams, Ronald J. Ebert, Prentice Hall of India Publications, Fourth Edition.
3. Modern Production/Operations Management, Buffia, Wiely India Ltd 4th Edition.
4. Operation Management, Author- Joseph G Monks McGraw Hill Publication, International Edition-1987.
5. Production and Operation Management”, Author-Pannerselvam R. PHI publications, 2nd edition
6. An Introductory book on lean System, TPS Yasuhiro Modern.
7. Operations Management, William J Stevenson, TataMcGraw Hill 13th edition.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. https://onlinecourses.nptel.ac.in/noc20_me30/preview



REFRIGERATION AND AIR-CONDITIONING

(Effective from the Academic Year 2023 - 2024)

VII SEMESTER

Course Code	ME72213MB	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Elements of Mechanical Engineering
- Fluid Dynamics
- Thermodynamics
- Heat transfer

COURSE OBJECTIVES:

- Study the basic definition, ASHRAE nomenclature for refrigerating systems.
- Understand the working principles and applications of different types of refrigeration systems.
- Study the working of air conditioning systems and their applications.
- Identify the performance parameters and their relations of an air conditioning system.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction to Refrigeration: Basic definitions, ASHRAE nomenclature, Air Refrigeration Cycles - Reversed Carnot cycle, Bell-Coleman cycle analysis, Air Refrigeration systems - merits and demerits and applications; Aircraft refrigeration cycles, Joule Thompson coefficient and Inversion Temperature, Linde, Claude and Stirling cycles for liquefaction of air.

Industrial Refrigeration: Chemical and process industries, Dairy plants, Petroleum refineries, Food processing and food chain, Miscellaneous

8 Hours

MODULE - II

Vapour Compression Refrigeration System: Comparison of Vapour Compression Cycle and Gas cycle, Vapour Compression Refrigeration system Working and analysis, Limitations, Superheat horn and throttling loss for various refrigerants, efficiency, Modifications to standard cycle – liquid-suction heat exchangers, Grindlay cycle and Lorenz cycle, Optimum suction condition for optimum COP, Actual cycles with pressure drops, Complete Vapour Compression Refrigeration System, Multi-Pressure, Multi-evaporator systems or Compound Vapour Compression Refrigeration Systems – Methods like Flash Gas removal, Flash inter cooling and Water inter cooling.

8 Hours

MODULE - III

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

Other types of Refrigeration systems: Brief Discussion on Steam-Jet refrigeration system and Thermoelectric refrigeration, pulse tube refrigeration, thermoacoustic refrigeration systems

8 Hours



MODULE - IV

Refrigerants: Primary and secondary refrigerants, Designation of Refrigerants, Desirable properties of refrigerants including solubility in water and lubricating oil, material compatibility, toxicity, flammability, leak detection, cost, environment and performance issues Thermodynamic properties of refrigerants, Synthetic and natural refrigerants, Comparison between different refrigerants vis a vis applications, Special issues and practical implications Refrigerant mixtures – zeotropic and azeotropic mixtures.

Refrigeration systems Equipment: Compressors, Condensers, Expansion Devices and Evaporators, A brief look at other components of the system.

8 Hours

MODULE - V

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

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

8 Hours

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Illustrate the principles, nomenclature and applications of refrigeration systems.	CL3
CO2	Demonstrate vapour compression refrigeration system and methods for performance improvement.	CL3
CO3	Describe the working principle of Vapour Absorption Refrigeration Systems, thermoelectric, steam-jet and thermoacoustic refrigeration systems.	CL3
CO4	Demonstrate the desirable properties, types of refrigerants and components of refrigerating systems.	CL3
CO5	Illustrate the principles of Transport air-conditioning Systems and load calculations.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	1			1	1	1				1			3
CO2	3	3	2			1	1	1				1			3
CO3	3	3	1			1	1	1				1			3
CO4	3	3	1			1	1	1				1			3
CO5	3	3	2			1	1	1				1			3
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)	Semester End Exam (SEE) (50%)
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Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII		MIII	MIII
		MIV	MIV	MIV
		MV	MV	MV

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Refrigeration and Air-conditioning, Arora C.P, Tata Mc Graw-Hill, New Delhi, 2nd Edition, 2001.
2. Refrigeration and Air-conditioning, Stoecker W.F., and Jones J.W., McGraw-Hill, New Delhi, 2nd edition, 1982.
3. Refrigeration and Air-Conditioning, S C Arora & S Domkundwar, Dhanpat Rai Publication.
4. Air conditioning, PITA, Pearson, 4th edition, 2005.
5. Principles of Refrigeration, Roy J. Dossat, Wiley Limited.
6. Heating, Ventilation and Air Conditioning, McQuiston, Wiley Students edition, 5th edition, 2000.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. <https://archive.nptel.ac.in/courses/112/105/112105129/>





AUTOMOTIVE ENGINEERING

(Effective from the Academic Year 2023 - 2024)

VII SEMESTER

Course Code	ME72213MC	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fundamental knowledge of Elements of mechanical Engineering.

COURSE OBJECTIVES:

- To understand the different chassis design & main components of an engine
- To understand the working of transmission and control system employed in automobiles
- To understand the automotive pollution and alternative automotive technologies under trail
- To understand the upcoming electric vehicle technology

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

ENGINE COMPONENTS AND IT'S PRINCIPLE PARTS: Spark Ignition (SI) & Compression Ignition (CI) engines, cylinder – arrangements and their relatives merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams, Types of combustion chambers for S.I. Engine and C.I. Engines, methods of a Swirl generation, engine positioning. Concept of HCCI engines, Hybrid engines, Twin spark engine, Electric car.

COOLING AND LUBRICATION: Cooling requirements, Types of cooling- Thermo siphon system, forced circulation water cooling system, water pump, Radiator, Significance of lubrication, Splash and Forced feed system.

8 Hours

MODULE - II

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

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

8 Hours

MODULE - III

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

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



MODULE - IV

SUPERCHARGERS AND TURBOCHARGERS: Naturally aspirated engines, Forced Induction, Types of superchargers, Turbocharger construction and operation, Intercooler, Turbocharger lag.	8 Hours
FUELS, FUEL SUPPLY SYSTEMS FOR SI AND CI ENGINES: Conventional fuels, Alternative fuels, Normal and Abnormal combustion, Cetane and Octane numbers, Fuel mixture requirements for SI engines, Types of carburetors, C.D.& C.C. carburetors, Multi point and Single point fuel injection systems, fuel transfer pumps, Fuel filters, fuel injection pumps and injectors. Electronic Injection system, Common Rail Direct Injection System.	

MODULE - V

AUTOMOTIVE EMISSION CONTROL SYSTEMS: Different air pollutants, formation of photochemical smog and causes. Automotive emission controls, controlling crankcase emissions, controlling evaporative emissions, Cleaning the exhaust gas, Controlling the air-fuel mixture, Controlling the combustion process, Exhaust gas recirculation, Treating the exhaust gas, Air-injection system, Air-aspirator system, Catalytic converter.	8 Hours
EMISSION STANDARDS: Euro emission norms, Bharat Stage I, II, III, IV and VI norms. Motor Vehicle Act.	

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Identify the different parts of an automobile and it's working.	CL2
CO2	Understand the working of transmission and braking systems.	CL2
CO3	Understand the working of steering and suspension systems and their applications.	CL2
CO4	Selection and applications of various types of fuels and injection systems.	CL2
CO5	Understand the cause of automobile emissions, its effects on environment and methods to reduce the emissions.	CL2

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	1				2				2			3
CO2	3	3	2					2				2			3
CO3	3	3	3					2				2			3
CO4	3	3	3					2				2			3
CO5	3	3	3					2				2			3
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	Semester End Examination (SEE)	100 %	50



ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)			Semester End Exam (SEE) (50%)	
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII		MIII	MIII
		MIV	MIV	MIV
		MV	MV	MV

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	25 %	05
3	Case Studies	25 %	05
4	Seminar/Presentation	50%	10
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer **FIVE** full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Automobile engineering Vol I and II Kirpal Singh Standard Publishers 12th Edition 2011
2. Automotive Mechanics S. Srinivasan Tata McGraw Hill 2003 2nd Edition
3. Automotive Mechanics William H Crouse & Donald L Anglin Tata McGraw Hill Publishing Company Ltd 10th Edition 2007
4. Automotive Mechanics: Principles and Practices, Joseph Heitner D Van Nostrand Company, Inc
5. Automobile Engineering R. B. Gupta Satya Prakashan 4th edition 1984.



FUTURE MOBILITY SYSTEM

(Effective from the Academic Year 2023 - 2024)

VII SEMESTER

Course Code	ME72213MD	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Basic understanding of IC engines working
- Fundamental knowledge of control systems

COURSE OBJECTIVES:

- To understand the basics of control systems used in automobiles
- To understand concept of hybrid vehicles and their topologies
- To need for electric and fuel cell vehicles

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction to EV

Introduction: Past, Present & Future of EV, Current Major Issues, Recent Development Trends, EV Concept, Key EV Technology, State-of-the Art EV, Comparison of EV Vs IC Engine. EV System: EV Configuration: Fixed & variable gearing, single & multiple motor drive, In-wheel drives EV Parameters: Weight, size, force, energy & performance parameters.

8 Hours

MODULE - II

Hybrid Electric Vehicles(HEV)

Configuration of HEV (Series, Parallel, Series-parallel & Complex), Power Flow control, Examples. Power flow control in all HEV configurations, Examples of HEV system performance

8 Hours

MODULE - III

Autonomous Vehicle Technology:

Driverless Car Technology-Different Levels of Automation -Localization - Path Planning. Controllers to Actuate a Vehicle - PID Controllers -Model Predictive Controllers, ROS Framework

8 Hours

MODULE - IV

Sensor Technology for Autonomous Vehicles:

Basics of Radar Technology and Systems -Ultrasonic Sonar Systems and Systems -Camera Technology -Night Vision Technology -Use of Sensor Data Fusion -Kalman Filters

8 Hours

MODULE - V

Advanced driver assistant systems (ADAS):

ADAS domain controller, automotive thermal camera, camera module without processing, conditionally automated drive controller, drive assist ECU, Drive monitoring, LiDAR.

8 Hours

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
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CO1	Identify EV concepts, EV configurations and various EV parameters for better understanding of the EV technology	CL3
CO2	Elaborate various hybrid electric vehicle configurations and explain the power flow control in all HEV configurations	CL3
CO3	Identify the different levels of automation involved in an Autonomous Vehicle.	CL3
CO4	Compare the different type of sensing mechanisms involved in Autonomous Vehicles	CL3
CO5	Recognize the electronically controlled system used in advanced driver assistance system	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2					2				2	1		
CO2	3	3	2					2				2	1		
CO3	3	3	3					2				2	1		
CO4	3	3	3					2				2	1		
CO5	3	3	3					2				2	1		
3: Substantial (High)				2: Moderate (Medium)						1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)	
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)		
I	II	III			
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage	
40%	30%	30%	100%	100%	
MI			MI	MI	
MII	MII		MII	MII	
	MIII		MIII	MIII	
		MIV	MIV	MIV	
		MV	MV	MV	

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05



4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Uwe Kiencke and Lars Nielson, Automotive Control System, SAE Publications, 2006
2. Bosch Automotive Handbook, Sixth Edition, 2004
3. Mehrdad Ehsani, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles”, CRC Press, 2005.
4. James Larminie and John Lowry, “Electric Vehicle Technology Explained”, John Wiley & Sons, 2003
5. Galip Ulsoy, Automotive Control System, Cambridge University Press, 2012
6. Iqbal Husain, “Electric and Hybrid Vehicles-Design Fundamentals”, CRC Press, 2003

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. <https://www.coursera.org/learn/electric-vehicles-mobility>
2. https://onlinecourses.nptel.ac.in/noc20_ee90/previewhttps://archive.nptel.ac.in/courses/107/106/107106088/
3. <https://www.coursera.org/specializations/self-driving-cars>





ENERGY AND ENVIRONMENT
(Effective from the Academic Year 2023 - 2024)
VII SEMESTER

Course Code	ME72224MA	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fundamental knowledge of Environment Science and Biology.

COURSE OBJECTIVES:

- To understand the fundamentals of energy sources, energy use, energy efficiency, and resulting environmental implications of various energy supplies.
- To introduce various aspects of environmental pollution and its control.
- To understand the causes and remedies related to social issues like global warming, ozone layer depletion, climate change etc.
- To introduce various acts related to prevention and control of pollution of water and air, forest protection act, wild life protection act etc.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Basic Introduction to Energy: Energy and power, forms of energy, primary energy sources, energy flows, world energy production and consumption, Key energy trends in India: Demand, Electricity, Access to modern energy, Energy production and trade, Factors affecting India's energy development: Economy and demographics Policy and institutional framework, Energy prices and affordability, Social and environmental aspects, Investment.	8 Hours
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MODULE - II

Energy storage systems: Thermal energy storage methods, Energy saving, Thermal energy storage systems Energy Management: Principles of Energy Management, Energy demand estimation, Energy pricing. Energy Audit: Purpose, Methodology with respect to process Industries, Characteristic method employed in Certain Energy Intensive Industries.	8 Hours
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MODULE - III

Environment: Introduction, Multidisciplinary nature of environmental studies- Definition, scope and importance, Need for public awareness. Ecosystem: Concept, Energy flow, Structure and function of an ecosystem. Food chains, food webs and ecological pyramids, Forest ecosystem, Grassland ecosystem, Desert ecosystem and Aquatic ecosystems, Ecological succession.	8 Hours
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MODULE - IV

Environmental Pollution: Definition, Cause, effects and control measures of - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution and Nuclear hazards, Solid waste Management, Disaster management Role of an individual in prevention of pollution. Pollution case	8 Hours
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studies.															
MODULE - V															
Social Issues and the Environment: Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies. Wasteland reclamation, Consumerism and waste products, Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation.														8 Hours	
COURSE OUTCOMES															
Upon completion of this course, the students will be able to:															
CO No.	Course Outcome Description													Bloom's Taxonomy Level	
CO1	Summarize the basic concepts of energy, its distribution and general scenario.													CL3	
CO2	Explain different energy storage systems, energy management, audit and economic analysis.													CL3	
CO3	Describe the environment, Eco system and need for awareness.													CL3	
CO4	Identify the various types of environmental pollution and their effects also to discuss the social issues of the environment with associated acts.													CL3	
CO5	Explain acts related to prevention and control of pollution of water and air, forest protection act, wild life protection acts etc.													CL3	
CO-PO-PSO MAPPING															
CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	1	1			1	2	2	1			2			2
CO2	2	2	1			1	2	2	1			2			2
CO3	1	1	1			1	2	2	2		1	2			2
CO4	1	1	1			1	2	2	2		1	2			2
CO5	1	1	1			1	2	2	2		1	2			2
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					
ASSESSMENT STRATEGY															
Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:															
Sl. No.	Assessment Description					Weightage (%)					Max. Marks				
1	Continuous Internal Assessment (CIA)					100 %					50				
	Continuous Internal Evaluation (CIE)					60 %					30				
	Assignments					40 %					20				
2	Semester End Examination (SEE)					100 %					50				
ASSESSMENT DETAILS															
Continuous Internal Assessment (CIA) (50%)										Semester End Exam (SEE) (50%)					
Continuous Internal Evaluation (CIE) (60%)							Assignment/ Activities (40%)								
I		II		III											
Syllabus Coverage							Syllabus Coverage			Syllabus Coverage					
40%		30%		30%			100%			100%					
MI							MI			MI					
MII		MII					MII			MII					



	MIII		MIII	MIII
		MIV	MIV	MIV
		MV	MV	MV

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Textbook for Environmental Studies for Undergraduate Courses of all Branches of Higher Education, University grant commission and Bharathi Vidyapeeth Institute of environment education and Research, Pune.
2. Energy Management Audit & Conservation- for Module 2, Barun Kumar De, Vrinda Publication, 2nd Edition 2010.
3. Energy Management Hand book, Turner, W. C., Doty, S. and Truner, W. C, Fairmont Press, 7th Edition 2009.
4. Energy Management, Murphy, W. R, Elsevier, 2007.
5. Energy Management Principles, Smith, C. B, Pergamum, 2007.
6. Environment pollution control Engineering, C S Rao, New Age International, reprint 2015, 2nd edition.
7. Environmental studies, Benny Joseph, Tata McGraw Hill, 2nd edition 2008.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. NPTEL Video on Energy Resources, Economics and Environment- <https://youtu.be/o28OSxpMa8w>
2. NPTEL Video on Materials for Energy- <https://youtu.be/SCUsVjOHp70>
3. NPTEL Video on Biodiversity, population and ecological principles- https://youtu.be/hihFHam_wNE
4. NPTEL Video on Wastewater Recycling: A Sustainable Option for Water Management- https://youtu.be/_BiQiK_hYo
5. NPTEL Video on Sustainable Water Management in Urban Areas- <https://youtu.be/ph3JcY8c1Oo>



PRODUCT DESIGN AND MANUFACTURING

(Effective from the Academic Year 2023 - 2024)

SEMESTER - VII

Course Code	ME72224MB	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

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COURSE OBJECTIVES:

- To Understand modern product development processes.
- To understand the concept of Industrial design.
- To understand the concept of Design for manufacture and assembly.

TEACHING - LEARNING STRATEGY:

- Following are some sample strategies that can be incorporate for the Course Delivery
- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction to Product design: Asimow's model: Definition of product design, Design by Evolution, Design by Innovation, Essential Factors of Product design, Production-Consumption Cycle, Flow and Value Addition in the Production-Consumption Cycle, The Morphology of Design (The seven phases), Primary Design Phases and Flowcharting, Role of Allowance, Process Capability and Tolerance in Detailed Design & Assembly.

8 Hours

MODULE – II

Product design practice and Industry: Introduction, Product Strategies, Time to Market, Analysis of the Product, The S's Standardization, Reynard Series, Simplification, Role of Aesthetics in Product Design, Functional Design Practice. **Review of Strength, Stiffness and Rigidity Considerations in Product Design:** Principal Stress Trajectories (Force-Flow Lines), Balanced Design, Criteria and Objectives of Design, Material Toughness: Resilience Designing for Uniform Strength. Review of Production Process: Introduction, Primary Processes, Machining Process, Non-traditional Machining Processes.

8 Hours

MODULE – III

Design for Production metal Parts: Producibility requirements in the Design of machine Components, Forging Design, Pressed components Design, Casting Design, and Design for Machining Ease, The Role of Process Engineer, Ease of Location Casting and Special Casting. Designing with Plastic, rubber, ceramics and wood: Approach to design with plastics, plastic bush bearings, gears in plastics, rubber parts, design recommendations for rubber parts, ceramic and glass parts.

8 Hours

MODULE – IV

Optimization in Design: Introduction, Siddal's Classification of Design Approaches, Optimization by Differential Calculus, Lagrange Multipliers, Linear Programming (Simplex Method), Geometric Programming, Johnson's Method of Optimum Design. **Economic Factor Influencing Design:** Product Value, Design for Safety, Reliability and Environmental Considerations, Manufacturing Operations in

8 Hours



relation to Design, Economic Analysis, Profit and Competitiveness, Break – even Analysis, Economic of a New Product Design.	
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MODULE – V

Value Engineering and Product Design: Introduction, Historical Perspective, What is Value? Nature and Measurement of Value, Normal Degree of Value, Importance of Value, The Value analysis Job Plan, Creativity, Steps to Problems-solving and Value Analysis, Value Analysis Test. Material and Process Selection in Value Engineering Modern Approaches to Product Design: Concurrent Design and Quality Function Deployment (QFD). Human Engineering Considerations In Product Design: Introduction, Human being as Applicator of Forces, Anthropometry; Man as occupant of Space, The Design of Controls, of controls, the Design of Displays, Man/Machine Information Exchange.	8 Hours
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COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Understand the morphology of design Process, Capability and Tolerance in detailed design & Assembly.	CL2
CO2	Classify the Product Strategies and Properties Considerations in Product Design.	CL3
CO3	Examine the requirements in the Design of machine Components and the role of Process engineer.	CL3
CO4	Interpret the different methods of Optimum design	CL3
CO5	Understand the Process to Problem solving and Value analysis.	CL2

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	1									2			2
CO2	2	2	1									2			2
CO3	2	2	1									2			2
CO4	2	2	1									2			2
CO5	2	2	1									2			2
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	Semester End Examination (SEE)	100 %	50

CO - ASSESSMENT MAPPING

Course Outcomes	Continuous Internal Assessment (CIA) (50%)						Semester End Exam (SEE) (50%)		
	Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)					
	I	II	III						
	Syllabus Coverage			Syllabus Coverage			Syllabus Coverage		
	40%	30%	30%	100%			100%		





CO1	x			x	X
CO2	x			x	X
CO3		x		x	X
CO4		x	x	x	X
CO5			x	x	X

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	5
2	Quiz	25 %	5
3	Field Visits/Survey/Case Studies	50 %	10
4	Model / Prototype Development	100 %	20
5	Project Based Learning		
6	Seminar/Presentation	25 %	5
7	Peer - to -Peer Learning	25 %	5

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions.
- Each full question consisting of 20 marks.
- There will be 2 full questions from all the FIVE modules.
- Each full question will have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Product design for manufacture and Assembly by Geoffrey Boothroyd, Peter Dewhurst, 3rd edition, 2010.
2. Product design and manufacturing by A.K. Chitale, R.C. Gupta, PHI Learning Private Limited, 2011.
3. Production Engineering, K.C Jain, A.K. Chitale, PHI Learning, 2010.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

- 1.



BUSINESS PLANNING AND PROJECT MANAGEMENT

(Effective from the Academic Year 2023 - 2024)

VII SEMESTER

Course Code	ME72224MC	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fundamentals of Management and Mathematics.

COURSE OBJECTIVES:

- Business Planning and Project Management aims to sensitize learners about the concept of planning in general and business planning specifically.
- The course would also give insights the learners about successfully managing projects.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction: Nature and Limitations of Planning, Planning Devices & Obstacles in Planning and Techniques of Forecasting	8 Hours
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MODULE - II

Introduction and Process of Forecasting: Techniques of Forecasting, Difference between Forecasting and Planning, Introduction to Project Management	8 Hours
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MODULE - III

Project Management Maturity, Project Selection - Model & Types, Project Management and Project Manager, Organization Structures for Project Management	8 Hours
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MODULE - IV

Project Organisation and Matrix Organisation, The Nature of Negotiation, Conflict and PLC, PERT and CPM, CPM & Crashing the Project, The Planning - Monitoring - Controlling Cycle	8 Hours
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MODULE - V

Fundamental Purposes of Project Control, Design of Control Systems, Some Essentials of an Audit, Varieties of Project Termination, Termination Process	8 Hours
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COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Understand the concept of Planning and its importance for Businesses.	CL2
CO2	Understand the concept of Project and importance of its management.	CL3



CO3	Critically examine which project needs to be undertaken using various models.	CL3
CO4	Understand the importance of human resources for the projects.	CL3
CO5	Learn the concept of project audit, project life cycle and project termination process.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1												2	1	1	1
CO2	2	3										2	1	1	1
CO3	3	3										2	1	1	1
CO4	3	3										2	1	1	1
CO5	3	3										2	1	1	1
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)	
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)		
I	II	III			
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage	
40%	30%	30%	100%	100%	
MI			MI	MI	
MII	MII		MII	MII	
	MIII		MIII	MIII	
		MIV	MIV	MIV	
		MV	MV	MV	

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10





8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Project Management: Vasant Desai, Himalaya Publishing House
2. Project Management: A Managerial Approach, Jack R. Meredith, Samuel J. Mantel Jr. Wiley India Pvt. Ltd.
3. Principles of Management: T. Ramasamy, Himalaya Publishing House 8. The McGraw-Hill 36-Hour Project Management Course -McGraw-Hill
4. Production and Operation Management: K. Ashwathappa and Siddharth Bhat, Himalaya Publishing House, 2010 editions
5. Project Management: Samule J Mantel, Jr, Jack R. Meredith, Scott M. Shafer, Margaret M, Sutton with M.R. Gopalan, Wiley India Pvt. Ltd.
6. Business Administration with G. M. Dumbre: Success Publications, Pune.
7. Successful Project Management: Milton D. Rosenau, Jr., Cregory D. Githens, Wiley India Pvt. Ltd.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. https://onlinecourses.swayam2.ac.in/cec20_mg07/preview



INTRODUCTION TO HYDRAULICS AND PNEUMATICS

(Effective from the Academic Year 2023 - 2024)

VII SEMESTER

Course Code	ME72224MD	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Basic knowledge of fluid mechanics and its applications.

COURSE OBJECTIVES:

- To provide knowledge on the application of fluid power in process, construction and manufacturing Industries.
- To provide an understanding of the fluids and components utilized in modern industrial fluid power system.
- To develop a measurable degree of competence in the design, construction and operation of fluid power circuits.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction to Hydraulic Power: Pascal's law, Sources of hydraulic power, Pumps, Pumping theory, pump classification, gear pumps, vane pumps, piston pumps, pump performance, variable displacement pumps.
Hydraulic Actuators and Motors: Linear Hydraulic Actuators [cylinders], Mechanics of Hydraulic Cylinder loading, Hydraulic Rotary Actuators, Gear motors, vane motors and piston motors.

8 Hours

MODULE - II

Control Components in Hydraulic Systems: Directional Control Valves, Symbolic representation, Constructional features, pressure control valves, direct and pilot operated types, flow control valves.
Maintenance of Hydraulic systems: Hydraulic oils, desirable properties, general type of fluids, sealing devices, reservoir system, filters and strainers, problem caused by gases in hydraulic fluids, wear of moving parts due to solid particle contamination, temperature control, trouble shooting.

8 Hours

MODULE - III

Hydraulic Circuit Design: Control of single and double acting hydraulic cylinder, regenerative circuit, pump unloading circuit, double pump hydraulic system, Counter Balance Valve application, Hydraulic cylinder sequencing circuits. Locked cylinder using pilot check valve, cylinder synchronizing circuits, speed control of hydraulic cylinder, speed control of hydraulic motors, accumulators and accumulator circuits.

8 Hours

MODULE - IV

Introduction to Pneumatic systems: Pneumatic power system, advantages, limitations, applications, Choice of working medium. Characteristics of compressed air and air compressors. Structure of pneumatic control System, fluid conditioners-dryers and FRL unit.
Pneumatic Actuators: Linear cylinder – types of cylinders, working, end position cushioning, seals, mounting arrangements, and applications. Rotary cylinders- types, construction and application, symbols.
Pneumatic Control Valves: DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, Quick exhaust valve, time delay valve, shuttle valve, twin pressure valve, symbols.

8 Hours

MODULE - V



Pneumatic control circuits: Direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and exhaust air throttling. Signal Processing Elements: Use of Logic gates - OR and AND gates in pneumatic applications. Practical examples involving the use of logic gates. Electro- Pneumatic Control: Principles - signal input and output, pilot assisted solenoid control of directional control valves, use of relay and contactors. Control circuitry for simple signal cylinder application.	8 Hours
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COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Understand the concepts of hydraulic power and operation of different types of pumps.	CL2
CO2	Summarize the controlling elements and maintenance involved in hydraulic systems.	CL2
CO3	Demonstrate the different types of Hydraulic circuits and systems.	CL3
CO4	Explain the working of different elements of pneumatic systems.	CL2
CO5	Interpret the working of different types of pneumatic circuits.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2					2		2		3			3
CO2	3	3	2					2		2		3			3
CO3	3	3	2					2		2		3			3
CO4	3	3	2					2		2		3			3
CO5	3	3	2					2		2		3			3
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)	
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)		
I	II	III			
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage	
40%	30%	30%	100%	100%	
MI			MI	MI	
MII	MII		MII	MII	
	MIII		MIII	MIII	
		MIV	MIV	MIV	
		MV	MV	MV	

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES



Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer **FIVE** full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Anthony Esposito, “Fluid Power with Applications”, Pearson Education 2005
2. Majumdar S.R., “Oil Hydraulics Systems- Principles and Maintenance”, Tata McGraw-Hill, 2001.
3. Shanmugasundaram K, “Hydraulic and Pneumatic controls”, Chand & Co, 2006
4. Craig. J. J. “Introduction to Robotics mechanics and control”, Addison-Wesley, 1999.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. <https://archive.nptel.ac.in/courses/112/106/112106300/>



Computer Integrated Manufacturing Lab

(Effective from the Academic Year 2023 - 2024)

SEMESTER - VII

Course Code	ME722L5M	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	24P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Knowledge of Machining processes and Industrial automation concepts

COURSE OBJECTIVES:

- To expose the students to the techniques of CNC programming and cutting tool path generation through CNC simulation software by using G-Codes and M-codes for Turning.
- To expose the students to the techniques of CNC programming and cutting tool path generation through CNC simulation software by using G-Codes and M-codes for Milling.
- To educate the students on the usage of CAM packages.
- To make the students understand the importance of automation in industries through exposure to FMS, Robotics, and Hydraulics and Pneumatics.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Demonstration
- Expert Talk/Webinar/Seminar
- Hands on Training on CNC Programming

PRE-REQUISITE EXPERIMENTS

Exp. No.	Description
1	Calculations of Machining parameters for Turning, Facing, Thread cutting, Grooving.
2	Understanding various forces involved in machining process using merchant circle diagram.

LIST OF EXPERIMENTS

Exp. No.	Description
1	Determination of various coordinate systems used in CNC Programming.
2	Understand and learning the various Codes used in CNC Turning and CNC Milling
3	Simple CNC programming for Turning and Facing using without standard cycle.
4	Simple CNC programming for Turning and facing using with standard cycle.
5	CNC program for Step turning with and without using Standard cycle
6	CNC program for Step turning with and without using Standard cycle (Canned Cycle)
7	CNC program for End milling/Slot milling without using sub program
8	CNC program for End milling/Slot milling with using sub program
9	CNC program for Drilling milling without using sub program
10	CNC program for Drilling milling with using sub program
11	Cutting path generation for various complex and intricate machining process using Solid Works
12	Cutting path generation for various complex and intricate machining process using Solid Works

COURSE OUTCOMES

Upon completion of this course, the students will be able to:



CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Describe the concepts and write the CNC program for Turning.	CL2
CO2	Describe the concepts and write the CNC program for Milling.	CL2
CO3	Analyze and simulate the effect of real time machining parameters.	CL3
CO4	Interpret the errors in CNC program.	CL3
CO5	Use of CAM packages in automation industries.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	1	1	3	1	-	-	2	1	-	1	2	2	-
CO2	2	2	1	1	3	1	-	-	2	1	-	1	2	2	-
CO3	2	2	1	1	3	1	-	-	2	1	-	1	2	2	-
CO4	2	2	1	1	3	1	-	-	2	1	-	1	2	2	-
CO5	2	2	1	1	3	1	-	-	2	1	-	1	2	2	-
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	Continuous Internal Assessment (CIA)	100 %	50
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT STRATEGY:

- I. In Laboratory Courses where (B) and (C) are not the components of the assessment pattern, then (A) will have 100% weightage (50 Marks).

Assessment Mode: Weekly Assessment of Laboratory Work (50 Marks) - the marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment, each of 25 marks) of the students in each laboratory session. The average of all the marks obtained across the sessions will be the Final CIA marks.

- II. In Laboratory Courses where (C) is not a component of the assessment pattern, then (A) will have 50% weightage (25 Marks), and (B) will have 50% weightage (25 Marks).

Assessment Mode: The marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment) (A) and One Laboratory Test (B).

- o In Weekly Assessment, the student will be evaluated in each laboratory session for 25 marks. The average marks obtained across all the experiments will be the marks obtained for (A).

- o A Laboratory Test, similar to the SEE exam is conducted towards the end of the Semester/Course, whichever is earlier. The obtained marks are scaled down to 25 Marks (B)

The Sum of marks obtained across (A) and (B) will be the Final CIA marks.

- III. In Laboratory Courses where (C) is a component of the assessment pattern, then assessment will be done by considering the weightages given above, i.e. (A) – 25 Marks (Weekly Assessment), (B) – 15 Marks



(Laboratory Examination), (C) – 10 marks (Open Ended Experiments/Mini Projects)

- The respective course instructor will design the assessment criteria for the said assessment components.
- The assessment components will be made known to the students by the respective Course Coordinators prior to the commencement of the Laboratory Work.
- In all the cases, the assessments will be done based on the criteria designed by the Course Coordinator.

SEE QUESTION PAPER PATTERN:

- All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
- SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
- General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
- Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE BOOKS:

1. Principles of CAD/CAM by P N Rao
2. Automation and production systems by M P Groover

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. <https://www.digimat.in/nptel/courses/video/112105211/L01.html>