KPR Institute of Engineering and Technology

Learn Beyond (Autonomous, NAAC "A")

Avinashi Road, Arasur, Coimbatore.

Great Place To Work. Certified MAR 2022 - MAR 2023 INDIA

B.E. – Mechanical Engineering

Curriculum and Syllabi

Regulations – 2021 (Revised)

CONTROLLED COPY

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I. Vision and Mission of the Institute

Vision

To become a premier institute of academic excellence by imparting technical, intellectual and professional skills to students for meeting the diverse needs of the industry, society, the nation and the world at large.

Mission

- Commitment to offer value–based education and enhancement of practical skills
- Continuous assessment of teaching and learning processes through scholarly activities
- Enriching research and innovation activities in collaboration with industry and institutes of repute
- Ensuring the academic processes to uphold culture, ethics and social responsibilities

II. Vision and Mission of the Department

Vision

To be recognized as a premier centre in the field of mechanical engineering education, research and development to meet the changing needs of industry and society

Mission

The Department of Mechanical Engineering is committed to

- Provide fundamental and skill–based education in mechanical engineering through innovative practicesin teaching and leaning
- Establishing centres of excellence in collaborate with reputed industries, professional bodies and research laboratories
- Promote entrepreneurship with leadership qualities, and human values for the society at large

III. Program Educational Objectives (PEOs)

Graduates of B.E. Mechanical Engineering four years after graduation will:

PEO1: Excel in their professional career with competencies in the field of Mechanical and Allied Engineering

PEO2: Apply modern research and simulation tools to solve industrial and societal needs

PEO3: Practice professional and ethical values in their respective organizations and society

IV. Program Outcomes (POs)

A Graduate of Mechanical Engineering should

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

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

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

PO 4 Conduct investigations of complex problems: Use research–based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis

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of theinformation to provide valid conclusions.

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

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

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

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

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

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

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

PO 12 Life–long learning: Recognize the need for, and have the preparation and ability to engage in independent and life–long learning in the broadest context of technological change.

V. Program Specific Outcomes (PSOs)

A Graduate of Mechanical Engineering should

PSO 1: Design, develop and implement advanced mechanical systems by applying engineering principles for improved performance and less human effort.

PSO 2: Apply quality tools to ensure quality, articulate maintenance principles and demonstrate managerial skills to comprehend the mechanical engineering processes and services.

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B.E. MECHANICAL ENGINEERING

REGULATIONS – 2021 (Revised)

For the students admitted 2022 onwards

CHOICE BASED CREDIT SYSTEM
CURRICULUM FOR I – VIII SEMESTERS
SEMESTER I

Sl.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
THEORY COURSES								
1	U21GEG01	Heritage of Tamils	HSMC	1	0	0	0	1
2	U21MA101	Calculus and Differential Equations	BSC	3	1	0	0	4
THEORY COURSE WITH LABORATORY COMPONENT								
3	U21EN101	English for Technologists	HSMC	1	0	2	0	2
4	U21CSG01	Problem Solving and C Programming	ESC	2	0	2	0	3
5	U21PH101	Engineering Physics	BSC	2	0	2	0	3
6	U21CY101	Engineering Chemistry	BSC	2	0	2	0	3
LABORATORY COURSES								
7	U21MEG01	Engineering Graphics	ESC	0	0	4	0	2
8	U21MEG02	Manufacturing Practices	ESC	0	0	4	0	2
MANDATORY NON-CREDIT COURSES								
9	U21MYC01	Induction program	MNC	Three Weeks				
			TOTAL	**11**	**1**	**16**	**0**	**20**

SEMESTER II

Sl.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
THEORY COURSES								
1	U21GEG02	Tamils and Technology	HSMC	1	0	0	0	1
2	U21MA201	Laplace Transforms and Complex Variables	BSC	3	1	0	0	4
3	U21EEG02	Basics of Electrical Engineering	ESC	3	0	0	0	3
4	U21ME201	Engineering Mechanics	PCC	3	0	0	0	3
5	U21PH201	Materials Science	BSC	2	0	0	0	2
THEORY COURSE WITH LABORATORY COMPONENT								
6	U21EN201	Personality Enhancement	HSMC	1	0	2	0	2
7	U21CSG02	Python Programming	ESC	2	0	2	0	3
8	U21ECG02	Basics of Electronics Engineering	ESC	2	0	2	0	3
LABORATORY COURSES								
9	U21ME202	Interfacing of Electronics and Electrical components and Troubleshooting	ESC	0	0	4	0	2
MANDATORY NON-CREDIT COURSES								
10	U21MYC02	Environmental Science	MNC	1	0	0	0	0
			TOTAL	**18**	**1**	**10**	**0**	**23**

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SEMESTER III

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
THEORY COURSES								
1	U21MA303	Fourier Analysis and Boundary Value Problems	BSC	3	1	0	0	4
2	U21ME301	Engineering Thermodynamics	PCC	3	1	0	0	4
3	U21ME302	Manufacturing Technology–I	PCC	3	0	0	0	3
4	U21ME303	Engineering Materials and Metallurgy	PCC	3	0	0	0	3
THEORY COURSE WITH LABORATORY COMPONENT / THEORY COURSE WITH PROJECT COMPONENT								
5	U21ME304	Fluid Mechanics and Applications	PCC	2	0	2	0	3
6	U21ME305	Mechanics of Solids	PCC	3	0	2	0	4
LABORATORY COURSES / LABORATORY COURSE WITH PROJECT COMPONENT								
7	U21ME306	Manufacturing Technology Laboratory – I	PCC	0	0	4	2	3
8	U21ME307	Design Studio – I	EEC	0	0	0	2	1
MANDATORY NON-CREDIT COURSES								
9	U21MYC03	Essence of Indian Traditional Knowledge	MNC	1	0	0	0	0
			TOTAL	**18**	**2**	**8**	**4**	**25**

SEMESTER IV

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
THEORY COURSES								
1	U21MA404	Statistics and Numerical Methods	BSC	3	0	0	0	3
2	U21ME401	Manufacturing Technology–II	PCC	3	0	0	0	3
3		Open Elective – I	OEC	3	0	0	0	3
THEORY COURSE WITH LABORATORY COMPONENT / THEORY COURSE WITH PROJECT COMPONENT								
4	U21ME402	Theory of Machines	PCC	3	0	2	0	4
5	U21ME403	Thermal Engineering	PCC	2	0	2	0	3
6	U21ME404	Sensors and Transducers	PCC	2	0	0	2	3
LABORATORY COURSES / LABORATORY COURSE WITH PROJECT COMPONENT								
7	U21ME405	Computer Aided Modelling and Assembly Laboratory	PCC	0	0	4	0	2
8	U21ME406	Manufacturing Technology Laboratory –II	PCC	0	0	4	0	2
9	U21ME407	Design Studio – II	EEC	0	0	0	2	1
10	U21SSG01	Soft Skills – I	HSMC	0	0	2	0	1
MANDATORY NON-CREDIT COURSES								
11	U21MYC04	Indian Constitution	MNC	1	0	0	0	0
			TOTAL	**17**	**0**	**14**	**4**	**25**

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SEMESTER V

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
THEORY COURSES								
1	U21ME501	Design of Machine Elements	PCC	3	0	0	0	3
2		Professional Elective – I	PEC	3	0	0	0	3
3		Professional Elective – II	PEC	3	0	0	0	3
4		Open Elective – II	OEC	3	0	0	0	3
THEORY COURSE WITH LABORATORY COMPONENT / THEORY COURSE WITH PROJECT COMPONENT								
5	U21ME502	Engineering Metrology and Measurements	PCC	2	0	2	0	3
6	U21ME503	Fundamentals of Automation	PCC	2	0	0	2	3
LABORATORY COURSES / LABORATORY COURSE WITH PROJECT COMPONENT								
7	U21ME504	Mechatronics Laboratory	PCC	0	0	4	0	2
8	U21ME505	Proto Studio – I	EEC	0	0	0	2	1
9	U21SSG02	Soft Skills – II	HSMC	0	0	2	0	1
MANDATORY NON-CREDIT COURSES								
10	U21MYC05	Cyber Security Essentials	MNC	1	0	0	0	0
			TOTAL	17	0	8	4	22

SEMESTER VI

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
THEORY COURSES								
1	U21ME601	Finite Element Analysis	PCC	3	0	0	0	3
2	U21ME602	Design of Transmission System	PCC	3	0	0	0	3
3		Professional Elective – III	PEC	3	0	0	0	3
4		Professional Elective – IV	PEC	3	0	0	0	3
5		Open Elective – III	OEC	3	0	0	0	3
THEORY COURSE WITH LABORATORY COMPONENT / THEORY COURSE WITH PROJECT COMPONENT								
6	U21ME603	Heat and Mass Transfer	PCC	3	0	2	0	4
LABORATORY COURSES / LABORATORY COURSE WITH PROJECT COMPONENT								
7	U21ME604	Simulation and Analysis Laboratory	PCC	0	0	4	0	2
8	U21ME606	Proto Studio – II	EEC	0	0	0	2	1
9	U21SSG03	Soft Skills – III	HSMC	0	0	2	0	1
MANDATORY NON-CREDIT COURSES								
10	U21MYC06	Introduction to UN SDGs: An Integrative Approach	MNC	1	0	0	0	0
			TOTAL	19	0	8	2	23

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SEMESTER VII

Sl.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
THEORY COURSES								
1	U21ME701	Engineering Economics and Cost Analysis	HSMC	3	0	0	0	3
2	U21ME702	Industrial Engineering	PCC	3	0	0	0	3
3		Professional Elective – V	PEC	3	0	0	0	3
4		Professional Elective – VI	PEC	3	0	0	0	3
5		Open Elective – IV	OEC	3	0	0	0	3
LABORATORY COURSES / LABORATORY COURSE WITH PROJECT COMPONENT								
6	U21ME703	Project Work Phase – I	EEC	0	0	0	4	2
			TOTAL	15	0	0	4	17

SEMESTER VIII

Sl.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21ME802	Project Work Phase – II	EEC	0	0	0	16	8
			TOTAL	0	0	0	16	8

INDUSTRIAL TRAINING / INTERNSHIP

Sl.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21MEI01	Industrial Training / Internship *	EEC	0	0	0	0	2
			TOTAL	0	0	0	0	2

*Four Weeks during any semester vacation from III to VI Semester

NCC CREDIT COURSES

Sl.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21NCC01	National Cadet Corps I	-	1	0	2	0	2
2	U21NCC02	National Cadet Corps II	-	1	0	2	0	2
3	U21NCC03	National Cadet Corps III	-	1	0	2	0	2
4	U21NCC04	National Cadet Corps IV	-	2	0	2	0	3
5	U21NCC05	National Cadet Corps V	-	1	0	2	0	2
6	U21NCC06	National Cadet Corps VI	-	2	0	2	0	3
				8	-	6	-	14

NCC Credit Course (Level 1 – Level 6) are offered for NCC students only. The grades earned by the students will be recorded in the mark sheet, however the same shall not be considered for the computation of CGPA.

TOTAL CREDITS: 165

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PROFESSIONAL ELECTIVES COURSES: VERTICALS

Vertical I ENGINEERING DESIGN	Vertical II MATERIALS AND MANUFACTURING	Vertical III INDUSTRIAL ENGINEERING	Vertical IV HEAT DYNAMICS	Vertical V ROBOTICS AND AUTOMATION	Vertical VI AUTOMOTIVE & ENERGY ENGINEERING
Design for Manufacture and Assembly	Failure Analysis and Non–Destructive Testing	Operations Research	Gas Dynamics and Jet Propulsion	Automation in Manufacturing	Automotive Engine and Subsystems
Computer Aided Design	Smart Materials and Structures	Process Planning and Cost Estimation	Heating, Ventilation and Air Conditioning	Robotics	Electric Vehicle Technology
Machine Tool Design	Composite Materials	Plant Layout and Materials Handling	Advanced Internal Combustion Engines	Measurements and Controls	Smart Mobility and Vehicle Systems
Vibration Analysis and Control	Non–Traditional Machining Processes	Computer Integrated Manufacturing	Computational Fluid Dynamics	Industry 4.0	Bioenergy Conversion Technologies
Tribology and Industrial Applications	Welding Technology	Lean Supply Chain Management	Power Plant Engineering	Microprocessor and Artificial Intelligence for Industry	Energy Storage Devices
Product Development and Life Cycle Management	Additive Manufacturing	Total Quality Management	Renewable Energy Resources and Systems	Embedded Systems and Programming	Energy Conservation in Industries
Design of Jigs, Fixtures and Press Tools	Biomaterials and Ceramics	Project Management	Turbomachines	Smart Manufacturing	Energy Management and Equipment Design

Registration of Professional Elective Courses from Verticals:

Professional Elective Courses will be registered in Semesters V and VII. These courses are listed in groups called verticals that represent a particular area of specialisation / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals.

The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VII.

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PROFESSIONAL ELECTIVE COURSES: VERTICALS

VERTICAL I ENGINEERING DESIGN

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21MEP01	Design for Manufacture and Assembly	PEC	3	0	0	0	3
2	U21MEP02	Computer Aided Design	PEC	3	0	0	0	3
3	U21MEP03	Machine Tool Design	PEC	3	0	0	0	3
4	U21MEP04	Vibration Analysis and Control	PEC	3	0	0	0	3
5	U21MEP05	Tribology and Industrial Applications	PEC	3	0	0	0	3
6	U21MEP06	Product Development and Life Cycle Management	PEC	3	0	0	0	3
7	U21MEP07	Design of Jigs, Fixtures and Press Tools	PEC	3	0	0	0	3

VERTICAL II MATERIALS AND MANUFACTURING

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21MEP08	Failure Analysis and Non–Destructive Testing	PEC	3	0	0	0	3
2	U21MEP09	Smart Materials and Structures	PEC	3	0	0	0	3
3	U21MEP10	Composite Materials	PEC	3	0	0	0	3
4	U21MEP11	Non – Traditional Machining Processes	PEC	3	0	0	0	3
5	U21MEP12	Welding Technology	PEC	3	0	0	0	3
6	U21MEP13	Additive Manufacturing	PEC	3	0	0	0	3
7	U21MEP14	Biomaterials and Ceramics	PEC	3	0	0	0	3

VERTICAL III INDUSTRIAL ENGINEERING

S .NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21MEP15	Operations Research	PEC	3	0	0	0	3
2	U21MEP16	Process Planning and Cost Estimation	PEC	3	0	0	0	3
3	U21MEP17	Plant Layout and Materials Handling	PEC	3	0	0	0	3
4	U21MEP18	Computer Integrated Manufacturing	PEC	3	0	0	0	3
5	U21MEP19	Lean Supply Chain Management	PEC	3	0	0	0	3

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6	U21MEP20	Total Quality Management	PEC	3	0	0	0	3
7	U21MEP21	Project Management	PEC	3	0	0	0	3

VERTICAL IV HEAT DYNAMICS

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21MEP22	Gas Dynamics and Jet Propulsion	PEC	3	0	0	0	3
2	U21MEP23	Heating, Ventilation and Air Conditioning	PEC	3	0	0	0	3
3	U21MEP24	Advanced Internal Combustion Engines	PEC	3	0	0	0	3
4	U21MEP25	Computational Fluid Dynamics	PEC	3	0	0	0	3
5	U21MEP26	Power Plant Engineering	PEC	3	0	0	0	3
6	U21MEP27	Renewable Energy Resources and Systems	PEC	3	0	0	0	3
7	U21MEP28	Turbomachines	PEC	3	0	0	0	3

VERTICAL V ROBOTICS AND AUTOMATION

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21MEP29	Automation in Manufacturing	PEC	3	0	0	0	3
2	U21MEP30	Robotics	PEC	3	0	0	0	3
3	U21MEP31	Measurements and Controls	PEC	3	0	0	0	3
4	U21MEP32	Industry 4.0	PEC	3	0	0	0	3
5	U21MEP33	Microprocessor and Artificial Intelligence for Industry	PEC	3	0	0	0	3
6	U21MEP34	Embedded Systems and Programming	PEC	3	0	0	0	3
7	U21MEP35	Smart Manufacturing	PEC	3	0	0	0	3

VERTICAL VI AUTOMOTIVE & ENERGY ENGINEERING

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21MEP36	Automotive Engine and Subsystems	PEC	3	0	0	0	3
2	U21MEP37	Electric Vehicle Technology	PEC	3	0	0	0	3
3	U21MEP38	Smart Mobility and Vehicle Systems	PEC	3	0	0	0	3
4	U21MEP39	Bioenergy Conversion Technologies	PEC	3	0	0	0	3

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5	U21MEP40	Energy Storage Devices	PEC	3	0	0	0	3
6	U21MEP41	Energy Conservation in Industries	PEC	3	0	0	0	3
7	U21MEP42	Energy Management and Equipment Design	PEC	3	0	0	0	3

COMMON PROFESSIONAL ELECTIVES

S .NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21MEP43	Comprehension - I	BSC	3	0	0	0	3
2	U21MEP44	Comprehension - II	BSC	3	0	0	0	3

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OPEN ELECTIVES

(Students shall choose the open elective courses, such that the course contents are not similar to any other course contents/title under other course categories).

OPEN ELECTIVES – I (SEMESTER: IV)

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21MEX01	Industrial Robotics	OEC	3	0	0	0	3
2	U21MEX02	Intelligent Vehicle Systems	OEC	3	0	0	0	3

OPEN ELECTIVES – II (SEMESTER: V)

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21MEX03	Industrial Safety	OEC	3	0	0	0	3
2	U21MEX04	Additive Manufacturing and 3D printing	OEC	3	0	0	0	3

OPEN ELECTIVES – III (SEMESTER: VI)

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21MEX05	Automotive Systems	OEC	3	0	0	0	3
2	U21MEX06	Low Cost Automation	OEC	3	0	0	0	3

OPEN ELECTIVES – IV (SEMESTER: VII)

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21MEX07	Product Design and Development	OEC	3	0	0	0	3
2	U21MEX08	Industrial Automation	OEC	3	0	0	0	3

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Scheme of Credit distribution – Summary

S.No	Stream	Credits/Semester								Credits
		I	II	III	IV	V	VI	VII	VIII	
1.	Humanities and Social Sciences including Management (HSMC)	3	3	–	1	1	1	3	–	12
2.	Basic Science Courses (BSC)	10	6	4	3	–	–	–	–	23
3.	Engineering Science Courses (ESC)	7	11	–	–	–	–	–	–	18
4.	Professional Core Courses (PCC)	–	3	20	17	11	12	3	–	66
5.	Professional Elective Courses (PEC)	–	–	–	–	6	6	6	–	18
6.	Open Elective Courses (OEC)	–	–	–	3	3	3	3	–	12
7.	Employability Enhancement Courses (EEC)	–	–	1	1	1	1	2	8	14
8.	Industrial Training/ Internship	–	–	–	–	–	–	–	2	2
9.	Mandatory Non–Credit Course (MNC)	–	–	–	–	–	–	–	–	–
Total		20	23	25	25	22	23	17	10	165

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Course Code	Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Semester 1															
U21GEG01	Heritage of Tamils	–	–	–	–	–	–	✓	✓	–	✓	–	✓	–	–
U21MA101	Calculus and Differential Equations	✓	–	–	–	–	–	–	–	–	–	–	–	✓	–
U21EN101	English for Technologists	–	–	–	–	–	–	–	✓	–	✓	–	✓	–	–
U21CSG01	Problem Solving and C Programming	✓	✓	✓	✓	–	–	–	✓	✓	✓	–	✓	–	–
U21PH101	Engineering Physics	✓	✓	✓	–	–	–	–	–	–	–	–	–	✓	–
U21CY101	Engineering Chemistry	✓	✓	–	–	–	–	✓	–	✓	–	–	✓	✓	–
U21MEG01	Engineering Graphics	✓	✓	✓	–	✓	–	–	–	–	✓	–	✓	✓	–
U21MEG02	Manufacturing Practices	✓	✓	✓	–	✓	–	✓	–	✓	✓	–	✓	✓	–
Semester 2															
U21GEG02	Tamils And Technology	–	–	–	–	–	–	✓	✓	–	✓	–	✓	–	–
U21MA201	Laplace Transforms and Complex Variables	✓	✓	–	–	–	–	–	–	–	–	–	–	✓	–
U21EEG02	Basics of Electrical Engineering	✓	✓	✓	✓	–	–	✓	✓	–	–	–	✓	–	–
U21ME201	Engineering Mechanics	✓	✓	✓	✓	–	–	–	–	–	–	–	✓	✓	–
U21PH201	Materials Science	✓	✓	–	–	–	✓	–	–	–	–	–	✓	✓	–
U21EN201	Personality Enhancement	–	–	–	–	–	–	–	✓	–	✓	–	–	–	✓

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U21ECG04	Basics of Electronics Engineering	✓	✓	✓	✓	✓	–	–	✓	✓	✓	–	✓	–	–
U21CSG02	Python Programming	✓	✓	–	–	–	–	–	✓	✓	✓	–	✓	–	–
U21ME202	Interfacing of Electronics and Electrical components and Troubleshooting	✓	–	–	–	✓	–	–	–	✓	✓	–	–	✓	–
Semester 3															
U21MA303	Fourier Analysis and Boundary Value Problems	✓	✓	–	–	–	–	–	–	–	–	–	–	✓	–
U21ME301	Engineering Thermodynamics	✓	✓	✓	–	–	–	–	–	–	–	–	–	✓	–
U21ME302	Manufacturing Technology–I	✓	✓	–	–	–	–	–	–	–	–	–	–	✓	✓
U21ME303	Engineering Materials and Metallurgy	✓	–	–	–	✓	–	–	–	–	–	–	–	✓	–
U21ME304	Fluid Mechanics and Applications	✓	✓	✓	✓	✓	–	–	–	–	–	–	✓	✓	–
U21ME305	Mechanics of Solids	✓	✓	✓	–	–	–	–	–	–	–	–	–	✓	–
U21ME306	Manufacturing Technology Laboratory – I	✓	✓	✓	–	✓	–	–	–	✓	–	–	✓	✓	✓
U21CG301	Design Studio I	–	–	–	–	✓	–	–	–	✓	✓	✓	✓	–	–
U21MYC02	Essence of Indian	–	–	–	–	–	–	–	–	–	–	–	–	–	–

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	Knowledge Traditional														
Semester 4															
U21MA404	Statistics and Numerical Methods	✓	✓	–	–	–	–	–	–	–	–	–	–	–	–
U21ME401	Manufacturing Technology–II	✓	–	–	–	✓	–	–	–	–	–	–	–	✓	–
U21ME402	Theory of Machines	✓	✓	✓	–	✓	–	–	–	✓	✓	–	✓	✓	–
U21ME403	Thermal Engineering	✓	✓	✓	–	–	–	–	–	–	–	–	–	–	–
U21ME404	Sensors and Transducers	✓	–	–	✓	✓	–	–	–	–	–	–	–	✓	–
U21ME405	Computer Aided Modelling and Assembly Laboratory	–	✓	✓	–	✓	–	–	–	✓	✓	✓	–	✓	–
U21ME407	Manufacturing Technology Laboratory –II	✓	–	–	–	✓	–	–	✓	✓	✓	–	–	✓	–
U21CG401	Design Studio II	–	–	–	–	✓	–	–	✓	✓	✓	✓	✓	–	✓
U21MYC04	Indian Constitution	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U21SSG01	Soft Skills – I	–	–	–	–	–	–	–	–	✓	✓	–	✓	–	✓
Semester 5															
U21ME501	Design of Machine Elements	✓	✓	✓	–	–	–	–	–	–	–	–	✓	✓	–
U21PE	Professional Elective – I														
U21PE	Professional Elective – II														

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U21XE	Open Elective – II														
U21ME502	Fundamentals of automation	✓	✓	✓	✓	✓	–	–	–	✓	–	–	–	✓	–
U21ME503	Engineering Metrology and Measurements	✓	✓	✓	–	✓	–	–	–	✓	–	–	–	✓	–
U21ME504	Mechatronics Laboratory	✓	✓	✓	✓	✓	–	–	–	✓	✓	–	✓	✓	–
U21SSG02	Soft Skills – II	–	–	–	–	–	–	–	–	–	✓	–	✓	–	–
U21CG501	Proto Studio – I	–	–	–	–	✓	–	–	✓	✓	✓	✓	✓	–	✓
Semester 6															
U21ME601	Finite element Analysis	✓	✓	✓	–	–	–	–	–	–	–	–	–	✓	–
U21ME602	Design of Transmission System	✓	✓	✓	✓	–	–	–	–	–	–	–	–	✓	–
U21PE	Professional Elective – III														
U21PE	Professional Elective – IV														
U21XE	Open Elective – III														
U21ME603	Heat and Mass Transfer	✓	✓	–	–	✓	–	–	–	–	✓	–	–	✓	–
U21ME604	Simulation and Analysis Laboratory	✓	✓	✓	✓	✓	–	–	–	–	✓	–	–	✓	–
U21SSG03	Soft Skills – III	–	–	–	–	–	–	–	✓	–	✓	–	✓	–	✓
U21CG501	Proto Studio – II	–	–	–	–	–	–	–	✓	✓	✓	✓	–	–	✓

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Semester 7															
U21ME701	Engineering Economics and Cost Analysis	✓	✓	✓	–	–	–	–	–	–	–	–	✓	–	✓
U21ME702	Industrial Engineering	✓	✓	–	–	–	–	–	–	✓	–	–	✓	–	✓
U21PE	Professional Elective – V														
U21PE	Professional Elective – VI														
U21XE	Open Elective – IV														
U21ME703	Project Work Phase – I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Semester 8															
U21ME801	Project Work Phase – II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PROFESSIONAL ELECTIVE COURSES: VERTICALS VERTICAL 1: ENGINEERING DESIGN															
U21MEP01	Design for Manufacture and Assembly	✓	✓	✓	✓	–	–	–	–	–	✓	–	–	✓	–
U21MEP02	Computer Aided Design	✓	–	–	–	–	–	–	–	–	–	–	–	✓	–
U21MEP03	Machine Tool Design	✓	✓	✓	–	–	–	–	–	–	–	–	–	✓	–
U21MEP04	Vibration Analysis and Control	✓	✓	✓	–	–	–	–	–	–	–	–	–	✓	–
U21MEP05	Tribology and Industrial Applications	✓	✓	✓	–	–	✓	–	–	–	–	–	–	✓	–

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U21MEP06	Product Development and Life Cycle Management	✓	–	–	–	–	–	✓	–	–	–	✓	–	✓	✓
U21MEP07	Design of Jigs, Fixtures and Press Tools	✓	✓	✓	–	✓	–	✓	–	–	–	–	✓	✓	✓
VERTICAL 2: MATERIALS AND MANUFACTURING															
U21MEP08	Failure Analysis and Non–Destructive Testing of Materials	✓	–	–	–	✓	–	–	✓	–	–	–	–	✓	–
U21MEP09	Smart Materials and Structures	✓	–	✓	–	–	–	–	–	–	–	–	–	✓	–
U21MEP10	Composite Materials	✓	–	–	–	–	–	–	–	–	–	–	–	✓	–
U21MEP11	Non–Traditional Machining Processes	✓	–	–	–	–	–	–	–	–	–	–	–	✓	–
U21MEP12	Welding Technology	✓	✓	–	–	–	–	–	–	–	–	–	–	✓	–
U21MEP13	Additive Manufacturing	✓	–	–	–	–	–	–	–	–	–	–	✓	✓	–
U21MEP14	Biomaterials and Ceramics	✓	–	–	–	–	✓	–	✓	–	–	–	–	✓	–
VERTICAL 3: INDUSTRIAL ENGINEERING															
U21MEP15	Operations Research	✓	✓	✓	–	✓	–	–	–	–	–	–	✓	–	✓
U21MEP16	Process Planning and Cost Estimation	✓	✓	–	–	–	–	–	–	–	–	–	✓	–	✓

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U21MEP17	Plant Layout and Materials Handling	✓	✓	–	–	–	–	–	–	–	–	✓	–	–	✓
U21MEP18	Computer Integrated Manufacturing	✓	✓	–	–	✓	–	–	–	–	–	–	✓	✓	–
U21MEP19	Lean Supply Chain Management	✓	✓	✓	–	–	–	–	–	–	–	✓	–	✓	✓
U21MEP20	Total quality management	✓	✓	–	–	–	–	✓	–	–	–	✓	–	–	✓
U21MEP21	Project Management	✓	✓	✓	–	✓	–	–	–	–	–	✓	✓	–	✓
VERTICAL 4: HEAT DYNAMICS															
U21MEP22	Gas Dynamics and Jet Propulsion	✓	✓	✓	✓	–	–	–	–	–	–	–	–	✓	–
U21MEP23	Heating, Ventilation and Air Conditioning	✓	✓	✓	–	✓	–	–	–	–	–	–	–	✓	–
U21MEP24	Advanced Internal Combustion Engines	✓	✓	✓	–	–	–	✓	–	–	–	–	–	✓	–
U21MEP25	Computational Fluid Dynamics	✓	✓	✓	✓	✓	–	–	–	–	–	–	–	✓	–
U21MEP26	Power Plant Engineering	✓	✓	–	–	–	–	–	–	–	–	✓	–	✓	–
U21MEP27	Renewable Energy Resources and Systems	✓	–	–	–	–	–	✓	–	–	–	–	–	✓	–

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U21MEP28	Turbomachines	✓	✓	✓	–	–	–	–	–	–	–	–	–	✓	–
VERTICAL 5: ROBOTICS AND AUTOMATION															
U21MEP29	Automation in Manufacturing	✓	–	–	–	✓	–	–	–	–	–	–	–	✓	–
U21MEP30	Robotics	✓	✓	–	–	✓	–	–	–	–	–	–	–	✓	–
U21MEP31	Measurements and Controls	✓	✓	–	–	–	–	–	–	–	–	–	–	✓	–
U21MEP32	Industry 4.0	✓	–	–	–	–	✓	–	–	–	–	–	✓	✓	–
U21MEP33	Microprocessor and Artificial Intelligence for Industry	✓	✓	–	–	✓	–	–	–	–	–	–	–	✓	–
U21MEP34	Embedded Systems and Programming	✓	–	–	–	✓	–	–	–	✓	–	–	–	✓	–
U21MEP35	Smart Manufacturing	✓	✓	–	–	–	–	–	–	–	–	–	–	✓	–
VERTICAL 6: AUTOMOTIVE & ENERGY ENGINEERING															
U21MEP36	Automotive Engine and Subsystems	✓	✓	–	–	–	–	–	–	–	–	–	✓	✓	–
U21MEP37	Electric Vehicle Technology	✓	–	–	–	–	–	–	–	–	–	–	–	✓	–
U21MEP38	Smart Mobility and Intelligent Vehicles	✓	–	–	–	–	–	–	–	–	–	–	✓	✓	–
U21MEP39	Bio energy Conversion Technologies	✓	–	–	–	–	–	✓	–	–	–	–	–	✓	–
U21MEP40	Energy Storage Devices	✓	–	–	–	–	–	–	–	–	–	–	✓	✓	–

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U21MEP41	Energy Conservation in Industries	✓	✓	–	–	–	–	–	–	–	–	–	–	✓	–
U21MEP42	Energy Management and Equipment Design	✓	✓	✓	–	–	–	✓	–	–	–	–	✓	✓	–
COMMON ELECTIVE COURSES															
U21MEP43	Comprehension - I	✓	✓	✓	–	–	–	–	–	–	–	–	✓	–	✓
U21MEP44	Comprehension - I	✓	✓	✓	–	–	–	–	–	–	–	–	✓	–	✓

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SEMESTER I

J21GEG01	HERITAGE OF TAMILS (Common to all programs)	Category: HSMC				
		L	T	P	J	C
		1	0	0	0	1

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

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

- To learn the extensive literature of classical tamil
- To review the fine arts heritage of tamil culture
- To realize the contribution of tamil in Indian freedom struggle

COURSE OUTCOMES:

CO1: Understand the extensive literature of Tamil and its classical nature (Understand)

CO2: Understand the heritage of sculpture, painting and musical instruments of ancient people (Understand)

CO3: Review on folk and martial arts of tamil people (Understand)

CO4: Realization of thinai concepts, trade and victory of Chozha dynasty (Understand)

CO5: Understand the contribution of tamils in Indian freedom struggle, Self-esteem movement and siddha medicine (Understand)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I LANGUAGE AND LITERATURE 3

Language Families in India - Dravidian Languages – Tamil as a Classical Language – Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural – Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars – Forms of minor Poetry – Development of Modern literature in Tamil – Contribution of Bharathiyar and Bharathidhasan

UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3

Hero stone to modern sculpture - Bronze icons – Tribes and their handicrafts – Art of temple car making - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments – Mridhangam, Parai, Veenai, Yazh and Nadhaswaram – Role of Temples in Social and Economic Life of Tamils

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UNIT III FOLK AND MARTIAL ARTS 3

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leatherpuppetry, Silambattam, Valari, Tiger dance – Sports and Games of Tamils

UNIT IV THINAI CONCEPT OF TAMILS 3

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature – Aram Concept of Tamils – Education and Literacy during Sangam Age – Ancient Cities and Ports of Sangam Age – Export and Import during Sangam Age – Overseas Conquest of Cholas

UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE 3

Contribution of Tamils to Indian Freedom Struggle – The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement – Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books

Contact Periods:

Lecture: 15 Periods	Tutorial: - Periods	Practical: – Periods	Project – Periods
			Total 15 Periods

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் - முனைவர். இல. சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை - ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies)
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book

EVALUATION PATTERN:

Continuous Internal Assessment	Total
	100

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER I

UJ21GEG01	தமிழர் மரபு (அனைத்து துறைகளுக்கும் பொதுவனது)	Category: HSMC				
		L	T	P	J	C
		1	0	0	0	1

முன்கூட்டிய துறைசார் அறிவு: தேவையில்லை

பாடத்தின் நோக்கங்கள்:

- தமிழ் மொழியின் இலக்கியச் செறிவைக் கற்றுணர்தல்
- தமிழர் பண்பாட்டின் நுண்கலைகள் பற்றிய ஒரு மீள்பார்வை
- இந்திய தேசிய இயக்கத்தில் தமிழர்களின் பங்கினை அறிதல்

பாடம் கற்றதின் விளைவுகள்:

CO1: தமிழ் மொழியின் செந்தன்மை மற்றும் இலக்கியங்கள் குறித்த தெரிதல் (புரிதல்)
CO2: தமிழர்களின் சிற்பக்கலை, ஓவியக்கலை மற்றும் இசைக்கருவிகள் குறித்த தெளிவு (புரிதல்)
CO3: தமிழர்களின் நாட்டுப்புறக் கலைகள் மற்றும் வீரவிளையாட்டுகள் குறித்த அறிமுகம் (புரிதல்)
CO4: தமிழர்களின் திணைக் கோட்பாடுகள், சங்ககால வணிகம் மற்றும் சோழர்களின் வெற்றிகள் குறித்த தகவல்கள் (புரிதல்)
CO5: இந்திய தேசிய இயக்கம், சுயமரியாதை இயக்கம் மற்றும் சித்த மருத்துவம் பற்றிய புரிதல் (புரிதல்)

CO-PO MAPPING:

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

பாடத்திட்டங்கள்:

அலகு I மொழி மற்றும் இலக்கியம் 3

இந்திய மொழிக்குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் – சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள் – தமிழகத்தில் சமண, பௌத்த சமயங்களின் தாக்கம் – பக்தி இலக்கியம் – ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு

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அலகு II மரபு - பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை - சிற்பக்கலை 3

நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள் – பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப்பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரி முனையில் திருவள்ளுவர் சிலை – இசைக்கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக, பொருளாதார வாழ்வில் கோவில்களின் பங்கு

அலகு III நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள் 3

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்

அலகு IV தமிழர்களின் திணைக் கோட்பாடுகள் 3

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்க காலத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும், துறைமுகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி

அலகு V இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு 3

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிற பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில் சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் – தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு

Contact Periods:

Lecture: 15 Periods	Tutorial: - Periods	Practical: – Periods	Project	– Periods
			Total	15 Periods

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் - முனைவர். இல. சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை - ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies)
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)

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11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book

மதிப்பீட்டு முறை:

தொடர்ச்சியான உள் மதிப்பீடு	மொத்தம்
	100

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER I

U21MA101	CALCULUS AND DIFFERENTIAL EQUATIONS (Common to AD, BM, CE, CH, CS, CS(AIML), EC, IT, ME, MI)	Category: BSC				
		L	T	P	J	C
		3	1	0	0	4

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the concepts of matrices and calculus which will enable them to model and analyze physical phenomena involving continuous change
- To understand the methodologies involved in solving problems related to fundamental principles of calculus
- To develop confidence to model mathematical pattern and give appropriate solutions

COURSE OUTCOMES:

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

CO1: Apply the knowledge of matrices with the concepts of eigenvalues to study their problems in core areas (Apply)

CO2: Apply the basic techniques and theorems of functions of several variables in other areas of mathematics (Apply)

CO3: Analyze the triple integrals techniques over a region in two dimensional and three dimensional geometry (Apply)

CO4: Apply basic concepts of integration to evaluate line, surface and volume integrals (Apply)

CO5: Solve basic application problems described by second and higher order linear differential equations with constant coefficients (Understand)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I MATRICES **9 + 3**

Eigenvalues and eigenvectors – Properties (without proof) – Cayley Hamilton theorem (without proof) – Diagonalization using orthogonal transformation – Applications

UNIT II FUNCTIONS OF SEVERAL VARIABLES **9 + 3**

Partial derivatives – Total derivative – Jacobians – Taylor's series expansion – Extreme values of functions of two variables – Lagrange multipliers method

UNIT III MULTIPLE INTEGRALS **9 + 3**

Double integrals – Change of order of integration – Triple integrals – Applications in area and volume

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UNIT IV LINE AND SURFACE INTEGRALS **9 + 3**

Line integrals – Surface integrals – Green's theorem in a plane – Gauss divergence theorem – Stokes' theorem (excluding proofs)

UNIT V ORDINARY DIFFERENTIAL EQUATIONS **9 + 3**

Second and higher order linear differential equations with constant coefficients – Variable coefficients – Euler Cauchy equation – Legendre's equation – Method of variation of parameters – Applications

Contact Periods:

Lecture: 45 Periods Tutorial: 15 Periods Practical: – Periods Project – Periods

Total 60 Periods

TEXT BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th edition, Wiley India Pvt Ltd, New Delhi, 2018
2. Grewal B S, "Higher Engineering Mathematics", 44th edition, Khanna Publishers, New Delhi,2017

REFERENCES:

1. Bali N P and Dr Manish Goyal, "A text book of Engineering Mathematics", 12th edition, Laxmi Publications,2016
2. Thomas G B and Finney R L, "Calculus and Analytic Geometry", 14th edition, Pearson Education India,2018
3. Maurice D Weir, Joel Hass and Christopher Heil, "Thomas Calculus", 14th edition, Pearson Education, India,2018
4. James Stewart, "Calculus: Early Transcendental", 7th edition, Cengage Learning, New Delhi,2015

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Seminar / MCQ	Written Test	Individual Assignment / Seminar / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER I

U21EN101	ENGLISH FOR TECHNOLOGISTS Common to AD, BM, CH, CE, CS, CS(AIML), EE, EC, ME, MI, IT	Category: HSM				
		L	T	P	J	C
		1	0	2	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To infer and interpret the meaning of Technical, Business, Social and Academic contexts
- To enhance the listening skills and facilitate effective pronunciation
- To make effective presentation and conversation in technical and professional environment

COURSE OUTCOMES:

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

CO1: Comprehend language and learn strategies for error-free communication (Understand)

CO2: Improve speaking skills in academic and social contexts (Apply)

CO3: Enhance both reading and writing skills to excel in professional career (Analyse)

CO4: Evaluate different perspectives on a topic (Analyse)

CO5: Develop listening skills to understand complex business communication in a variety of global English accents through Personality Development (Understand)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I SUBJECTIVE INTROSPECTION 9

Module:1 Vocabulary Building

Activity: Word Puzzles, Snappy words, Word Sleuthing

Module:2 Introducing and Sharing Information

Activity: Get to know oneself, Introducing Peer Members

Module:3 Opinion Paragraph

Activity: Note making, analyzing and writing a review

UNIT II CAREER ENHANCEMENT 9

Module:4 Reading Comprehension

Activity: Reading Newspaper articles/Blogs, Sentence completion

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Module:5 E-mail Communication
Activity: Drafting personal and professional emails
Module:6 Career Profiling
Activity: Resume Writing & Digital Profiling

UNIT III LANGUAGE ADEPTNESS 9

Module:7 Rewriting passages
Activity: Conversion of voices & Rephrasing Articles
Module:8 Enhancing Pronunciation skills
Activity: Listening to short technical Reels and reproducing it
Module:9 Making Conversations
Activity: Role play & Narrating Incidents

UNIT IV TECHNICAL WRITING 9

Module:10 Spotting Errors
Activity: Proof reading, Rewriting sentences
Module:11 Data interpretation
Activity: Interpretation of Graphics/Charts/Graphs
Module:12 Expository Writing
Activity: Picture inference, Captions for Posters& Products

UNIT V LANGUAGE UPSKILLING 9

Module:13 Listening for Specific Information
Activity: TED talks/Announcement/Documentaries
Module:14 Presentation
Activity: Extempore & Persuasive Speech
Module:15 Team Communication
Activity: Team building activities, Group Discussion

LIST OF EXERCISES

1. Introducing oneself
2. Role play
3. Listening to short technical Reels
4. Listening to TED Talks/ Announcements/ Documentaries
5. Presentation
6. Group Discussion

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project – Periods
Total 60 Periods

TEXT BOOKS:

1. Ashraf Rizvi, "Effective Technical Communication", 2nd edition, Tata McGraw Hill,2017
2. Rod Ellis, "English for Engineers & Technologists", Vol. II: (English for Engineers and Technologist: A Skills Approach). 2nd edition, Orient Black Swan,1990

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REFERENCES:

1. Raymond Murphy, "Intermediate English Grammar", 2nd edition, Cambridge University Press, 2009
2. Thomas L Means, "English and Communication for Colleges", 4th edition, Cengage,2017
3. Using English: "A Coursebook for Undergraduate Engineers and Technologists", 1st edition, Orient Black Swan,2017

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th>End Semester Examinations</th></tr>
<tr><td colspan="2">Assessment I
(Theory)
(100 Marks)</td><td colspan="2">Assessment II
(Practical)
(100 Marks)</td><td rowspan="2">Practical Examinations

(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>*Individual Assignment / Seminar / MCQ</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)</td><td>Test</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td><td></td></tr>
<tr><td colspan="2">25</td><td colspan="2">25</td><td>50</td></tr>
<tr><td colspan="4">50</td><td>50</td></tr>
<tr><td colspan="5">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER I

U21CSG01	PROBLEM SOLVING AND C PROGRAMMING Common to All Branches	Category: ESC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To provide exposure to problem-solving through programming
- To develop computational thinking perspective of one's own discipline
- To write, compile and debug programs using C language

COURSE OUTCOMES:

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

CO1: Formulate the algorithmic solutions for a given computational problem (Understand)

CO2: Describe modularization, structures and pointers in C language (Understand)

CO3: Design and implement algorithms for a given problem using C control structures (Apply)

CO4: Apply the C programming constructs for searching and sorting techniques (Apply)

CO5: Solve real time problems using suitable non-primitive data structures in C (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I COMPUTATIONAL THINKING 6

Computational Thinking – Modern Computer – Information based Problem solving – Real world information and Computable Data – Data types and data encoding – Number Systems – Introduction to programming languages – Basics of C programming – variables– Data types – keywords – C program structure – Simple programs in C

UNIT II ALGORITHMIC APPROACH 6

Logic – Boolean Logic – Applications of Propositional logic – Problem Definition – Logical Reasoning and Algorithmic thinking – Pseudo code and Flow chart – Constituents of algorithms – Sequence, Selection and Repetition – Problem understanding and analysis – Control structures in C – Algorithm design and implementation using control structures

UNIT III SEARCHING, SORTING, AND MODULARIZATION 6

Data Organization – Arrays – Introduction to Searching and Sorting – Linear Search, Binary Search – Basic sorting techniques – Two-dimensional arrays – Matrix manipulation – Modularization –

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Functions – Function prototype – Function definition – Function call – Built-in functions (string functions and math functions) – Recursion

UNIT IV STRUCTURES AND POINTERS 6

Pointers – Pointer operators – Pointer arithmetic – Arrays and pointers – Array of pointers – Example Program – Sorting of names – Parameter passing – Pass by value – Pass by reference – Structure – Nested structures – Pointer and Structures – Array of structures – Example Program using structures and pointers – Unions

UNIT V FILES 6

Files – Types of file processing – Sequential access – Random access – Sequential access file – Example Program – Finding average of numbers stored in sequential access file – Random access file – Example Program – Transaction processing using random access files – Command line arguments

LIST OF EXPERIMENTS

A. Lab Programs

1. Using IO Statements, get higher secondary marks of a student. Calculate and display the medical and engineering cut-off marks. [Assume the calculation formula]
2. Develop a C program to emulate the operations of an ATM using control structures. Authentication, Deposit, Withdrawal, and Balance check and pin change operations are to be supported.
3. Develop a calculator to perform the operations including addition, subtraction, multiplication, division and square of a number.
4. Given different prices of a vegetable which is varying through the day (from morning to evening), find out the best buy price and sell price for the maximum profit. Eg. For the prices [33, 35, 28, 36, 39, 25, 22, 31], best buy is at 28 and best sell is at 39.
5. Collect height and weight of 4 of your friends and calculate their body mass index. Use 2-dimensional array to store the values.
6. Weights of 10 students of your class who are standing in a line is given in a random order. Find out if there is a heavy person whose weight is the sum of previous two persons.
7. Convert the given decimal number into binary, octal and hexadecimal numbers using user defined functions.
8. From a given paragraph perform the following using built-in functions:
   a) Find the total number of words.
   b) Capitalize the first word of each sentence.
9. Solve Towers of Hanoi using recursion.
10. Develop an expense manager which reads date, product, price and product category. The program should display the total expense amount based on product category or date as per user's selection. Use structures.
11. Develop a banking application to store details of accounts in a file. Count the number of account holders based on a search condition such as - whose balance is less than the minimum balance.

B. Mini Project (SAMPLE)

Create a Railway Reservation system with the following modules of Booking,

- Availability checking

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- Cancellation

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project – Periods
Total 60 Periods

TEXT BOOKS:

1. David D. Railey and Kenny A.Hunt , "Computational Thinking for Modern problem Solver", 1st edition, CRC Press,2014
2. Brian W. Kernighan and Dennis Ritchie, "The C Programming Language", 2nd edition, Pearson, 2015

REFERENCES:

1. Paolo Ferragina and Fabrizio Luccio, "Computational Thinking First Algorithms", Then Code" ,1st edition,Springer International Publishing,2018
2. Reema Thareja, "Programming in C", 2nd edition, Oxford University Press,2016
3. Paul Deitel and Harvey Deitel, "C How to Program", 7th edition, Pearson Publication,2008
4. Juneja, B. L and Anita Seth, "Programming in C",1st edition, Cengage Learning India Pvt. Ltd., 2011
5. Pradip Dey, Manas Ghosh, "Fundamentals of Computing and Programming in C", 1st edition, Oxford University Press,2009

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th colspan="2" rowspan="2">End Semester Examinations</th></tr>
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(Theory)
(100 Marks)</th><th colspan="2">Assessment II
(Practical)
(100 Marks)</th></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record
(Rubrics Based Assessments)</td><td>Test</td><td rowspan="2">Theory Examinations
(Examinations will be conducted for 100 Marks)</td><td rowspan="2">Practical Examinations
(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td></tr>
<tr><td colspan="2">25</td><td colspan="2">25</td><td>25</td><td>25</td></tr>
<tr><td colspan="4">50</td><td colspan="2">50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER I

U21PH101	ENGINEERING PHYSICS (Common to all branches)	Category: BSC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the fundamental principles of laser and fibre optics with their applications
- To acquire the knowledge of ultrasonic waves, thermal conductivity and properties of liquids
- To understand the concepts of crystals

COURSE OUTCOMES:

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

CO1: Demonstrate the types of laser for various industrial and medical applications (Understand)

CO2: Apply the concepts of fibre optics in engineering (Understand)

CO3: Understand the production methods of ultrasonic waves and uses in engineering and medicine (Understand)

CO4: Apply the concepts of thermal conductivity in hybrid vehicles and viscosity of liquids in engineering applications (Understand)

CO5: Explain the basic concepts of crystals and its growth techniques (Understand)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I LASER 6

Laser characteristics – Spontaneous and stimulated emission – Pumping methods – CO_2 laser – Semiconductor laser – Material Processing – Selective laser Sintering – Hologram – Medical applications (Opthalmology)

UNIT II FIBER OPTICS 6

Total internal reflection – Numerical aperture and acceptance angle – Classification of optical fibers (Materials, modes and refractive index profile) – Fiber optical communication system – Displacement and temperature sensor – Medical Endoscopy

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UNIT III ULTRASONICS 6

Properties of ultrasonic waves – Piezoelecrtic generator – Acoustic grating – Applications of u trasonics in industry– SONAR – NDT – Ultrasonic scanning methods – Fetal heart movement

UNIT IV THERMAL PHYSICS AND PROPERTIES OF FLUIDS 6

Modes of heat transfer – Thermal conductivity – Lee's disc method – Solar thermal power generation – Hybrid vehicles – Microwave oven – Surface tension and coefficient of viscosity – Poiseuille's flow experiment

UNIT V CRYSTAL PHYSICS 6

Unit cell – Bravais lattices – SC, BCC, FCC structures – Miller indices – d spacing in cubic lattice – Crystal growth from melt: Bridgeman Technique – Silicon ingots from Czochralski method – Silicon wafers from ingots and its applications.

LIST OF EXPERIMENTS

1. Determination of the wavelength of a given laser source
2. Determination of acceptance angle and numerical aperture of an optical fibre
3. Determination of velocity of sound and compressibility of a liquid using Ultrasonic interferometer
4. Determination of thermal conductivity of a bad conductor using Lee's disc method
5. Determination of viscosity of the given liquid using Poiseuille's flow method

Contact Periods:

Lecture: 30 Periods Tutorial: - Periods Practical: 30 Periods Project: - Periods

Total: 60 Periods

TEXT BOOKS:

1. Bhattacharya D K and Poonam Tandon, "Engineering Physics", 2nd edition, Oxford University Press, Chennai,2017
2. Marikani A, "Engineering Physics", 3rd edition, PHI publishers, Chennai,2021

REFERENCES:

1. Shatendra Sharma and Jyotsna Sharma, "Engineering Physics", 2nd edition, Pearson India Education Services Private Limited, Chennai,2018
2. Avadhanulu M N, Kshirsagar P G and Arun Murthy TVS, "A Text book of Engineering Physics", 2nd edition, S Chand Publishing, New delhi,2018
3. Thyagaran K, Ajoy Ghatak, "Lasers – Fundamantals and Applications", 2nd edition, Laxmi Publications Pvt Limited, New delhi,2019

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25		25	25
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER I

U21CY101	ENGINEERING CHEMISTRY (Common to all BE./B.Tech. courses)	Category: BSC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To inculcate the fundamentals of water technology and electrochemistry
- To gain basic knowledge of corrosion of metals and alloys
- To acquire knowledge about the properties of fuels and applications of polymers

COURSE OUTCOMES:

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

CO1: Apply the principles of water technology in treatment of industrial and domestic water and estimate the various constituents of industrial water (Apply)

CO2: Describe the principles and applications of electrochemical cells, fuel cells and solar cells (Understand)

CO3: Outline the different types of corrosion processes and preventive methods adopted in industries (Understand)

CO4: Explain the analysis and calorific value of different types of fuels (Understand)

CO5: Classify the polymers and their engineering applications (Understand)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I CHARACTERISTICS OF WATER AND ITS TREATMENT 6

Characteristics of water – Hardness – Types, Dissolved oxygen, Total dissolved solids, Disadvantages due to hard water in industries – (Scale, Sludge, Priming, Foaming and Caustic embrittlement), Water softening methods – Lime-soda, Zeolite, Ion exchange processes and reverse Osmosis and their applications. Specifications of domestic water (ICMR and WHO) – Water treatment for municipal supply –Sedimentation with coagulant – Sand Filtration – Chlorination, Disinfection methods– UV treatment, Ozonolysis, Electro dialysis

UNIT II ELECTROCHEMISTRY AND ENERGY STORAGE SYSTEMS 6

Introduction, Electrodes – (Calomel electrode), Electrochemical series and its applications, Brief introduction to conventional primary and secondary batteries – (Pb acid, Lithium)

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Fuel cells – Polymer membrane fuel cells, Solid-oxide fuel cells – Working principles, advantages, applications. Solar cells – Dye sensitized solar cells –Working principles, characteristics and applications

UNIT III CORROSION AND ITS CONTROL 6

Types – Dry – Chemical corrosion and Wet – Galvanic and differential aeration (Pitting, Crevice, pipeline) – Factors influencing rate of corrosion – Corrosion control methods – Sacrificial anode and impressed current method – Protective coating – Electroplating – Ni plating.

Alloys – Ferrous (stainless steel), Heat treatment – Non-ferrous alloys (Brass -Dutch metal, German Silver) – Composition, properties and uses

UNIT IV FUELS AND COMBUSTION 6

Fuels- Solid fuel: Coal - Analysis of coal (Proximate analysis only) – Liquid fuel – Manufacture of synthetic petrol (Bergius process) – Octane number, cetane number, Knocking in engines- Anti-knocking agents, Gasoline additives, Gaseous fuel: Compressed natural gas (CNG) – Liquefied petroleum gases (LPG) – Composition only. Calorific value – Higher and lower calorific values – Flue gas analysis (ORSAT method). Measurement of calorific value using bomb calorimeter, Three-way catalytic converter – Selective catalytic reduction of NO_x

UNIT V POLYMERS 6

Introduction – Monomer, dimers, functionality, degree of polymerisation, transition glass temperature Classification of polymers, Difference between thermoplastics and thermosetting plastics, Engineering application of plastics - ABS, PVC, PTFE and Bakelite. Types of compounding of plastics – Moulding, Injection moulding, Extrusion moulding, Compression moulding Conducting polymers – Polypyrrole, Polyacetylene, Polyaniline – Structure and applications, Composites – FRP – Properties and applications

LIST OF EXPERIMENTS

1. Determination of total, permanent and temporary hardness of a given sample water by EDTA method
2. Estimation of ferrous ion by potentiometric titration
3. Estimation of Copper in Brass by EDTA method
4. Determination of percentage of moisture, volatile, ash and carbon content in a given sample of coal.
5. Determination of molecular weight and degree of polymerization of an oil sample by viscosity measurement (Ostwald's viscometer).
6. Determination of chloride content in the water sample
7. Determination of strength of HCl by pH metric method

Contact periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project – Periods
Total 60 Periods

TEXT BOOKS:

1. Jain P C and Monika Jain, "Engineering Chemistry", 16th edition, Dhanpat Rai Publishing Company, Pvt. Ltd., New Delhi,2015
2. Vairam S, Kalyani P and Suba Ramesh, "Engineering Chemistry", 2nd edition, Wiley India Pvt. Ltd, New Delhi,2014

REFERENCES:

1. Friedrich Emich, "Engineering Chemistry", 2nd edition, Scientific International Pvt. Ltd, New Delhi, 2014
2. Prasanta Rath, "Engineering Chemistry", 1st edition, Cengage Learning India, Pvt. Ltd, Delhi,2015
3. Shikha Agarwal, "Engineering Chemistry, Fundamentals and Applications", 1st edition, Cambridge University Press,2015

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25		25	25
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER I

U21MEG01	ENGINEERING GRAPHICS (Common to all B.E./B.Tech. courses)	Category: ESC				
		L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To expose the standards and conventions followed in preparation of engineering drawings
- To develop graphic skills for communication of concepts, ideas and engineering drawings
- To expose on 2D and 3D drawings and its projections

COURSE OUTCOME:

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

CO1: Sketch the curves and orthographic projections of points as per BIS conventions (Understand)

CO2: Illustrate the orthographic projections of straight lines and plane surfaces (Understand)

CO3: Sketch the orthographic projections of solids, lateral surfaces of frustums, truncated solids and its development (Apply)

CO4: Develop the lateral surfaces of simple solids (Apply)

CO5: Interpret the orthographic and isometric views of simple components (Understand)

CO PO Mapping:

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

SYLLABUS:

BASICS OF ENGINEERING DRAWING AND CAD (Not for examination)

Introduction – Drawing instruments and its uses – Sheet layout – BIS conventions – Lines – Lettering and dimensioning practices – Lines – Co – Ordinate points – Axes – Poly lines – Square – Rectangle – Polygons – Splines – Circles – Ellipse – Text – Move – Copy – Off – Set – Mirror – Rotate – Trim – Extend – Break – Chamfer – Fillet – Curves – Constraints viz. agency – Parallelism – Inclination and perpendicularity

UNIT I CONICS, SPECIAL CURVES AND PROJECTION OF POINTS **12**

Construction of parabola – Ellipse and hyperbola using eccentricity method – Construction of involutes for squares and circles – Construction of Tangent and normal to the above curves – Introduction – Method of projection – Planes of projection – Reference line and notations – Orthographic Projection of points – Points in all four quadrants

UNIT II PROJECTION OF STRAIGHT LINES AND SURFACES **12**

Projection of straight lines – Lines inclined to HP / VP plane – Inclined to both HP and VP planes (straight lines are assumed to be in first quadrant only) – Projection of planes – Projection of square

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– Rectangle – Pentagon – Hexagon and circular plane – Inclined to both the plane by change of position method

UNIT III PROJECTION OF SOLIDS 12

Introduction – Projection of solids – Prisms – Pyramids – Cylinders and cones with axis inclined to both the planes (Solids resting on HP only)

UNIT IV DEVELOPMENT OF LATERAL SURFACES OF SOLIDS 12

Introduction – Cutting plane – Sectional views of right regular solids resting with base on HP – Prisms – Pyramids – Cylinder and cone – True shapes of the sections – Development of lateral surfaces of right regular prisms – pyramids – Cylinders – Cones resting with base on HP only – Development of the frustums and truncations

UNIT V ORTHOGRAPHIC AND ISOMETRIC PROJECTIONS 12

Orthographic projection – Simple machine components using free hand sketching – Isometric projection – Simple Solid exercises and combination of solids

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Project – Periods

Total: 60 Periods

TEXT BOOKS:

1. ND Bhat & VM Panchal, "Engineering Drawing", 51st edition, Charotar Publishing House, Gujarat, 2013.
2. Venugopal K. and Prabhu Raja V, "Engineering Graphics", 6th edition, New Age International (P) Limited,2019.

REFERENCE BOOKS:

1. Natrajan K.V., A text book of Engineering Graphics, 21st edition, Dhanalakshmi Publishers, Chennai,2017.
2. Sam Tickoo, AutoCAD 2013 for Engineers and Designers, 1st edition, Dream tech Press,2013.
3. M.H.Annaiah & Rajashekar Patil, Computer Aided Engineering Drawing, 4th edition, New Age International Publishers,2012.
4. Basant Aggarwal, Engineering Drawing, 1st edition, Tata Mc Graw Hill Education Private Limited,2010.
5. D.M.Kulkarni, A.P.Rastogi, A.K.Sarkar, "Engineering Graphics with AutoCAD", PHI Learning Private Limited, New Delhi, Revised edition.,2010.

EVALUATION PATTERN:

Continuous Internal Assessments		End Semester Examinations
Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test	
75	25	
100		100
60		40
100		

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER I

U21MEG02	MANUFACTURING PRACTICES (Common to CE, CH, ME)	Category: ESC				
		L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To provide exposure on workshop tools and additive manufacturing processes
- To provide hands on training experiences in sheet metal, carpentry welding and plumbing operations
- To provide hands on experience on soldering and simple electrical circuit wiring

COURSE OUTCOMES:

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

CO1: Use appropriate tools and measuring instruments to perform assembly and dismantling operations as per standard workshop practices (Apply)

CO2: Produce simple components by applying 3D printing techniques based on the given design model (Apply)

CO3: Produce basic products by applying sheet metal and carpentry processes as per required specifications (Apply)

CO4: Perform basic workshop operations such as welding and plumbing to create functional joints (Apply)

CO5: Connect and test electrical and electronic components to implement the given circuit diagram with proper functionality (Apply)

CO PO Mapping:

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

UNIT I PRODUCT WORKSHOP **12**

Disassemble the product of sub assembly – Measure various dimensions using measuring instruments. Free hand rough sketch of the assembly and components – Name of the components and indicate the various materials used – Study the functioning of the assembly and parts – Study the assembly and components design for compactness – Processing – Ease of assembly and disassembly – Assemble the product or subassembly

UNIT II ADDITIVE MANUFACTURING WORKSHOP **12**

Study of 3 axis 3D printing machine – Methods of 3D printing – SLA and FDM methods – Pre – processing – Geometry creation – Support generation and slicing – Post Processing – Requirement and Techniques Support Removal – Sanding – Acetone treatment – Polishing

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UNIT III SHEET METAL AND CARPENTRY WORKSHOP 12

Study of tools and equipment – Draw development drawing of simple objects on sheet metal (cone – Cylinder – Pyramid – Prism – Tray etc.) – Fabrication of components using small shearing and bending machines – Riveting practice – Study of carpentry process – Fabrication of wood joints like Lap – Tee – Dovetail and mortise & tenon joint

UNIT IV WELDING AND PLUMBING WORKSHOP 12

Study of tools and equipment – Study of various welding – Arc welding practice – Fitting – Square butt joint and lap joint – Plumbing tools – Make a piping joint to a simple piping layout (should include cutting – Threading and pipe fixing)

UNIT V ELECTRICAL AND ELECTRONICS ENGINEERING WORKSHOP 12

Study of tools and equipment – Study of basic electrical components and symbols – Simple Wiring – Staircase Wiring – fluorescent wiring – Study of soldering tools and methods of soldering

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Project – Periods

Total: 60 Periods

LIST OF EXPERIMENTS

1. Study on measuring instruments used in workshop practices.
2. Dismantling, measuring and reassembling of centrifugal pump.
3. 3D prototyping of simple components using FDM method.
4. 3D Printing of simple geometric shapes using SLA printer.
5. Fabrication of sheet metal tray and funnel.
6. Fabrication of wood joints.
7. Preparation of MS plate for Lap, butt and Tee joints using arc welding
8. Installation of water lines for washbasin and showers faucets.
9. Preparation of wiring for tube light, staircase and electric fan.
10. Soldering of a simple circuit consists of THC and SMD components.

TEXT BOOKS:

1. Hajra Choudhury, "Elements of Mechanical Engineering", 11th edition, Media Promoters,2010.
2. S.K. Hajra Choudhury, A.K. Hajra Choudhury, Nirjhar Roy the Elements of Workshop Technology – Vol I & II, 11th edition, Media Promoters and Publishers, Mumbai,2001

REFERENCES:

1. Workshop manual prepared by Department of Mechanical Engineering

EVALUATION PATTERN:

Continuous Internal Assessments		End Semester Examinations
Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test	
75	25	

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100	100
60	40
100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER II

U21GEG02	TAMILS AND TECHNOLOGY (Common to all programs)	Category: HSMC				
		L	T	P	J	C
		1	0	0	0	1

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

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

- To learn weaving, ceramic and construction technology of Tamils
- To understand the agriculture, irrigation and manufacturing technology of Tamils
- To realize the development of scientific tamil and tamil computing

COURSE OUTCOMES:

CO1: Understand the weaving and ceramic technology of ancient tamil people nature (Understand)

CO2: Understand the construction technology, building materials in sangam period and case studies (Understand)

CO3: Infer the metal process, coin and beads manufacturing with relevant archeological evidence (Understand)

CO4: Realize the agriculture methods, irrigation technology and pearl diving (Understand)

CO5: Apply the knowledge of scientific tamil and tamil computing (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I WEAVING AND CERAMIC TECHNOLOGY 3

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY 3

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram – Sculptures and Temples of Mamallapuram – Great Temples of Cholas and other worship places – Temples of Nayaka Period – Type study (Madurai Meenakshi Temple) – Thirumalai Nayakar Mahal – Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period

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UNIT III MANUFACTURING TECHNOLOGY 3

Art of Ship Building – Metallurgical studies – Iron industry – Iron smelting,steel –Copper and gold– Coins as source of history – Minting of Coins – Beads making-industries Stone beads – Glass beads – Terracotta beads – Shell beads/ bone beats – Archeological evidences – Gem stone types described in Silappathikaram

UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY 3

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry – Wells designed for cattle use – Agriculture and Agro Processing – Knowledge of Sea – Fisheries – Pearl – Conche diving – Ancient Knowledge of Ocean – Knowledge Specific Society

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING 3

Development of Scientific Tamil – Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project

Contact Periods:

Lecture: 15 Periods Tutorial: - Periods Practical: – Periods Project – Periods

Total 15 Periods

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் - முனைவர். இல. சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை - ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies)
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book

EVALUATION PATTERN:

Continuous Internal Assessment	Total
	100

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER II

		Category: HSMC				
J21GEG02	தமிழரும் தொழில்நுட்பமும் (அனைத்து துறைகளுக்கும் பொதுவனது)	L	T	P	J	C
		1	0	0	0	1

முன்கூட்டிய துறைசார் அறிவு: தேவையில்லை

பாடத்தின் நோக்கங்கள்:

- தமிழர்களின் சங்ககால நெசவு, பானை வனைதல் மற்றும் கட்டட தொழில்நுட்பம் குறித்து அறிதல்
- தமிழர்களின் சங்ககால வேளாண்மை, நீர்ப்பாசனம் மற்றும் உற்பத்தி முறைகள் குறித்த கற்றல்
- நவீன அறிவியல் தமிழ் மற்றும் கணித்தமிழ் குறித்த புரிதல்

பாடம் கற்றதின் விளைவுகள்:

CO1: சங்ககாலத் தமிழர்களின் நெசவு மற்றும் பானை வனைதல் தொழில்நுட்பம் குறித்த கற்றுணர்தல் (புரிதல்)
CO2: சங்ககாலத் தமிழர்களின் கட்டட தொழில்நுட்பம், கட்டுமானப் பொருட்கள் மற்றும் அவற்றை விளக்கும் தளங்கள் குறித்த அறிவு (புரிதல்)
CO3: சங்ககாலத் தமிழர்களின் உலோகத்தொழில், நாணயங்கள் மற்றும் மணிகள் சார்ந்த தொல்லியல் சான்றுகள் பற்றிய அறிவு (புரிதல்)
CO4: சங்ககாலத் தமிழர்களின் வேளாண்மை, நீர்ப்பாசன முறைகள் மற்றும் முத்து குளித்தல் குறித்த தெளிவு (புரிதல்)
CO5: நவீன அறிவியல் தமிழ் மற்றும் கணித்தமிழ் குறித்த புரிந்துகொள்ளலும் மற்றும் பயன்படுத்துதலும் (கற்றலை பயன்படுத்துதல்)

CO-PO MAPPING:

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

பாடத்திட்டங்கள்:

அலகு I நெசவு மற்றும் பானைத் தொழில்நுட்பம் 3

சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் – கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்

அலகு II வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம் 3

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சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் மற்றும் சங்க காலத்தில் வீட்டுப் பொருட்களின் வடிவமைப்பு – சங்க காலத்தில் கட்டுமானப் பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் – மாமல்லபுரச் சிற்பங்களும் கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் – மாதிரி கட்டமைப்புகள் பற்றி அறிதல் – மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாடு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை

அலகு III உற்பத்தித் தொழில்நுட்பம் 3

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருகுதல், எக்கு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள் – கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத் துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்

அலகு IV வேளாண்மை மற்றும் நீர்ப்பாசனத் *தொழில்நுட்பம்* 3

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமிழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மை சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்

அலகு V அறிவியல் தமிழ் மற்றும் கணினித்தமிழ் 3

அறிவியல் தமிழின் வளர்ச்சி – கணினித்தமிழ் வளர்ச்சி – தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக் கழகம் – தமிழ் மின்நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்

Contact Periods:

Lecture: 15 Periods Tutorial: - Periods Practical: – Periods Project – Periods

Total 15 Periods

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் - முனைவர். இல. சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை - ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies)
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

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10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book

மதிப்பீட்டு முறை:

தொடர்ச்சியான உள் மதிப்பீடு	மொத்தம்
	100

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER II

U21MA201	LAPLACE TRANSFORMS AND COMPLEX VARIABLES (Common to CE, EE, CH, ME, MI)	Category: BSC				
		L	T	P	J	C
		3	1	0	0	4

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the mathematical aspects of conversion time domain to frequency domain using Laplace transform and Inverse Laplace transform vice versa
- To use the concepts of complex analysis, in the study of heat flow, fluid dynamics and electrostatics
- To understand the concepts of singularities in the various domains of engineering fields

COURSE OUTCOMES:

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

CO1: Apply the concepts of Laplace transform in core engineering applications (Apply)

CO2: Apply the concepts of Inverse Laplace transform with their properties in engineering field (Apply)

CO3: analyze the complex functions and their mapping in certain complex planes (Understand)

CO4: Evaluate complex contour integrals directly and use the Cauchy integral theorem in its various versions (Understand)

CO5: Compute the residues of a function at given points or singularities and use the residue theorem to evaluate a contour integral (Understand)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I LAPLACE TRANSFORM **9 + 3**

Laplace transform – Conditions for existence – Transform of elementary functions – Standard properties (statement only) – Transforms of unit step function – Impulse function – Periodic function – Initial and final value theorems – Convolution theorem (without proof)

UNIT II INVERSE LAPLACE TRANSFORM **9 + 3**

Inverse Laplace transform – Standard properties (statement only) – Second order linear differential equations with constant coefficients

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UNIT III COMPLEX DIFFERENTIATION **9 + 3**

Analytic functions: Cauchy-Riemann equations (Cartesian form) and sufficient conditions (excluding proofs) – Harmonic and orthogonal properties of analytic function – Construction of analytic functions – Bilinear transformations

UNIT IV COMPLEX INTEGRATION **9 + 3**

Complex integration – Statement and applications of Cauchy's integral theorem and Cauchy's integral formula

UNIT V SINGULARITIES AND RESIDUES **9 + 3**

Taylor's and Laurent's series expansions – Singular points – Classification of singularities – Residues – Cauchy's residue theorem

Contact Periods:

Lecture: 45 Periods Tutorial: 15 Periods Practical: – Periods Project – Periods

Total 60 Periods

TEXT BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th edition, Wiley India Pvt Ltd, New Delhi, 2018.
2. Grewal B S, "Higher Engineering Mathematics", 44th edition, Khanna Publishers, New Delhi, 2017.

REFERENCES:

1. Bali N P and Dr Manish Goyal, "A text book of Engineering Mathematics", 12th edition, Laxmi Publications, 2016.
2. Thomas G B and Finney R L, "Calculus and Analytic Geometry", 14th edition, Pearson Education India, 2018.
3. James Stewart, "Calculus: Early Transcendental", 7th edition, Cengage Learning, New Delhi, 2015.

EVALUATION PATTERN:

Continuous Internal Assessments				Total Internal Assessments	End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)			
*Individual Assignment / Seminar / MCQ	Written Test	Individual Assignment / Seminar / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER II

U21EEG02	BASICS OF ELECTRICAL ENGINEERING	Category: ESC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES

- Nil

COURSE OBJECTIVES

- To acquire the knowledge on basics of electrical circuits and machines
- To understand the working principle and applications of fractional HP machines
- To select the drive motor based on thermal overloading and load variation factors

COURSE OUTCOMES (CO)

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

CO1: Solve an electric network by Apply basic laws (Apply)

CO2: Explain the operating principles, characteristics and speed control methods of DC motors (Understand)

CO3: Summarize the operation of three phase induction motor and synchronous motor (Understand)

CO4: Interpret the working principle and applications of fractional HP machines (Understand)

CO5: Select the drive motor based on thermal overloading and load variation factors (Understand)

COURSE ARTICULATION MATRIX:

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

SYLLABUS

UNIT I BASIC CONCEPTS OF ELECTRIC CIRCUITS 9

Active elements – DC and AC sources – Passive elements – Elements in series and parallel connections – Star and delta conversion – Ohm's law and Kirchhoff's laws – Mesh and Nodal analysis – Power, Power factor and Energy

UNIT II DC MOTORS 9

DC motors – Construction, principle of operation, types, torque equation, characteristics and applications – Starters for DC motors – Speed control and braking (Qualitative Analysis only)

UNIT III AC MOTORS 9

Three phase induction motors – Construction, principle of operation, characteristics and applications – Starters for AC motors – Synchronous motors – Construction and operating principle (Qualitative Analysis only)

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UNIT IV FRACTIONAL HP MACHINES 9

Construction, principle of operation, characteristics and applications: Single phase induction motor – Reluctance motor – Servomotor – Stepper motor (Qualitative Analysis only)

UNIT V SELECTION OF MOTOR FOR ELECTRIC DRIVES 9

Basic Elements – Types of electric drives – Factors influencing the choice of electrical drives – Heating and cooling curves – Loading conditions and classes of duty – Selection of power rating for drive motors with regard to thermal overloading and load variation factors

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS

1. Sudhakar A and Shyam Mohan SP, "Circuits and Network Analysis and Synthesis", 5th edition, McGraw Hill Education, New Delhi,2017
2. R.K. Rajput, "Electrical Machines", 6th edition, Laxmi Publications,2016

REFERENCES

1. William H. Hayt Jr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis", 8th edition, McGraw–Hill Education, New Delhi,2013
2. S.K. Bhattacharya, "Electrical Machines", 4th edition, McGraw–Hill Education, New Delhi,2017
3. B.L. Theraja, A.K. Theraja, "A text book of Electrical Technology", 24th edition, S. Chand Publications,2014

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Seminar / Mini Project / MCQ	Written Test	Individual Assignment / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER II

U21ME201	ENGINEERING MECHANICS	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To expose various laws of force for equilibrium of rigid bodies
- To introduce the concepts of properties of surfaces and solids
- To impart knowledge on the fundamentals of dynamics of particles and rigid bodies

COURSE OUTCOMES (CO)

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

CO1: Apply various force systems in a plane (Apply)

CO2: Solve equilibrium of rigid bodies in two dimensions (Apply)

CO3: Calculate the centroid, area and mass moment of inertia for surfaces and solids (Apply)

CO4: Apply the concept of dynamics for particle motions (Apply)

CO5: Determine the friction of elements and dynamics of rigid bodies (Apply)

COURSE ARTICULATION MATRIX:

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

SYLLABUS:

UNIT I EQUILIBRIUM OF FORCES 9

Types of force systems – coplanar concurrent forces – Resultant – Moment of a force and its application – Couples and resultant of a force system equations of equilibrium of coplanar concurrent and non – concurrent force systems Lami's theorem – Resolution of a force into a force and a couple – Polygon law of forces for resultant

UNIT II EQUILIBRIUM OF RIGID BODIES 9

Free body diagram – Types of supports – Support reactions – Moment of a force about a point and about an axis – Moments and couples – Scalar components of a moment – Varignon's theorem – Single equivalent force – Equilibrium of rigid bodies in two dimensions

UNIT III PROPERTIES OF SURFACES AND SOLIDS 9

Centroids and centre of mass – Centroids of lines and areas – Rectangular – Circular – Triangular areas by integration – T section I section and Hollow section by using standard formula – Theorems of Pappus – Area moments of inertia of plane areas – Rectangular – Circular – Triangular areas by integration – T section – I section – Hollow section by using standard formula – Parallel axis theorem

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and perpendicular axis theorem – Principal moments of inertia of plane areas – Principal axes of inertia – Mass moment of inertia – Mass moment of inertia for prismatic and cylindrical solids

UNIT IV DYNAMICS OF PARTICLES 9

Displacements, velocity and acceleration – relationship – Relative motion – Curvilinear motion. Newton's laws of motion – Work energy equation – Impulse and momentum – Impact of elastic bodies

UNIT V FRICTION AND ELEMENTS OF RIGID BODY DYNAMICS 9

Friction force – Laws of sliding friction – Equilibrium analysis of simple systems with sliding friction – Wedge friction – Rolling resistance – Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion of simple rigid bodies such as cylinder, disc/wheel and sphere

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS

1. Vela Murali, "Engineering Mechanics", 1st edition, Oxford University Press,2010
2. S. S. Bhavikatti, Engineering Mechanics, 3rd edition, New Age International Publishers,2016

REFERENCES

1. Beer, F.P and Johnston Jr. E.R., "Vector Mechanics for Engineers: Statics and Dynamics", 8th edition, Tata McGraw Hill Publishing company, New Delhi,2014
2. S. Timoshenko,D.H. Young,J.V. Rao, Sukumar Pati, Engineering Mechanics, 4th edition, TMH Education,2016
3. Sanjay Bansal, R.K. Bansal, A Textbook of Engineering Mechanics, 8th edition, Laxmi Publications Pvt Ltd,2011

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Seminar / Mini Project / MCQ	Written Test	Individual Assignment / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER II

U21PH201	MATERIALS SCIENCE (Common to all branches except BME)	Category: BSC				
		L	T	P	J	C
		2	0	0	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To gain the knowledge of conducting and semiconducting materials
- To understand the concepts of magnetic, dielectric and optical properties of materials
- To enhance the knowledge of new engineering materials

COURSE OUTCOMES:

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

CO1: Demonstrate the electrical characteristics of conducting materials (Understand)

CO2: Interpret the properties and types of semiconducting materials (Understand)

CO3: Compare various types of magnetic materials for engineering applications (Understand)

CO4: Explain the fundamental concepts of dielectric and optical materials (Understand)

CO5: Examine new engineering materials for industrial applications (Understand)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I CONDUCTING MATERIALS 6

Classical free electron theory – Expression for electrical conductivity and thermal conductivity – Wiedemann - Franz law – Drawbacks – Fermi distribution function – Density of energy states in metals

UNIT II SEMICONDUCTING MATERIALS 6

Intrinsic and Extrinsic semiconductor – Carrier concentration in n-type semiconductor – P-type semiconductor(qualitative) – Applications of semiconductors – Solar cell – LED – Hall effect and its experimental determination

UNIT III MAGNETIC MATERIALS 6

Origin of magnetism – Dia, para and ferro magnetic materials – Domain theory – Soft and hard magnetic materials – Magnetic bubble memories – GMR sensor

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UNIT IV DIELECTRIC AND OPTICAL MATERIALS 6

Dielectrics – Types of polarisation – Electronic polarisation – Dielectric breakdown – Ferroelectrics – Applications of dielectrics – Classification of optical materials – Nonlinear optics – Applications

UNIT V NEW ENGINEERNG MATERIALS AND CHARACTERIZATION TECHNIQUES 6

SMA – SiC – GaN – Rheological materials – Nanomaterials – Synthesis (Ball milling and CVD) – Quantum dot, quantum wire and quantum well(qualitative) – Characterisation techniques – Powder XRD (qualitative) – SEM

Contact Periods:

Lecture: 30 Periods Tutorial: - 0 Periods Practical: - Periods Project: – Periods

Total: 30 Periods

TEXT BOOKS:

1. Wahab M A, "Solid State Physics: Structure and Properties of Materials", 3rd edition, Narosa Publishing House, Chennai, 2018
2. Marikani A, "Materials Science", 1st edition, PHI publishers, Chennai, 2017

REFERENCES:

1. Pillai S O "Solid State Physics", 9th edition, New Age International Publishers, New Delhi, 2020
2. Bangwei Zhang, "Physical Fundamentals of Nanomaterials", Chemical Industry Press, China, 2018
3. Joginder Singh Galsin, "Solid State Physics – An Introduction to Theory", Academic Press, India, 2019

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Seminar / Mini Project / MCQ	Written Test	Individual Assignment / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER II

U21EN201	PERSONALITY ENHANCEMENT Common to AD, BM, CH, CE, CS, CS(AIML), EE, EC, ME, MI, IT)	Category: HSM				
		L	T	P	J	C
		1	0	2	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To develop of personality traits that contributes in the professional environment
- To create a basic awareness about the significance of soft skills in professional and interpersonal communications
- To enhance the level of self-confidence that helps to excel in the leadership skills

COURSE OUTCOMES:

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

CO1: Nurture a deep understanding of personality development and interpersonal relationship for overall self-development (Understand)

CO2: Communicate proficiently in high-end interviews and in all social situations (Understand)

CO3: Synthesize complex concepts and present them in speech and writing (Analyse)

CO4: Negotiate and lead teams towards success (Understand)

CO5: Present ideas in an effective manner using web tools (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I LEXICAL REASONING 9

Module:1 Establishing Associations

Activity: Verbal Analogy, Logical Reasoning

Module:2 Lateral Thinking

Activity: Reasoning and Assertions

Module:3 Sentence Completion

Activity: Cloze Test, Single Word Substitutes

UNIT II SOCIAL CORRESPONDENCE 9

Module:4 Etiquettes

Activity: Brain storming & performing in actions

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Module:5 Introspection
Activity: SWOT Analysis, Goal Setting
Module:6 Co-verbal Gesture
Activity: Body Language, Non verbal cues

UNIT III ART OF NETWORKING 9

Module:7 Addressing a Multitude
Activity: Welcome address, Vote of Thanks, Public Speaking
Module:8Persuasive Communication
Activity: Making Technical Presentation
Module:9 Career Oriented Communication
Activity: Face to face Conversation, Mock Interview

UNIT IV CRITICAL THINKING 9

Module:10 Organizing ideas
Activity: Mind Mapping
Module:11 Problem Solving Skills
Activity: Conflict management, Case Study
Module:12 Critical Review
Activity: Book/ Movie Review, Comparative Analysis

UNIT V CONTENT WRITING 9

Module:13 Reports
Activity: Writing Event Report, Project Report
Module:14 Writing for Digital platform
Activity: Writing Posts, Blogs
Module:15 Developing Content
Activity: Product Description, Writing Proposals

LIST OF EXERCISES

1. Listening to Inspirational Speech
2. Listening to Product Description
3. Book/Movie Review
4. Presentation
5. Mock Interview
6. Public Speaking

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project – Periods
Total 60 Periods

TEXT BOOKS:

1. Meenakshi Raman & Sangeetha Sharma. "Professional English: for AKTU",1st edition, OxfordUniversity Press,2018
2. Barun. K. Mitra. "Personality Development and Soft Skills", 2nd edition, OUP India,2016

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REFERENCES:

1. Mathew Allen. "Smart Thinking: Skills for Critical Understanding and Writing", 2nd edition, OUP India,2016
2. Means, Thomas L, "English and Communication for Colleges", 4th edition, Cengage,2017
3. Using English: "A Coursebook for Undergraduate Engineers and Technologists", 1st edition, Orient Black Swan,2017

EVALUATION PATTERN:

<table>
<tr><td colspan="4">Continuous Internal Assessments</td><td>End Semester Examinations</td></tr>
<tr><td colspan="2">Assessment I
(Theory)
(100 Marks)</td><td colspan="2">Assessment II
(Practical)
(100 Marks)</td><td rowspan="2">Practical Examinations
(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>*Individual Assignment / Seminar / MCQ</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)</td><td>Test</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td><td></td></tr>
<tr><td colspan="2">25</td><td colspan="2">25</td><td>50</td></tr>
<tr><td colspan="4">50</td><td>50</td></tr>
<tr><td colspan="5">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER II

U21CSG02	PYTHON PROGRAMMING Common to All Branches	Category: ESC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand syntax and semantics of python programming
- To implement programs using python data structures
- To gain expertise in using python libraries for solving real time problems

COURSE OUTCOMES:

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

CO1: Describe the basic operations of tokens in python (Understand)

CO2: Demonstrate the programs using control statements (Apply)

CO3: Develop programs using python data structures (Apply)

CO4: Implement the exceptions in file-handling concepts (Apply)

CO5: Apply the python libraries in real-world problems (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I LANGUAGE BASICS 6

Python interpreter and interactive mode – Tokens – Data types – Numbers and math functions – Input and Output operations – Comments – Reserved words – Indentation – Operators and expressions – Precedence and associativity – Type conversion – Debugging – Common errors in Python

UNIT II CONTROL STATEMENTS, FUNCTIONS, AND MODULES 6

Selection – Conditional branching statements – if – if-else – Nested-if – if-elif-else statements – Iterative statements – while – for loop – break – continue and pass statements – Functions – Function Definition and Function call – Variable scope and Lifetime – Return statement – Lambda functions or Anonymous functions – Recursion – Modules and Packages

UNIT III PYTHON DATA STRUCTURES 6

Strings – Slicing – Immutability – Built-in string methods and functions – Concatenating – Appending and Multiplying strings – String modules – List – Creation – Accessing values – Slicing – List methods – In-built functions for Lists – Tuples – Creation – Operations on tuples – Traversing – Indexing and

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Slicing – Tuple assignment – In-built functions for tuples – Sets – Creation – Operations – Dictionaries – operations and methods

UNIT IV EXCEPTION AND FILE HANDLING 6

Exceptions – Errors and Exceptions – Handling exception – Built-in and User-defined exceptions – Files – Types – Operations – Open – Read – Write – Close

UNIT V NUMPY and PANDAS 6

Numpy – Introduction – Computations using NumPy functions – Computation on Arrays – Aggregation – Indexing and Sorting – Pandas – Introduction and Basic Pandas Concepts – Data frames – Data Handling

LIST OF EXPERIMENTS

1. Programs on selection and Iteration operations.
2. Get an integer input from a user. If the number is odd, then find the factorial of a number and find the number of digits in the factorial of the number. If the number is even, then check the given number is palindrome or not.
3. Strings and its operations.
4. Given two strings, PRINT (YES or NO) whether the second string can be obtained from the first by deletion of none, one or more characters.
5. List and its operations.
6. Programs for positive and negative indexing.
7. Program to check if the given list is in Ascending order or Not.
8. Tuples and its operations.
9. Python program to convert a tuple to a string.
10. Python program to reverse a tuple.
11. Sets and its operations.
12. Python program to check if a set is a subset of another set.
13. Dictionaries and its operations.
14. Python program to iterate over dictionaries using for loops.
15. Computations using NumPy functions.
16. NumPy program to convert a list of numeric value into a one-dimensional NumPy array.
17. NumPy program to convert a list and tuple into arrays.
18. Data manipulations using Pandas.
19. Program to convert a NumPy array and series to data frames.
20. Program to add, subtract, multiple and divide two Pandas Series.
21. Program to retrieve and manipulate data using dataframes.

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project – Periods

Total 60 Periods

TEXT BOOKS:

1. Reema Thareja, "Python programming: Using problem solving approach", 1st edition, Oxford Press,2017
2. William McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, 2nd edition, Shroff/O'Reilly Publication,2017

REFERENCES:

1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers,2016
2. Ashok Namdev Kamthane and Amit Ashok Kamthane, "Programming and Problem Solving with Python", 2nd edition, McGrawHill Education,2018
3. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach",1st edition, Pearson India Education Services Pvt. Ltd.,2016

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25		25	25
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER II

U21ECG02	BASICS OF ELECTRONICS ENGINEERING	Category: ESC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To study about the basic electronics components and their applications
- To explore operational amplifiers for different applications
- To introduce the digital circuits and microcontrollers

COURSE OUTCOMES:

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

CO1: Illustrate principles of electronic components (Understand)
CO2: Summarize the applications of diodes and transistors (Understand)
CO3: Explain about op-amp and its applications (Understand)
CO4: Compare sequential and combinational logic circuits (Understand)
CO5: Demonstrate applications of 8051 and Arduino (Understand)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I BASIC ELECTRONIC COMPONENTS 6

Passive and active components – Construction, Operation and characteristics of PN junction diode and Zener diode – Construction and Operation of NPN and PNP transistors

UNIT II APPLICATIONS OF DIODES AND TRANSISTOR 6

Half wave, full wave and bridge rectifiers, Zener diode voltage regulator – CE amplifier, frequency response – Oscillator – Hartley and RC phase shift

UNIT III OPERATIONAL AMPLIFIER 6

Operational amplifier – Ideal characteristics – Inverting and non-inverting amplifier – Applications of op-amp – Adder, subtractor, integrator, differentiator, comparator

UNIT IV DIGITAL CIRCUITS 6

Number systems, Boolean algebra, Logic gates, combinational circuits – Adder, subtractor, sequential logic circuits – Latch and flip-flop

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UNIT V INTRODUCTION TO MICROCONTROLLER 6

Introduction to microprocessor – 8051 Microcontroller – Architecture, instruction set, simple programs – Arduino controller

LIST OF EXPERIMENTS (INDICATIVE)

1. Study the volt-ampere characteristics of PN diode and Zener diode
2. Applications of PN diode as Half and Full wave rectifier
3. Realization of Zener diode as regulator
4. Characteristics of CE amplifier
5. Realization of adders and subtractor using logic gates
6. Simple application program using 8051 Microcontroller

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Donald A Neaman, "Semiconductor Physics and Devices", 4th edition, Tata McGraw Hill,2012
2. S. Salivahanan, N.Sureshkumar, A. Vallavaraj, "Electronic Devices and Circuits", 3rd edition, Tata McGraw Hill,2010

REFERENCES:

1. R. S. Sedha, "A Textbook of Applied Electronics", 3rd edition, S. Chand & Company Ltd,2013
2. M.Morris Mano, Michael D. Ciletti "Digital Design", 6th edition Pearson,2018
3. Soumitra Kumar Mandal, "Microprocessors and Microcontrollers Architecture Programming and interfacing using 8051, 8086 & 8051", 1st edition, Tata McGraw Hill,2011
4. Roy Chaudary, "Linear Integrated Circuits", 6th edition, New Age International Publishers,2021

EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25		25	25
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER II

U21ME202	INTERFACING OF ELECTRONICS & ELECTRICAL COMPONENTS AND TROUBLESHOOTING	Category: ESC				
		L	T	P	J	C
		0	0	3	0	2

PRE–REQUISITES:

- NIL

COURSE OBJECTIVES:

- To provide exposure in interfacing electronic components with hardware
- To provide hands on training experiences in interfacing of electronic components
- To provide knowledge on electrical components and circuits

COURSE OUTCOMES:

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

CO1: Interpret various electrical/electronic components used for interfacing (Understand)

CO2: Describe various sensors with display unit (Understand)

CO3: Demonstrate operations such as rotation of stepper motor, servo motor, controlling of valves and pumps (Apply)

CO4: Apply IoT for smart home automation system (Apply)

CO5: Demonstrate troubleshooting of various electrical and electronic components (Apply)

CO–PO MAPPING:

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

List of experiments:

1. Study on basics of interfacing:
   i. I/O Ports of Microcontroller
   ii. I/O Functions of Arduino
   iii. Basic electrical and electronics components used for interfacing
2. Interfacing of LCD display with Microcontroller.
3. Interfacing different sensors with Arduino and display the outputs.
4. Interfacing of stepper motor to make it run in required step angles with Arduino.
5. Interfacing of servo motor with Arduino to control a robotic arm.
6. Interfacing of solenoid valve with Arduino for controlling the flow of liquid.
7. Interfacing of water pump with Arduino for smart irrigation system.
8. Interfacing of software/hardware for smart home automation using IOT.

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9. Troubleshooting of electronic circuits/components.
10. Troubleshooting common electrical problems.

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 45 Periods Project: – Periods

Total: 45 Periods

EVALUATION PATTERN:

Continuous Internal Assessments		End Semester Examinations
Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test	
75	25	
100		100
60		40
		100

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER III

U21MA303	FOURIER ANALYSIS AND BOUNDARY VALUE PROBLEMS (Common to CE, EE, ME, MI)	Category: BSC				
		L	T	P	J	C
		3	1	0	0	4

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the concepts of partial differential equations and its solutions
- To understand the concept of Fourier series and Fourier transform techniques in the field of engineering
- To understand the mathematical aspects that contribute to the solution of one and two dimensional PDEs

COURSE OUTCOMES:

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

CO1: Apply the fundamental concepts of partial differential equations to solve real life practical applications (Apply)

CO2: Demonstrate Fourier series to study the behaviour of periodic functions and their applications in system communications and digital signal processing (Apply)

CO3: Analyze the spectral characteristics of signals using Fourier transforms to find the discrete/continuous function arising in signals (Apply)

CO4: Apply Fourier series to solve an initial–boundary value problem for one dimensional wave and heat equation (Apply)

CO5: Apply Fourier series to solve an initial–boundary value for two dimensional heat equations (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I PARTIAL DIFFERENTIAL EQUATIONS **9 + 3**

Formation of partial differential equations – Singular integrals – Solutions of standard types of first order partial differential equations – Lagrange's linear equation – Solution methods for second order homogeneous equations with constant coefficients

UNIT II FOURIER SERIES **9 + 3**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range series – Parseval's identity – Harmonic analysis

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UNIT III FOURIER TRANSFORM 9 + 3

Fourier transform pair – Fourier sine and cosine transforms – Properties (without proof) – Transforms of simple functions – Convolution theorem – Parseval's identity

UNIT IV ONE DIMENSIONAL BOUNDARY VALUE PROBLEMS 9 + 3

Fourier series solution – Vibration of strings – One dimensional wave equation – One dimensional heat flow equation (unsteady state)

UNIT V TWO DIMENSIONAL BOUNDARY VALUE PROBLEMS 9 + 3

Fourier series solution – Two dimensional (steady state) heat flow equations (Cartesian form only) separation of variables

Contact Periods:

Lecture: 45 Periods Tutorial: 15 Periods Practical: – Periods Project – Periods

Total 60 Periods

TEXT BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th edition, Wiley & Sons, 2018
2. Grewal B. S, "Higher Engineering Mathematics", 44th edition, Khanna Publishers, 2017

REFERENCES:

1. Bali N.P and Manish Goyal, "A text book of Engineering Mathematics", 12th edition, Laxmi Publications, 2016
2. Wylie C. R. and Barrett L. C, "Advanced Engineering Mathematics", 6th edition, Tata McGraw-Hill, New Delhi, 2016
3. Narayanan S, Manicavachagom Pillay T. K. and Ramanaiah G, "Advanced Mathematics for Engineering Students", Vol. II & III, 4th edition, S. Viswanathan Publishers Pvt. Ltd, Chennai, 2004

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
Individual Assignment / Seminar / MCQ *Individual Assignment / Seminar / MCQ	Written Test	Individual Assignment / Seminar / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER III

U21ME301	ENGINEERING THERMODYNAMICS	Category: PCC				
		L	T	P	J	C
		3	1	0	0	4

PRE–REQUISITES:

- U21PH101 - Engineering Physics

COURSE OBJECTIVES:

- To provide basic thermodynamic principles and laws
- To study the behaviour of substance and thermodynamic relations
- To develop the skills to analyse and design thermodynamic systems

COURSE OUTCOMES:

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

CO1: Apply the zeroth and first laws of thermodynamics to evaluate temperature scales and property changes. (Apply)

CO2: Utilize the second law of thermodynamics to evaluate the performance of thermal devices through energy and entropy calculations (Apply)

CO3: Analyse the thermodynamic properties of pure substances using steam table (Analyse)

CO4: Derive thermodynamic relations and use them to evaluate system properties. (Apply)

CO5: Evaluate psychrometric properties and processes for air-conditioning and related engineering applications. (Apply)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I FUNDAMENTAL CONCEPTS AND FIRST LAW **9+3**

Introduction, Basic Concepts: Thermodynamic system and control volume – Microscopic and macroscopic point of view – Thermodynamic properties – State of a substance – Process and cycle Thermodynamic equilibrium – Concept of Continuum – Quasi – Static process – The Zeroth Law of Thermodynamics – Temperature scales – First law of Thermodynamics: First law for a closed system undergoing a cycle and change of state – Energy PMM1 first law of thermodynamics for steady flow process – Steady flow energy equation applied to nozzle – Diffuser – Boiler – Turbine – Compressor pump – Heat exchanger and throttling process – Filling and emptying process

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UNIT II SECOND LAW OF THERMODYNAMICS AND AVAILABILITY **9+3**

Second law of thermodynamics: Limitations of first law of thermodynamics Kelvin – Planck and Clausius statements and their equivalence – PMM2 – Causes of irreversibility – Carnot theorem corollary of Carnot theorem – Thermodynamic temperature scale – Entropy: Clausius theorem property of entropy – Inequality of Clausius, entropy change in an irreversible process, principle of increase of entropy – Entropy change for non – flow and flow processes Exergy: Exergy of a heat input in a cycle exergy destruction in heat transfer process exergy of finite heat capacity body exergy of closed and steady flow system irreversibility second law efficiency

UNIT III PROPERTIES OF PURE SUBSTANCES AND GAS MIXTURES **9+3**

Ideal gas equation, Properties of Ideal Gases – Equations of State – Law of Corresponding States Properties of Mixtures – Compressibility, universal compressibility chart. Pure Substances – PVT Surfaces – Properties of steam – Saturation Temperature and Pressure – Use of property tables – TS diagrams – Mollier Chart. Introduction to Vapor Power cycles

UNIT IV THERMODYNAMIC RELATIONS **9+3**

General Thermodynamic Relations – Combined First and Second law Equations – Helmholtz and Gibb's functions – Application – Maxwell's Relations – Derivation, Tds Equations the Clapeyron Equation Equations for internal energy – Enthalpy and entropy – Specific heats – Throttling process Joule Thomson Coefficient inversion curve

UNIT V PSYCHROMETRY **9+3**

Basic Definitions – Properties of atmospheric air – Psychometric process – Usage of psychometric charts – Simple Problems in Psychometry using formulas and charts – Applications of Psychrometry

Contact Periods:

Lecture: 45 Periods Tutorial: 15– Periods Practical: – Periods Project – Periods

Total 60 Periods

TEXT BOOKS:

1. P. K.Nag;Engineering Thermodynamics, 5th edition McGraw Hill,2013
2. R.K. Rajput , "A Textbook of Engineering Thermodynamics 5th edition", Published by Laxmi Publications Pvt. Ltd,2011

REFERENCES:

1. Chattopadhyay, P, "Engineering Thermodynamics", Oxford University Press,2016
2. Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner, Margaret B. Bailey , "Fundamentals of Engineering Thermodynamics, 8th edition" , Wiley,2014
3. Adrian Bejan J. A. Jones, "Advanced Engineering Thermodynamics, Fourth Edition" Wiley,2016

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER III

		Category: PCC				
U21ME302	MANUFACTURING TECHNOLOGY – I	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21CY101 - Engineering Chemistry

COURSE OBJECTIVES:

- To gain knowledge in material casting processes.
- To introduce students to foundry practices and product design considerations
- To provide an overview of sheet metal and welding processes

COURSE OUTCOMES:

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

CO1: Explain pattern design and moulding methods with their merits, demerits and applications (Understand)

CO2: Explain casting, melting processes and testing methods used in foundry practice (Understand)

CO3: Explain the principles and classifications of various welding processes (Understand)

CO4: Explain hot and cold working processes and their effects on material properties (Understand)

CO5: Explain sheet metal working processes and their industrial applications (Understand)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I PATTERNS 9

PATTERNS AND PATTERN MAKING

Introduction to Foundry – Steps involved in casting – Advantages – Limitations and applications of casting process. Pattern types – Allowances for pattern – Pattern materials – Color coding and storing of patterns

MOULDING: Moulding methods and processes – Materials – Equipment – Moulding sand ingredients – Essential requirements – sand preparation and control – Testing – Cores and core making – Design considerations in casting – Gating and Riser – Directional solidification in castings – Metallurgical aspects of Casting – Introduction to moulding software's

UNIT II METAL CASTING 9

Casting Processes: Sand castings – Pressure die casting – Permanent mould casting – Centrifugal casting – Precision investment casting – Shell moulding – Continuous casting – Squeeze casting – Electro slag casting – Fettling and finishing – Defects in Castings – Casting of non – Ferrous materials

Melting – Pouring and Testing: Melting furnaces – Crucibles oil fired furnaces – Electric furnaces – Cupola – Selection of furnace – Degasification – Inoculation – Pouring techniques casting defects and Inspection of castings

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UNIT III METAL JOINING 9

Basic Joining Processes: Cold welding – Diffusion bonding – Explosive welding – Ultrasonic welding – Friction welding – Forge welding – Roll welding and Hot pressure welding processes – Resistance welding (spot – Seam – Projection – Percussion – Flash types) – Atomic hydrogen arc welding – Thermit welding – Flame cutting – Use of Oxyacetylene – Modern cutting processes – Arc cutting – Robotic welding

UNIT IV FORMING PROCESSES 9

Elastic and plastic deformation – Concept of strain hardening – Operating principle – Equipment – Types – Merits – Demerits and applications of hot and cold working process – Rolling – Forging – Extrusion – Swaging – Wire and tube drawing – Load consideration of hot and cold working processes

UNIT V SHEET METAL WORKS 9

Introduction – Sheet metal characteristics – Shearing mechanisms – Formability of sheet metal – Testing methods – Basic sheet metal operations – Principle – Equipment – Types – Merits – Demerits and applications. Special forming process – Hydro forming – rubber pad forming – Metal spinning – Introduction to explosive forming – Magnetic pulse forming – Peen forming – Super plastic forming – Micro forming

Contact Periods:

Lecture: 45 Periods Tutorial: Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall of India,2004
2. P.N.Rao – "Manufacturing Technology", 5th edition, MH Ltd.,2013

REFERENCES:

1. Serope Kalpakjian; Steven R.Schmid, "Manufacturing Engineering and Technology", 4th edition, Prentice Hall,2000
2. R.B Gupta, "Foundry Engineering" Satyaprakashan,3rd edition, Tata McGraw Hill Publishing Company Ltd,2012
3. Lal.O.P Mand Khanna A, "Text Book of Foundry Technology", 5th edition, Dhanpat Rai and Sons,2013

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based or the nature of the course.

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SEMESTER III

U21ME303	ENGINEERING MATERIALS AND METALLURGY	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21PH201 - Materials Science

COURSE OBJECTIVE:

- Impart knowledge on the structure Properties – Treatment – Testing and applications of metals and non – Metallic materials
- Identify and select suitable materials for various engineering applications
- Impart knowledge on the various material testing methods

COURSE OUTCOMES:

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

CO1: Discuss the Alloys and Phase Diagrams of Steel (Understand)

CO2: Explain the types of Ferrous and Non-Ferrous metals and its alloys (Understand)

CO3: Select the heat treatment processes to modify the material properties (Apply)

CO4: Explain the properties and applications of polymer composites and ceramics (Understand)

CO5: Test the mechanical properties of the materials by using standards (Apply)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I ALLOYS AND PHASE DIAGRAMS 9

Constitution of alloys – Solid solutions – Substitution land interstitial – Phase diagrams – Isomorphous – Eutectic – Eutectoid – Peritectic – and peritectoid reactions – Iron – Carbon equilibrium diagram – Iron and carbon phase diagram – Phases and reactions in iron – Carbon diagram – TTT diagram – Continuous cooling curve

UNIT II FERROUS AND NON–FERROUS METALS 9

Classification of steel and cast Iron microstructure – Properties and application – Effect of alloying additions – Stainless and tool steels – HSLA – Maraging steels – Cast Iron – Grey – White – Malleable – Spheroidal – Alloy cast irons – Copper and copper alloys – Brass – Bronze and Cupronickel – Aluminium and Al – Cu – Precipitation strengthening treatment – Bearing alloys – Mg – Alloys – Ni – Based super alloys and Titanium alloys

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UNIT III HEAT TREATMENT 9

Definition of Heat Treatment – Full annealing – Stress relief – Recrystallisation and spheroidising – Normalising – Hardening and Tempering of steel – Isothermal transformation diagrams – Cooling curves superimposed on I.T. diagram CCR – Hardenability – Jominy end quench test – Austempering – Martempering – Case hardening – Carburizing – Nitriding – Cyaniding – Carbonitriding – Flame and Induction hardening – Vacuum and Plasma hardening

UNIT IV NON-METALS 9

Non – Metals: Polymers – Thermoplastics and thermosets – Properties and applications : Acrylonitrile butadiene styrene – Polyamide – Polyphenyleneoxide – Polyetheretherketone – Urea formaldehyde – Phenol formaldehyde and epoxy) – Ceramics: properties and applications of SiC– Al2O3 and PSZ – Introduction to composites: Types of composites – MMC – CMC and PMC – Applications and smart materials – Biomaterials – Smart materials – Shape memory alloys

UNIT V MECHANICAL PROPERTIES AND MATERIAL TESTING 9

Mechanism of plastic deformation – Slip and twinning – Types of fracture – Ductile and brittle – Testing of materials under tension – Testing of materials under – compression and shear loads – Hardness test (Brinell Vickers – Rockwell – microhardness) – Impact test – Fatigue failure (SN Curve) – Creep failure mechanisms – Testing of corrosion

Contact Periods:

Lecture: 45 Periods Tutorial: Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Kenneth G Budinski and Michael K Budinski, "Engineering Materials properties and selection", 9th edition, PHI learning private limited,2016
2. William D. Callister Jr.; David G. Rethwisch, "Material Science and Engineering", 10th edition, An introduction, Wiley India,2018

REFERENCES:

1. Avner S.H., "Introduction to Physical Metallurgy", McGraw Hill Book Company,1994
2. G. E. Dieter, "Mechanical Metallurgy", 3rd edition, McGraw Hill,2017
3. Upadhyay. G.S. and Anish Upadhyay, "Materials Science and Engineering", 2nd edition, Viva Books Pvt.Ltd., New Delhi,2015
4. Raghavan.V. "Materials Science and Engineering", 5th edition, Prentice Hall of India Pvt. Ltd.,2005

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation–Record (Rubrics Based Assessments)	Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER III

		Category: PCC				
U21ME304	FLUID MECHANICS AND APPLICATIONS	L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- U21PH101 - Engineering Physics

COURSE OBJECTIVES:

- To learn the fluid properties and their flow dynamics.
- To solve the fluid flow problems and analyze the performance of the hydraulic machines
- To impart knowledge of dimensional analysis in fluid flow.

COURSE OUTCOMES:

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

CO1: Determine the properties of fluids and solve fluid dynamics problems (Apply)

CO2: Apply boundary layer and internal flow principles to compute pipe flow losses and analyze flow behavior in series and parallel pipe systems. (Apply)

CO3: Develop the models for the fluid flow phenomena (Apply)

CO4: Investigate the performance of pumps (Analyze)

CO5: Analyze the operating characteristics of a turbine (Analyze)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I FLUID PROPERTIES, STATICS AND DYNAMICS 6

Importance & applications of fluid mechanics – Units and Dimensions – Properties of fluids – Mass density – Specific weight – Specific volume – Specific gravity – Viscosity – Compressibility – Surface tension – Capillarity – Pressure and its measurement (description only)

Introduction to fluid kinematics and dynamics: types of fluid flow – Continuity equation – Euler's equation of motion – Bernoulli's equation and its applications – Momentum equation – Moment of momentum equation

UNIT II BOUNDARY LAYER AND FLOW THROUGH PIPES 6

Boundary layer concepts – Types of boundary layer thickness – Hagen – Poiseuille equation – Losses in pipes – Loss due to friction and Darcy Weisbach equation – Moody diagram – Minor losses – Hydraulic gradient and total energy line – flow through pipes in parallel and series

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UNIT III DIMENSIONAL ANALYSIS 6

Introduction to dimensional analysis – Dimensional homogeneity – Methods of dimensional analysis – Similitude and its types – Dimensionless numbers – Model analysis and model laws – Undistorted and distorted models

UNIT IV HYDRAULIC PUMPS 6

Definition and classifications – Efficiencies – Centrifugal pumps – Working principle – Velocity triangles – Work done by impeller – Specific speed – Performance curves Reciprocating pumps – Working principle – Indicator diagram – Pressure vessel – Simple problems

UNIT V HYDRAULIC TURBINES 6

Classification of turbines – Pelton Francis and Kaplan turbine: Working principles – Heads and efficiencies – Velocity triangles – Work done by the runner – Draft tube – Specific speed – Unit quantities – Performance curves – Simple problems

LIST OF EXPERIMENTS

1. Verification of Bernoulli's theorem
2. Calibration of a Venturimeter
3. Calibration of an Orifice meter
4. Calibration of a rotameter
5. Determination of co–efficient of friction in a pipe flow
6. Performance characteristics of a centrifugal pump
7. Performance characteristics of a reciprocating pump
8. Performance characteristics of a turbine

Contact Periods:

Lecture: 30 Periods	Tutorial: – Periods	Practical: 30 Periods	Project	– Periods
			Total	60 Periods

TEXT BOOKS:

1. Bansal R.K., "Fluid Mechanics and Hydraulic Machines", 10th edition, Laxmi Publications, New Delhi,2018
2. Modi P.N. and Seth S.M., "Hydraulics & Fluid Mechanics including Hydraulic Machines", 22nd edition, Standard Book House New Delhi,2019

REFERENCES:

1. Jain A.K., "Fluid Mechanics Including Hydraulic Machine", 12th edition, Khanna Publishers,2016
2. White, F.M., "Fluid Mechanics", 8th edition, Tata McGraw Hill, New Delhi,2016
3. Rajput R.K., "A Text Book of Fluid Mechanics and Hydraulic Machines", 6th edition, S Chand & Co Ltd, New Delhi,2016

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EVALUATION PATTERN:

<table>
<tr><td colspan="4">Continuous Internal Assessments</td><td colspan="2">End Semester Examinations</td></tr>
<tr><td colspan="2">Assessment I
(Theory)
(100 Marks)</td><td colspan="2">Assessment II
(Practical)
(100 Marks)</td><td rowspan="2">Theory Examinations
(Examinations will be conducted for 100 Marks)</td><td rowspan="2">Practical Examinations
(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)</td><td>Test</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td><td></td><td></td></tr>
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<tr><td colspan="6">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER III

U21ME305	MECHANICS OF SOLIDS	Category: PCC				
		L	T	P	J	C
		3	0	2	0	4

PRE–REQUISITES:

- U21ME201 - Engineering Mechanics

COURSE OBJECTIVES:

- To impart the concepts of stress and strain in various elements, principal stresses and principal planes
- To impart the knowledge of shearing force, bending moment, slope and deflection due to external loads in the beams and their effect on stresses
- To identity the torsion in the shaft and to design the spring, colums and thin cylinders

COURSE OUTCOMES:

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

CO1: Apply stress–strain relationships to compute stresses, strains, and deformations in simple and compound bars under axial, shear, and thermal loading (Apply)

CO2: Solve the shear force and bending moment of beams with transverse loading and evaluate stresses from forces and moments (Apply)

CO3: Choose a suitable method of solving for deflection and slope of beams under transverse loading (Apply)

CO4: Design a shaft using torsion equation and solve for various spring parameters (Apply)

CO5: Apply theories to design columns and thin cylinders and determine the hardness and impact strength of materials (Apply)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I STRESS – STRAIN AND DEFORMATION OF SOLIDS 9

Rigid bodies and deformable solids – Tension – Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants – Volumetric strains – Stresses on inclined planes – Principal stresses and principal planes – Mohr's circle of stress

UNIT II TRANSVERSE LOADING ON BEAM SAND STRESSES IN BEAM 9

Beams – Types – Transverse loading on beams – Shear force and bending moment in beams Cantilevers – Simply supported beams and overhanging beams – Theory of simple bending – Bending stress distribution – Load carrying capacity – Proportioning of sections – Flitched beams – Shear stress distribution

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UNIT III DEFLECTION OF BEAMS 9

Double Integration method – Macaulay's method – Area moment method for computation of slopes and deflections in beams – Conjugate beam and strain energy – Maxwell's reciprocal theorems

UNIT IV TORSION AND SPRINGS 9

Torsion formulation – Stresses and deformation in circular and hollows shafts – Stepped shafts – Compound Shafts – Deflection in shafts fixed at the both ends – Stresses in helical springs –Deflection of helical springs – Carriage springs

UNIT V COLUMNS AND THIN CYLINDERS 9

Columns – Euler's theory and Rankine's theory of columns – Effect of eccentricity – Stresses in thin cylindrical shells due to internal pressure – Circumferential and longitudinal stresses and deformation in thin cylindrical shell – Spherical shells subjected to internal pressure – Deformation in spherical shells

LIST OF EXPERIMENTS

1. Tension test on a mild steel rod
2. Double shear test on mild steel and aluminium rod
3. Torsion test on mild steel rod
4. Impact test on metal specimen
5. Hardness test on metal specimen – Brinell and Rockwell Hardness
6. Deflection test on beams
7. Compression test on helical springs
8. Strain measurements using Rosette strain gauge

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: 30 Periods Project – Periods

Total 75 Periods

TEXT BOOKS:

1. Bansal. R.K. "Strength of Materials", 6th edition, Laxmi Publications (P) Ltd.,2022
2. Rattan.S.S. "Strength of Materials", 3rd edition, McGraw Hill Publishing co.Ltd., New Delhi,2016

REFERENCES:

1. Jindal U.C. "Strength of Materials", 1st edition, Asian Books Pvt. Ltd., New Delhi,2012
2. Egor. P.Popov "Engineering Mechanics of Solids" 2nd edition, Prentice Hall of India, New Delhi,2015
3. Subramanian R. "Strength of Materials", Oxford University Press, 3rd edition, Oxford Higher Education Series,2016
4. Ferdinand P.Been; Russell Johnson J.R.and John J. Dewole. "Mechanics of Materials", 8th edition, Tata McGraw Hill Publishing co.Ltd., New Delhi,2019

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		**Assessment II (Practical) (100 Marks)**		**Theory Examinations (Examinations will be conducted for 100 Marks)**	**Practical Examinations (Examinations will be conducted for 100 Marks)**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test		
40	**60**	**75**	**25**		
25		**25**		**35**	**15**
50				**50**	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER III

U21ME306	MANUFACTURING TECHNOLOGY LABORATORY – I	Category: PCC				
		L	T	P	J	C
		0	0	4	2	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- Study and practice various operations in lathe, shaper, drilling and milling machines
- Equip practical knowledge on machining
- Study and practice various operations in foundry and welding

COURSE OUTCOMES:

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

CO1: Fabricate a workpiece by performing various lathe operations. (Apply)

CO2: Join metal parts by applying arc welding techniques to produce defect free welded joints.(Apply)

CO3: Operate special machine tools to perform shaping operations and generate required geometries. (Apply)

CO4: Prepare sand moulds by using different moulding patterns for casting applications. (Apply)

CO5: Produce sheet metal components by applying sheet metal forming processes such as bending,shearing, and drawing. (Apply)

CO–PO MAPPING:

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

LIST OF EXPERIMENTS

1. Taper Turning
2. External & Internal Thread cutting
3. Thread Cutting
4. Eccentric Turning
5. Knurling
6. Square and hexagonal head shaping
7. Fabrication of simple structural shapes using Gas Metal Arc Welding
8. Joining of plates and pipes using Gas Metal Arc Welding/ Arc Welding /Submerged arc welding
9. Preparation of green sand moulds
10. Manufacturing of simple sheet metal components using shearing and bending operations
11. Manufacturing of sheet metal components using metal spinning on a lathe

J component

1. Application in Fast production of gear prototypes – Case study/mini project

Contact Periods:

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Lecture: – Periods	Tutorial: – Periods	Practical: 30 Periods	Project	30 Periods
			Total	60 Periods

REFERENCES:

1. Heine Loper and Rosenthal. "Principles of Metal Casting", 4th edition, Tata Mc Graw Hill Publishing Co Ltd.,2015
2. E.H Doehler. "Die Casting", 5th edition, McGraw Hill Book Co1991
3. T.R Banga and R.L Agrawal. "Foundry Engineering", 4th edition, Khanna Publishers,2002

EVALUATION PATTERN:

<table>
<tr><th colspan="5">Continuous Internal Assessments</th><th>End Semester Examinations</th></tr>
<tr><td colspan="2">Assessment I (Practical) (100 Marks)</td><td colspan="3">Assessment II (Project) (100 Marks)</td><td rowspan="2">Practical Examinations
(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>Evaluation of Laboratory Observation, Record
(Rubrics Based Assessments)</td><td>Test</td><td>Review I</td><td>Review II</td><td>Review III</td></tr>
<tr><td>75</td><td>25</td><td>15</td><td>25</td><td>60</td><td></td></tr>
<tr><td colspan="2">25</td><td colspan="3">25</td><td>50</td></tr>
<tr><td colspan="5">50</td><td>50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER III

U21ME307	DESIGN STUDIO – I	Category: EEC				
		L	T	P	J	C
		0	0	0	2	1

PRE–REQUISITES:

- U21ME202 – Interfacing of Electronics & Electrical Components and Troubleshooting

COURSE OBJECTIVES:

- To inculcate the problem – Solving & Innovation mindset
- To provide a platform for self – Learning, experimenting, solving the real – World problems and to develop a product
- To enable hands–on experience for active learning

COURSE OUTCOMES:

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

CO1: Understand Design thinking, system thinking, mapping the problem statements to UNSDG.

CO2: Apply the design thinking steps "Empathize, Define, ideate and prototype".

CO3: Create Experimental proof of concept (TRL 3)

CO4: Demonstrate teamwork, project management, technical report writing and presentation skills

CO–PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	3	-	-	-	-	-	3	3	-
CO2	3	2	2	-	-	3	-	-	-	-	-	3	3	-
CO3	3	2	2	-	3	3	-	-	-	-	3	3	3	-
CO4	-	-	-	-	2	-	-	-	3	3	3	3	-	-

Course conduction:

- The students will be divided into batches (maximum 4 students / batch). They will be provided the space, time, resources, and a mentor
- With the guidance of assigned mentor, the students will find & validate a problem statement, map to UNSDG, identify the skills required for the project and self–learn
- Applying the design thinking concept, the students will provide a solution and produce the version 1 of prototype
- The student will learn teamwork, project management, technical report writing and presentation skills through this course

Lecture: – Tutorial: – Practical: – Project 30 Periods

Total 30 Periods

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EVALUATION PATTERN:

Review 0 (Within 10 days of commencement of semester)	Review 1 (Between 35th to 40th working day)	Review 2 (Between 80th to 90th working day)	Total
0	40	60	100

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER IV

U21MA404	STATISTICS AND NUMERICAL METHODS	Category: BSC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the concepts of probability and statistics in the field of engineering
- To understand the concepts of testing the hypothesis for large and small samples
- To understand the concepts in design of experiments in the field of engineering

COURSE OUTCOMES:

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

CO1: Apply probability axioms and the moments of discrete and continuous random variables to core engineering problems (Apply)

CO2: Analyze large and small sample tests and perform small sample tests based on Chi-square, t and F distributions (Understand)

CO3: Design an experiment with proper observations and measurement to get a valid result using various design methods (Understand)

CO4: Identify the basic concepts of solving algebraic and transcendental equations (Understand)

CO5: Solve initial value problems of ordinary differential equations using numerical techniques (Understand)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I PROBABILITY 9

Probability – Axioms of probability – Conditional probability – Total probability – Baye's Theorem – Discrete and continuous random variable

UNIT II TESTING OF HYPOTHESIS 9

Large sample test for single mean and difference of means – Small sample test: t distribution – Chi square distribution – F distribution

UNIT III DESIGN OF EXPERIMENTS 9

One way and two way classifications – Completely randomized design – Randomized block Design – Latin square design

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UNIT IV SYSTEM OF EQUATIONS 9

Newton Raphson method – Gauss elimination method – Gauss Jordon method – Iterative methods of Gauss Jacobi and Gauss Seidel

UNIT V NUMERICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS 9

Taylor's series method – Euler method – Modified Euler method – Fourth order Runge kutta method for solving first order differential equations

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total: 45 Periods

TEXT BOOKS:

1. Johnson R A, Miller I, Freund J, Miller and Freund's," Probability and Statistics for Engineers", 8th edition, Pearson Education, Asia,2015
2. Grewell B S, "Numerical methods in Science and Engineering", 9th edition Khanna Publishers, 2015
3. Gupta S C and Kapoor V K, "Fundamentals of Mathematical Statistics", 10th edition, Sultan Chand Publishers,2014

REFERENCES:

1. Bali N P and Manish Goyal "A textbook of Engineering Mathematics", 12th edition, Laxmi Publishers,2016

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Seminar / MCQ	Written Test	Individual Assignment / Seminar / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER IV

U21ME401	MANUFACTURING TECHNOLOGY – II	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21ME302 - Manufacturing Technology – I

COURSE OBJECTIVES:

- To impart knowledge on the basic concepts of metal cutting
- To make the students understand the working principles of lathe, shaping and allied machines milling, drilling, grinding, and broaching
- To impart the knowledge on Computer Numerical Control (CNC) of machine tools and CNC Programming

COURSE OUTCOMES:

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

CO1: Apply metal cutting theory to determine cutting forces, tool life and machining parameters for turning operations (Apply)

CO2: Describe the construction and working of lathe, shaping, milling, drilling and broaching machines (Understand)

CO3: Explain finishing operations and gear manufacturing processes with their applications (Understand)

CO4: Explain the structure and functions of CNC programming codes used in manufacturing processes (Understand)

CO5: Explain the principles and classifications of unconventional and special machining processes (Understand)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I THEORY OF METAL CUTTING (CONTACT CUTTING) 9

Mechanics of machining – Tools (materials – Temperature – Wear and life considerations) – Tool geometry – Single point and multi point cutting tool – Chip formation – Surface finish and machinability – Optimization – Merchant circle diagram of forces on cutting tool (simple problems only)

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UNIT II MACHINES TOOLS – I 9

Introduction to Lathe – Automatic & Semi – Automatic Lathe – Vertical Turret Lathe – Shaper – Planning – Milling – Drilling – Boring – Working Principles – Operations – Economics of machining processes – Lathe– Milling and Drilling – Working Holding Devices – Jig and fixtures

UNIT III MACHINES TOOLS – II 9

Broaching – Types of Grinding and Grinding Machines – Grinding wheel Specifications – Honing – Lapping – Burnishing – Super Finishing – Gear Manufacturing Processes – Gear cutting – Gear Hobbing – Gear Shaping Machines – Manufacture of Spur – Helical – Bevel – Worm and Worm Wheel – Sand blasting

UNIT IV CNC MACHINES 9

Introductory concepts of CAD – CAM and CIM – Numerical Control (NC) machine tools – Direct Numerical Control (DNC) – Computer Numerical Control (CNC) machine tools – CNC types – constructional details – Special features – Machining center – Turning centre – Milling centre – CNC part programming fundamentals

UNIT V UNCONVENTIONAL AND SPECIAL MACHINING METHODS 9

Electro – Chemical – Electro Discharge – Ultrasonic – Laser – Electron Beam and Water Jet machining – Introduction to additive manufacturing – Need – Evolution – Fundamentals and trends in micro and nano technologies – Thermal cutting methods

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1 Hajra Choudhury "Elements of Workshop Technology" Vol.II. 15th edition, Media Promoters,2014

2 Rao. P.N "Manufacturing Technology Metal Cutting and Machine Tools", 3rd edition, Tata McGraw Hill, New Delhi,2013

REFERENCES:

1. Kapakjian.S and Schmid. S.R., Manufacturing Engineering and Technology, 6th edition, Pearson Education (Singapore) Pvt. Ltd.,2010
2. Khanna. O.P. & Lal.M, A Text book of Production Technology, 1st edition, Dhanpat Rai Publications, New Delhi,2009
3. Kundra, T.K., Rao, P.N., and Tiwari, N.L.K., Numerical Control and Computer Aided Manufacturing, 2nd reprint, Tata McGraw Hill,2006

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EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER IV

U21ME402	THEORY OF MACHINES	Category: PCC				
		L	T	P	J	C
		3	0	2	0	4

PRE–REQUISITES:

- U21MEG01 - Engineering Graphics
- U21ME201 - Engineering Mechanics

COURSE OBJECTIVES:

- To design the linkages and cam for specified output motions and to determine the speeds of gear trains
- To impart knowledge on force–motion relationship in machine components and balancing forces in dynamic systems
- To gain knowledge on mechanism for control and vibration in mechanical systems

COURSE OUTCOMES:

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

CO1: Perceive the concept mechanisms and determine the velocity and acceleration of mechanisms (Apply)

CO2: Construct various plate cam profiles and calculate the velocity ratio of gear trains (Apply)

CO3 Analyze the dynamic forces acting on machine components and measure the degree of unbalance for mass systems (Analyze)

CO4: Demonstrate governors and gyroscopes with their applications (Apply)

CO5: Express relationships among the parameters in vibration (Apply)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I BASICS OF MECHANISMS AND KINEMATICS OF LINKAGE MECHANISMS 9

Classification of mechanisms – Kinematic concepts and definitions – Degree of freedom – Mobility – Kutzbach criterion – Gruebler's criterion – Grashof's Law – Kinematic inversions of four – Bar chain and slider crank chains – Straight line generators – Universal Joint – Geneva mechanism – Ratchet and Pawl mechanisms and robot gripper mechanisms – Displacement – Velocity and acceleration analysis of simple mechanisms – Graphical method – Demonstration of linkage mechanism using MATLAB software

UNIT II KINEMATICS OF CAM MECHANISMS, GEARS AND GEAR TRAINS 9

Classification of cams and followers – Terminology and definitions – Displacement diagrams – Uniform velocity – Parabolic – Simple harmonic and cycloidal motions – Derivatives of follower motions – Layout of plate cam profiles – Spur Gear terminology and definitions – Law of toothed gearing – Gear trains

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– Speed ratio – Train value – Parallel axis gear trains – Epicyclic Gear Trains – velocity ratio of epicyclic gear trains by tabular method.

UNIT III FORCE ANALYSIS AND BALANCING 9

Dynamic force analysis – Inertia force and Inertia torque – Dalembert's principle – Dynamic Analysis in reciprocating engines – Gas forces – Inertia effect of connecting rod – Bearing loads – Crank shaft – Static and dynamic balancing – Balancing of rotating masses.

UNIT IV MECHANISMS FOR CONTROL 9

Governors – Types – Centrifugal governors – Gravity controlled and spring controlled centrifugal governors – Characteristics – Effect of friction – Controlling force curves – Gyroscopes – Gyroscopic forces and torques – Gyroscopic stabilization – Gyroscopic effects in Automobiles, ships and airplanes

UNIT V VIBRATION 9

Basic features of vibratory systems – Degrees of freedom – single degree of freedom – Free vibration – Equations of motion – Natural frequency – Types of Damping – Damped vibration–Torsional vibration of shaft – Critical speeds of shafts – Forced Vibration – Harmonic disturbances – Vibration isolation

LIST OF EXPERIMENTS

1. Study of Four bar, Slider–crank and Double rocker mechanisms
2. Dynamic Analysis of Cam mechanism – Determination of cam profile and jump speed
3. Kinematics of Gear Trains – Simple, Compound and Epicyclic Gear Trains– Determinations of velocity ratio and torque
4. Balancing of Rotating masses and Balancing of Reciprocating masses
5. Experiment on Motorized gyroscope – Comparison of theoretical and experimental precessional velocity
6. Universal Governors (Watt, Porter, Proell and Hartnell) – Determination of centrifugal force and equilibrium speed
7. Whirling of Shaft and Compound Pendulum – Determination of natural frequency
8. Two rotor system – Comparison of theoretical and experimental torsional frequency
9. Vibrating Table – Determination of transmissibility ratio
10. Modelling of vehicle dynamics using MATLAB and Simulink

Contact Periods:

Lecture: 45 Periods	Tutorial: – Periods	Practical: 30 Periods	Project	– Periods
			Total	75 Periods

TEXT BOOKS:

1. Rattan, S.S, "Theory of Machines", 4th edition, Tata McGraw Hill,2014
2. Uicker,J.J.,Pennock G.R and Shigley,J.E., "Theory of Machines and Mechanisms", 4th edition, Oxford University Press,2018

REFERENCES:

1. Ghosh.A and Mallick A.K. "Theory of Mechanisms and Machines", 3rd edition Affiliated East – West Pvt. Ltd., New Delhi,2017
2. Khurmi, R.S.," Theory of Machines", 14th edition, S Chand Publications,2017
3. Robert L.Norton, "Kinematics and Dynamics of Machinery", 3rd edition, Tata McGraw Hill,2015

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		**Assessment II (Practical) (100 Marks)**		**Theory Examinations (Examinations will be conducted for 100 Marks)**	**Practical Examinations (Examinations will be conducted for 100 Marks)**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test		
40	**60**	**75**	**25**		
25		**25**		**35**	**15**
50				**50**	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER IV

U21ME403	THERMAL ENGINEERING	Category: PCC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- U21ME301 - Engineering thermodynamics

COURSE OBJECTIVES:

- To gain knowledge on applying thermodynamic concepts to thermal engineering systems
- To perform performance calculations for a variety of thermal applications
- To provide skill-based learning through hands on experiments

COURSE OUTCOMES:

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

CO1: Infer the performance of gas power systems (Analyze)

CO2: Apply thermodynamic principles in the vapour power systems (Apply)

CO3: Analyze the flow through nozzles and turbines (Analyze)

CO4: Calculate the various efficiencies of compressors (Apply)

CO5: Analyze the performance of refrigeration and air conditioning systems (Analyze)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I GAS POWER SYSTEMS 6

Overview of Internal Combustion Engines – Engine Terminologies – Air standard analysis – Otto cycle –Diesel cycle –Dual cycle – Saving Fuel and Money by Driving Sensibly – Gas Turbine Power Plants – Air–Standard Brayton Cycle analysis – Regenerative Gas Turbines with Reheat and Intercooling

UNIT II VAPOUR AND COMBINED POWER SYSTEMS 6

Modeling of Vapour Power Systems Steam power plant – Analyzing of Rankine Cycle – Improving Performance – Superheat and Reheat Regenerative Steam power Cycle – Cogeneration – Combined Gas – Vapour Power Cycles Binary Vapour Cycles

UNIT III STEAM NOZZLES AND TURBINES 6

Types of steam Nozzles – Isentropic flow through nozzles – Flow through actual nozzles – Supersaturated expansion in nozzles – Working principle of turbines – Classification of turbines – Combined velocity triangle diagram – Compounding of turbines – Governing of steam turbines

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UNIT IV AIR COMPRESSOR 6

Uses of compressed air – Classification – Compressor terminologies and efficiencies – Working principle of compressors – Indicated compression work with and without clearance volume – Multistage air compressor working and inter cooling

UNIT V REFRIGERATION AND AIR CONDITIONING 6

Ideal and actual Vapour – Compression Refrigeration Cycle – Selection of the Right Refrigerant – Absorption Refrigeration Systems – Applications of air conditioning – Air conditioning cycle – Central air conditioning systems – Cooling heat load calculations

LIST OF EXPERIMENTS

1 Performance Test on 4–stroke Diesel Engine
2 Heat Balance Test on 4–stroke Diesel Engine
3 Retardation Test to find Frictional Power of a Diesel Engine
4 Determination of COP of a refrigeration system
5 Performance analysis of Air conditioning system
6 Performance test on single/two stage reciprocating air compressor
7 Performance and Energy Balance Test on a Steam Generator
8 Performance and Energy Balance Test on Steam Turbine

Contact Periods:

Lecture: 30 Periods	Tutorial: – Periods	Practical: 30 Periods	Project	– Periods
			Total	60 Periods

TEXT BOOKS:

1. Mahesh M Rathore, "Thermal Engineering", 5th edition, McGraw Hill Education, New Delhi,2016
2. Yunus E. Cengel Michael A.Boles, "Thermodynamics – An engineering approach", 9th edition, McGraw Hill Education, New Delhi,2019

REFERENCES:

1. Rajput. R. K., "Thermal Engineering" 11th edition, Laxmi publications, New Delhi,2020
2. Arora.C.P. "Refrigeration and Air Conditioning" 3rd edition McGraw Hill Education,2019
3. Ganesan V., "Internal Combustion Engines", 4th edition, Mcgraw Hill Education,2014
4. Rudramoorthy R., "Thermal Engineering", 3rd edition, McGraw Hill Education, New Delhi,2016

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EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th colspan="2" rowspan="2">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I
(Theory)
(100 Marks)</th><th colspan="2">Assessment II
(Practical)
(100 Marks)</th></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record
(Rubrics Based Assessments)</td><td>Test</td><td>Theory Examinations
(Examinations will be conducted for 100 Marks)</td><td>Practical Examinations
(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td colspan="2">25</td><td colspan="2">25</td><td>25</td><td>25</td></tr>
<tr><td colspan="4">50</td><td colspan="2">50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER IV

U21ME404	SENSORS AND TRANSDUCERS	Category: PCC				
		L	T	P	J	C
		2	0	0	2	3

PRE–REQUISITES:

- U21PH101 - Engineering Physics
- U21EEG02 - Basics of Electrical Engineering

COURSE OBJECTIVES:

- To make student familiar with the concepts of measurement technology
- To make student aware about the various sensors used to measure various physical parameters
- To learn the fundamentals of signal conditioning, data acquisition and communication systems used in mechatronics system development

COURSE OUTCOMES:

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

CO1: Explain the essential elements of measurement systems, classify errors, and differentiate sensor characteristics with appropriate calibration and signal types (Understand)

CO2: Illustrate the working principles of motion, proximity, and ranging sensors, including optical, magnetic, inductive, capacitive, GPS, and LIDAR technologies (Apply)

CO3: Illustrate the principles and applications of strain, magnetic, heading, and motion tracking sensors such as gyroscopes and compasses (Apply)

CO4: Differentiate and explain the working principles of photoelectric, pressure, thermal, acoustic,and advanced smart sensors including MEMS and nano-sensors (Understand)

CO5: Explain the principles of signal conditioning, data acquisition, and logging, and interpret their applications in automotive, aerospace, and industrial systems (Understand)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION 6

Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types

UNIT II MOTION– PROXIMITY AND RANGING SENSORS 6

Motion Sensors – Potentiometers– Resolver– Encoders – Optical– Magnetic– Inductive – Capacitive – LVDT – RVDT – Synchro – Microsyn – Accelerometer – GPS – Bluetooth – Range Sensors – RF beacons – Ultrasonic Ranging – Reflective beacons – Laser Range Sensor (LIDAR)

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UNIT III FORCE– MAGNETIC AND HEADING SENSORS 6

Strain Gage – Load Cell – Magnetic Sensors – Types – Principle – Requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass – Gyroscope – Inclinometers

UNIT IV OPTICAL– PRESSURE AND TEMPERATURE SENSORS 6

Photo conductive cell – Photo voltaic – Photo resistive – LDR – Fibre optic sensors – Pressure – Diaphragm – Bellows – Piezoelectric – Tactile sensors – Temperature – IC – Thermistor – RTD – Thermocouple – Acoustic Sensors – Flow and level measurement – Radiation Sensors – Smart Sensors – Film sensor – MEMS & Nano Sensors – LASER sensors

UNIT V SIGNAL CONDITIONING AND DAQ SYSTEMS 6

Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi – Channel data acquisition – Data logging – Applications – Automobile – Aerospace – Home appliances – Manufacturing – Environmental monitoring

J component

1. Application in Proximity –force–magnetic–optical–pressure–temperature sensors and signal conditioning –case study/project

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: – Periods Project 30 Periods

Total 60 Periods

TEXT BOOKS:

1. Ernest O Doebelin. "Measurement Systems Applications and Design", 4th edition, Tata McGraw Hill, 2009
2. Sawney A K and Puneet Sawney. "A Course in Mechanical Measurements and Instrumentation and Control", 12th edition, Dhanpat Rai & Co New Delhi,2013

REFERENCES:

1. Patranabis D. "Sensors and Transducers", 2nd edition, PHI, New Delhi,2010
2. B.C, "Automatic control systems", 7th edition Prentice Hall India, New Delhi, 007
3. Mujumdar.S.R "Sensors and its application System", Tata McGraw Hill,2006

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (Theory) (100 Marks)		Assessment II (Project) (100 Marks)			Theory Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Review I	Review II	Review III	
40	60	15	25	60	
25		25			50
50					50
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER IV

U21ME405	COMPUTER AIDED MODELLING AND ASSEMBLY LABORATORY	Category: PCC					
		L	T	P	J	C	
		0	0	4	0	2	

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To impart fundamental knowledge and basic skills to the students in drafting and modelling techniques
- To make the students understand and interpret drawings of machine components
- To develop skills on creating 2D and 3D models using modelling packages

COURSE OUTCOMES:

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

CO1: Create orthographic views from given isometric drawings using engineering drawing principles. (Apply)

CO2: Construct three-dimensional models and assemblies of basic machine components using modelling software. (Apply)

CO3: Model, assemble, and animate simple mechanisms to analyze their working. (Apply)

CO4: Generate three-dimensional models and assemblies of machine parts with appropriate tolerances. (Apply)

CO5: Develop and assemble complex mechanical systems such as suspension systems, valves, and jigs/fixtures. (Apply)

CO–PO MAPPING:

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

LIST OF EXPERIMENTS

1. Create an orthographic view of the machine components for the given isometric drawings
2. Construct a three-dimensional modelling and assembly of bearing
3. Create a three-dimensional modelling and assembly of simple mechanism and animate its working using modelling software
4. Generate a three-dimensional modelling and assembly of shaft and coupling using tolerance
5. Create a three-dimensional modelling and assembly of piston and connecting rod
6. Create a three-dimensional modelling and assembly of tailstock of lathe
7. Create a three-dimensional modelling and assembly of tool head of shaper

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8. Create a three-dimensional modelling and assembly of two-wheeler suspension system
9. Construct a three-dimensional modelling and assembly of control valve
10. Generate a three-dimensional modelling and assembly of Jig/fixture

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Project – Periods

Total 60 Periods

REFERENCES:

1. Geometric Modelling: Theoretical and Computational Basis towards Advanced CAD Applications Fumihiko Kimura
2. Creo Parametric 2.0 for Engineers and Designers Prof Sham Tickoo – Prabhakar Singh

EVALUATION PATTERN:

Continuous Internal Assessments		**End Semester Examinations**
Evaluation of Laboratory Observation–Record **(Rubrics Based Assessments)**	Test	
75	25	
100		100
60		40
100		

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER IV

U21ME406	MANUFACTURING TECHNOLOGY LABORATORY – II	Category: PCC				
		L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- U21ME302 - Manufacturing Technology – I

COURSE OBJECTIVES:

- To acquire knowledge on various basic machining operations in special purpose machines
- To demonstrate the applications of special machining in real life manufacture of components
- To impart the knowledge on CNC machines

COURSE OUTCOMES:

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

CO1: Perform various milling operations to produce components with specified dimensions and tolerances (Apply)

CO2: Operate different machine tools to manufacture gears using appropriate cutting methods (Apply)

CO3: Carry out grinding operations to achieve required surface finish and dimensional accuracy (Apply)

CO4: Analyze tool geometry and perform tool grinding using cutter grinder for specific machining applications (Apply)

CO5: Develop and execute CNC part programs for turning and machining operations with proper tool path and codes (Apply)

CO–PO MAPPING:

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

LIST OF EXPERIMENTS

1. Contour milling using vertical milling machine
2. Spur gear / helical gear cutting in milling machine
3. Gear generation in hobbing machine / gear shaping machine
4. Keyway & spline cutting using Slotter / shaper
5. Plain Surface grinding & Cylindrical grinding
6. Tool angle grinding with tool and Cutter Grinder
7. Taper Turning and Threading using CNC Lathe
8. Drilling and grooving using CNC Lathe with canned cycle
9. Pocketing and Contour milling using CNC Milling Machine

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10. Drilling and Tapping using CNC Milling Machine

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Project – Periods

Total 60 Periods

TEXT BOOKS:

1. Hajra Choudhury, "Elements of Workshop Technology", Vol.II. 15th edition Media Promoters,2016
2. Rao. P.N "Manufacturing Technology Metal Cutting and Machine Tools", 3rd edition, Tata McGraw Hill, New Delhim,2013

REFERENCES:

1. Richerd R Kibbe: John E. Neely; Roland O. Merges and Warren J.White "Machine Tool Practices", 2nd edition Prentice Hall of India,2004
2. Kundra, T.K., Rao, P.N., and Tiwari, N.L.K., Numerical Control and Computer Aided Manufacturing, 3rd edition, Tata McGraw Hill,2006
3. Kapakjian.S and Schmid. S.R., Manufacturing Engineering and Technology, 6th edition, Pearson Education (Singapore) Pvt. Ltd.,2010

EVALUATION PATTERN:

Continuous Internal Assessments		**End Semester Examinations**
Evaluation of Laboratory Observation–Record **(Rubrics Based Assessments)**	Test	
75	25	
100		100
60		40
100		

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER IV

U21ME407	DESIGN STUDIO – II	Category: EEC				
		L	T	P	J	C
		0	0	0	2	1

PRE–REQUISITES:

- Design Clinic I

COURSE OBJECTIVES:

- To inculcate the problem–solving & Innovation mindset
- To provide a platform for self–learning, experimenting, solving the real–world problems and to develop a product
- To enable hands–on experience for active learning

COURSE OUTCOMES:

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

CO1: Apply the problem–solving techniques (Design thinking & system thinking)

CO2: Create and validate low fidelity prototype / Experimental proof of concept (TRL 4)

CO3: Demonstrate teamwork, project management, technical report writing and presentation skills

CO–PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	3	-	-	-	-	-	3	3	-
CO2	3	2	2	-	3	3	-	-	-	-	-	-	2	-
CO3	-	-	-	-	2	-	-	2	3	3	3	2	-	2

Course conduction:

- The students will be divided into batches (maximum 4 students / batch). They will be provided the space, time, resources, and a mentor for this design clinic 2 course.
- With the guidance of assigned mentor, the students will find & validate a problem statement, map to UNSGD, identify the skills required for the project and self–learn.
- Applying design thinking & system thinking concept the students will solve the problem and produce the version 1 of prototype. (TRL 4)
- The student will learn teamwork, project management, technical report writing and presentation skills through this course.

Lecture: – Tutorial: – Practical: – Project –30 Periods

Total 30 Periods

EVALUATION PATTERN:

Review 0 (Within 10 days of commencement of semester)	Review 1 (Between 35th to 40th working day)	Review 2 (Between 80th to 90th working day)	Total
0	40	60	100

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SEMESTER IV

U21SSG01	SOFT SKILLS – I	Category: HSM				
		L	T	P	J	C
		0	0	2	0	1

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To inculcate potential skills and to work as a team effectively
- To develop confidence and enhance interpersonal skills

COURSE OUTCOMES:

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

CO1: Enhance decision making and negotiation skills (Analyze)

CO2: Maintain open, effective, and Professional Communication (Apply)

CO-PO MAPPING:

POs / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	3	-	2	-	1
CO2	-	-	-	-	-	-	-	-	2	3	-	1	-	1

SYLLABUS:

UNIT I VERBAL COMPETENCE **10**

Verbal Analogy – Spotting Errors – Ordering of Sentences – Cloze Test – Effective Listening – Reading Comprehension

UNIT II EFFECTIVE COMMUNICATION **10**

Overcoming Communication Barriers – Body Language and its Etiquettes – Contextual Communication – 7C's of Communication – Listening to Documentaries

UNIT III INTERPERSONAL SKILLS **10**

Group Decision Making – Paralanguage – Negotiation Skills – Preparation & Planning, Bargaining & Problem Solving –Self Grooming – SWOT Analysis

Contact Periods:

Lecture: - Periods Tutorial: - Periods Practical 30 Periods Project – Periods

Total 30 Periods

TEXT BOOKS:

1. Prashant Sharma,"Soft Skills: Personality Development for Life Success", 1st edition, BPB Publications,2022
2. Suresh Kumar E, Sreehari P and Savithri J, "Communication Skills and Soft Skills: An Integrated Approach", 1st edition, Dorling Kindersley,2011

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REFERENCES:

1. Jeff Butterfield, "Problem Solving and Decision Making", 2nd edition, Course Technology,2010
2. Wushow Bill Chou, "Fast-Tracking your Career: Soft Skills for Engineering and IT Professionals", 1st edition, IEEE Press,2013

EVALUATION PATTERN:

Continuous Internal Assessments	Marks
Test - I	50
Test - II	50
Total	100

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SEMESTER V

U21ME501	DESIGN OF MACHINE ELEMENTS	Category: PCC				
		L	T	P	L	C
		3	0	0	0	3

PRE–REQUISITES:

- U21ME305 – Mechanics of Solids

COURSE OBJECTIVES:

- To familiarize the various steps involved in design of machine elements
- To understand the principle involved to satisfy functional and strength requirements
- To learn to use standard practices and standard data

COURSE OUTCOMES:

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

CO1: Apply the principles of stress analysis to explain the different types of stresses developed in machine members under load. (Apply)

CO2: Design shafts, keys, and couplings for power transmission systems. (Apply)

CO3: Select and design suitable bearings for mechanical applications. (Apply)

CO4: Design energy storing elements such as springs and flywheels. (Apply)

CO5: Design temporary and permanent joints for mechanical systems. (Apply)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I STRESSES IN MACHINE MEMBERS 9

Introduction to the design process – Factors influencing machine design – Selection of materials based on mechanical properties – Preferred numbers – Direct – Bending and Torsional stress – Impact and shock loading – Eccentric loading – Design of curved beams – Theories of failure

UNIT II DESIGN OF SHAFTS AND COUPLINGS 9

Design of shafts based on strength, rigidity and critical speed – Design of keys – Key ways and splines – Design of rigid and flexible couplings

UNIT III DESIGN OF BEARINGS 9

Sliding contact and rolling contract bearings – Design of hydrodynamics journal bearings – Selection of rolling contact bearings

UNIT IV DESIGN OF ENERGY STORING ELEMENTS 9

Design of springs: helical springs – Leaf springs – Design of flywheels considering stresses in rims and arms

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UNIT V DESIGN OF TEMPORARY AND PERMANENT JOINTS 9

Threaded fasteners – Design of bolted joints including eccentric loading – Knuckle joints and Cotter joints – Design of welded joints – Design of riveted joints

Contact Periods:

Lecture: 45 Periods Tutorial: Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Bhandari V, "Design of Machine Elements", 4th edition, Tata McGraw–Hill Book Co,2016
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 9th edition, Tata McGraw Hill,2011

REFERENCES:

1. Shigley J.E and MischkeC.R.,"Mechanical Engineering Design",Tata McGraw Hill ,2003
2. Bhandari V.B, "Design of Machine Elements",Tata McGraw Hill,2007
3. Sundararajamoorthy T. V, Shanmugam. N, "Machine Design", Anuradha Publications, Chennai, 2003
4. Orthwein W, "Machine Component Design", Jaico Publishing Co,2003
5. Ugural A.C, "Mechanical Design – An Integral Approach", McGraw Hill,2004

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based or the nature of the course.

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SEMESTER V

U21ME502	ENGINEERING METROLOGY AND MEASUREMENTS	Category: PCC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVE:

- To impart knowledge on the basic principles of measurements
- To provide knowledge on various metrological equipments
- To provide knowledge on the correct procedure to be adopted to measure the components

COURSE OUTCOMES:

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

CO1: Discuss the basic principles of measurements and its parameters (Understand)

CO2: Select an appropriate measuring device for measuring physical (Understand)

CO3: Illustrate the techniques used in form and surface finish measurement (Understand)

CO4: Explain the various types of optical measurement systems (Understand)

CO5: Explain the concepts of advanced metrology and measurement system analysis. (Understand)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I FUNDAMENTALS OF MEASUREMENT 7

Elements of a generalized measurement system – Standards and types of signals – Static and dynamic performance characteristics – Instrument types Principles of calibration – Calibration of Instruments Types of error limits fits tolerances and G&DT symbols

UNIT II MEASUREMENT OF PHYSICAL VARIABLES 6

Linear and angular displacement – Velocity – Force – Torque – Strain – Pressure Flow rate and temperature; Transfer functions of some standard measuring devices – Comparators – Types of comparators

UNIT III FORM AND FINISH MEASUREMENT 5

Measurement of surface finish – Inspection of straightness – Flatness and alignment – Gear testing digital read outs – Interferometry – Laser Interferometers

UNIT IV OPTICAL MEASUREMENT 6

Special Measuring Equipments – Principels of measurements using Tool Maker's microscope profile projector, Coordinate measuring machine Optical microscopy – Scanning Electron Microscope – Atomic Force microscopy – Transmission Electron Microscopy

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UNIT V ADVANCES IN METROLOGY 6

Machine vision system – Non – Contact type measurements – Acoustics – Ultrasonic – Radiation thermal and capacitance-based measurement – Principles of measurement system analysis

LIST OF EXPERIMENTS

1. Study on basic measuring instruments – Vernier caliper, micrometer, Vernier height gauge, Digital height gauge – bevel protractor, sine bar
2. Non–contact (Optical) measurement using Profile Projector
3. Measurement of gear parameters using Gear tooth vernier
4. Measurement of dimensions using floating gauge Micrometer
5. Measurement of Surface Finish Measurement using surface roughness tester
6. Measurement of dimensions using Coordinate Measuring Machine (CMM)
7. Measurement of force, torque and temperature
8. Measurement of linear dimensions using Comparators

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project – Periods

Total 60 Periods

TEXT BOOKS:

1. Jain R.K. "Engineering Metrology", 20th edition, Khanna Publishers,2009
2. Gupta. I.C., "Engineering Metrology", 5th edition, Dhanpatrai Publications,2005

REFERENCES:

1. Beckwith, Marangoni, Lienhard, "Mechanical Measurements", Pearson Education,2014
2. Raghavendra, Krishnamurthy"Engineering Metrology &Measurements", Oxford Univ. Press,2013
3. Eckman Donald PEckman, "Industrial Instrumentation", Wiley Eastern Limited,2019

EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25		25	25
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based or the nature of the course.

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SEMESTER V

U21ME503	FUNDAMENTALS OF AUTOMATION	Category: PCC				
		L	T	P	J	C
		2	0	0	2	3

PRE–REQUISITES:

- U21EEG02 – Basics of Electrical Engineering
- U21ECG04 – Basics of Electronics Engineering
- U21ME404 – Sensors and Transducers

COURSE OBJECTIVES:

- To understand the necessity of automation in industries
- To learn the drives and actuators used in an automation environment
- To apply the concepts of PLC and SCADA in industries

COURSE OUTCOMES:

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

CO1: Identify the different components of an automation system (Understand)

CO2: Illustrate hydraulic and pneumatic sequencing circuits (Understand)

CO3: Interface the given I/O device with an appropriate PLC module (Understand)

CO4: Develop PLC programs using ladder logic and other programming languages for industrial automation applications. (Apply)

CO5: Implement SCADA systems by interfacing with PLCs for monitoring and control applications. (Apply)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION TO AUTOMATION 6

Needs and benefits of Industrial Automation – Automation Hierarchy – Basic Components of Automation System – Description of each component – Types of Automation System Fixed Programmable – Flexible – Different systems for Industrial Automation PMC – SCADA – HMI – DCS – Drives

UNIT II HYDRAULICS AND PNEUMATICS 6

Hydraulic Actuators: Types and Construction of Cylinders, Cushioning – Flow Control and Pressure Control Valves – Pneumatic Properties of Air – Perfect Gas Laws – Compressor – FRL Unit – Quick Exhaust Valves and Pneumatic Actuators – Electro Pneumatic Systems – Elements – Ladder Diagrams

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UNIT III PLC FUNDAMENTALS 6

Building Blocks of PLC: CPU, Memory organization, Input–output modules (discrete and analog), Special I/O Modules – Power Supply – Fixed and Modular PLC – their types – Redundancy in PLC modules – I/) module selection criteria – Interfacing different I/O devices with appropriate I/O modules

UNIT IV PLC PROGRAMMING AND APPLICATIONS 6

PLC I/O addressing – PLC programming instructions: Relay type instructions: On delay off delay retentive – Counter instructions – Comparison instructions – Data handling Instructions – Arithmetic instructions – PLC programming language – Functional Block Diagram – Instruction List – Structured text – Sequential Function Chart – Ladder Programming – Simple Programming examples using ladder logic Language based on relay – Timer counter – Logical – Comparison – Arithmetic and data handling instructions – PLC based applications – Motor sequence control – Traffic light Control elevator control – Conveyor system – Stepper motor control – Reactor control

UNIT V SUPERVISORY CONTROL AND DATA ACQUISITION SYSTEM 6

Introduction to SCADA – typical SCADA architecture/ block diagram – Benefits of SCADA – Various editors of SCADA – Interfacing SCADA system with PLC Typical connection diagram – Object linking and embedding for Process Control architecture – Steps in creating SCADA screen for simple object – Steps for linking SCADA object with PLC ladder program using OPC – Applications of SCADA: Traffic light control – Water distribution – Pipeline control

Contact Periods:

Lecture:	30 Periods	Tutorial:	– Periods	Practical:	– Periods	Project	30 Periods
						Total	60 Periods

J Component – Suggested projects: One micro – Project is planned to be undertaken by a student group that needs to be assigned to them in the beginning of the semester – In any case – The number of students in the group should not exceed four

The micro project could be industry application – Based internet – Based – Workshop based laboratory based or field based – Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation on it before the submission – The total duration of the micro project should not be less than 30 hours during the course, the student ought to submit micro – project by the end of the semester

A suggested list of micros – Projects is given here, similar micro–project could be added by the faculty member concerned:

a **Automatic Street light controller**: Prepare a PLC based system to control the street light as per the intensity of natural light
b **Automatic agriculture irrigation system:** Prepare a PLC based system to control drip irrigation
c **Railway gate automation:** Prepare a PLC and SCADA based system to open of close the prototype railway gate automatically
d **Home automation:** Implement the versatile automation system for home that can automate any three home appliances
e **Bottle filling station:** Prepare a PLC and SCADA based system for prototype bottle filling station
f. **Troubleshoot a Faulty Equipment/ Kit available related to automation in any laboratory**

TEXT BOOKS:

1 Frank D. Petruzella, "Programmable Logic Controllers". 5th edition, McGraw Hill,2019
2 Stuart A Boyer, "SCADA: Supervisory Control and Data Acquisition". 4th edition, International Society of Automation,2016

REFERENCES:

1 Madhuchhanda Mitra, "Programmable Logic Controllers and Industrial Automation: An Introduction". Penram International Publishing,2017
2 Jon Stenerson, "Industrial Automation and Process Control", 3rd edition, Pearson,2022
3 David Bailey, Edwin Wright, "Practical SCADA for Industry", 2nd edition, Elsevier,2003

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EVALUATION PATTERN:

<table>
<tr><th colspan="5">Continuous Internal Assessments</th><th>End Semester Examinations</th></tr>
<tr><td colspan="2">Assessment I (Theory) (100 Marks)</td><td colspan="3">Assessment II (Project) (100 Marks)</td><td rowspan="2">Theory Examinations
(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td>Review I</td><td>Review II</td><td>Review III</td></tr>
<tr><td>40</td><td>60</td><td>15</td><td>25</td><td>60</td><td>50</td></tr>
<tr><td colspan="2">25</td><td colspan="3">25</td><td>50</td></tr>
<tr><td colspan="5">50</td><td>50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER V

U21ME504	MECHATRONICS LABORATORY	Category: PCC				
		L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To design and simulate the pneumatic and hydraulic circuits
- To develop the programming skills using microprocessors and microcontrollers
- To execute automatic control using PLC and implement the concept of mechatronics

COURSE OUTCOMES:

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

CO1: Demonstrate the various design concepts involved in pneumatics and hydraulics (Apply)

CO2: Apply Electro Pneumatics and PLC for basic automation control circuits (Apply)

CO3: Demonstrate various programs using microprocessor and microcontroller (Apply)

CO4: Demonstrate image processing techniques in automation (Apply)

CO5: Apply electronic controllers, PLC, suitable sensors and actuators to design and develop automation modules (Apply)

CO–PO MAPPING:

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

LIST OF EXPERIMENTS

1. Operation of Meter–In & Meter–Out Circuits
2. Sequencing of Two Double Acting Cylinders (A+B+A–B–)
3. Cascading of Three Double Acting Cylinders (A+B+C+C–B–A–)
4. Operation of a Double Acting Cylinder Using SR and SS Valve
5. Single Cycle Automation and Multi cycle Automation of a Double Acting Cylinder
6. Multi cycle Automation Using Logo Soft PLC
7. Sequencing of Two Double Acting Cylinders Using Logo Soft PLC (A+B+A–B–)
8. Assembly Language Programming of 8085 for addition and subtraction.
9. Stepper Motor Interfacing with 8051 Microcontroller Clockwise and Anti clockwise Rotation
10. Study: Image Processing hardware and software
11. Study: Hydraulic components and circuits

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12. Study: Traffic Light Interface
13. Door opening and closing circuits

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 30 Periods Project – Periods

Total 30 Periods

REFERENCES:

1. Bolton, "Mechatronics", Prentice Hall,2018
2. Ramesh S Gaonkar, "Microprocessor Architecture Programming and Applications with the 8085", 5th edition, Prentice Hall,2018
3. Krishna Kant, "Microprocessors & Microcontrollers", Prentice Hall,2013
4. Clarence W.de Silva, "Mechatronics", CRC Press, First Indian Reprint,2019

EVALUATION PATTERN:

Continuous Internal Assessments		End Semester Examinations
Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test	
75	25	
100		100
40		60
100		

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER V

U21ME505	PROTO STUDIO – I	Category: EEC				
		L	T	P	J	C
		0	0	0	2	1

PRE–REQUISITES:

- U21ME407 - Design Studio II

COURSE OBJECTIVES:

- To inculcate the problem–solving & Innovation mindset
- To provide a platform for self – learning, experimenting, solving the real–world problems and to develop a product
- To enable hands–on experience for active learning

COURSE OUTCOMES:

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

CO1: Apply the problem–solving techniques (Design thinking & system thinking)

CO2: Create Minimum Viable Prototype (TRL 5)

CO3: Analyze product to technology fit

CO4: Demonstrate teamwork, project management, technical report writing and presentation skills

CO–PO MAPPING:

COs \ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	3	-	-	-	-	-	3	3	-
CO2	3	2	2	-	2	3	-	-	-	-	-	3	3	-
CO3	3	3	2	-	2	3	-	-	-	-	-	3	3	-
CO4	-	-	-	-	2	-	-	3	3	3	3	3	-	3

Course conduction:

- The students will be divided into batches (maximum 4 students / batch). They will be provided the space, time, resources, and a mentor for this Proto clinic 1 course
- With the guidance from assigned mentor, the students will find & validate a problem statement, map to UNSGD, identify the skills required for the project and self–learn
- The students will learn and apply design thinking, system thinking concept to solve the problem and produce the version 1 of MVP (TRL 5)
- The student will learn teamwork, project management, product development, technical report writing and pitching through this course

Lecture: – Tutorial: – Practical: – Project –30 Periods

Total 30 Periods

EVALUATION PATTERN:

Review 0 (Within 10 days of commencement of semester)	Review 1 (Between 35th to 40th working day)	Review 2 (Between 80th to 90th working day)	Total
0	40	60	100

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SEMESTER V

U21SSG02	SOFT SKILLS - II	Category: HSM				
		L	T	P	J	C
		0	0	2	0	1

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the importance of communication and enhance self confidence
- To acquire employability skills

COURSE OUTCOMES:

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

CO1: Actively participate in Group Discussion (Analyze)

CO2: Enhance interview skills and make effective Presentation (Apply)

CO-PO MAPPING:

POs / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	2	3	-	-	-	1
CO2	-	-	-	-	-	-	-	-	2	3	-	-	-	1

SYLLABUS:

UNIT I PRESENTATION SKILLS **10**

Presentation Techniques – Time Management Techniques – Body language – Managerial Skills – Making Effective Presentation

UNIT II GROUP DISCUSSION AND PUBLIC SPEAKING **10**

Introduction to Group Discussion – Understanding Group Dynamics – Group Discussion Strategies– Activities to Improve GD Skills – Public Speaking Techniques – Public Speaking Activiti

UNIT III INTERVIEW SKILLS **10**

Listening to Interviews – Preparation for the Interview – Interview Techniques and Etiquettes – Handling Stress Interview – Mock Interview – Online Interview Techniques

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 30 Periods Project – Periods

Total 30 Periods

TEXT BOOKS:

1. Prashant Sharma, "Soft Skills: Personality Development for Life Success", 1st edition, BPB Publications,2022
2. Leader Interpersonal and Influence Skills: The Soft Skills of Leadership." Routledge Publications, 2014

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REFERENCES:

1. Ghosh B N, "Managing Soft Skills for Personality Development", 1st edition, Tata McGraw Hill,2012
2. Nitin Bhatnagar and Mamta Bhatnagar, "Effective Communication and Soft Skills Strategies for Success", 1st edition, Pearson Education,2012

EVALUATION PATTERN:

Continuous Internal Assessments	Marks
Test - I	50
Test - II	50
Total	100

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SEMESTER VI

U21ME601	FINITE ELEMENT ANALYSIS	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21ME305 - Mechanics of Solids
- U21MA404 - Statistics and Numerical Methods

COURSE OBJECTIVES:

- To introduce the concept of Mathematical Modelling for engineering problems
- To appreciate the use of FEM to a range of variable problems
- To impart the applications of FEM in heat transfer and fluid mechanics problems

COURSE OUTCOMES:

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

CO1: Solve a mathematical model using the concepts of weighted residuals and boundary value problems. (Apply)

CO2: Apply the basic finite element equations for one dimensional structural and vibrational problems (Analyze)

CO3: Formulate the finite element equations for two-dimensional elements scalar problems (Analyze)

CO4: Interpret the finite element equations for 2D plane stress, plane strain and axisymmetric problems (Analyze)

CO5: Solve 1D and 2D heat transfer, fluid mechanics and isoparametric element problems (Analyze)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION TO FEA 9

Historical background – Mathematical modelling of field problems in engineering – Governing equations – Discrete and continuous models – Introduction to boundary, initial and eigen value problems – Weighted residual methods – Variational formulation of boundary value problems – Ritz technique – Basic concepts of the FEM

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UNIT II ONE DIMENSIONAL FINITE ELEMENT ANALYSIS 9

One Dimensional second order equations – Discretization – Element types – Linear and higher order elements – Shape functions – Stiffness matrices and force vectors – Assembly of matrices – Solution of problems from solid mechanics Vibrational problems – Equations of motion based on weak form – Longitudinal vibration of bars –Transverse vibration of beams – Consistent mass matrices – Element equations – Solution of eigen value problems – Vector iteration methods – Normal modes – Transient vibrations

UNIT III TWO – DIMENSIONAL SCALAR VARIABLE PROBLEMS 9

Second order 2D equations involving scalar variable functions – Variational formulation – Finite element formulation – Triangular elements – Shape functions, element matrices and vectors. Application to field problems – Thermal problems – Quadrilateral elements

UNIT IV TWO – DIMENSIONAL VECTOR VARIABLE PROBLEMS 9

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces & temperature effects – Stress calculations

UNIT V APPLICATIONS OF HEAT TRANSFER & FLUID MECHANICS USING FEA 9

One dimensional heat transfer element – Application to one–dimensional heat transfer problems – scalar variable problems in 2D – Applications to heat transfer in 2D – Application of problems in fluid mechanics in 2D Introduction to Iso – Parametric formulation

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Reddy.J.N., "An Introduction to the Finite Element Method", 3rd edition, Tata McGraw Hill,2016
2. Seshu, P, "Text Book of Finite Element Analysis", Prentice Hall of India,2017

REFERENCES:

1. Rao, S.S., "The Finite Element Method in Engineering",3rd edition, Butter worth Heinemann,2018
2. Chandrupatla & Belagundu, "Introduction to Finite Elements in Engineering",3rd edition, Prentice Hall College Div,2019
3. Cook, Robert.D., Plesha, Michael.E & Witt, Robert.J."Concepts and Applications of Finite Element Analysis", Wiley Student Edition,2012

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EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER VI

U21ME602	DESIGN OF TRANSMISSION SYSTEM	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21ME501 - Design of Machine Elements

COURSE OBJECTIVES:

- To impart knowledge on the various components of a transmission system
- To develop skillset on designing gears and gear boxes
- To build design skills in developing a workable model based on design principles

COURSE OUTCOMES:

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

CO1: Design the flexible transmission elements (Apply)

CO2: Develop spur and helical gears for the given specification (Apply)

CO3: Design worm and bevel gears for the given problems (Apply)

CO4: Analyze various types of gears and gear boxes (Analyze)

CO5: Investigate clutches and brakes for the given problems (Analyze)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I FLEXIBLE TRANSMISSION ELEMENTS 9

Introduction to transmission systems – Factors – Materials selection – Stresses – Belt &chain drives – Design of flat and V – Belts – Design of chain drives – Design of rope drives

UNIT II DESIGN OF SPUR AND HELICAL GEARS 9

Spur gear – Introduction – Gear kinematics – Forces & stresses – Factors – Materials selection – design of spur gears – Helical gear – Introduction – Types – Gear kinematics – Virtual number of teeth – Forces & stresses – Factors – Design of helical gears

UNIT III DESIGN OF BEVEL AND WORM GEARS 9

Bevel gear – Introduction – classifications – Gear kinematics – Factors – Design of bevel gears – force analysis – Worm gear – Introduction – Classifications – Applications – Efficiency – Design of worm gears

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UNIT IV DESIGN OF GEAR BOXES 9

Introduction – Types – Components – Gear box housing – Progression ratio – Kinematic arrangement – Ray diagram – Design of multi speed gear boxes

UNIT V CLUTCHES AND BRAKES 9

Design of plate clutches – Axial clutches – Cone clutches – Internal expanding rim clutches – Electromagnetic clutches – Band and Block brakes – External shoe brakes – Internal expanding shoe brake

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Bandari V B, "Design of Machine Elements", 5th edition, Tata McGraw Hill,2017
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett, "Mechanical Engineering Design", 11th edition, Tata McGraw Hill,2020

REFERENCES:

1. Robert L Mortt, "Machine Elements in Mechanical Design", 6th edition, Pearson/Prentice Hall,2021
2. Design Data Book, PSG College of Technology, M/s. Kalaikathir Publishers, Coimbatore,2020
3. Jindal U C, "Design of Transmission System", 3rd edition, Dorling Kindersley,2010

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER VI

U21ME603	HEAT AND MASS TRANSFER	Category: PCC				
		L	T	P	J	C
		3	0	2	0	4

PRE–REQUISITES:

- U21ME301- Engineering Thermodynamics
- U21ME304 - Fluid Mechanics and Applications

COURSE OBJECTIVES:

- To impart knowledge on mechanisms of heat transfer under steady and transient conditions
- To familiarize with the sizing and rating of heat exchangers
- To explore the basic concepts of mass transfer models

COURSE OUTCOMES:

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

CO1: Apply general conduction equation to solve steady state and transient heat transfer problems (Apply)

CO2: Utilize empirical correlations to analyze convection heat transfer problems (Analyze)

CO3: Solve radiation heat exchange problems (Apply)

CO4: Analyze heat exchangers and phase change heat transfer problems (Analyze)

CO5: Apply mass transfer principles to solve mass transfer problems (Apply)

CO – PO MAPPING:

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

SYLLABUS:

UNIT I CONDUCTION HEAT TRANSFER 9

Thermodynamics and Heat Transfer – Heat transfer in Engineering – Mechanisms of Heat transfer – Concept of Driving potential General differential Equation of Heat conduction – Cartesian & Polar Coordinate systems – One dimensional steady state conduction – With and without heat generation – Composite systems – Critical radius of insulation – Heat transfer in fins – Introduction to transient heat conduction

UNIT II CONVECTION HEAT TRANSFER 9

Concept of Velocity and Thermal boundary layer – Forced convection systems – Flow over surfaces – Flat plate, Cylinders and Spheres – Flow through tubes – Natural convection systems – Natural convection on a vertical flat plate and Horizontal cylinders – Case study – Reducing Heat Transfer through Surfaces

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UNIT III RADIATION HEAT TRANSFER 9

Thermal Radiation – Basic relations – Radiation between two black and Gray bodies – Radiation shape factor –Shape factor Algebra – Electrical Network Analogy for Thermal Radiation systems – Radiation shields – Radiation from Gases

UNIT IV BOILING, CONDENSATION AND HEAT EXCHANGERS 9

Boiling and Condensation heat Transfer – Boiling types –Heat Transfer Correlations –Condensation types – Heat Transfer Correlations – Types of Heat Exchangers – Overall Heat Transfer Coefficient – Fouling Factor – Analysis of Heat Exchangers – LMTD method & Effectiveness NTU Method

UNIT V MASS TRANSFER 9

Analogy between Heat and Mass Transfer – Mass Diffusion – Fick's Law of Diffusion – Boundary Conditions – Steady Mass Diffusion through a Wall – Mass Convection – Mass Convection Relations – Simultaneous Heat and Mass Transfer

LIST OF EXPERIMENTS

1. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus
2. Determination of heat transfer coefficient under natural convection from a vertical cylinder
3. Determination of heat transfer coefficient under forced convection from a tube
3. Experimentation and simulation of finding overall thermal conductance and temperature distribution in case of a composite wall
4. Determination of Stefan – Boltzmann constant
5. Determination of emissivity of a grey surface
6. Determination of effectiveness and overall heat transfer coefficient of Parallel/Counter flow heat exchanger
7. Simulation of Steady and Unsteady heat conduction problem using MATLAB

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: 30 Periods Project – Periods

Total 75 Periods

TEXT BOOKS:

1. Cengel, Yunus A,Ghajar, Afshin J., "Heat and mass transfer", 4th edition, McGraw – Hill Education, New Delhi,2016
2. Kothandaraman, C.P., "Fundamentals of heat and mass transfer", 4th edition, New Age International (p) limited, Publishers, New Delhi,2012

REFERENCES:

1. Sachdeva, R C., "Fundamentals of engineering heat and mass transfer", 5th edition, New Age International (p) limited, Publishers, New Delhi,2017
2. Rudramoorthy, R., Mayilsamy, K., "Heat and mass transfer", 2nd edition, Pearson Publishers, New Delhi,2013
3. Incropera, Frank P. (et...al)., K., "Fundamentals of heat and mass transfer", 6th edition, John Wiley & Sons,2019

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		**Assessment II (Practical) (100 Marks)**		**Theory Examinations (Examinations will be conducted for 100 Marks)**	**Practical Examinations (Examinations will be conducted for 100 Marks)**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test		
40	**60**	**75**	**25**		
25		**25**		**35**	**15**
50				**50**	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER VI

U21ME604	SIMULATION AND ANALYSIS LABORATORY	Category: PCC				
		L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- U21ME305 - Mechanics of Solids

COURSE OBJECTIVES:

- To give exposure to FEA and MATLAB software tools to analyze engineering problems
- To expose the students on different applications of simulation and analysis tools
- To solve the structural, vibration and thermal problems using FEA software tools

COURSE OUTCOMES:

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

CO1: Demonstrate simple vibration problems using MATLAB software (Apply)

CO2: Predict the forces in simple mechanisms using MATLAB software (Apply)

CO3: Analyze structural stresses for various 1D and 2D structural models (Analyze)

CO4: Analyze thermal stresses in a component for heat transfer problems (Analyze)

CO5: Demonstrate harmonic and transient analysis for 1D structural models (Apply)

CO–PO MAPPING:

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

LIST OF EXPERIMENTS

1. MATLAB basics, Dealing with matrices, Graphing–Functions of one variable and two variables
2. Use of MATLAB to solve simple problems in vibration
3. Mechanism Simulation using MATLAB
4. Force and Stress analysis using trusses elements
5. Stress and deflection analysis in beams with different support conditions
6. Stress analysis of rectangular plate with hole
7. Stress analysis of axi – symmetric components
8. Thermal stress and heat transfer analysis of plates
9. Model analysis of beams
10. Harmonic and transient analysis of beams
11. Vibration analysis of spring–mass systems

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Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Project – Periods

Total 60 Periods

REFERENCES:

1. Brian D. Harper, "Solving Dynamics Problems in MATLAB", 6th edition, John Wiley & Sons,2007
2. Mary Kathryn Thompson, John M. Thompson," ANSYS Mechanical APDL for Finite Element Analysis", Butterworth Heinemann,2017
3. Xiaolin Chen, Yijun Liu, "Finite Element Modeling and Simulation with ANSYS Workbench", 2nd edition, CRC Press,2019
4. Erodgan Madenci, Ibrahim Guven, "The Finite Element Method and Applications in Engineering Using ANSYS", Springer,2006

EVALUATION PATTERN:

Continuous Internal Assessments		End Semester Examinations
Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test	
75	25	
100		100
40		60
100		

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER VI

U21ME606	PROTO STUDIO – II	Category: EEC				
		L	T	P	J	C
		0	0	0	2	1

PRE–REQUISITES:

- U21ME505 - Proto Studio - I

COURSE OBJECTIVES:

- To inculcate the problem–solving & Innovation mindset
- To provide a platform for self–learning, experimenting, solving the real–world problems and to develop a product
- To enable hands–on experience for active learning

COURSE OUTCOMES:

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

CO1: Apply the problem–solving techniques (Design thinking & system thinking)

CO2: Create Minimum Viable Prototype (TRL 6)

CO3: Analyze product to market fit

CO4: Develop a business model

CO5: Demonstrate teamwork, project management, technical report writing and presentation skills

CO–PO MAPPING:

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

COURSE CONDUCTION:

- The students will be divided into batches (maximum 4 students / batch). They will be provided the space, time, resources, and a mentor for this Proto clinic 2 course
- With the guidance from assigned mentor, the students will find & validate a problem statement, map to UNSGD, identify the skills required for the project and self–learn
- The students will apply design thinking, system thinking concepts to solve the problem and produce the version 2 of MVP (TRL 6)
- The student will learn teamwork, project management, product development, technical report writing and pitching through this course

Lecture: – Tutorial: – Practical: – Project 30 Periods

Total 30 Periods

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EVALUATION PATTERN:

Review 0 (Within 10 days of commencement of semester)	Review 1 (Between 35th to 40th working day)	Review 2 (Between 80th to 90th working day)	Total
0	40	60	100

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SEMESTER VI

		Category: HSM				
		L	T	P	J	C
U21SSG03	SOFT SKILLS – III	0	0	2	0	1

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To improve language adeptness and to enhance fluency in language
- To Gain emotional intelligence and to manage stress

COURSE OUTCOMES:

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

CO1: Write reports and make reasoning and assertions (Apply)

CO2: Overcome stress and attain work-life balance (Analyze)

CO-PO MAPPING:

POs / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	1	3	-	-	-	1
CO2	-	-	-	-	-	-	-	1	-	3	-	2	-	1

SYLLABUS:

UNIT I LANGUAGE ADEPTNESS **10**

Sentence Completion – Report Writing – Logical Reasoning – Cause and Effect – Assertion and Reasoning – Digital Profiling – Creative Resume

UNIT II STRESS MANAGEMENT **10**

Factors Causing Stress – Positive and Negative Stress – Effects of Stress – Stress Overcoming Techniques – Context Based Tasks

UNIT III EMOTIONAL INTELLIGENCE **10**

Leadership effectiveness – Self-awareness – Self-management – Self-motivation – Empathy and Social Skills

Contact Periods:

Lecture: - Periods Tutorial: -Periods Practical: 30 Periods Project – Periods

Total 30 Periods

TEXT BOOKS:

1. Daniel Goleman, "Emotional Intelligence: Why it Can Matter More Than IQ", 1st edition, Bloomsbury, 2009
2. Alan Barker, "Improve Your Communication Skills: Present with Confidence; Write with Style; Learn Skills of Persuasion", 1st edition, Kogan Page,2010

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REFERENCES:

1. Jeremy Stranks," Stress at Work: Management and Prevention", 1st edition, Butterworth-Heinemann,2005
2. Edward J Watson, "Emotional Intelligence: A Practical Guide on How to Control Your Emotions and Achieve Lifelong Social Success", 1st edition, Amazon Digital Services LLC,2016

EVALUATION PATTERN:

Continuous Internal Assessments	Marks
Test - I	50
Test - II	50
Total	100

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SEMESTER VII

U21ME701	ENGINEERING ECONOMICS AND COST ANALYSIS	Category: HSMC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To impart knowledge on cost estimation of component
- To provide knowledge about value engineering
- To know about the cash flow in Industry

COURSE OUTCOMES:

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

CO1: Explain the concept of engineering economics (Understand)

CO2: Discuss the concept of value engineering and the various payment factors (Understand)

CO3: Apply Evaluation Methods to solve cash flow problems for decision making (Apply)

CO4: Determine the most cost-effective options for maintenance and replacement of asset (Apply)

CO5: Calculate Depreciation to determine asset value and its impact on financial decision making (Apply)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION TO ECONOMICS 9

Introduction to Economics – Flow in an economy – Law of supply and demand – Concept of engineering economics – Engineering efficiency – Economic efficiency – Scope of engineering economics – Element of costs – Marginal cost – Marginal revenue – Sunk cost – Opportunity cost – Break – Even analysis – V ratio – Elementary economic analysis – Material selection for product design – Selection for a product – Process planning – Make or buy decision

UNIT II VALUE ENGINEERING 9

Value engineering – Function – Aims – Value engineering procedure – Interest formulae and their applications –Time value of money – Single payment compound amount factor – Single payment present worth factor – Equal payment series sinking fund factor – Equal payment series payment – present worth factor – Equal payment series capital recovery factor – Uniform gradient series annual equivalent factor – Effective interest rate – Examples in all the methods

UNIT III CASH FLOW 9

Methods of comparison of alternatives – Present worth method (Revenue dominated cash flow diagram), future worth method (Revenue dominated cash flow diagram – Cost dominated cash flow

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diagram) – Annual equivalent method (Revenue dominated cash flow diagram – cost dominated cash flow diagram) – Rate of return method – Examples in all the methods

UNIT IV REPLACEMENT AND MAINTENANCE ANALYSIS 9

Replacement and Maintenance analysis – Types of maintenance – Types of replacement problem – determination of economic life of an asset – Replacement of an asset with a new asset – Capital recovery with return and concept of challenger and defender – Simple probabilistic model for items which fail completely

UNIT V DEPRECIATION 9

Depreciation– Introduction – Straight line method of depreciation – Declining balance method of depreciation – Sum of the years digits method of depreciation – Sinking fund method of depreciation/ Annuity method of depreciation – Service output method of depreciation – Evaluation of public alternatives – Introduction examples – Inflation adjusted decisions – Procedure to adjust inflation – examples on comparison of alternatives and determination of economic life of asset – Case study

Contact Periods:

Lecture: 45 Periods Tutorial: Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Panneer Selvam R, "Engineering Economics", 2nd edition, Prentice Hall of India,2013
2. Courtland A. Collier, Charles R. Glagola, "Engineering Economic and Cost Analysis", 3rd edition, Addison Wesley Longman,2006

REFERENCES:

1. Park, C.S., "Contemporary Engineering Economics", 3rd edition, Prentice Hall of India,2002
2. Donald.G. Newman, Jerome.P.Lavelle, "Engineering Economics and analysis", 2nd edition, Engg Press,Texas,2002
3. Suma Damodaran, 'Managerial economic", 2nd edition, Oxford university press,2006

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER VII

U21ME702	INDUSTRIAL ENGINEERING	Category: HSMC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To learn how to perform time study activities and importance of lean tools
- To know the role of logistics and supply chain in modern transportation
- To learn how to construct project network

COURSE OUTCOMES:

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

CO1: Perform Time study activities to analyze the existing process (Understand)

CO2: Identify and reduce non–value–added activities in the process using lean tools (Understand)

CO3: Use Logistics, supply chain strategies and inventory models to solve operational problems (Apply)

CO4: Determine the shortest route to complete the project (Apply)

CO5: Apply quality tools to detect and rectify the failures in the process/products (Apply)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION TO WORK MEASUREMENT AND PLANT LAYOUT 9

Industrial Engineering Principles – Concepts and Evaluation – Importance – Elements and Tools – Method study – Micro motion and memo motion study – work measurement – Techniques of work measurement – Time study – Plant Layout – Facility design and factors

UNIT II LEAN AND SIX SIGMA 9

Conventional Manufacturing Versus Lean Manufacturing – Principles and elements of Lean Manufacturing – 5S – Kanban – Kaizen – Value stream Mapping – PDCA Cycle. TPM – Pillars of TPM. TQM Principles and implementation

UNIT III LOGISTICS, SUPPLY CHAIN AND INVENTORY MODELS 9

Logistics and Supply chain Management – Definition– Evaluation and importance– Procurement– Modes of Transportation – Packing and Packaging – Storage and Warehouse Management – Inventory models – Economic order quantity models – ABC analysis – Elements of JIT Systems

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UNIT IV PROJECT NETWORK **9**

Networks models – Shortest route – Minimal spanning tree – Maximum flow models –Project network – CPM and PERT networks – Critical path scheduling – Sequencing models

UNIT V PROCESS CAPABILITY AND SIX SIGMA **9**

Process Capability studies – Seven QC Tools – FMEA – Design and Process FMEA six Sigma – Concepts – Methodology – Applications in manufacturing and service sectors

Contact Periods:

Lecture: 45 Periods Tutorial: Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Martand Telsang, "Industrial Engineering and Production Management", 1st edition, S. Chand and Company,2000
2. James R. Evans and William M. Lindsay, "The Management and Control of Quality" ,8th edition, First Indian Edition, Cengage Learning,2012

REFERENCES:

1. Jain. K.C. & Aggarwal. L.N., "Production Planning Control and Industrial Management", Khanna Publishers,2000
2. Upendra Kachru, "Production and Operations Management, text and cases", 1st edition, Excel books,2007
3. Michael L.George, David Rownalds, Bill Kastle, What is Lean Six Sigma, McGraw Hill,2003
4. Adam, E. E.,,Jr., & Swamidass, P. M. (1989). Assessing operations management from a strategic perspective. Journal of Management

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER VII

U21ME703	PROJECT WORK PHASE – I	Category: EEC				
		L	T	P	J	C
		0	0	0	4	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVE

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same

SYLLABUS

The students individually/ in a group of 3 – 4 members can work on a topic approved by the Head of the Department under the guidance of a faculty member who is familiar in the area of interest. The student can select any topic which is relevant to Mechanical Engineering. The progress of the project is evaluated based on a minimum of three reviews. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated based on the report submitted and the viva–voce examination by an internal examiner and an external examiner

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Total: 60 Periods

COURSE OUTCOMES:

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

CO1: Engage in independent study to conduct a research literature, identify a research work in mechanical and allied engineering for the benefit of the society (Apply)

CO2: Identify and select appropriate engineering tools /components for the research work adopting the environmental standards/ safety norms and abiding professional ethics (Apply)

CO3: Schedule the project, engage in budget analysis, and assign responsibility for the team members (Apply)

CO4: Communicate effectively through oral communication, project report, presentation (Apply)

CO5: Perform in the team, contribute to the team and mentor/lead the team (Apply)

CO–PO MAPPING:

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

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EVALUATION PATTERN:

Internal Assessment (60 Marks)			End semester Examinations (40 Marks)			
Review I	Review II	Review III	Project Report		Viva-Voce	
			Supervisor	External	Internal	External
10	20	30	10	10	10	10

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER VIII

U21ME802	PROJECT WORK PHASE – II	Category: EEC				
		L	T	P	J	C
		0	0	0	16	8

PRE–REQUISITES:

- Nil

COURSE OBJECTIVE

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same
- To train the students in preparing project reports, to analyze the results, make conclusions and to face viva–voce examination

SYLLABUS

The students individually/ in a group of 3 – 4 members can work on a topic approved by the Head of the Department under the guidance of a faculty member who is familiar in the area of interest. The student can select any topic which is relevant to Mechanical Engineering. The progress of the project is evaluated based on a minimum of three reviews. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated based on the report submitted and the viva–voce examination by an internal examiner and an external examiner

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 240 Periods Total: 240 Periods

COURSE OUTCOMES:

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

CO1: Engage in independent study to conduct a research literature, identify a research work and apply the mathematical, science and engineering concepts to carry the identified research work for the benefit of the society (Apply)

CO2: Identify and select appropriate engineering tools /components to design, implement, analyse and interpret the results of the work adopting the environmental standards/ safety norms and abiding professional ethics (Apply)

CO3: Schedule the project, engage in budget analysis, and assign responsibility for the team members (Apply)

CO4: Communicate effectively through oral communication, project report, presentation, demonstration and publication in conference/journal/patent (Apply)

CO5: Perform in the team, contribute to the team and mentor/lead the team (Apply)

CO–PO MAPPING:

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

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EVALUATION PATTERN:

Internal Assessment (60 Marks)			End semester Examinations (40 Marks)			
Review I	Review II	Review III	Project Report		Viva-Voce	
			Supervisor	External	Internal	External
10	20	30	10	10	10	10

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC				
U21MEP01	DESIGN FOR MANUFACTURE AND ASSEMBLY	L	T	P	L	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To learn the concepts of tolerance analysis
- To study the DFM&A impacts product design and manufacturing methodologies
- To provide knowledge on product design and processes

COURSE OUTCOMES:

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

CO1: Identify the systematic methods for design and manufacturing (Understand)

CO2: Execute a systematic procedure to analyze a tolerances (Apply)

CO3: Elaborate the concept of datums for machining and assembly (Apply)

CO4: Identify the true position theory for various assembly components (Apply)

CO5: Implement the design and tolerancing concept to structures (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION TO DFMA 9

Phases of design – General requirements for material and process selection, effect of material properties and manufacturing process on design – DFM approach – DFM Guidelines – Product design for manual assembly, automatic assembly and robotic assembly – Computer aided DFMA

UNIT II TOLERANCE ANALYSIS 9

Process capability – Metrics – Costs aspects – Feature tolerance – Geometric tolerance – Surface finish, review of relationship between attainable tolerance grades and difference machining process – Cumulative effect of tolerances; sure, fit law, normal law and truncated normal law – Tolerance charting technique: Tolerance worksheets and centrality analysis, examples – Computer aided tolerance charting

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UNIT III SELECTIVE ASSEMBLY AND DATUM SYSTEMS 9

Interchangeable selective assembly – Control and axial play; introducing secondary machining operations, laminated shims, examples – Datum systems: Degrees of freedom, grouped datum systems different types, two and three mutually perpendicular grouped datum planes; Grouped datum system with spigot and recess pair and tongue – Slot pair – Computation of translational and rotational accuracy, geometric analyses and applications

UNIT IV TRUE POSITION THEORY 9

Comparison between co – Ordinate and convention method of feature location, tolerancing and true position tolerancing, virtual size concept, floating and fixed fasteners, projected tolerance zone, assembly with gasket, zero true position tolerance, functional gauges, paper layout gauging, compound assembly, examples

UNIT V DESIGN FOR MACHINING 9

Design features to facilitate machining – Functional and manufacturing datum features, component design, machining considerations, redesign for manufacture, examples – Form design: Form design of castings and weldments – Redesign of castings based on parting line considerations, minimizing core requirements – Redesigning case members using weldments

Contact Periods:

Lecture: 45 Periods Tutorial: Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Boothroyd G., Dewhurst P. and Knight W., "Product Design for Manufacture and Assembly", 4th edition, Marcel Dekker, New York,2012
2. George E. Deiter, "Engineering Design Material & Processing Approach", 2nd edition, McGraw Hill Education,2000

REFERENCES:

1. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", 5th edition, Tata McGraw Hill, New Delhi,2017
2. Chitale A K and Gupta R C, "Product Design and Manufacturing", Prentice Hall of India, 2014
3. Boothroyd, G. "Assembly Automation and Product Design", 2nd edition, Taylor and Francis, Boca Raton, Florida,2006
4. Boothroyd, G., Dewhurst, P. and Knight, W., "Product Design for Manufacture and Assembly", 2nd edition, Marcel Dekker, New York,2002
5. Boothroyd G., Dewhurst P. and Knight W., "Product Design for Manufacture and Assembly", 3rd edition, CRC Press,2010

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EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC				
U21MEP02	COMPUTER AIDED DESIGN	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21MEG01 – Engineering Graphics

COURSE OBJECTIVES:

- To inculcate knowledge on CAD design process and computer graphics
- To impart knowledge on curves, surface and solid modeling
- To familiarize concepts of visual realism, CAD standards, collaborative design and PLM

COURSE OUTCOMES:

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

CO1: Explain the fundamentals of computer graphics and their application in computer aided design (Understand)

CO2: Apply the concepts of curves, surface and solid modelling for new product development (Apply)

CO3: Explain the concepts of CAD visualization (Understand)

CO4: Describe the concepts of collaborative design and PLM software (Understand)

CO5: Adapt the CAD standards to ensure the correct data conversion between different CAD software (Understand)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION 9

Product cycle – Design process – Sequential and concurrent engineering – Computer aided design – CAD system architecture – Computer graphics – coordinate systems – 2D and 3D transformations homogeneous coordinates – Line drawing – Viewing transformation

UNIT II GEOMETRIC MODELING 9

Basics – Curves, lines, arcs, circle and bilinear surface – Representation of curves – Hermite curve – Bezier curve – B spline curves – NURBS – Techniques for surface modelling – Surface patch – Coons and bicubic patches – Bezier and B-spline surfaces – Regularized Boolean set operations – Primitive instancing – Sweep representations – Boundary representations – Constructive solid geometry – Comparison of representations – User interface for solid modelling

UNIT III VISUAL REALISM 9

Hidden–Line – Surface Solid removal algorithms – Shading – Coloring – Engineering Animation

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UNIT IV COLLABORATIVE DESIGN AND PLM 9

Principles of collaborative – Design collaborative approaches – Collaboration tools – Collaborative design system Product information – PLM frame work – Introduction to windchill and siemens PLM software

UNIT V CAD STANDARDS 9

Standards for computer graphics – Graphical Kernel System (GKS) – Standards for exchange images – Open Graphics Library (OpenGL) – Data exchange standards – IGES, STEP, CALS etc.– communication standards

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Ibrahim Zeid, "Mastering CAD CAM", special Indian edition, Tata McGraw Hill Education,2007
2. Donald Hearn and M. Pauline Baker, "Computer Graphics", 2rd edition, Pearson Education,2002

REFERENCES:

1. Radhakrishnan. P, Subramanyan. S, "CAD/CAM/CIM", 3rd edition, New Age International Publishers,2008
2. Chris McMahon, Jimmie Browne "CAD/CAM Principles", Practice and Manufacturing management, 2rd edition, Pearson Education,2000
3. William M.Newman , Robert .F.Sproull, "Principles of Interactive Computer Graphics", 2rd edition, Tata McGraw Hill Education,2006
4. Groover. M, "CAD/CAM", 1st edition, Pearson Education,2006

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC				
U21MEP03	MACHINE TOOL DESIGN	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21ME501 – Design of Machine Elements
- U21ME602 – Design of Transmission System

COURSE OBJECTIVES:

- To impart knowledge on different machine tools used for machining
- To acquire knowledge on the design criteria for machine tool structures
- To explore the design of slide ways, power screws and spindles for machine tools

COURSE OUTCOMES:

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

CO1: Discuss different machine tools used for machining (Understand)

CO2: Design sliding and rolling friction elements like guide ways and power screws (Apply)

CO3: Apply minimum deflection criterion to select spindles and its bearings (Apply)

CO4: Design machine tool structures based on strength and stiffness considerations (Apply)

CO5: Apply failure theories to design components for fluctuating loads (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION **9**

Classification of machining processes – Machine tools – Machine tool construction – Factors – Performance criteria – Trends in modern machine tools – Kinematic arrangement of different types of machine tools – Calculation of cutting forces and power requirements for machining operation – Force distribution on different parts of machine tools

UNIT II DESIGN OF GUIDEWAYS AND POWER SCREWS **9**

Design Criteria (Wear Resistance & Stiffness) Stick Slip phenomena aerostatic Slideways – Design of Anti friction Guideways – Concept of Combination Guideways. Function & Types of Guideways and Slideways – Types of Slideways & Antifrictionways – Sliding friction Power Screw for Wear Resistance – Strength – Stiffness – Buckling Stability

UNIT III DESIGN OF SPINDLE AND SPINDLE SUPPORTS **9**

Function & Requirements of Spindle Units – Their Materials – Effect of Machine Tool Compliance on Machining accuracy – Design of Spindle for Bending – Deflection of Spindle Axis – Location of Bearings and Drive elements – Balancing – Device Requirements of Spindle Supports

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UNIT IV DESIGN OF MACHINE TOOL STRUCTURE 9

Function & Requirement of Machine Tool Structure – Design Criteria from Strength & Stiffness considerations – Torsion and Bending – Manufacturing Factors affecting stiffness of machine tool structures – Basic Design procedure of machine tool structures

UNIT V DESIGN FOR FLUCTUATING LOADS 9

Stress Concentration and remedies – S.N. Diagram – Endurance limit – Factors affecting Endurance Strength – Design for Finite and Infinite life under reverse stresses – Cumulative damage – Soderberg and Goodman's Diagram

Contact Periods:

Lecture: 45 Periods Tutorial: -Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. N. K. Mehta, "Machine Tool Design", 3rd edition, Tata McGraw Hill Education,2017
2. D.K. Pal, S.K. Basu, "Design of machine Tools, 4th edition, Oxford University,2017

REFERENCES:

1. A. Bhattacharya and S.G. Sen., "Principles of Machine Tools", 2nd edition, New Central Book Agency,2009
2. N. S. Acherkan, "Machine Tool Design, 2nd edition, MIR Publisher,2013
3. F. Koenigsberger, "Design Principles of Metal Cutting Machine Tools", 1st edition, Pergamon Publisher,2013

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC				
U21MEP04	VIBRATION ANALYSIS AND CONTROL	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21ME502 – Theory of Machines

COURSE OBJECTIVES:

- To familiarize students with two and multi degree of freedom systems
- To Impart knowledge on the vibration measuring instruments
- To gain knowledge on vibration and control in automobile components

COURSE OUTCOMES:

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

CO1: Solve problems in simple harmonic motion (Apply)

CO2: Determine vibratory responses of TDOF systems (Analyze)

CO3: Determine vibratory responses of MDOF systems for the given conditions (Analyze)

CO4: Select suitable vibration measuring instrument based on the damping conditions (Apply)

CO5: Calculate vibrations in automotive suspension systems (Analyze)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION 9

Types of vibrations – Definitions – Simple Harmonic Motion (S.H.M.) – Work done by harmonic force – Principle of super position applied to SHM – Beats – Fourier theorem and problems

UNIT II TWO DEGREE OF FREEDOM SYSTEMS 9

Free and forced vibrations of damped and undamped systems – Equations of motion – Coordinate coupling and Principal coordinates – Dynamic vibration absorbers – Orthogonality principle – Technical applications

UNIT III MULTI DEGREE OF FREEDOM SYSTEMS 9

Equations of motion – Method of influence coefficients – Free vibration of undamped system – Natural frequencies and mode shapes – solutions by matrix method and influence coefficients – Mode shape Orthogonality – Free vibration of damped system – Rayleigh – Damping – General viscous damping – Forced vibrations of multi degree of freedom system – Harmonic excitations

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UNIT IV VIBRATION MEASURING INSTRUMENTS AND WHIRLING OF SHAFTS 9

Vibrometers – Accelerometer – Frequency measuring instruments and Problems – Whirling of shafts with and without damping – Discussion of speeds above and below critical speeds and Problems

UNIT V VIBRATION CONTROL IN STRUCTURES 9

Introduction – State space representation of equations of motion – Passive control – Active control and semi active control – Free layer and constrained damping layers – Piezo electric sensors and actuators for active control – Semi active control of automotive suspension systems

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. S. S. Rao, "Mechanical Vibrations", 6th edition, Pearson Education,2021
2. S. Graham Kelly, "Fundamentals of Mechanical Vibration", 2nd edition, McGraw Hill Education,2000

REFERENCES:

1. William T. Thomson, Marie Dillon Dahleh, Chandramouli, "Theory of Vibration with Application", 5th edition, Pearson Education,2008
2. C Sujatha, "Vibrations and Acoustics Measurements and signal analysis", 2nd edition, Tata McGraw Hill,2017
3. V. P. Singh, "Mechanical Vibrations", 2nd edition, Dhanpat Rai & Company,2014
4. A. G. Ambedkar, "Mechanical Vibrations and Noise Engineering", 2nd edition, PHI Learning Pvt Ltd,2006
5. G. K. Grover, "Mechanical Vibrations", 1st edition, Nem Chand and Bros,2009

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC				
U21MEP05	TRIBOLOGY AND INDUSTRIAL APPLICATIONS	L	T	P	J	C
		3	0	0	0	3

PRE—REQUISITES:

- Nil

COURSE OBJECTIVES:

- To build the knowledge on wear behaviour of materials under different environments
- To diagnose and control wear in metallic parts
- To assess wear in different mechanical components

COURSE OUTCOMES:

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

CO1: Explain the students to know the basic concepts of wear (Understand)

CO2: Use the concepts of friction and calculate the wear parameters (Apply)

CO3: Determine the wear in the lubricated contacts (Apply)

CO4: Diagnose and control the wear in engineering applications (Apply)

CO5: Develop their knowledge on tribology in different mechanical applications (Apply)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION TO WEAR 9

Types of wear – Adhesive wear – Two body and three body abrasive wear – Erosive wear – Cavitation wear – Wear due to surface fatigue – Chemical reaction

UNIT II SURFACE ROUGHNESS AND WEAR MEASUREMENTS 9

Tribo systems and tribo elements – Measurement of Surface roughness (Re and Rz) – Experimental studies on friction on various tribo systems using pin-on-ring (POR) and pin – On – Disc (POD) machines – Sample preparation – Wear measurement of various tribo – elements using POR and POD machines – Calculation of wear volume and wear coefficient – Comparison with existing data

UNIT III WEAR IN LUBRICATED CONTACTS 9

Rheological lubrication regime – Functional lubrication regime – Fractional film defect – Load sharing in lubricated contacts – Adhesive wear equation – Fatigue wear equation – Numerical example

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UNIT IV DIAGNOSIS AND CONTROL OF WEAR 9

Diagnosis of wear mechanisms using optical microscopy and scanning electron microscopy – Wear resistant materials – Wear resistant coatings – Eco – Friendly coatings designing for wear – Systematic wear analysis – Wear coefficients – Filtration for wear control

UNIT V WEAR IN MECHANICAL COMPONENTS 9

Component wear – Bushings – Lubricated piston rings and cylinder bore wear – Dry piston rings – Rolling bearings – Seal wear – Gear wear – Gear couplings – Wear of brake materials – Wear of cutting tools – Chain wear

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Basu S K, Sengupta S N, Ahuja B B, "Fundamentals of Tribology", 2nd edition, Prentice Hall of India Learning,2006
2. Hutchings, Ian, Shipway, Philip, "Tribology: Friction and Wear of Engineering Materials", 2nd edition, Elsevier Science, United Kingdom,2017

REFERENCES:

1. Bhushan, Bharat, "Introduction to Tribology," 1st edition, John Wiley & Sons,2013
2. Fuller, Dudley D, "Theory and Practice of Lubrication for Engineers", 1st edition, John Wiley & Sons,2007
3. Ghosh M K, Majumdar B C, Sarangi M, "Fundamentals of Fluid Film Lubrication", 2nd edition, Tata McGraw Hill Eduucation,2014

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC				
U21MEP06	PRODUCT DEVELOPMENT AND LIFE CYCLE MANAGEMENT	L	T	P	L	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To familiarize with various strategies of PLM
- To impart knowledge on new product development, product structure and supporting systems
- To indulge in technology forecasting, product innovation, product building, and configuration

COURSE OUTCOMES:

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

CO1: Explain the concepts, strategies, and implementation of PLM and PDM systems. (Understand)

CO2: Apply product design methodologies and concurrent engineering principles in product development. (Apply)

CO3: Apply and plan new product development processes including market and financial considerations. (Apply)

CO4: Apply technology forecasting methods and innovation tools for business decision-making. (Apply)

CO5: Apply digital product development tools and data management techniques in product building and structures (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION TO PLM AND PDM 9

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 – ts identification – Selection – Implementation – Product Data Management – Implementation of PDM systems

UNIT II PRODUCT DESIGN 9

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

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UNIT III PRODUCT DEVELOPMENT 9

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

UNIT IV TECHNOLOGY FORECASTING 9

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

UNIT V PRODUCT BUILDING AND STRUCTURES 9

Virtual product development tools for components – Machines – 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

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. John Stark, "Product Lifecycle Management: 21st Century Paradigm for Product Realisation", Springer,2011
2. Fabio Giudice, Guido La Rosa, "Product Design for the environment-A life cycle approach", 2nd edition, CRC Press,2019

REFERENCES:

1. Michael Grieves, "Product Lifecycle Management", 6th edition, McGraw Hill Education,2006
2. Antti Saaksvuori and Anselmi Immonen, "Product Life Cycle Management", 5th edition, Springer,2013
3. IvicaCrnkovic, Ulf Asklund and Annita Persson Dahlqvist, "Implementing and Integrating Product Data Management and Software Configuration Management", 2nd edition, Artech House Publishers,2013

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

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PROFESSIONAL ELECTIVE

		Category: PEC				
U21MEP07	DESIGN OF JIGS, FIXTURES AND PRESS TOOLS	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- Applying the principles of locating and clamping in Jigs and fixtures and various components related to Press tools
- Designing various types of Jigs and Fixtures for given components and draw multiple views of the same with dimensions and parts List
- Designing various parts of cutting dies and forming dies and draw the standard dimensioned views

COURSE OUTCOMES:

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

CO1: Explain locating and clamping principles used in jigs and fixtures (Understand)

CO2: Design various types of jigs for drilling and reaming operations. (Apply)

CO3: Design fixtures for machining, welding, assembly, and inspection operations. (Apply)

CO4: Design press tools and dies for sheet metal operations. (Apply)

CO5: Design bending, forming, and drawing dies for metal forming operations. (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I LOCATING AND CLAMPING PRINCIPLES 9

Jigs and fixtures – Basic elements – Principles of location – Locating methods and devices – Redundant Location – Principles of clamping – Mechanical actuation – Pneumatic and hydraulic actuation – Standard parts – Drill bushes and jig buttons – Tolerances and materials used – New ways of Locating and clamping

UNIT II DESIGN OF JIGS 9

Degrees of freedom – Fool – Proofing – Types of jigs – Post, turnover, channel, latch, box, pot type and Angular post jigs – Indexing jigs – Principles of jig design – Design of jigs for drilling and reaming

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UNIT III DESIGN OF FIXTURES 9

General principles of fixture design – Elements of fixtures – Provision for tool setting – Design of fixtures for milling, turning and boring – Broaching and grinding, welding, assembly and inspection – Modular fixturing – Concepts and applications

UNIT IV DESIGN OF PRESS TOOLS 9

Press tool terminology – Sheet metal operations – Types of presses – Press accessories – Centre of pressure – Design of various elements of dies – Die block – Punch holder, die set, guide plates, stops, strippers – Pilots – Computation of press capacity – Strip layout – Material Utilization – Simple blanking,piercing, compound and progressive dies

UNIT V BENDING FORMING AND DRAWING DIES 9

Difference between bending forming and drawing – Blank development for above operations – Types of Bending dies – Press capacity – Spring back – Knockouts – Direct and indirect – Pressure pads – Ejectors – Variables affecting metal flow in drawing operations – Ironing – Design of bending, forming, drawing and combination dies

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Joshi, P.H. "Jigs and Fixtures", 2nd edition, Tata McGraw Hill Education,2010
2. Donaldson, Lecain and Goold "Tool Design", 4th edition, TataMcGrawHill,2012

REFERENCES:

1. Sushan Shi, "10 Basic Principles of Jig and Fixture Design", 1st edition, Tata McGraw Hill,2015
2. Hoffman., "Jigs and Fixture Design", 5th edition, Cengage India,2008
3. K. Venkataraman, "Design of Jigs Fixtures Press Tools", 2nd edition, Anne Publications,2016

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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KPRIET
Learn Beyond

PROFESSIONAL ELECTIVE

		Category: PEC				
U21MEP08	FAILURE ANALYSIS AND NON–DESTRUCTIVE TESTING	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- Gain knowledge on failure and their characteristics
- Familiarize the instrumentation in different NDT methods
- Explore the advanced instrumentation in NDT methods

COURSE OUTCOMES:

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

CO1: Identify various modes of failure and their effects. (Understand)

CO2: Describe the procedure for liquid penetrant testing and magnetic particle testing. (Understand)

CO3: Illustrate the thermography and eddy current testing methods. (Understand)

CO4: Discuss the working principle of ultrasonic testing and acoustic emission. (Understand)

CO5: Explain need for advance instrumentation to precisely find the internal defect.(Understand)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I FAILURE ANALYSIS 9

Failure – Types and characteristics – Cause of failure in components – Techniques of failure analysis – Concept of failure – Definition – Modes – Root causes – Mechanisms – Effects – Types of FMEA and their associated benefits – Design level FMEA – System level FMEA – Process level FMEA – Steps for performing FMEA – Criticality assessment – Risk priority number technique – Military standard technique – FMEA information needs – Data sources and users – Advantages of FMEA

UNIT II SURFACE NDE METHODS 9

Overview of the Non Destructive Testing Methods – Visual inspection – Unaided and aided – Liquid Penetrant Testing – Principles – Types and properties of liquid penetrants – Developers – advantages and limitations of various methods – Testing Procedure, interpretation of results – Magnetic Particle Testing – Theory of magnetism – Inspection materials magnetization methods – Interpretation and evaluation of test indications – Principles and methods of demagnetization – Residual magnetism

UNIT III THERMOGRAPHY AND EDDY CURRENT TESTING (ET) 9

Thermography – Principles – Contact and non – Contact inspection methods – Techniques for applying liquid crystals – Advantages and limitation – Infrared radiation and infrared detectors –

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Instrumentations and methods – Applications – Eddy Current Testing – Generation of eddy currents – Properties of eddy currents – Eddy current sensing elements – Probes – Instrumentation – Types of arrangement – Applications – Advantages – Limitations – Interpretation/Evaluation

UNIT IV ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE) 9

Ultrasonic Testing – Principle – Transducers – Transmission and pulse – Echo method – Straight beam and angle beam – Instrumentation – Data representation – A/Scan – B–scan – C–scan Phased Array Ultrasound – Time of Flight Diffraction – Acoustic Emission Technique – Principle– AE parameters – Applications

UNIT V RADIOGRAPHY (RT) 9

Principle – Interaction of X–Ray with matter – Imaging – Film and film less techniques – Types and use of filters and screens – Geometric factors – Inverse square – Law– Characteristics of films – Graininess – Density – Speed – Contrast – Characteristic curves – Penetrameters – Exposure charts – Radiographic equivalence – Fluoroscopy – Xero – Radiography – Computed Radiography – Computed Tomography

Contact Periods:

Lecture: 45 Periods Tutorial: – Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non Destructive Testing", 5th edition, Narosa Publishing House,2014
2. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers,2010
3. Carlson, Carl, "Effective FMEAs: Achieving Safe, Reliable, and Economical Products and Processes Using Failure Mode and Effects Analysis", 2nd edition, John Wiley & Sons,2012

REFERENCES:

1. Kapur, Kailash C.., Pecht, Michael., "Reliability Engineering", 3rd edition, John Wiley & Sons,2014
2. Wong, B. Stephen., "Non–Destructive Testing Theory, Practice and Industrial Applications", 2nd edition, LAP Lambert Publication,2014
3. Nathan Ida, Norbert Meyendorf, "Handbook of advanced Nondestructive evaluation", 1st edition, Springer,2019
4. Jose Luis Otegui, "Failure Analysis: Fundamentals and Applications in Mechanical Components", 1st edition, Springer,2014

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

U21MEP09	SMART MATERIALS AND STRUCTURES	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21PH201 – Materials Science
- U21ME303 – Engineering Materials and Metallurgy

COURSE OBJECTIVES:

- To learn about basis of smart material science, processing and characteristics
- To familiarize students with types of biomaterials and their properties
- To Impart knowledge on the smart structures and its advancements

COURSE OUTCOMES:

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

CO1: Describe the shape memory alloys and its processing and characteristics (Understand)

CO2: Explain the electro rheological and magneto rheological fluids and their applications (Understand)

CO3: Elucidate the properties and characterization of biomaterials (Understand)

CO4: Summarize the principles of smart structures and its applications in engineering fields (Understand)

CO5: Identify advanced smart materials for different engineering applications (Understand)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION 9

Characteristics of composites and ceramics materials – Dynamics and controls – Concepts – Electro – Magnetic materials and shape memory alloys – Processing and characteristics

UNIT II ELECTRO RHEOLOGICAL AND MAGNETO RHEOLOGICAL FLUIDS 9

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).

UNIT III BIOMATERIALS 9

Introduction – Bulk properties – Surface properties and characterization – Polymers – Silicone biomaterials – Medical fibers and biotextiles – Smart polymers – Bioresorbable and bioerodible materials – Natural materials – Metals and ceramics – Physicochemical surface modification

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Biocompatibility concepts – Introduction to biocompatibility – Cell material interaction – Types of materials – Toxic – Inert – Bioactive – Long term effects of materials within the body – Cell response

UNIT IV SMART STRUCTURES 9

Principles of drag and turbulence control through smart skins – Applications in environment such as aerospace and transportation vehicles – Manufacturing – Repair and maintainability aspects

UNIT V ADVANCES IN SMART STRUCTURES & MATERIALS 9

Self-sensing piezoelectric transducers – Energy harvesting materials – Autophagous materials – Self – Healing polymers – Intelligent system design – Emergent system design

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. M. V. Gandhi and B. S. Thompson, "Smart Materials and Structures", 3rd edition, Springer,2012
2. Brian Culshaw, "Smart Structures and Materials", 2nd edition, Artech House Publication,2004

REFERENCES:

1. Duerig,T. W., Melton, K. N, Stockel, D. and Wayman, C.M., "Engineering aspects of Shape memory Alloys", 1st edition, Butterworth Heinemann,2013
2. Mohsen Shahinpoor and Hans-Jo¨rg Schneider "Intelligent Materials", 1st edition, Royal Society of Chemistry,2007
3. Mel Schwartz (Ed), "Encyclopaedia of Smart Materials" Volume –I and II, John Wiley & Sons, Inc.2002
4. Sujata V. Bhat, "Biomaterials", 1st edition, Narosa Publishing House, 2002
5. Gauenzi, P., "Smart Structures", 2nd edition, John Wiley & Sons,2009

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

U21MEP10	COMPOSITE MATERIALS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21ME303 – Engineering Materials and Metallurgy

COURSE OBJECTIVES:

- To introduce the various composite materials and sandwich structure technology
- To provide an understanding of the manufacturing techniques in composite structures
- To impart knowledge on industrial applications of composite materials

COURSE OUTCOMES:

Upon completion of the course– the student will be able to

CO1: Elaborate the classification of composites materials and composite structure (Understand)

CO2: Discuss the various reinforcement and matrices in composite materials (Understand)

CO3: Discuss the various fabrication methods, properties and applications of MMC (Understand)

CO4: Explain the various method for manufacturing of polymer composite materials (Understand)

CO5: Develop the knowledge in different processing methods of CMC with industrial applications (Understand)

CO - PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION TO COMPOSITE 9

Definition – Classification of composite materials based on structure – Based on matrix – Advantages and application of composites – Functional requirements of reinforcement and matrix – Reinforcement types – Fibres – Continuous – Particulate and whisker reinforcement – Properties – applications – Comparison of fibre strength – Matrix materials – Properties – Wettability fiber with matrix – Effect of surface roughness – Interfacial bonding

UNIT II REINFORCEMENT AND MATRICES 9

Manufacturing process – Properties, structure and uses of glass – Carbon – Aramid and boron fibers – Extraction process – Properties – Structures and uses of natural fiber – Types – Properties – Chemistry and applications of fillers such as silica – Titanium oxide – Talc – Mica etc – Thermoset

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and thermoplastics matrices – Properties of epoxy – Polyester – Nylon – Polypropylene and PEEK matrices

UNIT III METAL MATRIX COMPOSITES (MMC) 9

Fabrication of MMC: solid state fabrication – Liquid state fabrication and in – Situ fabrication techniques – Interfaces in MMC – Mechanical bonding – Chemical bonding and interfaces in – Situ composites – Discontinuously reinforced MMC – Properties – Application of MMC

UNIT IV POLYMER MATRIX COMPOSITES (PMC) 9

Fabrication of PMC: Hand layup method – Compression and Resin Transfer Moulding – Pressure and vacuum bag process – Filament winding – Protrusion – Reinforced RIM – RRIM – Injection moulding – SMC and DMC – Advantages and disadvantages – Application of PMC

UNIT V CERAMIC MATRIX COMPOSITES (CMC) 9

Fabrication and processing methods of CMC: Powder processing – Slurry infiltration – Liquid infiltration – Chemical vapor infiltration – Directed metal oxidation – Properties – Comparison of polymers – Metals and ceramics – Applications of CMC

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. John C. Bittence, "Engineering Plastics and Composites", 1st edition, ASM Pblisher,2016
2. Issac, M. Daniel, "Engineering Mechanics of Composite Materials", 2nd edition, Oxford University publication,2005

REFERENCES:

1. Dominick V. Rosato, "Designing with Reinforced composites Technology Performance Economics", 8th edition, Carl Hanser,2017
2. Nicholas P. Cheremisionff, "Fiber glass Reinforce Plastics", N.J. U.S.A. Reprint 2015
3. Y.C. Ke, P. Stroeve and F.S. Wang, "Polymer layered silicate and silica nano composites", 1st edition, Elsevier,2005

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC				
U21MEP11	NON-TRADITIONAL MACHINING PROCESSES	L	T	P	L	C
		3	0	0	0	3

PRE–REQUISITES:

- U21ME302 – Manufacturing Technology - I

COURSE OBJECTIVES:

- To comprehend the unconventional manufacturing processes and study its advantages over conventional techniques
- To impart knowledge on surface engineering process
- To impart knowledge on advanced and finishing processes

COURSE OUTCOMES:

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

CO1: Explain the various unconventional machining processes (Understand)

CO2: Apply thermal machining process knowledge to select suitable methods for machining hard, brittle, or heat-resistant materials. (Apply)

CO3: Recognize the appropriate surface treatment for property enhancement (Understand)

CO4: Identify various chemical and hybrid machining processes (Understand)

CO5: Utilize appropriate advanced finishing process for a product (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I UNCONVENTIONAL MACHINING PROCESS 9

Unconventional Machining Process (UMP) Classification – EDM and Wire cut EDM process – Process parameters – Surface finish and MRR – Abrasive Jet machining – Principles – Equipment's – Applications – Advantages and limitations

UNIT II THERMAL MACHINING PROCESSES 9

Laser beam machining (LBM) – Plasma arc machining (PAM) – Electron beam machining (EBM) – Beam control techniques – Advantages – Disadvantages and applications

UNIT III SURFACE TREATMENT PROCESS 9

Surface Cleaning – Methods of cleaning – Surface coating types – Ceramic and plastic coating – Economics of coating – Physical vapor deposition – Chemical vapor deposition – Plasma spraying – Ion implantation – Diffusion coating – Boriding and chromizing – Cladding – Laser gladding – Friction

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stir processing – Laser hard facing – Micro Arc Oxidation process – Shot peening and ultrasonic shot peening – Thermal barrier coating – Laser shock peening – Nano scale surface hardening

UNIT IV CHEMICAL AND HYBRID MACHINING PROCESS 9

Hybrid Machining Process – Electro Chemical Drilling – Shaped Tube Electrolytic Machining – Electro stream Drilling – Electro Chemical Jet Drilling – Electro Chemical Deburring – Electro Chemical Grinding (ECG) – Electro Chemical Honing (ECH) – Electrochemical super finishing – Electrical Discharge Grinding (EDG) – Electrical Discharge Diamond Grinding (EDDG) – Electro Chemical Discharge Grinding (ECDG) – Process capabilities and applications

UNIT V ADVANCED FINISHING PROCESS 9

Abrasive Flow Machining (AFM) – Magnetic Abrasive Finishing (MAF) – Magneto-rheological Finishing (MRH) – Chemo Mechanical Polishing (CMP) – Working principle – Mechanism of material removal – Surface quality – Applications

Contact Periods:

Lecture: 45 Periods Tutorial: Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. P.C.Pandey and H.S.Shan, "Modern Machining Process", 2nd edition, Tata McGraw Hill Education,2017
2. Adithan M, "Unconventional Machining Process", 1st edition, Atlantic Publishers,2018

REFERENCES:

1. Akhlesh Lakhtakia, "The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations", 1st edition, John Wiley & Sons,2004
2. J Paulo Davim, "Materials and Surface Engineering", 1st edition, Woodhead Publishing,2012
3. H.El-Hofy, "Fundamentals of Machining Processes: conventional and non-conventional", 2nd edition, CRC Press,2014

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC				
U21MEP12	WELDING TECHNOLOGY	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21ME302 – Manufacturing Technology - I

COURSE OBJECTIVE

Objective of this course is to

- Gain knowledge on basics of welding and their classification
- Explore knowledge on weldability issues in joining of different metals
- Learn the principles of Robotics in welding applications

COURSE OUTCOMES:

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

CO1: Explain the working principles of various arc and resistance welding processes (Understand)

CO2: Illustrate the solid-state welding process for engineering applications (Understand)

CO3: Describe the working principles of special welding processes (Understand)

CO4: Interpret the different weld joint design, weldability issues and testing of weldments (Apply)

CO5: Analyze the effect of heat transfer in welding using different mathematical models and simulation (Analyse)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I ARC AND RESISTANCE WELDING PROCESSES 9

Variants of TIG and MIG welding – CMT welding process – Electroslag welding processes – Seam welding – Projection welding – Resistance Butt welding – Flash Butt welding – High frequency resistance welding processes – Advantages – Limitations and applications

UNIT II SOLID STATE WELDING PROCESSES 9

Cold welding – Diffusion bonding – Explosive welding – Ultrasonic welding – Friction welding – Friction stir welding – Forge welding – Roll welding and Hot pressure welding processes – Advantages – Limitations and applications

UNIT III SPECIAL WELDING PROCESSES 9

Electron beam – Laser beam welding – Plasma arc processes – Weld cladding – Surfacing advantages – Limitations – Introduction to Robotic welding – Underwater welding – Case studies and applications

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UNIT IV DESIGN OF WELD JOINTS, WELDABILITY AND TESTING OF WELDMENTS 9

Various weld joint designs – Welding defects – Causes and remedies – Weldability of Aluminium – Copper – Titanium and Stainless steels – Residual stresses and distortion in welding – Destructive and non-destructive testing of weldments

UNIT V WELDING METALLURGY AND WELD SIMULATION 9

Weld thermal cycles and their effects – Effects of pre and post weld heat treatments – Concept of HAZ – Thermal modeling and simulation of welding processes – Governing heat transfer equations and boundary conditions for various types of welding processes

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS

1. Little R.L., "Welding and welding Technology", 34th reprint, Tata McGraw Hill Education,2008
2. Parmer R.S., "Welding Engineering and Technology", 1st edition, Khanna Publishers,2008
3. Norrish, J, "Advanced Welding Processes", 2nd edition, Elsevier Science,2006

REFERENCE

1. Mishra. R.S and Mahoney. M.W, "Friction Stir Welding and Processing", 14th edition, Springer,2014
2. Lindgren, Lars Erik, "Computational Welding Mechanics", 1st edition, CRC Press,2007
3. Paulo Dvaim, "Welding Technology", 3rd edition, Springer,2021
4. Saeed B. Niku, "Introduction to Robotics: Analysis, Control, Applications", 2nd edition, John Wiley & Sons,2012

EVALUATION PATTERN:

Continuous Internal Assessments				Total Internal Assessments	End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)			
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC			
U21MEP13	ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To know the principle, methods, possibilities and limitations as well as environmental effects of Additive Manufacturing technologies
- To be familiar with the characteristics of the different materials used in Additive Manufacturing technologies
- To understand the 3D printing processes and its applications

COURSE OUTCOMES:

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

CO1: Describe an overview of additive manufacturing and applications (Understand)

CO2: Apply appropriate part orientation and support structure generation techniques to improve build quality and reduce material usage (Apply)

CO3: Familiarize with the manufacturing method of photopolymerization and powder bed fusion processes (Understand)

CO4: Acquire knowledge on process and applications of powder bed fusion and material extrusion.(Understand)

CO5: Explain the manufacturing method of printing processes and beam deposition processes (Understand)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION **9**

Overview – Need – Development of Additive Manufacturing Technology – Principle – AM Process Chain – Classification – Rapid Prototyping – Rapid Tooling – Rapid Manufacturing – Applications – Benefits – Case studies

UNIT II DESIGN FOR ADDITIVE MANUFACTURING **9**

Data processing – CAD model preparation – Part orientation and support structure generation – Model slicing – Tool path generation – Design for Additive Manufacturing: Concepts and objectives – AM unique capabilities – DFAM for part quality improvement – Customized design and fabrication for medical application

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UNIT III PHOTOPOLYMERIZATION AND POWDER BED FUSION PROCESSES 9

Photo polymerization: SLA – Photo curable materials – Process – Advantages and Applications – Powder Bed Fusion: SLS – Process description – Powder fusion mechanism – Process Parameters – Typical Materials and Application – Electron Beam Melting

UNIT IV EXTRUSION BASED AND SHEET LAMINATION PROCESSES 9

Extrusion Based System: FDM – Introduction – Basic Principle – Materials – Applications and Limitations – Bio Extrusion – Sheet Lamination Process: LOM – Gluing or Adhesive bonding – Thermal Bonding

UNIT V PRINTING PROCESSES AND BEAM DEPOSITION PROCESSES 9

Three - Dimensional Printing (3DP) – Droplet formation technologies – Continuous mode – Drop on Demand mode – 3DP Advantages – Bioplotter – Beam Deposition Process: LENS – Process description – Material delivery – Process parameters – Materials – Benefits – Applications

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. Chua C K, and Leong K F, "Rapid prototyping: 3D printing and additive manufacturing principles and applications", 5th edition, World Scientific Publishing Company,2019
2. Ramesh, S, "A Textbook of Rapid Prototyping", 12th edition, Ane Books,2017

REFERENCES:

1. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing", 2nd edition, Hanser Gardner Publication,2011
2. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", 2nd edition, Springer,2006
3. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", 1st edition, CRC Press,2007
4. Tom Page, "Design for Additive Manufacturing", 2nd edition, LAP Lambert Academic Publishing,2012

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC			
U21MEP14	BIOMATERIALS AND CERAMICS	L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- U21ME303 – Engineering Materials and Metallurgy

COURSE OBJECTIVES:

- To acquaint the bio materials used in medical application
- To learn the effectiveness of the bio materials technology and the medical devices

COURSE OUTCOMES:

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

CO1: Classify biomaterials and their performance with respect to their applications (Understand)

CO2: Explain the composition and properties of Polymeric and Composite biomaterials (Understand)

CO3: Identify suitable testing for biomaterial Implant (Understand)

CO4: Select appropriate biomaterials for implant and surgical aids (Understand)

CO5: Explain the applications of various metallic and Ceramic bio materials (Understand)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION TO BIOMATERIALS 9

Biomaterial – Types of Biomaterials – Biocompatibility – Biological material – Biodegradable material – Bioresorbable material – Bio-inert material – Bio-active material – Pyrogenicity – Minimum Requirements of Biomaterials – Surface Properties of Biomaterials – Desirable Properties of Biomaterial – Performance of Biomaterials – Applications of Biomaterials

UNIT II POLYMERIC AND COMPOSITE BIOMATERIALS 9

Polymeric Biomaterials: Introduction – Basic structures of Polymers – Hydrogel – Bone cement – Fluorocarbon polymers – Silicon Rubber – Bioactive Polymers – Biodegradable Polymers – Applications – Composite Biomaterials: Introduction – Dental filling Composites and cement – Porous Composites – Fibrous and Particulate composites

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UNIT III BIOCOMPATIBILITY TESTING AND amp; RESPONSE OF BIOMATERIAL TO HUMAN BODY 9

Biocompatibility Testing: Introduction – In-Vitro Testing – In-Vivo Testing – Hypersensitivity – Haemocompatibility – Odontocompatibility – Osteocompatibility – Cytotoxicity – Genotoxicity – Carcinogenicity – Response of Biomaterial to Human Body: Blood-Biomaterial Interactions – Biomaterials – Tissue Interactions – Tissue response to Implants – Inflammation – Wound Healing – Foreign Body Response – Infection and Tumorigenesis of Biomaterials

UNIT IV BIO-IMPLANTS AND SURGICAL AIDS 9

Stent, Vascular grafts – Artificial Heart valves – Inferior Vanacava filter – Contact lenses – Intra-ocular Lenses – Artificial Silicon Retina – Temporary fixation Devices – Total Hip Replacement – Total Knee Replacement – Dental filling – Restoration material – Dental implants – Suture materials – Wound dressings – Tissue Adhesives

UNIT V METALLIC AND CERAMIC BIOMATERIALS 9

Metallic Biomaterials: Introduction – Stainless steel – Co-Cr Alloys – Ti-Alloys – Nitinol – Dental metals, Corrosion of Metallic implants – Manufacturing of Metallic implants – Applications – Ceramic Biomaterials: Introduction – Types of Ceramics – Bio-inert ceramics: Alumina – Zirconia – Carbon – Bioresorbable ceramics: Calcium Phosphate – Bioactive ceramics: Glass ceramics – Applications

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. William R., "Biomaterials Science: An Introduction to Materials in Medicine", 4th edition, Academic Press,2020
2. Michael Shuler, Fikert Kargi, Matthew De Lisa., "Bioprocess Engineering: Basic Concepts", 3rd edition, Prentice Hall International Series,2017

REFERENCES:

1. "Cell Culture Bioprocess Engineering", 2nd edition, Wei-Shou Hu publishers,2020
2. Biomaterials Science: "An Introduction to Materials in Medicine", 3rd edition, Academic Press 2012
3. Tadashi Kokubo, "Bioceramics and their Clinical Application", 1st edition, Woodhead Publisher,2008

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

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PROFESSIONAL ELECTIVE

U21MEP15	OPERATIONS RESEARCH	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To impart the knowledge on linear programming methods to solve engineering problems
- To study the concepts of network and inventory models
- To learn queuing theories and decision models to solve real time problems

COURSE OUTCOMES:

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

CO1: Apply the concepts of linear programming models to solve engineering problems (Apply)

CO2: Demonstrate problem solving ability using network models (Apply)

CO3: Use the optimization techniques in inventory control (Apply)

CO4: Make use of Queueing theories to solve real-time problems (Apply)

CO5: Demonstrate problem solving ability using decision models (Apply)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I LINEAR MODELS 9

The phase of an operation research study – Linear programming – Graphical method – Simplex algorithm – Duality formulation – Sensitivity analysis using software (TORA)

UNIT II NETWORK MODELS 9

Network models – Shortest route – Minimal spanning tree – Maximum flow models – Project network – CPM and PERT networks – Critical path scheduling – Sequencing models – Demonstration of network model using software

UNIT III INVENTORY MODELS 9

Inventory models – Economic order quantity models – Quantity discount models – Stochastic Inventory models – Multiproduct models – Inventory control models in practice – Introduction to SAP

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UNIT IV QUEUING THEORY 9

Queueing models – Queueing systems and structures – Notation – Parameter – Single server and multi- server models – Poisson input – Exponential service – Constant rate service – Infinite population – Simulation

UNIT V DECISION MODELS 9

Decision models – Game theory – Two-person zero sum games – Graphical solution – Algebric solution – Linear programming solution – Replacement models – Models based on service life – Economic life – Single / Multi variable search technique – Application of OR models – Case studies

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. H.A.Taha, "Operations Research", 8th edition, Prentice Hall of India,2016
2. Shennoy, Srivastava, "Operation Research for Management", 3rd edition, New Age Publisher,2018

REFERENCES:

1. Ravindran, A., Phillips,D.T.,& Solberg,J.J."Operations research-principles and practice" 2nd edition, John Wiley & Sons,2015
2. Hillier,F.S.,& Lieberman,G.J."Introduction to operations research – concepts and cases" 9th edition, Tata McGraw Hill Education,2017

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
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				100	

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PROFESSIONAL ELECTIVE

		Category: PEC				
U21MEP16	PROCESS PLANNING AND COST ESTIMATION	L	T	P	L	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To introduce the process planning concepts to make cost estimation
- To determine the process and sequence of operations to obtain a useful final product
- To enhance the knowledge related to cost estimation

COURSE OUTCOMES:

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

CO1: Select the process, equipment, and tools for various industrial products (Understand)

CO2: Prepare process planning flow chart (Understand)

CO3: Implement work study techniques to improve productivity (Apply)

CO4: Apply motion study techniques to eliminate unnecessary motions (Apply)

CO5: Calculate the machining time for various machining operations (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION TO PROCESS PLANNING 9

Introduction – Methods of process planning – Drawing interpretation – Material evaluation – Steps in process selection – Production equipment and tooling selection

UNIT II PROCESS SELECTION 9

Process selection – Technological choice – Specific component choice – Process flow choice – Factors affecting process selection – Machine capacity – Analysis of machine capacity – Process and equipment selection procedure – Determination of man, machine and material requirements – Simple problems – Selection of material – Jigs – Fixtures etc

UNIT III WORK STUDY 9

Motive of work study – Concept of work content – Techniques to reduce work content – Method study – Procedure – Recording techniques used in method study – Micro motion study – Principles of motion economy – Therbligs – Simo chart – Cycle graph – Chrono cycle graph – Work measurement – Basic Procedures for the conduct of time study – Calculation of standard time – Simple problems –

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Ergonomics – Definition – Objectives – Applications -working environment – Work place layout – Other areas

UNIT IV MOTION STUDY 9

Goals of Motion Study – Time Study (Stopwatch Measurement) – Criticisms – Work Sampling – Learning Curve – Taylor vs. the Gilbreths – Direct Time Study Procedure – Case studies – Difference between Time Study and Motion Study

UNIT V MACHINING TIME CALCULATIONS 9

Elements of metal machining – Cutting speed – Feed – Depth of cut – Procedure for assigning cutting variables – Calculation of machining time for lathe operations – Calculation of machining time for operations on drilling machine – Machining time for shaping, planning, slotting, broaching and sawing operations – Face milling and slab milling operations – Timing for thread cutting – Estimation of total unit time – Simple problems

Contact Periods:

Lecture: 45 Periods Tutorial: Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Adithan.M, "Process planning and Cost Estimation", 2nd edition, New Age International Publishers,2015
2. Sinha B.P, "Mechanical Estimating and Costing", 2nd edition, Tata McGraw Hill Education,2003

REFERENCES:

1. O.P Khanna, "Industrial Engineering & Management", 17th edition, Dhanpat Rai Publication,2017
2. Martand Telsang, "Industrial Engineering & Production Management", 1st edition, Sultan Chand & Sons,2006

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
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PROFESSIONAL ELECTIVE

		Category: PEC				
U21MEP17	PLANT LAYOUT AND MATERIALS HANDLING	L	T	P	L	C
		3	0	0	0	3

PRE–REQUISITES:

- U21ME401 – Manufacturing Technology – II

COURSE OBJECTIVES:

- To acquire knowledge about the importance of industrial layout and safety
- Identify the key factors for location decision and site selection
- To impart knowledge required on plant layout tools for better solute

COURSE OUTCOMES:

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

CO1: Interpret all types of plant layouts for better industrial layout design (Understand)

CO2: Identify the key factors for location decision and site selection (Understand)

CO3: Apply computer-based layout design (Apply)

CO4: Estimate cost and corresponding implementation activities in layout (Apply)

CO5: Use material handling principles and techniques to improve movement, storage and safety (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I PLANT LAYOUT 9

Plant Layout – Importance of Plant Location – Facilities Design Procedure, Principles of Plant layout and Types – Factors affecting layout – Methods, factors governing flow pattern – Travel chart – Analytical tools of plant layout – Layout of manufacturing shop floor – Repair shop – Services sectors and process plant – Evaluation and Improvement of layout

UNIT II PLANT LOCATION 9

Plant location – Need Factors – Comparison – Quantitative methods for evaluation – Types – Tools and techniques for layout design – Line balancing and sequence analysis concept – Site selection – Procedures – Factors affecting selection – Dynamic Nature of Plant Location

UNIT III COMPUTER AIDED PLANT LAYOUT 9

Data requirements – Mathematical programming procedures – Heuristics – CORE LAP – PLANET – MAT – CRAFT – Probabilistic Approach – Random selection (ALDEP) – Based sampling – Simulation – Graph Theory – Layout states – Scale effect – Criticism concerning Computer Aided Plant Layout

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UNIT IV EVALUATION AND IMPLEMENTATION OF LAYOUT 9

Evaluating the Layout – Qualitative Evaluation Techniques – Efficiency indices – Cost Evaluation of Layout – Quantitative evaluation Techniques – Evaluation procedures – Making the alteration – Presenting the Layout to management – Displaying the Layout – Follow up – Approval – Reproducing the Layout – Installing the Layout

UNIT V MATERIAL HANDLING 9

Objectives – Principles – Types – Degree of mechanization – Unit load concept – Material Handling cost – Relationship between Material Handling and Plant Layout – Material Handling system Design – Specification of the Design – Analyzing an existing material Handling system. Basics of material handling selection – AGVS in material Handling – Packing

Contact Periods:

Lecture:	45 Periods	Tutorial:	– Periods	Practical:	– Periods	Project	– Periods
						Total	45 Periods

TEXT BOOKS:

1. S.C. Sharma, "Plant Layout and Materials Handling", 3rd edition, Khanna Publishers,2015
2. Mark A. Friend, James P. Kohn, "Fundamentals of Occupational Safety and Health", 6th edition by Government Institutes,2014

REFERENCES:

1. Francis, "Facility Layout and Location: An analytical Approach", 2nd edition, Pearson Education,2015
2. Sunderesh S. Heragu, "Facilities Design", 4th edition, CRC Press,2016

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PROFESSIONAL ELECTIVE

		Category: PEC				
U21MEP18	COMPUTER INTEGRATED MANUFACTURING	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To demonstrate the application of computers in various aspects of manufacturing
- To acquire knowledge on design, proper planning, manufacturing cost and layout
- To familiarize in Group Technology (GT), cellular manufacturing, Shop Floor Control (SFC), Flexible Manufacturing System (FMS), Automated Guided Vehicle System (AGVS) and Industrial robots

COURSE OUTCOMES:

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

CO1: Demonstrate CAD/CAM concepts, manufacturing models, automation principles, and lean/JIT techniques to solve basic manufacturing planning and control problems. (Apply)

CO2: Prepare process plans and production schedules through CAPP, MRP, MRP-II, ERP, and shop floor control techniques. (Apply)

CO3: Implement group technology, part coding systems, and cell design methods to form machine cells and solve simple cellular manufacturing problems. (Apply)

CO4: Use FMS and AGV's planning methods to solve simple problems related to manufacturing flexibility and material handling. (Apply)

CO5: Perform robot programming, control operations, and economic evaluation for simple industrial robotics applications. (Apply)

CO - PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION TO CAD AND CAM 9

Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control – Introduction to CAD/CAM – Concurrent engineering – CIM concepts – Computerised elements of CIM system – Types of production – Manufacturing models and metrics – Mathematical models of production performance – Simple problems – Manufacturing control – Simple problems – Basic elements of an automated system – Levels of automation – Lean production and Just – In – Time (JIT) production

UNIT II PRODUCTION PLANNING AND CONTROL AND COMPUTERISED PROCESS PLANNING 9

Process planning – Computer Aided Process Planning (CAPP) – Logical steps in computer aided process planning – Aggregate production planning and Master Production Schedule (MPS) – Material

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Requirement Planning (MRP) – Capacity planning- Control systems – Shop Floor Control (SFC) – Inventory control – Brief on manufacturing resource planning – II (MRP-II) & Enterprise Resource Planning (ERP)

UNIT III CELLULAR MANUFACTURING 9

Group Technology (GT) – Part families – Parts classification and coding – Simple problems in Opitz part coding system – Production Flow Analysis (PFA) – Cellular manufacturing – Composite part concept – Machine cell design and layout – Quantitative analysis in cellular manufacturing – Rank order clustering method – Arranging machines in a GT cell – Hollier method – Simple problems

UNIT IV FLEXIBLE MANUFACTURING SYSTEM (FMS) AND AGVS 9

FMS – FMS Components – FMS application & benefits – FMS planning and control – Types of flexibility – Quantitative analysis in FMS – Simple problems. Automated Guided Vehicle System (AGVS) – AGVS application – Vehicle guidance technology – Vehicle management & safety

UNIT V INDUSTRIAL ROBOTICS 9

Introduction to robot – Robot anatomy and related attributes – Classification of robots – Robot control systems – End effectors – Sensors in robotics – Robot accuracy and repeatability – Simple problems Industrial robot applications – Robot part programming and languages – Economic analysis of robotics

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Mikell.P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", 3rd edition, Prentice Hall of India,2018
2. Radhakrishnan P, Subramanyan S and Raju V., "CAD/CAM/CIM", 3rd edition, New Age Publication,2020

REFERENCES:

1. Kant Vajpayee S, "Principles of Computer Integrated Manufacturing", 2nd edition, Prentice Hall India,2013
2. Gideon Halevi and Roland Weill, "Principles of Process Planning A Logical Approach", 3rd edition, Springer Education,2003
3. Rao. P, N Tewari &T.K. Kundra, "Computer Aided Manufacturing", 3rd edition, Tata McGraw Hill Publishing Company,2019

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th rowspan="3">Total Internal Assessments</th><th rowspan="3">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (100 Marks)</th><th colspan="2">Assessment II (100 Marks)</th></tr>
<tr><th>*Individual Assignment / Case Study / Seminar / Project / MCQ</th><th>Written Test</th><th>*Individual Assignment / Case Study / Seminar / Project / MCQ</th><th>Written Test</th></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>200</td><td>100</td></tr>
<tr><td colspan="4" rowspan="2">Total</td><td>40</td><td>60</td></tr>
<tr><td colspan="2">100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC				
U21MEP19	LEAN SUPPLY CHAIN MANAGEMENT	L	T	P	L	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To learn the individual processes of supply chain management and their interrelationships within individual companies and across the lean supply chain
- Provide knowledge on the management components of lean supply chain management
- To know the tools and techniques useful in implementing lean supply chain management

COURSE OUTCOMES:

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

CO1: Explain the framework and scope of supply chain networks and functions (Understand)

CO2: Discuss the various inventory management techniques (Understand)

CO3: Design a supply chain model using different tools (Apply)

CO4: Execute the designed supply chain models (Apply)

CO5: Design and execute the lean case studies in the real time application (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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CO3	3	2	1	1	-	-	-	-	-	-	2	-	3	2
CO4	3	2	1	1	-	-	-	-	-	-	-	-	3	2
CO5	3	2	1	1	-	-	-	-	-	-	-	-	3	2

SYLLABUS:

UNIT I LEAN SUPPLY CHAIN **9**

Lean opportunities in supply chain and logistics – Examples of JIT in the supply chain – Competitive strategy – Logistics and customer value – Measuring logistics cost and performance

UNIT II INVENTORY MANAGEMENT **9**

Traditional inventory management versus lean inventory management – Kanban sizing – WIP inventory: FIFO management – Lot sizing in lean – One-piece – Every part every interval – Lot sizing as part of scheduling – Reducing pipeline inventory: Kanban – Visual car – Inventory reduction through reducing lot sizes – Point of sales data

UNIT III LEAN SUPPLY CHAIN DESIGN **9**

Principles – Lean layouts – Lean production schedules – Lean service – Traditional physical control of inventories – Traditional relationships packaging – Preparing an item for shipment – Overall warehouse setup and item locations. Contractor management: Selection of contractors – Induction – Onsite management – Risk management – Lean logistics: product availability and its effect on logistics – Collaboration: visibility and reliability – The impact of globalization – Enterprise resource

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planning – Leveraging enterprise resource planning in the supply chain – Sales and operations planning – Lean supply chain tools for the perfect order

UNIT IV LEAN SUPPLY CHAIN EXECUTION 9

E-Commerce – QR – ECR – And CPFR – Collaborative planning – Forecasting – Replenishment – Vendor – Managed inventory – Other potential areas for collaboration – Future opportunities – Logistics of a global supply chain – Value stream mapping to identify waste – Areas to reduce waste policies and procedures – Relevant lean supply chain and logistics metrics – Balanced scorecard – Display and control metrics – Barriers to supply chain integration – Trends in the lean supply chain – Data analytics – Supply chain analytics and lean – Potential obstacles to lean thinking in the supply chain

UNIT V CASE STUDIES 9

Reverse logistics – Warehouse management using lean concept – Lean supply chain management of an automobile component manufacturing industry – Introducing lean concept in E- procurement

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total: 45 Periods

TEXT BOOKS:

1. Sunil Chopra, Peter Meindl and Kalra., "Supply Chain Management, Strategy Planning and Operation", 6th edition, Pearson Education,2010
2. Paul Myerson, "Lean Supply Chain and Logistics Management", 1st edition, Tata McGraw Hill Education,2012

REFERENCES:

1. Robert Jacobs F., Richard B Chase "Operations and Supply Chain Management", 13th edition, McGraw Hill Education,2012
2. Martin Christopher, "Logistics and Supply Chain Management", 1st edition, Pearson Publications, 2011
3. Bill Kerber, Brian J Dreckshage, "Lean Supply Chain Management Essentials: A Framework for Materials Managers", 1st edition, CRC Press,2011

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
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Total				40	60
				100	

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PROFESSIONAL ELECTIVE

		Category: PEC				
U21MEP20	TOTAL QUALITY MANAGEMENT	L	T	P	L	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To introduce the evolution of quality principles and practices
- To emphasize on the quality management tools and techniques
- To learn the standards of quality management system

COURSE OUTCOMES:

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

CO1: Explain the quality principles of TQM (Understand)

CO2: Apply TQM principles for eliminating non-value-added activities in an organization (Apply)

CO3: Use process capability study to assess process performance and its ability to meet specification limits (Apply)

CO4: Apply quality tools to detect and rectify the failures in the process/products (Apply)

CO5: Implement Quality management system and Environmental management system (ISO Standards) in the organization (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION TO QUALITY STATEMENTS AND PRINCIPLES 9

Need and evolution of quality – Definition of quality- Important philosophies - Deming – Juran – Crosby – shikawa and Taguchi. Fundamentals of TQM and TQM framework. Barriers to TQM, Leadership – Quality council – Quality statements and quality planning

UNIT II TOTAL QUALITY MANAGEMENT PRINCIPLES 9

Customer focus – Customer satisfaction – Customer perception of quality – Customer complaints and customer retention – Employee Involvement – Motivation-Empowerment – Team and team work Supplier quality management – Supplier partnership – Supplier selection and supplier rating Continuous Process improvement – Juran trilogy – PDCA cycle – 5S – Kaizen and Re – Engineering Performance measures quality costs

UNIT III PROCESS CONTROL 9

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Seven QC tools – New seven management tools – Statistical fundamentals – Normal Curve – Charts for variables and attributes – Process capability studies

UNIT IV TQM TOOLS AND TECHNIQUES 9

TQM tools – Benchmarking Process – Quality function deployment and house of quality – FMEA – Design FMEA and Process FMEA. Six sigma – Concepts – Methodology – Applications in manufacturing and service sectors – Total productive maintenance

UNIT V PROJECT RESOURCE MANAGEMENT 9

Need of ISO 9001:2015 – Elements – Implementation-documentation auditing and Registration Environmental management system – ISO14001:2015 Concept and Elements – Requirements and benefits. OSHAS 18000- concept – Requirements and benefits – Case studies

Contact Periods:

Lecture: 45 Periods Tutorial: Practical: – Periods Project – Periods

Total: 45 Periods

TEXT BOOKS:

1. Besterfield, D.H., Besterfield - Michna,C, Besterfield- Sacre, M.Bester field, G.H.,& Urdhwareshe,H. "Total Quality Management", revised 3rd edition, Pearson Education,2012
2. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th edition, Cengage Learning,2012

REFERENCES:

1. Janaki Raman, Band Gopal.R.K., "Total Quality Management- Text and Cases", 2nd edition, Prentice Hall,2006
2. Ismael Dambolena, Lawrence P. Carr, Ashok Rao, Robert J Kopp, "Total Quality Management: Across functional perspective", 2nd edition, John Wiley and Sons,2012.
3. Adam, E. E.,,Jr., & Swamidass, P. M., "Assessing operations management from a strategic perspective", 2nd edition, Journal of Management,2015

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC				
U21MEP21	PROJECT MANAGEMENT	L	T	P	L	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To introduce phases involved in project management
- To acquire knowledge on project risk analysis and planning
- To apply project and resource management tools to increase productivity of an organization

COURSE OUTCOMES:

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

CO1: Explain the steps involved in project management (Understand)

CO2: Identify various risks associated with the project and manage it effectively (Understand)

CO3: Prepare a detailed project plan addressing its components (Apply)

CO4: Use project management techniques to plan, schedule and control project activities effectively (Apply)

CO5: Apply resource management in the allocation of projects (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION AND PROJECT INITIATION 9

Introduction to – Project and – Project management – Projects in contemporary organization – Project lifecycle – Project initiation – Project evaluation methods and techniques – Project selection criteria – Project design – Work breakdown structure

UNIT II RISK ANALYSIS 9

Sources of risk: Project Specific – Competitive – Industry specific – Market and international risk – Perspectives of risk – Risk analysis: sensitivity analysis – Scenario analysis – Break even analysis – Simulation analysis – Decision tree analysis – Managing / mitigating risk – Project selection under risk

UNIT III PROJECT PLANNING AND IMPLEMENTATION 9

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Project planning – Importance – Functions – Areas of planning – Planning objectives and policies – Steps in planning process – WBS – capital requirements – Budgeting and cost estimation – Feasibility analysis – Creation of project plan – Project implementation: pre – Requisites – Forms of project organization – Project responsibility matrix – Project leadership – Communication and soft skills

UNIT IV PROJECT MANAGEMENT TECHNIQUES 9

Project scheduling – Network construction – Estimation of project completion time – Identification of critical path – PERT / CPM / PDM – Network techniques for manufacturing critical chain methods – Using software such as MS project / primavera for CPM/PERT/PDM – Scheduling using software such as MS project / primavera for project monitoring and control

UNIT V PROJECT RESOURCE MANAGEMENT 9

Crashing of project network – Complexity of project scheduling with limited resources – Resource allocation – Resource leveling – Resource smoothing – Project resource management – Project risk management using ERP in projects

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Prasanna Chandra, "Projects: Planning, Analysis, Financing, Implementation and Review", 8th edition, Tata McGraw Hill Education,2017
2. Narendra Singh, "Project Management and Control", 6th edition, Himalaya Publishing,2016

REFERENCES:

1. Jerome, D. Weistand Ferdinand K. Levy, "A Management Guide to PERT/CPM", 3rd edition, Prentice Hall of India,2005
2. John M Nicholas, "Project Management for Business and Technology: Principles and Practice", 3rd edition, Pearson Education,2008
3. Robert K. Wysocki, Robert Back Jr. and David B. Crane, "Effective Project Management", 8th edition, John Wiley and Sons,2019

EVALUATION PATTERN:

Continuous Internal Assessments				Total Internal Assessments	End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)			
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC				
		L	T	P	L	C
J21MEP22	GAS DYNAMICS AND JET PROPULSION	3	0	0	0	3

PRE–REQUISITES:

- U21ME301 – Engineering Thermodynamics
- U21ME304 – Fluid Mechanics & Applications

COURSE OBJECTIVES:

- To study the concept of a compressible flow through ducts with friction and heat transfer
- To discuss the shock wave and the variation of flow properties across the shock wave
- To identify and elucidate various types of aircraft and rocket engines

COURSE OUTCOMES:

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

CO1: Apply the governing equations for compressible flow to flow through variable area ducts (Apply)

CO2: Determine the effects of friction on compressible flows using appropriate relations (Apply)

CO3: Compute the effects of heat transfer on compressible flows (Apply)

CO4: Predict the occurrence of shocks and calculate property changes across a shock wave (Apply)

CO5: Use gas dynamic principles to calculate aircraft and rocket propulsion performance parameters(Apply)

CO – PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION TO COMPRESSIBLE FLOW 9

Basic governing equations of compressible fluid – Stagnation properties – Speed of sound and Mach number – Various regions of flow – Reference velocities – Effect of Mach number on compressibility – 1D Isentropic flow through variable area ducts – Nozzle and Diffusers – Use of Gas tables

UNIT II FANNO FLOW 9

Compressible flows through constant area ducts with Friction (Fanno flow) – Fanno curves and flow equations – Variation of flow parameters – Isothermal flow with friction – Fundamental equations – Variation of flow properties – Tables and charts – Applications

UNIT III RAYLEIGH FLOW 9

Compressible flows through constant area ducts with heat transfer (Rayleigh flow) – Rayleigh curves – Rayleigh flow relations – Variation of flow properties – Maximum heat transfer – Tables and charts – Applications

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UNIT IV COMPRESSIBLE FLOW WITH SHOCK WAVES 9

Wave motion and its Basics – Governing equations of flow across the normal and oblique shock waves – Variation of flow parameters across the waves – Prandtl – Meyer relations – Use of table and charts

UNIT V AIRCRAFT AND ROCKET PROPULSION 9

Aircraft engines and its types – Aircraft propulsion theory – Ramjet and Pulsejet engine – Rocket propulsion – Rocket engines and its types – Liquid and Solid propellant Rocket engines – Rocket propulsion theory – Rocket applications and space flights

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. S.M. Yahya., "Fundamentals of Compressible Flow with Aircraft and Rocket propulsion", 6th edition, New Age Publisher,2019
2. John D Andserson., "Modern Compressible flow",3rd edition, McGraw Hill Education,2012

REFERENCES:

1. Robert D.Zucker, Oscar Biblarz., "Fundamentals of Gas dynamics", 2nd edition, John Wiley & Sons,2011
2. James John, Theo Keith., "Gas dynamics", 3rd edition, Dorling Kindersley,2010
3. E. Rathakrishnan., "Gas dynamics", 2nd edition, Prentice Half of India,2008

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC			
U21MEP23	HEATING, VENTILATION AND AIR CONDITIONING	L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- U21ME301 – Engineering Thermodynamics
- U21ME403 – Thermal Engineering

COURSE OBJECTIVES:

- To learn the fundamental principles and applications of HVAC
- To study and apply the various air – Conditioning systems and its heat load estimation
- To apply various auxiliary systems and to draft the HVAC subsystems

COURSE OUTCOMES:

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

CO1: Apply the fundamental principles of HVAC systems in practical applications (Apply)
CO2: Determine psychrometric properties for HVAC applications (Apply)

CO3: Calculate heat load for air conditioning systems used for various purposes (Apply)

CO4: Implement suitable air distribution and hydronic systems to improve efficiency (Apply)

CO5: Apply relevant codes and standards in HVAC system design (Apply)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION TO HVAC 9

Introduction – Scope of Modern HVAC – Objective of HVAC – Air Conditioning processes – Basic Refrigeration cycle – Sensible and Latent heat – Refrigeration units – Codes and standards – Environment for human comfort – Application of HVAC systems

UNIT II AIR-CONDITIONING SYSTEMS AND PSYCHROMETRY PROCESSES 9

HVAC basic components – Working of HVAC system – Psychrometric processes – Psychrometric Chart – Basic Air Conditioning system – Classification – Window A/C system – Split A/C system – Ductable split A/C system – Package A/C system – VRF/VRV system – Central Air Conditioning system – Chilled Water system – Air water system – Direct Refrigerant system – Indirect Refrigerant system

UNIT III HEAT LOAD ESTIMATION 9

Sources of Heat – Heat Load Formula – Finding U value for Walls, Roof, Glass – Determining temperature difference value for Walls, Roof, and Glass – Determination of Heat Gains – Ventilation

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requirements – Infiltration Gains – Heating load calculations – ASHRAE heat load calculation Excel Sheet

UNIT IV AIR DISTRIBUTION SYSTEM AND HYDRONIC SYSTEM 9

Duct design methodologies – Gauge selection for Sheet Metal – Selection of air terminals, dampers, filters – Pressure drop estimation – Duct Materials and Insulation materials – Duct Routing – Basic Hydronic system, chiller, pumps, valves – Types and arrangements of Piping – Routing and sizing of Pumping system – TDH, NDSH and Cavitation

UNIT V DRAFTING OF HVAC SYSTEMS 9

Introduction to drafting using AutoCAD – Symbols and code in HVAC designing – Study and preparation of floor drawings – Conventional AC systems drawing – Ventilation system Drawings – Ductable AC system Drawings – Section drawings

Contact Periods:

Lecture: 45 Periods Tutorial: Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Samuel C. Sugarman, "HVAC Fundamentals", 3rd edition, Fairmount Press,2016
2. Kreider, Jan F, "Handbook of heating ventilation and air conditioning", 3rd edition, CRC Press,2013

REFERENCES:

1. Arthur A Bell, "HVAC Equations, Data and Rules of Thumb", 2nd edition, McGraw Hill Education,2007
2. Herbert W. Stanford, "HVAC Water Chillers and Cooling Towers Fundamentals, Application, and OperationII", 2nd edition, CRC press,2011
3. A. Vedavarz, S. Kumar & Hussain, "HVAC Handbook of Heating Ventilation and AC",4th edition, Industrial press,2006

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC				
		L	T	P	L	C
U21MEP24	ADVANCED INTERNAL COMBUSTION ENGINES	3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To familiarize with the engine fuel and air supply systems, electronic injection systems in modern automotive engines
- To make the students understand about the combustion phenomenon of SI and CI engines, engine pollutants
- To teach the students on production and utilization of alternative solid, liquid and gaseous fuels

COURSE OUTCOMES:

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

CO1: Explain various fuel supply systems used for IC engines (Understand)

CO2: Explain the concepts of combustion of IC and SI engines (Understand)

CO3: Apply suitable methods to control emission formation in IC engines (Apply)

CO4: Explain the types and feasibility of alternative fuels used in IC engines (Understand)

CO5: Explain the new trends of IC engine technology (Understand)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I FUEL SUPPLY SYSTEM 9

Introduction – Carburetion – Mixture requirements – Simple carburetor compensation devices high altitude fuel supply device – Electronic injection system CI engine – Injection systems – Mechanical and electronic systems

UNIT II COMBUSTION IN SI AND CI ENGINES 9

Ignition – Stages of combustion – Normal and abnormal combustion – Factors affecting knock – Combustion chambers – Fuel spray behaviour – Spray structure spray penetration – Evaporation – Air motion – Stages of combustion – Factors affecting combustion – Direct and indirect injection systems – Combustion chambers

UNIT III POLLUTANT FORMATION AND CONTROL 9

Pollutant – Sources – Formation of Carbon Monoxide Unburnt Hydrocarbon Oxides of Nitrogen Smoke and Particulate matter – Methods of controlling Emissions – Catalytic converters Selective

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Catalytic Reduction and Particulate Traps – Methods of measurement – Emission norms and Driving cycles

UNIT IV ALTERNATIVE FUELS **9**

Alcohol – Hydrogen Compressed Natural Gas – Liquefied Petroleum Gas and Bio Diesel – Properties – Suitability – Merits and Demerits – Engine Modifications

UNIT V RECENT TRENDS **9**

Air assisted Combustion – Homogeneous charge compression ignition engines – Variable Geometry turbochargers – Common Rail Direct Injection Systems – Hybrid Electric Vehicles – NOx Adsorbers – Onboard Diagnostics

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. J.B Heywood, "Internal Combustion Engine Fundamentals", 2nd edition, Tata McGraw Hill Education,2018
2. V. Ganesan, "Combustion Engines", 2nd edition, Tata McGraw Hill Education,2002

REFERENCES:

1. Mathur. R.B. and R.P. Sharma, "Internal Combustion Engines", 2nd edition, Dhanpat Rai & Sons,2007
2. Duffy Smith, "Auto Fuel Systems", 2nd edition, The Good Heart Willcox Publication,2002
3. Eric Chowenitz, "Automobile Electronics", 2nd edition, Butterworth Heinemann,2005

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC				
U21MEP25	COMPUTATIONAL FLUID DYNAMICS	L	T	P	L	C
		3	0	0	0	3

PRE–REQUISITES:

- U21ME301 – Engineering Thermodynamics
- U21ME304 – Fluid Mechanics and Applications

COURSE OBJECTIVES:

- To provide the basics of partial differential equation and solving equations
- To provide the concepts and application of governing equations
- To gain some basic knowledge about programming of numerical methods

COURSE OUTCOMES:

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

CO1: Explain the mathematical characteristics of partial differential equations (Understand)
CO2: Explain the formulation and characteristics of the Euler and Navier–Stokes equations(Understand)
CO3: Apply the concepts of accuracy, stability, and consistency to numerical methods for governing equations (Apply)
CO4: Implement numerical techniques for space and time integration of partial differential equations (Apply)
CO5: Demonstrate basic skills on programming of numerical methods used to solve the Governing equations (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION TO CFD AND GOVERNING EQUATIONS 9

Need of CFD as tool – Role in R&D – Continuum, material or substantial derivative or total derivative – Gradient – Divergence and curl operators – Linearity – Principle of Superposition – Derivation of Navier – Stokes equations in control volume (integral form) and partial differential form – Euler equations (governing inviscid equations) – Mathematical classification of PDE (Hyperbolic – Parabolic, Elliptic) – Method of characteristics – Introduction to Riemann Problem and Solution Techniques

UNIT II ONE DIMENSIONAL EULER'S EQUATION 9

Conservative – Non – Conservative form and primitive variable forms of Governing equations – Eigenvalues and Eigenvectors of Flux Jacobian – Decoupling of Governing equations – Introduction of characteristic variables – Relation between the two non – Conservative forms – Conditions for

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genuinely nonlinear characteristics of the flux Jacobian – Introduction to Turbulence Modeling: Derivation of RANS equations and k – Epsilon model

UNIT III REPRESENTATION OF FUNCTIONS ON COMPUTER 9

Need for representation of functions – Box Function – Hat Function – Representation of sinx using hat functions: Aliasing, high frequency – Low frequency – Representation error as a global error. Derivatives of hat functions – Haar functions – Machine Epsilon – Using Taylor series for representation of Derivatives

UNIT IV FINITE DIFFERENCE METHOD 9

Applied to Linear Convection equation – Laplace Equations – Convection Diffusion equations – Burgers equations, modified equations Explicit methods and Implicit methods – As applied to applied to linear convection equation – Laplace equations – Convection diffusion equation FTCS, FTFS,FTBS,CTCS – Jacobi Method, Gauss – Siedel – Successive Over Relaxation Method – TDMA, Von Naumann stability (linear stability) analysis – Upwind Method in Finite Difference method

UNIT V FINITE VOLUME METHOD 9

Introduction finite volume method – Finding the flux at interface – Lax – Friedrichs Method, Lax – Wendroff Method – Two – Step Lax – Wendroff Method and Mac Cormack Method. Flux Splitting Method Steger and Warming – VanLeer, Roe's Method and finding Roe's Averages – Solving simple problem using ANSYS FLUENT

Contact Periods:

Lecture: 45 Periods Tutorial: Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. HK Versteeg," Introduction to Computational Fluid Dynamics", 2nd edition, Prentice Hall of India,2007
2. John Anderson, "Computational Fluid Dynamics", 2nd edition, Tata McGraw Hill Education,2017

REFERENCES:

1. Rathakrishnan. E., "Gas Dynamics", Prentice Hall of India,2001. Pletcher, R. H., Tannehill, j. C., Anderson, d., "Computational fluid mechanics and heat transfer", 3rd edition., CRC Press,201
2. Moin, p., "Fundamentals of engineering numerical analysis", 2nd edition, Cambridge University press,2010
3. Niyogi, "Indroduction to Computational fluid dynamics", 2nd edition, Pearson Education,2012

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

24/11/23

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PROFESSIONAL ELECTIVE

		Category: PEC				
J21MEP26	POWER PLANT ENGINEERING	L	T	P	L	C
		3	0	0	0	3

PRE–REQUISITES:

- U21ME301 – Engineering Thermodynamics
- U21ME405 – Thermal Engineering

COURSE OBJECTIVES:

- To impart knowledge on the layouts of steam, diesel and gas power plants
- To inculcate the working principle of nuclear, hydroelectric and non-conventional power plants
- To familiarize with the calculation of power plant economics

COURSE OUTCOMES:

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

CO1: Discuss layout of the steam power plant along with their components (Understand)

CO2: Describe the working of the diesel power plant and gas turbine power plant (Understand)

CO3: Explain the types of nuclear reactors and working of the nuclear power plant (Understand)

CO4: Discuss the working of hydroelectric and nonconventional power plants (Understand)

CO5: Analyze the economics of power plants (Analyze)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I STEAM POWER PLANTS 9

Layout of steam power plant – Components – Types of boilers – Fire tube and water tube boilers – High pressure and supercritical boilers – Fluidized bed boiler – Waste heat recovery boilers – Boiler mountings and accessories – Heat exchangers – Feed water heaters – Super heaters – Preheaters – Economizer – Condenser – Cooling tower – Coal handling – Combustion equipment and firing methods – Mechanical stokers – Pulverized coal firing systems – Cyclone separator – Ash handling systems – electrostatic precipitator – Forced draft and induced draft fans – Site selection

UNIT II DIESEL AND GAS TURBINE POWER PLANTS 9

Layout of diesel power plant – Components – Subsystems – Starting and stopping – Fuel supply – Lubricating system – Cooling system – Supercharging – Constraints in operating range – Heat balance – Site selection – Layout of gas turbine power plant – Components – Open and closed cycles – Intercooling – Reheating and regenerating – Combined cycle power plant types – Site selection

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UNIT III NUCLEAR POWER PLANTS 9

Principles of nuclear energy – Energy from nuclear reactions – Layout of nuclear power plants – Components – Nuclear reactors – Boiling water reactor – Pressurized water reactor – Pressurized heavy water reactor – Gas cooled reactor – Liquid metal cooled reactor – Canada Deuterium – Uranium reactor – Fast breeder reactor – Reactor materials – Radiation shielding – Nuclear waste disposal – Site selection

UNIT IV HYDROELECTRIC AND NON-CONVENTIONAL POWER PLANTS 9

Layout of hydroelectric power plant – Components – Classification of hydroelectric power plants and their applications – Selection of prime movers – Governing of turbines – Site selection – Introduction to non – Conventional power plants (wind turbines – Geothermal plants – Tidal power plants – Biogas plants – OTEC plants)

UNIT V ECONOMICS OF POWER PLANTS 9

Plant load factor and utilization factor – Plant economics – Cost of electrical energy – Fixed and operating costs – Energy rates – Types of tariffs – Load distribution – Load curves – Energy conservation – Comparison of economics of various power plants

Contact Periods:

Lecture: 45 Periods Tutorial: – Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. R.K. Rajput, "A Text Book of Power Plant Engineering", 5th edition, Laxmi Publication, New Delhi, 2019
2. El-Wakil M M, "Power Plant Technology", 1st edition, Tata McGraw Hill,2017

REFERENCES:

1. P. K. Nag, "Power Plant Engineering", 4th edition, Tata McGraw Hill Education,2015
2. R.K.Hegde, "Power Plant Engineering", 1st edition, Pearson Education,2015
3. Arora S C and Domkundwar S, "Power Plant Engineering", 8th edition, Dhanpat Rai,2016

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC				
		L	T	P	L	C
U21MEP27	RENEWABLE ENERGY RESOURCES AND SYSTEMS	3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To emphasize the importance of using various renewable energy systems in the present energy scenario
- To impart the knowledge on the working of solar energy, wind energy and small hydro systems
- To inculcate the knowledge on ocean energy and biomass systems

COURSE OUTCOMES:

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

CO1: Explain the energy scenario and the importance of renewable energy systems (Understand)

CO2: Illustrate the working of solar thermal and photovoltaic systems (Understand)

CO3: Describe the components of wind energy and small hydro energy systems (Understand)

CO4: Explain the technology to generate energy through ocean energy conversion (Understand)

CO5: Describe the methods of generating energy from the biomass (Understand)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I INTRODCUTION TO RENEWABLE ENERGY RESOURCES 9

Energy chain and common forms of usable energy – World energy status – Energy scenario in India – Classification of energy resources; conventional energy resources – Availability and their limitations; Renewable energy resources – Classification – Needs – Advantages and limitations – Applications

UNIT II SOLAR ENERGY SYSTEMS 9

Introduction to solar energy – Energy from Sun – Spectral distribution of solar radiation – Instruments for measurement of solar radiation; Solar thermal collectors – Flat plate collectors – Evacuated tubes – Concentrators – Applications – Solar photovoltaic systems – Physics of solar cells – Characteristics of cells and module – Performance parameters – Balance of system (BoS) – Types of photovoltaic systems – Applications

UNIT III WIND ENERGY AND SMALL HYDRO POWER SYSTEMS 9

Principles of wind power – Wind turbine operation – Site characteristics – Selection of components – Types of wind turbines – Power regulation – Various methods of control – Design principles of wind

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turbine blades – Wind farms – Off shore wind farms – Solar wind hybrid energy systems – Introduction small hydro power systems – Types – System components – Discharge curve and estimation of power potential – Turbines for small hydro power plants

UNIT IV OCEAN ENERGY SYSTEMS 9

Tidal energy – Principle of tidal power – Components of tidal power plant (TPP) – Classification of tidal power plants – Advantages and limitations of TPP – Ocean Thermal Energy Conversion (OTEC): principle of OTEC system – Methods of OTEC power generation – Open cycle (Claude cycle) – Closed cycle (Anderson cycle) and hybrid cycle (block diagram description of OTEC); site – Selection criteria – Bio – Fouling – Advantages and limitations of OTEC

UNIT V ENERGY FROM BIOMASS 9

Biomass fuels – Concepts and systems – Biomass production – Energy plantations – Biomass resources and processing – Environmental factors; Pyrolysis – Fixed bed and fast pyrolysis – Gasification and liquefaction – Types of gasifiers; Bioconversion: biogas – Fermentation and wet processes; Biofuels: Manufacturing methods and properties

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Rai G D, "Non-Conventional Sources of Energy", 6th edition, Khanna Publishers,2017
2. D.P.Kothari, K.C.Singal, Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", 2nd edition, Prentice Hall of India,2011

REFERENCES:

1. Fang Lin Luo, Hong Ye, "Renewable Energy Systems: Advanced Conversion Technologies and Applications",1st edition, CRC Press,2012
2. John.A.Duffie, William A.Beckman, "Solar Engineering of Thermal Processes", 4th edition, John Wiley & Sons,2013
3. Bent Sorensen, "Renewable Energy", 5th edition, Academic Press,2017

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

U21MEP28	TURBOMACHINES	Category: PEC				
		L	T	P	L	C
		3	0	0	0	3

PRE–REQUISITES:

- U21ME304 – Fluid Mechanics and Applications
- U21ME403 – Thermal Engineering

COURSE OBJECTIVES:

- To acquire the knowledge on the operation of turbomachine
- To develop the ability to analyze and design various types of turbomachine
- To study the performance characteristics of turbomachine

COURSE OUTCOMES:

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

CO1: Explain the performance characteristics of turbomachines (Understand)

CO2: Apply the principles of fluid flow to determine the energy transfer mechanism in radial flowturbomachines (Apply)

CO3: Apply airfoil theory, vortex theory, cascade effects, and dimensionless parameters in axial turbine analysis (Apply)

CO4: Apply noise control techniques, material selection and speed/throttling control strategies for turbomachines (Apply)

CO5: Calculate the velocity and flow coefficients of turbine project (Apply)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I PRINCIPLES OF TURBO-MACHINERY 9

Introduction to turbo-machines – Classification of turbo-machinery – Transfer of energy to fluids – Energy transfer between a fluid and a rotor – Euler turbine equation – Components of energy transfer – Performance characteristics – Fan laws – Dimensionless parameters – Specific speed – Selection of centrifugal – Axial – And mixed flow machines

UNIT II RADIAL FLOW MACHINES 9

Radial flow pumps – Compressors – Blowers and fans – Theoretical characteristic curves – Euler characteristics and Euler velocity triangles – losses and hydraulic efficiency – Volute – diffusers – Leakage – disc friction – and mechanical losses – Multi – vane impellers of impulse type – Design of radial flow impellers

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UNIT III AXIAL FLOW MACHINES 9

Axial flow fans – Rotor design – air foil theory – vortex theory – and cascade effects – Degree of reaction – surging and stalling – Mixed flow impellers – Axial flow pumps and compressors – Dimensionless parameters Efficiency and utilization factor in turbo– machinery – Design of axial flow impellers

UNIT IV TESTING AND CONTROL OF FANS AND BLOWERS 9

Fan testing – Noise control – Materials and components – Blower regulation – Speed control – throttling control at discharge and at inlet

UNIT V TURBINES 9

Radial flow turbines – Inward flow turbines for compressible fluids – Velocity and flow coefficients – Impulse Turbines

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Venkanna B.K., "Fundamentals of Turbo Machinery", 4th edition, Prentice Hall of India,2011
2. Yahya, S.M., "Turbines compressors and fans", 4th edition, Tata McGraw Hill Education,2011

REFERENCES:

1. S. Larry Dixon and Cesare Hall., "Fluid Mechanics and Thermodynamics of Turbomachinery", 7th edition, Academic Press,2019
2. A. Srinivasan., "Turbomachine: Design and Performance Analysis", 2nd edition, CRC Press,2018
3. S.B. Pope., "Turbulent Flows", 3rd edition, Cambridge University Press,2020

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC				
U21MEP29	AUTOMATION IN MANUFACTURING	L	T	P	L	C
		3	0	0	0	3

PRE–REQUISITES:

- U21ME401 - Manufacturing Technology - II

COURSE OBJECTIVES:

- To perform a sequence of automated or mechanized assembly operations by logic control and associated technologies
- To apply the concept of automation and data monitoring using Arduino in industries
- To enhance the knowledge on CAE in manufacturing

COURSE OUTCOMES:

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

CO1: Explain the process of automation and types (Understand)

CO2: Illustrate the Programmable Logic Controllers to automate machine (Understand)

CO3: Apply the knowledge on Automated Material handling equipment's (Apply)

CO4: Apply ARDUINO to perform the automation of machine (Apply)

CO5: Apply CAE to simulate casting process (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION TO AUTOMATION 9

Principles and Components of industrial automation systems and their functionalities – Levels of automations – Fundamentals of manufacturing – Production System Facilities – Manufacturing support systems – Different types of manufacturing systems – Automation in Production Systems – Manufacturing Operations

UNIT II CONTROLLERS FOR INDUSTRIAL AUTOMATION 9

Industrial logic Control Systems – Mechanical – Electrical – Pneumatic – Electronic and Hybrid systems – Programmable Logic Controllers – Architecture – Different types of I/O modules – Interfacing real world devices with PLC – Different methodologies and strategies adopted for logic development – Basics of HMI and SCADA systems

UNIT III MANUFACTURING AUTOMATION 9

Automated flow lines – Buffers – Part feeding systems – Quantitative analysis of transfer lines and assembly systems – Material handling – AGV – AS/RS – FMS layout configurations and benefits of

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FMS – Automated inspection – Quality Control Systems – Traditional and Modern Quality Control Methods – SPC Tools – Shop – Floor Control – Automated data collection – Bar codes – Optical character recognition – Vision or image processing – Radio frequency identification – Magnetic identification – Voice technology – Comparison

UNIT IV DATA MONITORING USING ARDUINO 9

Basic structure – Input / Output processing – Programming – Mnemonics Timers – Internal relays and counters – Analog – To – Digital (A/D) and Digital – To –Analog (D/A) Conversion – Analog input / output – Programming and interfacing with Sensors in manufacturing applications – Design – Develop and integrate the sensors to interface with Arduino

UNIT V APPLICATION OF CAE IN MANUFACTURING 9

Simulation of molten metal flow using CAE Techniques – Solidification process in casting – Analysis of forging process using CAE – Problem solving using CAE packages and softwares used in foundries – Iinterpretation of results

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Groover, M P, "Automation, Production systems and Computer Integrated Manufacturing Systems", 2nd edition, Prentice Hall of India,2015
2. Frank Lamb, "Industrial Automation", 2nd edition, Tata McGraw Hill Education,2013

REFERENCES:

1. Kesheng Wang Yi Wang Jan Ola Strandhagen and Tao Yu, "Advanced Manufacturing and Automation VII", 1st edition,2018
2. Yusuf Altintas "Manufacturing Automation Metal Cutting Mechanics Machine Tool Vibrations and CNC Design" 2nd edition, Cambridge University Press,2012
3. Nussey, J "Arduino for Dummies", 1st edition, John Wiley & Sons,2013
4. Boothroyd G Poli C and Murch L E "Automatic Assembly", 3rd edition, Marcel Dekker,2014

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC				
		L	T	P	J	C
U21MEP30	ROBOTICS	3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To introduce the basic concepts, parts of robots and types of robots
- To make the student familiar with the various drive systems for robots – sensors and their applications in robots
- To discuss the various applications of robots– justification and implementation of robots

COURSE OUTCOMES:

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

CO1: Explain the basic concepts motion of robots (Understand)

CO2: Illustrate the various robot components and operation (Understand)

CO3: Explain the actuators–drive systems and sensors (Understand)

CO4: Apply PLC to elaborate the concept of PLC and program (Apply)

CO5: Demonstrate various industrial robot applications (Apply)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION 9

Definition of a Robot – Basic Concepts – Robot configurations – Industrial brands and specification – Types of Robot drives – Basic robot motions – Point to point control – Continuous path control

UNIT II ROBOT COMPONENTS AND OPERATIONS 9

Robot Anatomy – Basic control system concepts – Control system analysis – Robot actuation and feedback – Types of Robot and effectors – Grippers – Tools as end effectors – Robot/End – Effort interface – Manipulators – director and inverse kinematics – Coordinate transformation – Brief Robot dynamics

UNIT III ACTUATORS, DRIVE SYSTEMS AND SENSORS 9

Characteristics of actuating systems – Comparison of actuating systems – Hydraulic actuators – Pneumatic devices – Electric motors – Sensor characteristics – Position sensors – Velocity sensors –

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Acceleration sensors Force and pressure sensors – Torque sensors – Visible light and IR sensors – Touch and tactile sensors – Proximity sensors

UNIT IV PLC IN INDUSTRIAL ROBOTICS 9

Definitions of PLC – basic structure of PLC – working principles – Timer and Counter Instructions – on delay and Off delay and retentive timer instructions – Retentive timers – Programming examples – Counter up and down instructions – combining counters and timers – Comparison and data handling instructions

UNIT V INDUSTRIAL APPLICATIONS 9

Selection of robots for industrial applications – Welding – Assembly – Material handling – Loading and unloading – Demonstration using beginner level robots

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Mikell P. Groover Mitchell Weiss Roger N.Nagel Nicholas G.Odrey, "Industrial Robotics Technology Programming and Applications", 2nd edition, McGraw Hill Education,2018
2. Frank Lamb "Industrial Automation", 2nd edition, McGraw Hill Education,2013

REFERENCES:

1. James A Rehg "Introduction to Robotics in CIM Systems", 1st edition, Prentice Hall of India,2002
2. Saeed B Niku, "Introduction to Robotics Analysis Control Applications", 3rd edition, John Wiley & Sons,2019
3. Richard D Klafter Thomas Achmielewski and Mickael Negin "Robotic Engineering an Integrated Approach", 3rd edition, Prentice Hall India,2013

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC				
J21MEP31	MEASUREMENTS AND CONTROLS	L	T	P	L	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To know the basic concepts of measurements used in industry
- To discuss various methods of measurements
- To focus the control system concepts to interpret the data

COURSE OUTCOMES:

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

CO1: Illustrate the significance of mechanical measurements (Understand)

CO2: Describe the type of measurement instruments for industrial application (Understand)

CO3: Describe the block diagram algebra used in control system (Understand)

CO4: Apply control systems used for steady state analysis in industry (Apply)

CO5: Apply control systems used for stability analysis in industry (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I BASIC CONCEPTS OF MEASUREMENT **9**

Significance of Mechanical Measurements – Classification of measuring instruments – Generalized measurement system – Types of inputs – Desired – Interfering and modifying inputs – Static characteristics – Static calibration – Linearity – Static Sensitivity – Accuracy – Static error – Precision – Reproducibility – Threshold – Resolution – Hysteresis – Drift – Span and Range etc – Errors in measurement – Types of errors – Effect of component errors – Probable errors

UNIT II MEASURING DEVICES AND MANIPULATION OF DATA **9**

Motion and dimensional measurement – Force – Torque – Shaft power – Pressure – Sound – Flow – Temperature measurement – Manipulating and comparing compensating devices – Data transmission – Instrument concerning voltage – Indicating and recording devices – Measurement system applied to micro and nano technology

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UNIT III INTRODUCTION TO CONTROL SYSTEMS 9

Introduction to control systems – Classification of control system – Open loop and closed loop systems – Mathematical modelling of control systems – concept of transfer function – Block diagram algebra

UNIT IV STEADY STATE ANALYSIS 9

Transient and steady state analysis of first and second order system – Time Domain specifications – Step response of second order system. Steady - state error – Error coefficients – Steady state analysis of different type of systems using step – Ramp and parabolic inputs

UNIT V STABILITY ANALYSIS 9

Introduction to concepts of stability –The Routh criteria for stability – Experimental determination of frequency response – Stability analysis using Root locus – Bode plot and Nyquist Plots – State space modeling – Process control systems – ON - OFF control –P-I-D Control

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. O. E. Doeblin and D. N. Manik, "Measurements System", 7th edition, Tata McGraw Hill Education,2019
2. A. K. Sawhney and Puneet Sawhney, "A Course in Mechanical Measurements and Instrumentation and Control", 3rd edition, Dhanpat Rai,2017

REFERENCES:

1. Thomas A Huge, "Measurement and Control Basics", 3rd edition, ISA Press,2002
2. Figiola RS & Beasley DE; "Theory and Design for Mechanical Measurements", 3rd edition, John Wiley & Sons,2014
3. Katsuhiko Ogata; "Modern Control Engineering", 4th edition Pearson Education,2012

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PROFESSIONAL ELECTIVE

		Category: PEC			
U21MEP32	INDUSTRY 4.0	L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To impart basic idea on Industry 4.0
- To provide students with good depth of knowledge of designing Industrial 4.0 Systems
- To know the opportunities and challenges in Industry 4.0

COURSE OUTCOMES:

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

CO1: Explain the basic concepts of Industry 4.0 and the other related fields (Understand)

CO2: Describe the conceptual framework of Industry 4.0 (Understand)

CO3: Illustrate the various advances in Industry 4.0 (Understand)

CO4: Explain various technologies associated with Industry 4.0 (Understand)

CO5: Illustrate the opportunities, challenges and future skills required for Industry 4.0 (Understand)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION TO INDUSTRY 4.0 9

Introduction – History of Industry 4.0 – Application areas of Industry 4.0 – Dissemination of Industry 4.0 – Overview on technologies of Industry 4.0 – Artificial intelligence, internet of things and industrial internet of things, additive manufacturing, robotization and automation – Current state of Industry 4.0 – Industry 4.0 to Industry 5.0 advances

UNIT II A CONCEPTUAL FRAMEWORK FOR INDUSTRY 4.0 9

Introduction – Main concepts and components of Industry 4.0 – State of art – Supportive technologies – Proposed framework for Industry 4.0

UNIT III ADVANCES IN ROBOTICS IN THE ERA OF INDUSTRY 4.0 9

Introduction – Recent technological components of robots – Advanced sensor technologies – Internet of robotic things – Cloud robotics and cyber – Physical systems – Industrial robotic applications – Manufacturing, maintenance and assembly

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UNIT IV THE ROLE OF IOT AND EXTENDED REALITY IN THE AGE OF INDUSTRY 4.0 9

Internet of things & internet of services – Interfaces – Introduction to extended reality (AR, VR & MR) – Hardware and software technology – Industrial applications of AR, VR and MR

UNIT V SMART MANUFACTURING APPLICATIONS AND OPPORTUNITIES 9

Smart manufacturing – Smart devices and products – Predictive analytics – Opportunities – Challenges and skills for workers in the Industry 4.0 – Supply chain management – Readiness of industry – Case study – Smart Cars & self-driving cars

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. Jesús Hamilton Ortiz," Industry 4.0 Current Status and Future Trends", 1st edition, IntechOpen,2020
2. Diego Galar, Pasquale Daponte, Uday Kumar, "Handbook of Industry 4.0 and SMART Systems", 1st edition, CRC Press,2019

REFERENCES:

1. Bernard Maar, "Extended Reality in Practice", 3rd edition, John Wiley & Sons,2021
2. Anand Nayyar, Akshi Kumar, "A Roadmap to Industry 4.0: Smart Production, Sharp Business and Sustainable Development", 1st edition, Springer,2020
3. Uthayan Elangovan, "Smart Automation to Smart Manufacturing: Industrial Internet of Things", 1st edition, Momentum Press,2019

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC				
U21MEP33	MICROPROCESSOR AND ARTIFICIAL INTELLIGENCE FOR INDUSTRY	L	T	P	L	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To study the architecture of 8085 microprocessors and interfacing devices
- To know the basics of Artificial Intelligence and Machine learning
- To discuss the various applications AI in Industry 4.0

COURSE OUTCOMES:

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

CO1: Explain architecture and instruction sets of 8085 (Understand)

CO2: Illustrate the various interfacing devices for 8085 and its working (Understand)

CO3: Explain the basics and functions of AI (Understand)

CO4: Apply the concept of Machine learning and its functions (Apply)

CO5: Demonstrate various applications of AI in industries (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I MICRO PROCESSOR 9

Evolution of microprocessors – Architecture –Functional block diagram – Instruction set – Addressing modes – Timing diagrams – Assembly language programming – Interrupts and memory interfacing

UNIT II INTERFACING OF MICROPROCESSOR 9

Interfacing of ADC – DAC – Stepper motor – Speed control of DC motor interfacing – Traffic light control and case study of washing machine control

UNIT III ARTIFICIAL INTELLIGENCE 9

Artificial Intelligence – History of AI – Foundations of AI –The AI - Environment – Societal Influences of AI – Application Domains and Tools – Associated Technologies of AI – Future Prospects of AI – Challenges of AI–NLP in AI – Computer Vision

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UNIT IV INTRODUCTION TO MACHINE LEARNING 9

Linear Regression – Linear Regression Assignment – Logistic Regression – Naive Bayes – Model Selection – Advanced Regression – Tree Models – Model Selection – Practical Considerations– Boosting – Unsupervised Learning: Clustering – Principal Component Analysis – Investment Case Study –Telecom Churn Case Study

UNIT V APPLICATIONS OF AI TO INDUSTRY 4.0 9

Smart factories – Predictive Analytics – Predictive maintenance – Computer vision – Cyber – Physical systems – Industrial robots and Inventory Management

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Krishna Kant, "Microprocessors and Microcontrollers Architecture, Programming and System Design", 8th edition, Prentice Hall of India,2011
2. Robert Bond Randall, "Vibration-Based Condition Monitoring, Industrial Aerospace and Automotive applications", 1st edition, John Wiley & Sons,2011

REFERENCES:

1. P Kaliraj T Devi, "Higher Education for Industry 4.0 and Transformation to Education 5.0", 1st edition, CRC Press,2021
2. Rashmi Agrawal, Marcin Paprzycki– Neha Gupta, "Big Data– IoT– and Machine Learning Tools and Applications", 1st edition, CRC Press,2020

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th rowspan="2">Total Internal Assessments</th><th rowspan="3">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (100 Marks)</th><th colspan="2">Assessment II (100 Marks)</th></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Project / MCQ</td><td>Written Test</td><td>*Individual Assignment / Case Study / Seminar / Project / MCQ</td><td>Written Test</td><td></td></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>200</td><td>100</td></tr>
<tr><td colspan="4" rowspan="2">Total</td><td>40</td><td>60</td></tr>
<tr><td colspan="2">100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC				
U21MEP34	EMBEDDED SYSTEMS AND PROGRAMMING	L	T	P	L	C
		3	0	0	0	3

PRE–REQUISITES:

- U21ECG02 - Basics of Electronics Engineering

COURSE OBJECTIVES:

- To gain knowledge in Embedded Systems.
- To Introduce students to the Embedded C programming fundamentals
- To understand and practice various sensors and actuators with Arduino.

COURSE OUTCOMES:

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

CO1: Explain the Embedded System Design Process (Understand)

CO2: Explain the Embedded Programming Concepts (Understand)

CO3: Apply MSP430 Micro controller for actuation (Apply)

CO4: Demonstrate the sensors and Actuators with Arduino/MSP430 (Apply)

CO5: Demonstrate real time applications of Raspberry pi and ARM architecture (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION TO EMBEDDED COMPUTING AND ARDUINO 9

Introduction to embedded systems and computer systems terminology – Embedded system design process – Introduction to the arduino microcontroller – Arduino hardware overview – Atmega micro controller – Arduino ide and sketch overview – Understanding arduino syntax

UNIT II EMBEDDED PROGRAMMING 9

Basics of embedded C programming for Arduino – Arduino libraries: library adding and removing – Variables, functions for analog sensor interfacing – Functions for digital sensor interfacing – Conditional statements and loops

UNIT III EMBEDDED SYSTEM DESIGN WITH MSP430 9

Introduction to MSP430 microcontroller – MSP430 CPU Architecture – Programming methods for MSP430 – Introduction to lunchbox platform – Fundamentals of physical interfacing – Generating pulse width modulation (PWM) using timer capture mode – ADC operation in MSP430

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UNIT IV SENSORS AND ACTUATORS 9

Programming and interfacing of actuators: Liquid crystal display – Relay – DC motor with L298N – Motor driver controller- PWM technique – Servos – IoT networking devices programming and interfacing: GSM Modem – HC05 Bluetooth Transceiver

UNIT V EMBEDDED APPLICATIONS AND ARM 9

Connected vehicles – Engine locking system Using GSM technology – GPS & GSM based tracker – ARM architecture versions – ARM architectures – SOC – Raspberry pi

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Wayne Wolf, "Computers as Components: Principles of Embedded Computing System Design", 2nd edition, Morgan Kaufman,2008
2. Massimo Banzi, "Getting Started with Arduino", 3rd edition, O'Reilly,2015

REFERENCES:

1. Jimenez, Manuel, Palomera, Rogelio, Couvertier, Isidoro, "Introduction to Embedded Systems Using Microcontrollers and the MSP430", 1st edition, Springer,2014
2. Brian Evans, "Beginning Arduino Programming", 1st edition, Apress publisher,2011
3. Jonathan W.Valvano, "Embedded Microcomputer Systems Real Time Interfacing", 3rd edition, Cengage Learning,2012

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC				
U21MEP35	SMART MANUFACTURING	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- Impart knowledge of smart manufacturing for industry 4.0 and its key technologies
- Apply digitalization techniques to improve manufacturing processes and decision-making
- Assess the challenges and opportunities associated with implementing smart manufacturing systems

COURSE OUTCOMES:

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

CO1: Describe the concept of Industry 4.0 and its relevance to Smart Manufacturing (Understand)

CO2: Illustrate IoT platforms and cloud computing used in Smart Manufacturing (Understand)

CO3: Explain and use various hardware and software tools in Smart Manufacturing (Understand)

CO4: Illustrate machine learning techniques and their application in Smart Manufacturing (Understand)

CO5: Describe the device integration, data acquisition, and data storage (Understand)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION TO INDUSTRY 4.0 9

Globalization and Emerging Issues – The Fourth Revolution – LEAN Production Systems – Mass Customization – Smart and Connected Business Perspective – Smart Factories

UNIT II INTRODUCTION TO IIOT 9

Architectural Overview – Design principles and needed capabilities – IoT Applications – Sensing – Actuation – Basics of Networking – M2M and IoT Technology Fundamentals – Devices and gateways – Data management – Role of Cloud in IoT, Security aspects in IoT

UNIT III ELEMENTS OF IIOT 9

Hardware Components – Computing (Arduino, Raspberry Pi) – Communication – I/O interfaces – Software Components – Programming API's (using Python/Node.js/Arduino) for Communication Protocols – MQTT – ZigBee – Bluetooth – CoAP – UDP – TCP

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UNIT IV MACHINE LEARNING FOUNDATION 9

Learning algorithms – Supervised – Unsupervised – Self learning – Feature learning – Models – Artificial Neural Networks – Decision trees – Regression analysis – Genetic algorithms – Free and open source software – Propriety software – Case studies

UNIT V IOT SOLUTIONS FOR INDUSTRIAL APPLICATIONS 9

Solution framework for IoT applications – Implementation of Device integration – Data acquisition and integration – Device data storage – Unstructured data storage on cloud/local server – Authentication – Authorization of devices

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Sudip Misra, Chandana Roy and Anandarup Mukherjee, "Introduction to Industrial Internet of Things and Industry 4.0", 1st edition, CRC Press, Boca Raton,2021
2. Kamal, R., "Internet of Things: Architecture and Design", 1st edition, McGraw Hill Education,2018

REFERENCES:

1. Pethuru Raj, Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", 1st edition, CRC Press,2017
2. Pfister, C., "Getting Started with the Internet of Things", 2nd edition, O'Reilly Media, Inc,2016
3. Tsiatsis, V., Karnouskos, S., Mulligan, C., Holler, J., Boyle, D, "Internet of Things: Technologies and Applications for a New Age of Intelligence", 1st edition, Elsevier Science, United Kingdom,2018
4. Reddy, S., Thukral, R., Mishra, M., "Introduction to Internet of Things: A Practical Approach", ETI Labs,2018

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC				
U21MEP36	AUTOMOTIVE ENGINE AND SUBSYSTEMS	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21ME403 - Thermal Engineering

COURSE OBJECTIVES:

- To impart knowledge on construction and operation of SI and CI Engines
- To learn about engine components, combustion, cooling and lubrication systems
- To explore the recent developments in engine technology

COURSE OUTCOMES:

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

CO1: Explain the basic theory, performance characteristics, and operating parameters of IC engines. (Understand)

CO2: Discuss fuel supply and ignition systems used in automobile engines. (Understand)

CO3: Explain cooling and lubrication systems in IC engines. (Understand)

CO4: Describe combustion processes and combustion chamber designs in SI and CI engines. (Understand)

CO5: Explain modern engine technologies for improved performance and emission control.(Understand)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I ENGINE BASIC THEORY 9

Engine types – Otto, diesel, dual operating cycles – Engine design and operating parameters – Two and four stroke engines – Typical performance curves for automobile engines – Two stroke engine – Performance and pollution aspects

UNIT II FUEL SUPPLY AND IGNITION SYSTEMS 9

Theory of carburetion and carburettors – System – Conventional ignition systems, advance mechanisms

UNIT III COOLING AND LUBRICATING SYSTEMS 9

Air cooling and water cooling – Thermo syphon cooling, forced cooling systems. Fins and radiator – design aspects. Theory of lubrication – Types of lubrication, splash lubrication system, petrol lubrication system, forced feed lubrication system

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UNIT IV AIR MOTION, COMBUSTION AND COMBUSTION CHAMBERS 9

Premixed combustion, diffused combustion, laminar and turbulent combustion of fuels in engines. Droplet combustion – combustion in SI and CI engines. – Cylinder pressure data and heat release analysis. Optimized design of combustion chambers. Supercharger and Turbochargers.

UNIT V NEW ENGINE TECHNOLOGY 9

Lean Burn engine – Different approaches to lean bum – LHR engine – Surface ignition concept – catalytic ignition – homogeneous charge compression ignition – variable valve timing – Multi Port Injection System – Gasoline Direct Injection – Common Rail Direct Injection – Recent Trends.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. J.B.Heywood, "Internal Combustion Engine Fundamentals",1st edition, McGraw Hill Education,2017
2. V.Ganesan, "Internal Combustion Engines", 4th edition, Tata McGraw Hill Education,2017

REFERENCES:

1. M.Khovakh, "Motor Vehicle Engines", 1st edition, Manakin Press,2016
2. M. L. Mathur, R. P. Sharma, "Internal Combustion Engines", 2nd edition, Dhanpat Rai Publications,2016
3. W.H.Crouse and A.L.Anglin, "Automotive Emission Control", 3rd edition, McGraw Hill Education,2006

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC				
U21MEP37	ELECTRICAL VEHICLE TECHNOLOGY	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To study the fundamental concepts and components of hybrid, electric vehicles
- To learn various aspects of hybrid and electric drive system
- To familiarize various electric drives suitable for hybrid electrical vehicles

COURSE OUTCOMES:

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

CO1: Explain the fundamentals of electric vehicles and propulsion system design. (Understand)

CO2: Comprehend the properties of batteries and its types. (Understand)

CO3: Explain the electric vehicle drive systems. (Understand)

CO4: Assess various aspects of hybrid and electric drive train that can be used. (Understand)

CO5: Discuss a logical progression for hybrid electric vehicle systems. (Understand)

CO–PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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CO3	2	1	-	-	-	-	-	-	-	-	-	1	1	-
CO4	2	1	-	-	-	-	-	-	-	-	-	1	1	-
CO5	2	1	-	-	-	-	-	-	-	-	-	1	1	-

SYLLABUS:

UNIT I ELECTRIC VEHICLES 9

Introduction – Components – vehicle mechanics – Road way fundamentals – Vehicle kinetics – Dynamics of vehicle motion – Propulsion System Design

UNIT II BATTERY TECHNOLOGY 9

Basics – Types – Parameters – Capacity – Discharge rate – State of charge – State of Discharge – Depth of Discharge – Technical characteristics – Battery pack Design – Properties of Batteries – battery disposal

UNIT III ELECTRICAL POWER DRIVES 9

Motor and Engine rating – Requirements – DC machines – Three phase A/c machines – Induction machines – Permanent magnet machines – Switched reluctance machines

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UNIT IV ELECTRIC VEHICLE DRIVE TRAIN 9

Transmission configuration – Components – Gears – Differential – Clutch – Brakes – Regenerative braking – Motor sizing

UNIT V HYBRID ELECTRIC VEHICLES 9

Types – Series – Parallel and series – Parallel configuration – Design – Drive train – Sizing of components – Case Studies: Design of a Hybrid Electric Vehicle (HEV) and Battery Electric Vehicle (BEV)

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Iqbal Hussain, "Electric & Hybrid Vehicles – Design Fundamentals", 2nd edition, CRC Press,2011
2. James Larminie, "Electric Vehicle Technology Explained", 2nd edition, John Wiley & Sons, 2013

REFERENCES:

1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals", 3rd edition, CRC Press, 2010
2. Sandeep Dhameja, "Electric Vehicle Battery Systems", 2nd edition, Newnes,2010
3. Mi, M. Abul Masrur, "Hybrid Electric Vehicles: Principles and Applications with Practical", 2nd edition, CRC Press,2013

EVALUATION PATTERN:

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Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
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40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC				
U21MEP38	SMART MOBILITY AND VEHICLE SYSTEMS	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To impart knowledge various smart mobility technologies
- To learn about smart mobility technology enablers and disruptors
- To explore the recent developments in intelligent vehicles and its motion control system

COURSE OUTCOMES:

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

CO1: Explain the latest technologies in smart mobility (Understand)

CO2: Discuss on various enablers in smart mobility (Understand)

CO3: Describe the various smart mobility disruptive platforms (Understand)

CO4: Explain the key techniques available in intelligent vehicles (Understand)

CO5: Describe the motion control and assistance systems in intelligent vehicles (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	1	-	-	-	-	-	-	-	1	-
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CO3	2	1	-	-	-	-	-	-	-	-	-	-	1	-
CO4	2	1	-	-	-	-	-	-	-	-	-	-	1	-
CO5	2	1	-	-	-	-	-	-	-	-	-	-	1	-

SYLLABUS:

UNIT I SMART MOBILITY TECHNOLOGIES 9

Introduction – Foundational technologies – PNT and GIS – Wireless communication – Mobile computing – Block chain – IOT – Artificial Intelligence – Robotics – Electrification

UNIT II SMART MOBILITY TECHNOLOGY ENABLERS 9

Intelligent infrastructure – Connected mobility – Automated mobility – E-Mobility – Micro mobility – Active – Soft – Zero – Impact Mobility – Inclusive mobility – Context Awareness Systems (CAS)

UNIT III SMART MOBILITY DISRUPTORS 9

Kano model – Disruptive mobility platforms – Shared mobility – Mobility – As a Service (Maas) – Mobility on Demand (MOD) – Seamless Integrated Mobility Systems (SIMS) – Last – Mile Delivery – Vehicle – As a Service (VaaS) – Gig Economy and Passenger Economy. Smart mobility during and post pandemic

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UNIT IV AUTONOMOUS INTELLIGENT VEHICLES 9

Introduction – Key technologies – Road detection and tracking – Vehicle detection and tracking – Multiple – Sensor based multiple – Object Tracking – Vehicle localization and navigation – Integrated DGPS/IMU positioning approach – Global views – Fundamentals of driver assistance. Intelligent Speed Adaptation (ISA)

UNIT V ADVANCED VEHICLE MOTION CONTROL 9

Longitudinal motion control for intelligent vehicles – Adaptive and cooperative cruise control – Vehicle lateral and steering control. Integral safety – Lane change assistance – Proactive Pedestrian Protection – Parking Assist – Post – Crash Support Systems

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Alaa Khamis, "Smart Mobility – Exploring fundamental technologies and wider impacts", 1st edition, Apress Media, Canada, USA,2021
2. Hong Cheng, "Advances in Computer Vision and Pattern Recognition - Autonomous Intelligent Vehicles - Theory, algorithms, and implementation", Springer-Verlag, London,2011

REFERENCES:

1. Barbara Flugge, "Smart Mobility - Connecting Everyone Trends, concepts and best practices", 1st edition, Springer,2017
2. Gerrit Meixner, " Smart Automotive Mobility - Reliable technology for the mobile human", 2nd edition, Springer,2020
3. Azim Eskandarian, "Handbook of Intelligent Vehicles", 2nd edition, Springer,2012

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC				
		L	T	P	J	C
UJ21MEP39	BIOENERGY CONVERSION TECHNOLOGIES	3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To introduce the energy conversion technologies related to biomass
- To familiarize the properties of biomass and its energy products
- To analyze the feasibility of power production from biomass sources

COURSE OUTCOMES:

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

CO1: Describe the properties of biomass and the energy conversion process. (Understand)

CO2: Compare the characteristics of products obtained from biomass pyrolysis (Understand)

CO3: Interpret the fundamentals of biomass gasification and gasifier design. (Understand)

CO4: Assess the potential of electrical power production from biomass (Understand)

CO5: Describe national and international standards of biofuels. (Understand)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I INTRODUCTION TO BIOMOLECULES 9

Classification of amino acids – Carbohydrates and nucleotides – Structure and properties of carbohydrate polymers – Proteins and nucleic acids – Classification and utility of lipids and fatty acids – Functional roles of biomolecules – Energy carriers – Enzyme cofactors and biochemical regulation – Biosynthesis and Metabolism

UNIT II BIOMASS 9

Biomass as energy source – Sources – Biomass conversion processes – Biological – Thermal – Chemical – Hybrid conversions – Application of biomass conversion products – Biomass properties for conversion process – Physical properties : Particle size, distribution, heat capacity and thermal conductivity – Thermal properties : Proximate, Ultimate and heating value analysis – Biomass pretreatment processes – Biodiesel and bioethanol : Sources and extraction methods

UNIT III TORREFACTION AND LIQUEFACTION 9

Torre faction – products obtained – properties of terrified biomass – Physical and chemical – composition changes – Torre faction as pretreatment process – Pyrolysis – Types – Effects of process

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parameters – Product characterization techniques – Oxidation stability – Bio-oil upgradation – Applications – Liquefaction – Direct and indirect methods – Advanced liquefaction techniques

UNIT IV BIOMASS GASIFICATION 9

Biomass gasification – Chemistry – Types of gasifiers – Gasifier design: TDR, throughput, A/F ratio and equivalence ratio calculations – Advanced gasification – Fluidized bed gasifier – Component design – Cold fluidization tests – Electrical power production – Biomass combustion – Types of combustors – Co-combustion and Co-firing – Applications – Eutectic point of biomass ash

UNIT V BIOFUELS STANDARDS AND POWER GENERATION 9

Physical and chemical characteristics of biofuels – Biomass – Wood gas – Biomethane – Ethanol – Biodiesel – Wood oil – Bioblends – Indian and International standard specifications – Bioblends – Adaptation of biofuel in various applications – Biomass integrated gasification/combined cycles systems – Sustainable co-firing of biomass with coal – Biofuel economy.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Sergio C. Capareda, "Introduction to Biomass Energy Conversions", 1st edition, CRC Press,2013
2. Prabir Basu, "Biomass Gasification, Pyrolysis and Torre faction", 2nd edition, Academic Press,2013

REFERENCES:

1. Erik Dahlquist, "Biomass as Energy Source: Resources, systems and applications", 2nd edition, CRC Press,2012
2. Anju Dahiya, "Bioenergy: Biomass to Biofuels", 3rd edition, Academic press,2014
3. D.P.Kothari, K.C Singal and Rakesh Ranjan "Renewable Energy Sources And Emerging Technologies", 2nd edition, Prentice Hall of India,2011

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC			
U21MEP40	ENERGY STORAGE DEVICES	L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- U21CY101 - Engineering Chemistry

COURSE OBJECTIVES:

- To acquire knowledge on energy storage devices
- To understand the operation and performance of energy storage devices
- To apply the concept of charge controllers for real time applications

COURSE OUTCOMES:

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

CO1: Explain the concepts of energy storage technologies (Understand)

CO2: Summarize fabrication and performance evaluation of primary batteries (Understand)

CO3: Describe the fabrication and performance evaluation of secondary batteries (Understand)

CO4: Infer the importance and classification of fuel cells (Understand)

CO5: Illustrate the concept of charge controllers (Understand)

COURSE ARTICULATION MATRIX:

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

SYLLABUS:

UNIT I ENERGY STORAGE TECHNOLOGIES 9

Types – Thermal – Mechanical – Hydrogen – Electro chemical – Battery parameters – Power density – Nominal voltage – Cut off voltage – Float voltage – Nominal capacity – Service time – Cycle life

UNIT II PRIMARY BATTERIES 9

Dry cells and alkaline batteries – Fabrication techniques – Packing – Rating – Effect of temperature – Internal resistance – Charging – Discharging – Safety

UNIT III SECONDARY BATTERIES 9

Lead acid – Lithium polymer – Lithium ion and air flow batteries – Construction – Working principle – Characteristics – SOC – DOD – SOH – ROD – C rating – E rating – Applications

UNIT IV FUEL CELLS 9

Hydrogen – Alkaline – Solid oxide fuel cells – Construction – Working principle – Characteristics – Thermodynamic analysis – Thermal effect – Reversible voltage – Applications

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UNIT V CHARGE CONTROLLERS 9

Types – Standalone, series, shunt – Integrated charge controller – Battery balancing, monitoring and management system – Safety measures – Applications

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. Viswanathan, B., Scibioh, Aulice M., "Fuel cells principles and applications", 1st edition, University Press,2009
2. Dhameja, Sandeep, "Electric vehicle battery systems", 1st edition, Newnes,2013

REFERENCES:

1. Christopher M. and Brett A., "Electrochemistry – Principles, Methods and Applications", 2nd edition, Oxford University,2004
2. Newman J.S. and Thomas - Alyea K.E., "Electrochemical Systems" 3rd edition, John Wiley & Sons,2004
3. David Elliott, "Energy Storage Systems", 1st edition, IOP Publishing,2017

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC			
		L	T	P	C
U21MEP41	ENERGY CONSERVATION IN INDUSTRIES	3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the types of fuels used in Industries and their characteristics
- To know the techniques adopted for performance evaluation of thermal utilities
- To learn the working principle employed in VCRS and VAM systems

COURSE OUTCOMES:

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

CO1: Estimate the stoichiometric air for fuel and suggest measures for efficient combustion (Apply)

CO2: Outline the reasons for underperformance of thermal utilities and suitable remedial measures. (Understand)

CO3: Analyze the factors affecting COP of a VCR and VAR system (Analyze)

CO4: Use appropriate methods to determine the performance of induction motors and transformers.(Apply)

CO5: Assess energy conservation avenues of thermal and electrical utilities (Apply)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I BOILERS 9

Types – Performances evaluation via direct and indirect method – Energy conservation avenues – Properties of steam – Assessment of steam distribution losses – Steam trapping – Condensate and flash steam recovery system – Opportunities for energy saving in steam consumption systems

UNIT II FURNACES AND THERMIC FLUID HEATERS 9

Furnaces and Thermic Fluid Heaters: Types – Performances evaluation via direct and indirect method – Energy conservation avenues – Insulation and refractory: types and application

UNIT III HVAC AND WASTE HEAT RECOVERY 9

VCRS – Performance assessment – Energy savings opportunities – VAM: working, types, benefits, comparison with vapor compression system – WHR systems: Classification – Benefits – Commercial waste heat recovery devices: recuperator, regenerator, heat pipe, heat exchangers (Plate, Shell & Tube), heat pumps, thermo compressor – CHP – Poly generation

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UNIT IV ELECTRICAL SYSTEMS AND INDUCTION MOTORS 9

Electricity billing – Demand side management – Power factor improvement transformer losses – Harmonics induction Motors: Types – Losses – Performance assessment adopting direct and indirect method – Factors affecting motor performance – Energy efficient motors

UNIT V ENERGY CONSERVATION IN ELECTRICAL UTILITIES 9

Performance assessment and energy conservation avenues in: Fans – Blowers – Pumps – Air compressors – Illumination systems – Cooling towers

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. Alwyn Clarenece asts, A., Pon Vengatesh, R., "Electrical energy generation utilisation and conservation", 1st edition, Bennett Coleman,2007
2. Rao, Sunil S., "Utilization generation and conservation of electrical energy", 1st edition, Khanna Publisher,2005

REFERENCES:

1. K. Nagabhushan Raju, "Industrial Energy Conservation Techniques: (concepts, Applications and Case Studies)", 1st edition, Atlantic Publishers,2007
2. Albert Thumann and Paul Mehta D, "Handbook of Energy Engineering", 7th edition, The Fairmont Press,2013
3. Steve Doty, Wayne Turner C, "Energy Management Handbook", 7th edition, The Fairmont Press, 2009

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

		Category: PEC			
		L	T	P	C
J21MEP42	ENERGY MANAGEMENT AND EQUIPMENT DESIGN	3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To inculcate the importance of energy conservation and management
- To learn the process of energy auditing
- To design and optimize the energy systems

COURSE OUTCOMES:

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

CO1: Realize the present energy scenario and the need for energy conservation measures (Understand)

CO2: Explain the process of energy audit for optimizing the energy requirements (Apply)

CO3: Use energy equipment concepts for heat transfer applications (Apply)

CO4: Demonstrate the model for the typical energy systems (Apply)

CO5: Apply the different types of optimization techniques for energy systems (Apply)

CO–PO MAPPING:

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

SYLLABUS:

UNIT I IMPORTANCE OF ENERGY MANAGEMENT AND CONSERVATION 9

Energy management as a profession – Primary and secondary sources of energy – Energy Scenario world and India – Energy resources availability in India – Energy consumption pattern – Energy intensive industries – An overview – Energy conservation and energy efficiency – Needs and advantages – Energy conservation act

UNIT II ENERGY AUDIT 9

Definition – Need – And types of energy audit; Energy management (audit) approach: Understanding energy costs – Benchmarking – Energy performance – Matching energy use to requirement – Maximizing system efficiencies – Optimizing the input energy requirements – Energy auditing – Types – Methodologies – Barriers – Energy audit instruments – Duties and responsibilities of energy managers and auditors – Energy audit questionnaire

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UNIT III DESIGN OF ENERGY EQUIPMENT 9

Primary energy analysis – Energy balance for closed and control volume systems – Applications of energy analysis for selected energy system design – Modeling overview – Levels and steps in model development – Examples of models – Curve fitting and regression analysis

UNIT IV MODELING OF ENERGY SYSTEMS 9

Modeling of energy systems – Heat exchanger – Compressors – Solar collectors – Distillation – Rectification of turbo machinery components – Refrigeration systems – Information flow diagram – Solution set for nonlinear algebraic equations – Successive substitution – Newton Raphson Method

UNIT V OPTIMIZATION OF ENERGY SYSTEMS 9

Objectives – Constraints – Problem formulation – Unconstrained problems – Necessary and sufficient Conditions – Constrained optimization – Lagrange multipliers – Constrained variations – Linear Programming – Simplex tableau – Pivoting – Sensitivity analysis – New generation optimization techniques

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. Kreith, F. and Goswami, D. Y., "Energy management and conservation handbook", 2nd edition, CRC Press,2018
2. Stoecker W. F., "Design of Thermal Systems", 3rd edition, McGraw Hill Education, New Delhi,2017

REFERENCES:

1. Doty, S. and Turner, W.C., "Energy management handbook", 9th edition, CRC Press,2019
2. C. Balaji, "Essentials of Thermal System Design and Optimization", 1st edition, CRC Press,2018
3. Jaluria, Y., "Design and Optimization of Thermal systems", 2nd edition, CRC Press,2013

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

U21MEP43	COMPREHENSION - I	Category: BSC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To impart knowledge on engineering mechanics and its applications
- To disseminate expertise on fluid mechanics and thermal science

COURSE OUTCOMES:

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

CO1: Solve problems on mechanics of statics and dynamics bodies (Apply)

CO2: Apply the practical engineering problems involving stress and strain analysis in elementary structural members, such as bars and beams (Apply)

CO3: Apply velocity and acceleration calculation for various mechanisms and to design various loaded members (Apply)

CO4: Apply the principles of fluid mechanics for solving fluid flow problems (Apply)

CO5: Solve problems related to thermal applications (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I ENGINEERING MECHANICS 9

Free – Body diagrams and equilibrium; trusses and frames; virtual work; kinematics and dynamics of particles and of rigid bodies in plane motion; impulse and momentum (linear and angular) and energy formulations – Collisions

UNIT II MECHANICS OF MATERIALS 9

Stress and strain – Elastic constants, Poisson's ratio; Mohr's circle for plane stress and plane strain; thin cylinders; shear force and bending moment diagrams; bending and shear stresses; deflection of beams; torsion of circular shafts; Euler's theory of columns; energy methods; thermal stresses; strain gauges and rosettes

UNIT III THEORY OF MACHINES AND MACHINE DESIGN 9

Displacement – Velocity and acceleration analysis of plane mechanisms; dynamic analysis of linkages; cams; gears and gear trains; flywheels and governors; Vibrations: Free and forced vibration of single degree of freedom systems, effect of damping; vibration isolation; resonance; critical speeds of shafts – Design for static and dynamic loading; failure theories, principles of the design of machine

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elements such as bolted, riveted and welded joints; shafts, gears, rolling and sliding contact bearings, brakes and clutches – Springs

UNIT IV FLUID MECHANICS 9

Fluid properties; fluid statics, manometry – Buoyancy – Forces on submerged bodies – Stability of floating bodies; control – Volume analysis of mass – Momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; dimensional analysis; viscous flow of incompressible fluids – Boundary layer – Elementary turbulent flow – Flow through pipes – Head losses in pipes – Bends and fittings

UNIT V THERMAL SCIENCES 9

Thermodynamics: Thermodynamic systems and processes; properties of pure substances – Zeroth and first laws of thermodynamics – Calculation of work and heat in various processes; second law of thermodynamics; availability and irreversibility; thermodynamic relations
Applications: Power Engineering: Air and gas compressors; vapour and gas power cycles – Concepts of regeneration and reheat – I.C. Engines: Air-standard Otto – Diesel and dual cycles
Heat-Transfer: Modes of heat transfer; one dimensional heat conduction – Heat transfer through fins; unsteady heat conduction – Lumped parameter system – Heat exchanger performance – LMTD and NTU methods

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: – 0 Periods Project – 0 Periods

Total 45 Periods

TEXT BOOKS:

1. Bhavikatti, S. S., and K. G. Rajashekarappa. Engineering Mechanics, 8th edition, New Age International, 2021
2. Gere, James M., and Stephen P. Timoshenko. "Mechanics of materials, 3rd edition, CBS Publisher, 2021
3. Rattan, Sarjit S. Theory of machines, 1st edition, Tata McGraw-Hill Education, 2017
4. Bansal, R. K., A textbook of fluid mechanics, 10th edition, Laxmi Publication, 2019

REFERENCES:

1. Nag, P. K. "Engineering thermodynamics", 6th edition, McGraw Hill Education, 2017
2. Cengel, Yunus A., Michael A. Boles, and Mehmet Kanoğlu. Thermodynamics: an engineering approach, 8th edition, McGraw-hill, 2017
3. Sachdeva, R. C. Fundamentals of Engineering Heat and Mass Transfer (SI Units), 1st edition, New Age International Publishers, 2017

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
Individual Assignment / Seminar / MCQ *Individual Assignment / Seminar / MCQ	Written Test	Individual Assignment / Seminar / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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PROFESSIONAL ELECTIVE

U21MEP44	COMPREHENSION - II	Category: BSC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To impart knowledge on engineering materials and manufacturing.
- To disseminate expertise on metrology and industrial engineering.

COURSE OUTCOMES:

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

CO1: Interpret the phase diagrams of materials for the application of engineering field (Apply)

CO2: Apply different metal forming process to various engineering applications (Apply)

CO3: Apply various machining processes for industrial applications (Apply)

CO4: Apply the knowledge of measurements in metrology and CIM (Apply)

CO5: Analyse the real time problems in industry for effective implementation of planning and control (Apply)

CO-PO MAPPING:

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

SYLLABUS:

UNIT I ENGINEERING MATERIALS **9**

Structure and properties of engineering materials – Phase diagrams – Heat treatment – Stress – Strain diagrams for engineering materials

UNIT II MANUFACTURING PRACTICES -I **9**

Casting – Forming and Joining Processes: Different types of castings – Design of patterns – Moulds and cores; solidification and cooling; riser and gating design – Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling – Extrusion, drawing) and sheet (shearing, deep drawing – Bending) metal forming processes; principles of powder metallurgy – Principles of welding – Brazing – Soldering and adhesive bonding

UNIT III MANUFACTURING PRACTICES -II **9**

Machining and Machine Tool Operations: Mechanics of machining; basic machine tools; single and multi-point cutting tools – Tool geometry and materials – Tool life and wear; economics of machining;

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principles of non – Traditional machining processes; principles of work holding – Jigs and fixtures; abrasive machining processes; NC/CNC machines and CNC programming

UNIT IV METROLOGY AND COMPUTER INTEGRATED MANUFACTURING 9

Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly – Basic concepts of CAD/CAM and their integration tools

UNIT V INDUSTRIAL ENGG, 9

Forecasting models – Aggregate production planning – Scheduling – Materials requirement planning – Deterministic models – Safety stock – Inventory control systems – Linear programming – Simplex method – Transportation – Assignment – Network flow models – Simple queuing models – PERT and CPM

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: – 0 Periods Project – 0 Periods

Total 45 Periods

TEXT BOOKS:

1. Jain, R. K. "Production technology Manufacturing processes, technology and automation", 4th edition, Khanna Publication, 2013
2. Jindal, U. C. "Material science and metallurgy", 1st edition, Pearson Education India, 2012
3. Khanna, O. P. "Industrial engineering and management", 2nd edition, Dhanpat rai publications, 2017

REFERENCES:

1. Ghosh, Amitabha, and Asok Kumar Mallik. "Manufacturing science. Vol. 432. Chichester: Ellis Horwood, 1986
2. Kalpakjian, Serope. "Manufacturing processes for engineering materials", 6th edition, Pearson Education India, 2018
3. Buffa, Elwood Spencer. "Modern production/operations management", 8th edition, Wiley Publication, 2007

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
Individual Assignment / Seminar / MCQ *Individual Assignment / Seminar / MCQ	Written Test	Individual Assignment / Seminar / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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