

CARE COLLEGE OF ENGINEERING
(An Autonomous Institution)





Approved AICTE New Delhi | Affiliated to Anna University Chennai
No 27, Thayanur, Tiruchirappalli 620 009

Regulations 2024
Undergraduate Degree
B.E. Mechanical Engineering
Full Time Programmes
Curriculum and Syllabus

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Chairman
Board of Studies
HEAD
Mechanical Engineering
CARE College of Engineering
Trichy -620 009

Principal
Principal
CARE College of Engineering (Autonomous)
No. 27, Thayanur, Trichy - 620 009.



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Department of Mechanical Engineering

Institute Vision

Transform Lives through Education and Research.

Institute Mission

To impart quality education to students through critical thinking, creativity, leadership and spirit of entrepreneurship**.**

Institute Values

We develop in each member the ability and passion to work effectively for the betterment of humanity with cultural awareness, high ethical and moral values and a sense of social responsibility.

Department Vision

To Produce globally competent Mechanical Engineers who can cater to the contemporary needs of industry and society.

Department Mission

M1 Infrastructure and curriculum development: To provide excellent infrastructure and innovative curriculum delivery to meet national and global requirements.

M2 Skill development: To organize workshops, seminars, and hand-on training sessions to equip the students with required technical skills. Also emphasize on the development of soft skills like communication, leadership and teamwork.

M3 Research, Innovation and Collaboration: To encourage the students and faculty to engage in research and innovative projects in association with Industry.

CARE COLLEGE OF ENGINEERING, TIRUCHIRAPPALLI

(AN AUTONOMOUS INSTITUTION)

REGULATION 2024 CURRICULUM AND SYLLABUS

CHOICE BASED CREDIT SYSTEM (CBCS)

B.E. MECHANICAL ENGINEERING

Program Educational Objectives (PEOs)

The Graduates of Mechanical Engineering shall

PEO1: Apply core principles of mechanical engineering, mathematics, and science to solve complex engineering Problems.
PEO2: Design, analyze, and improve mechanical systems and processes using modern tools, sustainable practices, and innovative thinking.
PEO3: Work effectively as individuals and team members, exhibiting leadership, communication, and project management skills in multidisciplinary and diverse environments.
PEO4: Engage in lifelong learning, uphold professional ethics, and contribute responsibly to societal and environmental well-being through their engineering practice.

Knowledge and Attitude Profile (WK)

WK1 (**Natural Science):** A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2 (Mathematics and Modelling): Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3 (Engineering Fundamentals): A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4 (Engineering Specialization): Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5 (Environmental impact on design and practice): Knowledge, including efficient resource use, environmental impacts, whole-life cost, reuse of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6 (Newer Practical Knowledge): Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

WK7 (Engineer role and responsibility in Society): Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8 (Critical Thinking and Creativity): Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

Program Outcomes: On completion of the program, the graduates will be able to

PO1 Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2 Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3 Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4 Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5 Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6 The Engineer and the World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO7 Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO8 Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9 Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10 Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11 Life-Long Learning: Recognize the need for, and have the preparation and ability for

(i) independent and life-long learning
(ii) adaptability to new and emerging technologies and
(iii) critical thinking in the broadest context of technological change (WK8).

Program Specific Outcomes (PSOs)
Upon completion of the program, the students will be able to

PSO1: Integrate core mechanical engineering domains design, thermal systems, materials, and manufacturing to develop and maintain mechanical equipment and processes.
PSO2: Apply discipline-specific technologies such as CAD/CAM, CAE, CNC, additive manufacturing, and automation for effective product realization.



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REGULATIONS 2024
CHOICE BASED CREDIT SYSTEM
B. E. MECHANICAL ENGINEERING
CURRICULUM AND SYLLABI FOR I TO VIII SEMESTERS

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24MA111	Matrices and Calculus	BSC	3	1	0	4	4	40	60
2	U24GE111	Problem Solving using Python	ESC	3	0	0	3	3	40	60
3	U24HS111	Heritage of Tamils	HSMC	1	0	0	1	1	40	60
THEORY CUM PRACTICAL COURSES										
4	U24HS123	Communicative English for Engineers	HSMC	3	0	2	5	4	50	50
5	U24PH113	Engineering Physics	BSC	3	0	2	5	4	50	50
6	U24CY113	Engineering Chemistry	BSC	3	0	2	5	4	50	50
PRACTICAL COURSES										
7	U24GE122	Problem Solving using Python Laboratory	ESC	0	0	4	4	2	60	40
			Total	**16**	**1**	**10**	**27**	**22**		

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24MA211	Statistics and Numerical Methods	BSC	3	1	0	4	4	40	60
2	U24PH211	Materials Science	BSC	3	0	0	3	3	40	60
3	U24EE211	Basic Electrical and Electronics Engineering	ESC	3	0	0	3	3	40	60
4	U24CE211	Engineering Graphics	ESC	2	0	4	6	4	40	60
5	U24HS211	Tamils and Technology	HSMC	1	0	0	1	1	40	60
THEORY CUM PRACTICAL COURSES										
6	U24HS223	Technical English for Engineers	HSMC	2	0	2	4	3	50	50
PRACTICAL COURSES										
7	U24CE232	Engineering Practices Laboratory for Civil and Mechanical Engineers	ESC	0	0	4	4	2	60	40
8	U24EE222	Basic Electrical and Electronics Engineering Laboratory	ESC	0	0	4	4	2	60	40
9	U24EM212	Professional Development	EEC	0	0	2	2	1	100	-
			Total	**14**	**1**	**16**	**31**	**23**		



SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24MA311	Transforms and Partial Differential Equations	BSC	3	1	0	4	4	40	60
2	U24ME311	Engineering Mechanics	ESC	3	0	0	3	3	40	60
3	U24ME321	Engineering Materials and Metallurgy	ESC	3	0	0	3	3	40	60
4	U24ME331	Engineering Thermodynamics	PCC	3	1	0	4	4	40	60
5	U24ME341	Manufacturing Technology I	PCC	3	0	0	3	3	40	60
PRACTICAL COURSES										
6	U24ME352	Computer Aided Machine Drawing	PCC	0	0	4	4	2	60	40
7	U24ME362	Manufacturing Technology Laboratory	PCC	0	0	4	4	2	60	40
8	U24EM312	Design Thinking and Innovation	EEC	0	0	2	2	1	100	-
			Total	**15**	**2**	**10**	**27**	**22**		

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24ME411	Fluid Mechanics and Machinery	ESC	3	1	0	4	4	40	60
2	U24ME421	Theory of Machines	PCC	3	0	0	3	3	40	60
3	U24ME431	Thermal Engineering	PCC	3	0	0	3	3	40	60
4	U24ME441	Manufacturing Technology – II	PCC	3	0	0	3	3	40	60
5	U24EM411	Aptitude and Reasoning – I	EEC	1	0	0	1	1	100	-
THEORY CUM PRACTICAL COURSES										
6	U24ME453	Strength of Materials	PCC	3	0	2	5	4	50	50
7	U24ME463	CAD /CAM	PCC	3	0	2	5	4	50	50
PRACTICAL COURSES										
8	U24ME472	Fluid Mechanics and Machinery Laboratory	ESC	0	0	2	2	1	60	40
9	U24ME482	Thermal Engineering Laboratory	PCC	0	0	4	4	2	60	40
10	U24EM422	Soft skill and Personality Development – I	EEC	0	0	2	2	1	100	-
			Total	**19**	**1**	**12**	**32**	**26**		

SEMESTER V

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24ME511	Design of Machine Elements	PCC	3	1	0	4	4	40	60
2	U24ME521	Heat and Mass Transfer	PCC	3	1	0	4	4	40	60
3	U24EM511	Aptitude and Reasoning –II	EEC	2	0	0	2	2	100	
4	U24MG511	Leadership and Team Management	EEC	2	0	0	2	2	40	60
5		Professional Elective – I	PEC							
6		Professional Elective – II	PEC							
7		Professional Elective – III	PEC							
8		Mandatory Course – I*	MC	3	0	0	3	0	100	-
PRACTICAL COURSES										
9	U24ME532	Heat Transfer Laboratory	PCC	0	0	4	4	2	60	40
10	U24EM522	Soft skill and Personality Development – II	EEC	0	0	2	2	1	100	-
			Total							

* Mandatory Course-I is a Non-credit Course (Student shall select one course from the list given under MC)

SEMESTER VI

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24ME611	Design of Transmission Systems	PCC	3	1	0	4	4	40	60
2	U24ME621	Metrology and Measurements	PCC	3	0	0	3	3	40	60
3	U24MG611	Project Management	HSMC	2	0	0	2	2	40	60
4	U24MG621	Entrepreneurship	EEC	2	0	0	2	2	40	60
5		Professional Elective – IV	PEC							
6		Open Elective – I	OEC							
7		Mandatory Course – II*	MC	3	0	0	3	0	100	-
PRACTICAL COURSES										
8	U24ME632	Metrology and Dynamics Laboratory	PCC	0	0	4	4	2	60	40
9	U24ME642	Design and Fabrication Project	EEC	0	0	4	4	2	60	40
			Total							

* Mandatory Course-II is a Non-credit Course (Student shall select one course from the list given under MC- II)

SEMESTER VII

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24ME711	Finite Element Analysis	PCC	3	1	0	4	4	40	60
2	U24MG711	Human Values and Ethics	HSMC	2	0	0	2	2	40	60
3	U24MG721	Total Quality Management	HSMC	3	0	0	3	3	40	60
4		Professional Elective - V	PEC							
5		Professional Elective - VI	PEC							
6		Open Elective - II	OEC							
PRACTICAL COURSES										
7	U24ME722	Simulation and Analysis Laboratory	PPC	0	0	4	4	2	60	40
8	U24ME732	Summer Internship	EEC	0	0	0	0	2	100	
			Total	**14**	**0**	**8**	**22**	**22**		

*Four weeks Summer Internship carries two credits and it will be done during VI semester summer vacation and the same will be evaluated in VII semester.

SEMESTER VIII

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
PRACTICAL COURSES										
1	U24ME812	Capstone Project/ Industry Internship	EEC	0	0	16	16	8	60	40
			Total	**0**	**0**	**16**	**16**	**8**		

PROFESSIONAL ELECTIVES

VERTICAL 1: PRODUCT AND PROCESS DEVELOPMENT (PD)

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24MEPD01	Ergonomics in Design	PEC	3	0	0	3	3	40	60
2	U24MEPD02	New Product Development	PEC	3	0	0	3	3	40	60
3	U24MEPD03	Testing of Materials	PEC	3	0	0	3	3	40	60
4	U24MEPD04	Process Planning and Cost Estimation	PEC	3	0	0	3	3	40	60
5	U24MEPD05	Reverse Engineering	PEC	3	0	0	3	3	40	60
6	U24MEPD06	Lean Manufacturing	PEC	3	0	0	3	3	40	60
7	U24MEPD07	Welding Engineering	PEC	3	0	0	3	3	40	60
8	U24MEPD08	Non-Traditional Machining Processes	PEC	3	0	0	3	3	40	60

VERTICAL 2: THERMAL SYSTEMS (TS)

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24METS01	Computational Fluid Dynamics	PEC	3	0	0	3	3	40	60
2	U24METS02	Gas Dynamics and Jet Propulsion	PEC	3	0	0	3	3	40	60
3	U24METS03	Energy Engineering	PEC	3	0	0	3	3	40	60
4	U24METS04	Refrigeration and Air Conditioning	PEC	3	0	0	3	3	40	60
5	U24METS05	Thermal Power Engineering	PEC	3	0	0	3	3	40	60
6	U24METS06	Batteries and Management system	PEC	3	0	0	3	3	40	60
7	U24METS07	Mechanical Measurements	PEC	3	0	0	3	3	40	60
8	U24METS08	Equipment for Pollution Control	PEC	3	0	0	3	3	40	60

VERTICAL 3: INDUSTRY 4.0 AND AUTOMATION (IA)

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24MEIA01	Additive Manufacturing	PEC	2	0	2	4	3	50	50
2	U24MEIA02	Design for Manufacturing	PEC	3	0	0	3	3	40	60
3	U24MEIA03	Industrial Automation Systems	PEC	3	0	0	3	3	40	60
4	U24MEIA04	Industrial safety	PEC	3	0	0	3	3	40	60
5	U24MEIA05	Digital Enterprise for Industry 4.0	PEC	3	0	0	3	3	40	60
6	U24MEIA06	Industrial Robotics	PEC	3	0	0	3	3	40	60
7	U24MEIA07	Quality Engineering	PEC	3	0	0	3	3	40	60
8	U24MEIA08	Material Handling and Solid Processing Equipment	PEC	3	0	0	3	3	40	60

VERTICAL 4: MODERN MOBILITY SYSTEMS (MM)

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			Total Contact Periods	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24MEMM01	Automobile Engineering	PEC	3	0	0	3	3	40	60
2	U24MEMM02	Hybrid and Electric Vehicle Technology	PEC	3	0	0	3	3	40	60
3	U24MEMM03	Vehicle Health Monitoring, Maintenance and Safety	PEC	3	0	0	3	3	40	60
4	U24MEMM04	CAE and CFD Approach in Future Mobility	PEC	3	0	0	3	3	40	60
5	U24MEMM05	Automotive Materials, Components, Design and Testing	PEC	2	0	0	2	3	40	60
6	U24MEMM06	Advanced Vehicle Engineering	PEC	3	0	0	3	3	40	60
7	U24MEMM07	Drone Technologies	PEC	3	0	0	3	3	40	60
8	U24MEMM08	Conventional and Futuristic Vehicle Technology	PEC	3	0	0	3	3	40	60

OPEN ELECTIVES

Mechanical Engineering Open Elective Courses to other Departments

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24OEME01	Automobile Systems	OEC	3	0	0	3	3	40	60
2	U24OEME02	Renewable Energy Systems	OEC	3	0	0	3	3	40	60
3	U24OEME03	Robotics	OEC	3	0	0	3	3	40	60
4	U24OEME04	Production Planning and Control	OEC	3	0	0	3	3	40	60
5	U24OEME05	Non-Destructive Testing	OEC	3	0	0	3	3	40	60

MANDATORY COURSES (MC)

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24MC11	Disaster Risk Reduction and Management	MC	3	0	0	3	0	100	-
2	U24MC21	Environmental Science	MC	3	0	0	3	0	100	-
3	U24MC31	History of Science and Technology in India	MC	3	0	0	3	0	100	-
4	U24MC41	Personal Finance	MC	3	0	0	3	0	100	-
5	U24MC51	Well-Being with Traditional Practices-Yoga, Ayurveda and Siddha	MC	3	0	0	3	0	100	-

Credit Distribution Summary

B.E.: Mechanical Engineering									
Category/Semester	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**
HSMC	5	4				2	5		**16**
BSC	12	7	4						**23**
ESC	5	11	6	5					**27**
PCC			11	19	10	9	6		**55**
PEC					9	3	6		**18**
OEC						3	3		**6**
Project/EEC		1	1	2	5	4	2	8	**23**
Total	**22**	**23**	**22**	**26**	**24**	**21**	**22**	**8**	**168**

MINOR COURSES

Vertical 1: Business Data Analytics

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24MNBA01	Statistics for Management	MN	3	0	0	3	3	40	60
2	U24MNBA02	Datamining for Business Intelligence	MN	3	0	0	3	3	40	60
3	U24MNBA03	Human Resource Analytics	MN	3	0	0	3	3	40	60
4	U24MNBA04	Marketing and Social Media Web Analytics	MN	3	0	0	3	3	40	60
5	U24MNBA05	Operation and Supply Chain Analytics	MN	3	0	0	3	3	40	60
6	U24MNBA06	Financial Analytics	MN	3	0	0	3	3	40	60

Vertical 2: Public Administration

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24MNPA01	Principles of Public Administration	MN	3	0	0	3	3	40	60
2	U24MNPA02	Constitution of India	MN	3	0	0	3	3	40	60
3	U24MNPA03	Public Personnel Administration	MN	3	0	0	3	3	40	60
4	U24MNPA04	Administrative Theories	MN	3	0	0	3	3	40	60
5	U24MNPA05	Indian Administrative System	MN	3	0	0	3	3	40	60
6	U24MNPA06	Public Policy Administration	MN	3	0	0	3	3	40	60

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SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24MA111	Matrices and Calculus	BSC	3	1	0	4	4	40	60
2	U24GE111	Problem Solving using Python	ESC	3	0	0	3	3	40	60
3	U24HS111	Heritage of Tamils	HSMC	1	0	0	1	1	40	60
THEORY CUM PRACTICAL COURSES										
4	U24HS123	Communicative English for Engineers	HSMC	3	0	2	5	4	50	50
5	U24PH113	Engineering Physics	BSC	3	0	2	5	4	50	50
6	U24CY113	Engineering Chemistry	BSC	3	0	2	5	4	50	50
PRACTICAL COURSES										
7	U24GE122	Problem Solving using Python Laboratory	ESC	0	0	4	4	2	60	40
				16	**1**	**10**	**27**	**22**		

ASSESSMENT SCHEME

Sl. No	Course Type	L	T	P	C	CIA Weightage (Theory)				CIA	ESE		CIA (W)	ESE (W)	Min. Marks to Pass for 100	
						T1	A1	T2	A2	Prac	Th	Prac			ESE	Total
1	U24MA111	3	1	0	4	60	40	60	40	-	100		40	60	45	50
2	U24GE111	3	0	0	3	60	40	60	40	-	100		40	60	45	50
3	U24HS111	1	0	0	1	60	40	60	40	-	100		40	60	45	50
4	U24HS123	3	0	2	4	60	40	60	40	100	70	30	50	50	45	50
5	U24PH113	3	0	2	4	60	40	60	40	100	70	30	50	50	45	50
6	U24CY113	3	0	2	4	60	40	60	40	100	70	30	50	50	45	50
7	U24GE122	0	0	4	2	-	-	-	-	100	-	100	60	40	45	50

(W) – Weightage

U24MA111	MATRICES AND CALCULUS	L	T	P	C
		3	1	0	4

Course Objective:

After completing this course, the students will be able to:

- To develop the use of matrix algebra techniques those are needed to engineers for practical applications.
- To familiarize the students with differential calculus.
- To introduce the methods of solving linear and nonlinear ordinary differential equations.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.
- To acquaint the student with the concepts of vector calculus needed for problems in all engineering disciplines.

Detailed Syllabus

UNIT I MATRICES 9+3

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley - Hamilton theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms – Applications : Stretching of an elastic membrane

UNIT II DIFFERENTIAL CALCULUS 9+3

Functions of single variable – Limit of the function- Continuity and Differentiability - Mean value Theorems - Partial derivatives - Total derivative - Taylor series (in one and two variables) - Maxima and Minima (in one and two variables).

UNIT III ORDINARY DIFFERENTIAL EQUATION 9**+3**

Higher order linear differential equations with constant coefficients - Method of variation of parameters – Homogenous equation of Euler's and Legendre's type – System of simultaneous linear differential equations with constant coefficients.

UNIT IV INTEGRAL CALCULUS 9+3

Evaluation of definite and improper integrals - Change of order of integration - Double integrals in polar coordinates - Area enclosed by plane curves - Triple integrals.

UNIT V VECTOR CALCULUS 9+3

Gradient and directional derivative – Divergence and curl - Vector identities – Irrotational and Solenoidal vector fields – Line integral over a plane curve – Surface integral - Area of a curved surface - Volume integral - Green's, Gauss divergence and Stoke's theorems – Verification and application in evaluating line, surface and volume integrals.

Total Periods:60

Learning Resources

1	Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 44th Edition, New Delhi, 2015.
2	Erwin Kreyszig. E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016
3	Anton. H, Bivens. I and Davis. S, " Calculus ", Wiley, 10th Edition, 2016

4	Jain. R.K. and Iyengar. S.R.K., “Advanced Engineering Mathematics”, Narosa Publications, New Delhi, 5th Edition, 2016.
5	Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Apply the matrix algebra methods for solving practical problems.	Apply
CO2	Apply differential calculus tools in solving various Engineering problems.	Apply
CO3	Apply various techniques in solving differential equations.	Apply
CO4	Apply double and triple integration techniques in solving areas and volumes.	Apply
CO5	Evaluate of line, surface and volume integrals using Gauss, Stokes and Green's Theorems.	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24GE111	**PROBLEM SOLVING USING PYTHON**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

After completing this course, the students will be able to:

- To understand the basics of algorithmic problem solving.
- To learn to solve problems using Python conditionals and loops.
- To define Python functions and use function calls to solve problems.
- To use Python data structures - lists, tuples, dictionaries to represent complex data.
- To do input/output with files in Python.

Detailed Syllabus

UNIT-I COMPUTATIONAL THINKING AND PROBLEM SOLVING 9

Fundamentals of Computing – Identification of Computational Problems -Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

UNIT-II DATA TYPES, EXPRESSIONS, STATEMENTS 9 Python interpreter and interactive mode, debugging; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.
UNIT-III CONTROL FLOW, FUNCTIONS, STRINGS 9 Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.
UNIT-IV LISTS, TUPLES, DICTIONARIES 9 Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.
UNIT-V FILES, MODULES, PACKAGES 9 Files and exceptions: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file, Voter's age validation, Marks range validation (0-100).
Total Periods:45

Learning Resources

1	Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
2	Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1st Edition, BCS Learning & Development Limited, 2017
3	Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
4	G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021.
5	John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data", Third Edition, MIT Press , 2021
6	Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019.
7	Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Develop algorithmic solutions to simple computational problems	Apply
CO2	Write simple python programs using the basic data types, expressions and Statements.	Apply
CO3	Write simple Python programs using conditionals and loops for solving problems and decompose a Python program into functions.	Apply
CO4	Represent compound data types using Python lists, tuples, dictionaries etc.	Apply
CO5	Read and write data from/to files in Python programs.	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24HS111	**தமிழர் மரபு / HERITAGE OF TAMILS**	**L**	**T**	**P**	**C**
		1	**0**	**0**	**1**

Course Objective:

After completing this course, the students will be able to:

- Recognize Tamil literature and its significance in Tamil culture.
- Introduce the Tamils' rich artistic and cultural legacy.
- Familiarize the different types of folk and martial arts that are unique to Tamil Nadu.
- Acquaint the concept of Thinai in Tamil literature and culture.
- Comprehend the significance of Tamil in developing Indian culture.

Detailed 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.

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.
Total Periods:15

Learning Resources

1	Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
2	Social Life of the Tamils - The Classical Period (Dr.S. Singaravelu) (Published by: International Institute of Tamil Studies.
3	Historical Heritage of the Tamils (Dr.S.V. Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
4	The Contributions of the Tamils to Indian Culture (Dr.M. Valarmathi) (Published by: International Institute of Tamil Studies).
5	Keeladi - ‘Sangam City Civilization on the banks of river Vaigai’ (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu).
6	Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K. Pillay) (Published by: The Author).
7	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu).
8	Journey of Civilization Indus to Vaigai (R. Balakrishnan) (Published by: RMRL) – Reference Book.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Describe the various types of Tamil Literature.	Understand
CO2	Discuss about Tamil Arts and Sculpture.	Understand
CO3	Explain the Tamil Folks and Martial Arts.	Understand
CO4	Summarize the Thinai Concepts of Tamil.	Understand
CO5	Review the contribution of Tamil Culture to Indian Culture and National Movements.	Understand

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24HS123	COMMUNICATIVE ENGLISH FOR ENGINEERS	L	T	P	C
		3	0	2	4

Course Objective:

After completing this course, the students will be able to:

- To learn to use basic grammatical structures in suitable contexts.
- To acquire lexical competence and use them appropriately in a sentence and understand their meaning in a text.
- To help learners use language effectively in both informal and professional contexts.
- To develop learners' ability to read and write complex texts, summaries, articles, blogs, definitions, essays and user manuals.

Detailed Syllabus

UNIT I INTRODUCTION TO EFFECTIVE COMMUNICATION 1

What is effective communication? (Explain using activities) Why is communication critical for excellence during study, research and work? What are the seven C's of effective communication? What are key language skills? What is effective listening? What does it involve? What is effective speaking? What does it mean to be an excellent reader? What should you be able to do? What is effective writing? How does one develop language and communication skills? What does the course focus on? How are communication and language skills going to be enhanced during this course? What do you as a learner need to do to enhance your English language and communication skills to get the best out of this course?

UNIT I INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION 8

Reading - Reading brochures (technical context), telephone messages / social media messages relevant to technical contexts and emails. Writing - Writing emails / letters introducing oneself. Grammar - Present Tense (simple and progressive); Question types: Why / Yes or No / and Tags. Vocabulary - Synonyms; One word substitution; Abbreviations & Acronyms (as used in technical contexts).

UNIT II NARRATION AND SUMMATION 9

Reading - Reading biographies, travelogues, newspaper reports, Excerpts from literature, and travel & technical blogs. Writing - Guided writing-- Paragraph writing; Short Report on an event (field trip etc.) Grammar –Past tense (simple); Subject-Verb Agreement; and Prepositions. Vocabulary - Word forms (prefixes& suffixes); Synonyms and Antonyms. Phrasal verbs.

UNIT III DESCRIPTION OF A PROCESS / PRODUCT 9

Reading – Reading advertisements, gadget reviews; user manuals. Writing - Writing definitions; instructions; and Product /Process description. Grammar - Imperatives; Adjectives; Degrees of

comparison; Present & Past Perfect Tenses. Vocabulary - Compound Nouns, Homonyms; and Homophones, discourse markers (connectives & sequence words).
UNIT IV CLASSIFICATION AND RECOMMENDATIONS 9 Reading – Newspaper articles; Journal reports –and Non-Verbal Communication (tables, pie charts etc.). Writing – Note-making / Note-taking (*Study skills to be taught, not tested); Writing recommendations; Transferring information from non-verbal (chart, graph etc., to verbal mode) Grammar – Articles; Pronouns - Possessive & Relative pronouns. Vocabulary - Collocations; Fixed / Semi fixed expressions.
UNIT V EXPRESSION 9 Reading – Reading editorials; and Opinion Blogs; Writing – Essay Writing (Descriptive or narrative), Dialogue-writing. Grammar – Future Tenses, Punctuation; Negation (Statements & Questions); and Simple, Compound & Complex Sentences. Vocabulary - Cause & Effect Expressions – Content vs Function words.
Total Periods:45

PRACTICAL – LIST OF EXPERIMENTS

Sl. No.	Practical – List of experiments:
1	Listening comprehension
2	Telephone conversation & Introductions (listening & speaking)
3	Mock Interviews
4	Narrating personal experiences
5	Short Oral Presentations
6	Advertising a product
7	Situational conversation – 3 in a team
8	Creating educational videos
9	Group discussion
10	ICT based presentations
	Total Periods:30

Learning Resources

1	Communication Book, Portfolio Penguin, 2018. Authored by Mikael Krogerus, Roman Tschäppeler. ISBN-13 : 978-0241982280.
2	English for Science & Technology, Cambridge University Press, 2021. Authored by Dr.Veena Selvam, Dr.Sujatha Priyadarshini, Dr.Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.
3	Technical Communication – Principles And Practices By Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.
4	English For Technical Communication (With CD) By AyshaViswamohan, Mcgraw Hill Education, ISBN : 0070264244, 2008.
5	How to win at Interviews & Group Discussions, Abhishek Publications, 2014. Authored by D.S.Cheema, ISBN: 9788182475175, 8182475171.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain different points of view during discussions.	Apply
CO2	Prepare for formal ICT based presentations and video creation.	Apply
CO3	Construct English sentences in both formal and informal contexts.	Apply
CO4	Interpret technical texts, audio materials and visual representation.	Understand
CO5	Write letters, definitions, descriptions, narrations and essays on various topics.	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24PH113	**ENGINEERING PHYSICS**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

Course Objective:

After completing this course, the students will be able to:

- To make the students effectively to achieve an understanding of mechanics.
- To enable the students to gain knowledge of electromagnetic waves, optics and its applications.
- To introduce the basics knowledge of lasers and fibre optics.
- Equipping the students to successfully understand the importance of quantum mechanics.
- To make the students understand the basics of crystal structure and its importance in studying materials properties.

Detailed Syllabus

UNIT I MECHANICS 9

Multi-particle dynamics: Center of mass (CM) – CM of continuous bodies – motion of the CM Rotation of rigid bodies: Rotational kinematics – Theorems of M .I –moment of inertia of continuous bodies – torque – rotational dynamics of rigid bodies — gyroscope - torsional pendulum – double pendulum.

UNIT II ELECTROMAGNETIC WAVES AND OPTICS 9

Maxwell's equations - wave equation; Conditions on the wave field - properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - Producing electromagnetic waves - Cell-phone reception.

Reflection and refraction of light waves - interference –Michelson interferometer –Theory of air wedge and experiment.

UNIT III LASERS AND FIBRE OPTICS 9

Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein's coefficients - population inversion - Nd-YAG laser, CO2 laser, semiconductor laser –Basic applications of lasers in industry.

Fiber optics: Principle, Numerical aperture and acceptance angle –types of optical fibers (material, refractive index, mode)- fibre optic communication- losses associated with optical fibers- fibre optic sensors: pressure and displacement- medical endoscope.

UNIT IV QUANTUM MECHANICS 9

Photons and light waves - Electrons and matter waves –Compton effect - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization – particle in a infinite potential well: 1D- particle in a infinite potential well:2D and 3D Boxes (Qualitative).

UNIT V CRYSTAL PHYSICS 9

Crystal structures: Crystal structures: BCC, FCC and HCP – crystal imperfections- edge and screw dislocations – grain and twin boundaries - Burgers vector and elastic strain energy- Slip systems, plastic deformation of materials and Miller indices –distance between successive planes – crystalline and noncrystalline material.

Total Periods:45

PRACTICAL – LIST OF EXPERIMENTS

Sl. No.	Practical – List of experiments (Any Seven experiments)
1	Determination of rigidity modulus – Torsion pendulum
2	Determination of Young's modulus by non-uniform bending method
3	Determination of wavelength using Laser.
4	Determination of Numerical aperture and acceptance angle in an optical fiber.
5	Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer
6	Determination of thickness of a thin wire – Air wedge method
7	Determination of band gap of a semiconductor
8	Determination of Young's modulus by uniform bending method.
9	Compact disc- Determination of width of the groove using laser.
10	Simple harmonic oscillations of cantilever.
11	Spectrometer - Determination of wavelength of Mercury Spectrum using diffraction grating.
12	Michelson's interferometer -Determine the wave length of monochromatic light.
13	Melde's Experiment - Determine the Frequency of a tuning fork.
	Total Periods:30

Learning Resources

1	D. Kleppner and R. Kolenkow, An Introduction to Mechanics. McGraw Hill Education (Indian Edition), 2017.
2	E.M. Purcell and D.J. Morin, Electricity and Magnetism, Cambridge Univ.Press, 2013.
3	Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, Concepts of Modern Physics,McGraw-Hill (Indian Edition), 2017.
4	Gaur R K and Gupta S L, "Engineering Physics", DhanpatRai Publications, 2018.
5	Charles Kittel, "Introduction to Solid State Physics", Wiley India Pvt. Ltd, 7th ed., 2017.



6	D. K. Mynbaev and Lowell L. Scheiner, Fiber Optic Communication Technology, 2011,1st Edition, Pearson, USA.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Apply the principles of mechanics to solve problems.	Apply
CO2	Apply the knowledge of the Maxwell's equations for electromagnetic waves and optics.	Apply
CO3	Apply the knowledge on the concepts of laser and their applications in fiber optics.	Apply
CO4	Apply quantum mechanical principles towards the formation of energy bands.	Apply
CO5	Describe the basics of crystals, their structures and defects.	Understand

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24CY113	ENGINEERING CHEMISTRY	L	T	P	C
		3	0	2	4

Course Objective:

After completing this course, the students will be able to:

- To inculcate sound understanding of water quality parameters and water treatment techniques.
- To impart knowledge on the basic principles and preparatory methods of nanomaterials.
- To introduce the basic concepts and applications of phase rule and composites.
- To facilitate the understanding of different types of fuels, their preparation, properties and combustion characteristics.
- To familiarize the students with the operating principles, working processes and applications of energy conversion and storage devices.

Detailed Syllabus

UNIT I WATER AND ITS TREATMENT 9

Water: Sources and impurities, Water quality parameters - color, odour, turbidity, pH, hardness, alkalinity, TDS, COD and BOD, fluoride and arsenic.

Municipal water treatment: primary treatment and disinfection (UV, Ozonation, break-point chlorination). Desalination of brackish water-Reverse Osmosis.

Boiler troubles - Scale and sludge, Boiler corrosion, Caustic embrittlement, Priming & foaming.

Treatment of boiler feed water: Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) and External treatment – Ion exchange demineralization and zeolite process.

UNIT II NANOCHEMISTRY 9

Distinction between molecules, nanomaterials and bulk materials; Size-dependent properties (optical, electrical, mechanical and magnetic);

Types of nanomaterials: Definition, properties and uses of – nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro spinning. Applications of nanomaterials in medicine, agriculture, energy, electronics and catalysis.

UNIT III PHASE RULE AND COMPOSITES 9

Phase rule: Introduction, definition of terms with examples. One component system - water system; Reduced phase rule; Construction of a simple eutectic phase diagram - Thermal analysis; Two component system: lead-silver system - Pattinson process.

Composites: Introduction: Definition & Need for composites; Constitution: Matrix materials (Polymer matrix, metal matrix and ceramic matrix) and Reinforcement (fiber, particulates, flakes and whiskers). **Nano Composites:** Properties and applications of Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites. Hybrid composites - definition and examples.

UNIT IV FUELS AND COMBUSTION 9

Fuels: Introduction: Classification of fuels; Coal and coke: Analysis of coal (proximate and ultimate), Carbonization, Manufacture of metallurgical coke (Otto Hoffmann method). Petroleum and Diesel: Manufacture of synthetic petrol (Bergius process), Knocking - octane number, diesel oil - cetane number; Power alcohol and biodiesel.

Combustion of fuels: Introduction: Calorific value - higher and lower calorific values, Theoretical calculation of calorific value; Ignition temperature: spontaneous ignition temperature, Explosive range; Flue gas analysis - ORSAT Method.

UNIT V ENERGY SOURCES AND STORAGE DEVICES 9

Nuclear energy: light water nuclear power plant, breeder reactor. Solar energy conversion: Principle, working and applications of Silicon (si) Solar cell, Wind energy, Geo thermal energy.

Batteries: Types of batteries, Primary battery - dry cell, Secondary battery - lead acid battery and lithium- ion battery; Electric vehicles - working principles; Fuel cells: H_2-O_2 fuel cell, microbial fuel cell; Super capacitors: Storage principle, types and examples.

Total Periods:45

PRACTICAL – LIST OF EXPERIMENTS

Sl. No.	Practical – List of experiments (Any Seven experiments)
1	Determination of types and amount of alkalinity in a water sample. - Split the first experiment into two.
2	Determination of total, temporary & permanent hardness of water by EDTA method.
3	Determination of DO content of water sample by Winkler's method.
4	Determination of chloride content of water sample by Argentometric method.
5	Determination of strength of given hydrochloric acid using pH meter.
6	Determination of strength of acids in a mixture of acids using conductivity meter.

7	Conductometric titration of barium chloride against sodium sulphate (precipitation titration)
8	Conductometric titration of strong acid vs strong base.
9	Estimation of iron content of the given solution using potentiometer.
10	Estimation of sodium /potassium present in water using a flame photometer.
	Total Periods:30

Learning Resources

1	P. C. Jain and Monica Jain, “Engineering Chemistry”, 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2018.
2	Sivasankar B., “Engineering Chemistry”, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
3	Mary Francisca.L.J, Engineering Chemistry-I, 1, 2004.
4	O.G. Palanna, “Engineering Chemistry” McGraw Hill Education (India) Private Limited, 2nd Edition, 2017.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Describe the water treatment processes and Calculate the quality parameters of different types in Water Samples and Apply the appropriate method to find the PH, conductance and potential values of various solutions	Understand
CO2	Apply the concepts of nano science in Engineering Applications.	Apply
CO3	Apply the knowledge of phase rule and composites for material selection requirements	Apply
CO4	Identify the types of fuels and calculate the calorific value, explosive range for engineering processes.	Understand
CO5	Apply suitable energy resources for Engineering sectors.	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24GE122	PROBLEM SOLVING USING PYTHON LABORATORY	L	T	P	C
		0	0	4	2

Course Objective:

After completing this course, the students will be able to:

- To learn about Variables, Operators available and how to write loops and decision statements in Python.
- To learn and Implement programs using non recursive and recursive functions.
- To Learn and execute a program using different Data Types - String, List, advance List, Dictionary, Tuple, Sets, Python Modules and packages.
- To learn how to read and write files in Python and also learn to use exception handling in Python applications for error handling.
- To build a mini project using fundamental programming constructs like variables, conditional logic, looping, and function and other required modules.

List of Experiments

1	Environment Setup and execute Basic Exercise to learn about Variables, Operators available in python.
2	Execute programs using Python Control Flow -Python Loops and Control Statements
3	Implement programs using String and array in python.
4	Write functions and pass arguments [Non Recursive, Recursive] in Python
5	Execute program to learn different Data Types in python- String, List, advance List, Dictionary, Tuple, Sets
6	Learn and execute programs using Python Modules and packages.
7	Execute program using Python Directory and Files Management.
8	Implement program to learn about python exception handling
9	Mini project [Group project- demo and presentation]
	Total Periods: 60

Learning Resources

1	Allen B. Downey, “Think Python: How to Think like a Computer Scientist”, 2nd Edition, O’Reilly Publishers, 2016.
2	Karl Beecher, “Computational Thinking: A Beginner's Guide to Problem Solving and Programming”, 1st Edition, BCS Learning & Development Limited, 2017.
3	Paul Deitel and Harvey Deitel, “Python for Programmers”, Pearson Education, 1st Edition, 2021.
4	G Venkatesh and Madhavan Mukund, “Computational Thinking: A Primer for Programmers and Data Scientists”, 1st Edition, Notion Press, 2021.
	Reema Thareja, “Python Programming using problem solving approach”, 2019, Oxford University Press.
5	John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data”, Third Edition, MIT Press, 2021
6	Eric Matthes, “Python Crash Course, A Hands - on Project Based Introduction to Programming”, 2nd Edition, No Starch Press, 2019. https://www.python.org/
7	Martin C. Brown, “Python: The Complete Reference”, 4th Edition, Mc-Graw Hill, 2018.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Understand and make use of Variables, Operators available and how to write loops and decision statements in Python.	Apply
CO2	Execute programs to implement non recursive and recursive functions in Python.	Apply
CO3	Write Python Programs using core data structures like array, string, Lists, Set, Dictionaries and use Tuples.	Apply
CO4	Use and carry out examples to handle File Systems and exception handling in Python.	Apply
CO5	Deconstruct exemplary applications in Python.	Analyse

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24MA211	Statistics and Numerical Methods	BSC	3	1	0	4	4	40	60
2	U24PH211	Materials Science	BSC	3	0	0	3	3	40	60
3	U24EE211	Basic Electrical and Electronics Engineering	ESC	3	0	0	3	3	40	60
4	U24CE211	Engineering Graphics	ESC	2	0	4	6	4	40	60
5	U24HS211	Tamils and Technology	HSMC	1	0	0	1	1	40	60
THEORY CUM PRACTICAL COURSES										
6	U24HS223	Technical English for Engineers	HSMC	2	0	2	4	3	50	50
PRACTICAL COURSES										
7	U24CE232	Engineering Practices Laboratory for Civil and Mechanical Engineers	ESC	0	0	4	4	2	60	40
8	U24EE222	Basic Electrical and Electronics Engineering Laboratory	ESC	0	0	4	4	2	60	40
9	U24EM212	Professional Development	EEC	0	0	2	2	1	100	
				14	**1**	**16**	**31**	**23**		

ASSESSMENT SCHEME

Sl. No	Course Type	L	T	P	C	CIA Weightage (Theory)				CIA	ESE		CIA (W)	ESE (W)	Min. Marks to Pass for 100	
						T1	A1	T2	A2	Prac	Th	Prac			ESE	Total
1	U24MA211	3	1	0	4	60	40	60	40	-	100	-	40	60	45	50
2	U24PH211	3	0	0	3	60	40	60	40	-	100	-	40	60	45	50
3	U24EE211	3	0	0	3	60	40	60	40	-	100	-	40	60	45	50
4	U24CE211	2	0	4	4	60	40	60	40	-	100	-	40	60	45	50
5	U24HS211	1	0	0	1	60	40	60	40	-	100	-	40	60	45	50
6	U24HS223	2	0	2	3	60	40	60	40	100	50	50	50	50	45	50
7	U24CE232	0	0	4	2	-	-	-	-	100	-	100	60	40	45	50
8	U24EE222	0	0	4	2	-	-	-	-	100	-	100	60	40	45	50
9	U24EM212	0	0	2	1	-	-	-	-	-	-	-	100	-	-	50

(W) – Weightage

U24MA211	STATISTICS AND NUMERICAL METHODS	L	T	P	C
		3	1	0	4

Course Objective:

After completing this course, the students will be able to:

- This course aims at providing the necessary basic concepts of a few statistical and numerical methods and gives procedure for solving numerically different kinds of problems occurring in engineering and technology.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems?
- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines?
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations

Detailed Syllabus

UNIT I TESTING OF HYPOTHESIS 9+3

Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample tests based on Normal distribution for single mean and difference of means -Tests based on t, Chi-square and F- distributions for mean, variance and proportion - Contingency table (test for independent) - Goodness of fit.

UNIT II DESIGN OF EXPERIMENTS 9+3

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

UNIT III SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 9+3

Solution of algebraic and transcendental equations - - Fixed point iteration method - Newton Raphson method - Solution of linear system of equations - Gauss elimination method –Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigenvalues of a matrix by Power method.

UNIT IV INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION 9+3

Lagrange's and Newton's divided difference interpolation – Newton's forward and backward difference interpolation – Approximation of derivatives using interpolation polynomials - Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

UNIT V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS9+3

Single step methods: Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge-Kutta method for solving first order equations - Multi step methods: Milne's and Adams - Bash forth predictor corrector methods for solving first order equations.

Total Periods: 60

Learning Resources

1	Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 44th Edition, New Delhi, 2015.



2	Johnson, R.A., Miller, I and Freund J., “Miller and Freund’s Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
3	Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum’s Outlines on Probability and Statistics ", Tata McGraw Hill Edition, 4th Edition, 2012.
4	Gupta S.C. and Kapoor V. K., “Fundamentals of Mathematical Statistics”, Sultan Chand & Sons, New Delhi, 12th Edition 2020.
5	Devore. J.L., “Probability and Statistics for Engineering and the Sciences”, Cengage Learning, New Delhi, 8th Edition, 2014.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Apply the concept of testing of hypothesis for small and large samples in real life problems.	Apply
CO2	Apply the basic concepts of classifications of design of experiments in the engineering field.	Apply
CO3	Determine the numerical solution of algebraic, transcendental and system of linear equations.	Apply
CO4	Apply appropriate numerical methods to solve the interpolation with equal and unequal intervals.	Apply
CO5	Determine the solution of ordinary differential equation of first order by Euler, Taylor and Runge-Kutta methods.	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24PH211	MATERIALS SCIENCE	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- To introduce the basics of heat transfer through different materials, thermal performance of building and various thermal applications.
- To impart knowledge on the ventilation and air conditioning of buildings.
- To introduce the concepts of sound insulation and lighting designs.
- To introduce the properties and applications of semiconductor, magnetic materials.
- To give an introduction to the processing and applications of new engineering materials.

Detailed Syllabus

UNIT I THERMAL APPLICATIONS 9
Principles of heat transfer, steady state of heat flow, conduction through compound media-series and parallel-heat transfer through fenestrations, thermal insulation and its benefits- heat gain and heat loss estimation - factors affecting the thermal performance of buildings, thermal measurements, thermal comfort, indices of thermal comfort, climate and design of solar radiation, shading devices-central heating.
UNIT II VENTILATION AND REFRIGERATION 9
Requirements, principles of natural ventilation- ventilation measurements, design for natural ventilation-Window type sand packaged air conditioners- chilled water plant- fan coil systems-water piping-cooling load-Air conditioning systems for different types of buildings-Protection against fire to be caused by AC. Systems.
UNIT III ACOUSTICS AND LIGHTING DESIGNS 9
Methods of sound absorptions – absorbing materials – noise and its measurements, sound insulation and its measurements, impact of noise in multistoried buildings. Visual field glare, colour daylight calculations – daylight design of windows, measurement of day – light and use of models and artificial skies, principles of artificial lighting, supplementary artificial lighting.
UNIT IV SEMICONDUCTOR AND MAGNETIC PROPERTIES OF MATERIALS 9
Intrinsic Semiconductors – Energy band diagram – Direct and indirect band gap semiconductors – Intrinsic semiconductors – Extrinsic semiconductors –Variation of carrier concentration with temperature – Carrier transport in Semiconductor: drift and diffusion – Ohmic contacts. Magnetic dipole moment –Magnetic permeability and susceptibility – Magnetic material classification: Diamagnetism – Paramagnetism – Ferromagnetism – Antiferromagnetism–Hard and soft magnetic materials.
UNIT V NEW ENGINEERING MATERIALS 9
Composites – Definition and Classification – Fibre reinforced plastics (FRP) and fiber reinforced metals (FRM) – Metallic glasses – Shape memory alloys – Ceramics – Classification – Crystalline –Non Crystalline – Bonded ceramics, Manufacturing methods – Slip casting - Isostatic pressing-Gas pressure bonding – Properties - thermal, mechanical, electrical and chemical ceramic fibres - ferroelectric and ferromagnetic ceramics – High Aluminium ceramics.
Total Periods: 45

Learning Resources

1	Marko Pinteric, Building Physics, Springer 2017.
2	William D Callister and David G. Rethwisch, “Material Science and Engineering: An Introduction”, John Wiley, 10th Edition, 2018.
3	Stevens. W .R. “Building Physics: Lighting: Seeing in the Artificial Environment”, Pergamon Press, 2013.
4	Charles Kittel, Introduction to Solid State Physics, Wiley India Edition, 2019.
5	D.S.Mathur, Elements of Properties of Matter, S Chand & Company, 2010.
6	Hugo Hens, Building Physics: Heat, Air and Moisture, Wiley, 2017.
7	Hugo Hens, Applied Building Physics, Wiley, 2016.
8	Raghavan.V, “Materials Science and Engineering”, Prentice-Hall, 6th Edition, 2015.

Course Outcomes

At the end of the course, the students will be able to		
CO	Course Outcome Statement	Knowledge Level
CO1	Apply the basics of heat transfer through different materials, thermal performance of building and various thermal applications.	Apply
CO2	Describe knowledge on the ventilation and air conditioning of buildings.	Understand
CO3	Apply the concepts of sound insulation and lighting designs.	Apply
CO4	Describe concepts of semiconductors and magnetic properties of materials	Understand
CO5	Describe basic knowledge about new engineering materials.	Understand

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EE211	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- To improve the communicative competence of learners
- To understand Basic DC & AC electrical circuits
- To impart knowledge in Basic Electrical wiring & Safety and Protection.
- To understand basic principles of Transformers and Rotating Machines.
- To educate on the fundamental concepts of analog devices & digital electronics.
- To introduce the Working principle of various measuring instruments.

Detailed Syllabus

UNIT I BASIC CONCEPTS OF DC ELECTRIC CIRCUITS 9

Basic Terminology, Resistances in series and parallel; Capacitors & Inductors: energy stored. Ohm's Law and Kirchhoff's Laws-Problems; Analysis of DC electric circuits: Mesh current method - Node voltage methods- Numerical problems. Introduction to AC Circuits and Parameters: Waveforms, Average value, RMS Value, power, power factor. solutions of sinusoidally excited R-L-C circuits.

UNIT II ELECTRICAL WIRING 9

Connectors and switches, systems of wiring, domestic wiring installation, sub circuits in domestic wiring, simple control circuit in domestic installation, industrial electrification. SAFETY and PROTECTION: Safety, electric shock, first aid for electric shock and other hazards, safety rules, use of multimeters, grounding, importance of grounding, equipment grounding for safety. Protection-need for earthing, fuses and circuit breakers. Energy Tariff calculation for domestic loads.

UNIT III ELECTRICAL DC & AC MACHINES 9

Constructional features, working principle of DC motor and DC generator, Emf and Voltage equations. Three phase circuit and production of rotating magnetic field. Working principle of induction motor and torque-speed characteristics (concept only). Single-Phase Transformer: Brief idea on constructional parts, classifications, working principle. EMF equation.

UNIT IV ANALOG & DIGITAL ELECTRONICS 9

Semiconductor Materials: Silicon & Germanium – PN Junction Diodes, Zener Diode – Characteristics Applications – Bipolar Junction Transistor, Thyristors- Types, I-V Characteristics and Applications. Review of number systems-SOP and POS forms, K-map representations - minimization using K maps (Simple Problems).

UNIT V MEASUREMENTS & INSTRUMENTATION 9

Transducers; Definitions, Types of transducers and their applications for measurements-Classification of instruments-Types of indicating Instruments - Energy meter - multimeters – Oscilloscopes – three-phase power measurement, instrument transformers (CT and PT), DSO-Block diagram

Total Periods: 45

Learning Resources

1	Kothari DP and I.J Nagrath, “Basic Electrical and Electronics Engineering”, Second Edition, McGraw Hill Education, 2020
2	Sedha R.S., “A text book book of Applied Electronics”, S. Chand & Co., 2008
3	S.K. Bhattacharya “Basic Electrical and Electronics Engineering”, Pearson Education, Second Edition, 2017.
4	Fundamentals of Electrical and Electronics Engineering, B. L. Theraja, S. Chand and Company. REPRINT 2013, ISBN 8121926602
5	Del. Toro, “Principles of Electrical Engineering”, Prentice Hall of India
6	A.K. Sawhney, Puneet Sawhney ‘A Course in Electrical & Electronic Measurements & Instrumentation’, Dhanpat Rai and Co, 2015.

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Demonstrate a comprehensive understanding of elementary concepts in DC & AC electrical circuits.	Apply
CO2	Explain the principles and practices of electrical wiring & concepts of safety and protection.	Understand
CO3	Summarize a comprehensive observation of electrical rotating machines.	Analyse
CO4	Analyze the characteristics, basic concepts of analog & digital electronics.	Analyse
CO5	Classify operating principles of measuring Instruments.	Analyse

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24CE211	ENGINEERING GRAPHICS	L	T	P	C
		2	0	4	4

Course Objective:

After completing this course, the students will be able to:

- Drawing engineering curves.
- Drawing projection of points, lines and plane surfaces.
- Drawing orthographic projection of solids and freehand sketches.
- Drawing projection of sectioned solids and development of surfaces.
- Drawing isometric and perspective projections of simple solids.

Detailed Syllabus

UNIT – I PLANE CURVES 6+12

Basic Geometrical constructions, Curves used in engineering practices: Conics - Construction of ellipse, parabola and hyperbola by eccentricity method -Construction of cycloid, Epicycloid and Hypocycloid - construction of involutes of square, circle and polygon - Drawing of tangents and normal to the above curves.

UNIT – II PROJECTION OF POINTS, LINES AND PLANE SURFACE 6+12

Orthographic projection- Principles-Principal Planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method. Projection of planes (square, circle and polygon) - Inclined to H.P & V.P.

UNIT – III PROJECTION OF SOLIDS AND FREEHAND SKETCHING 6+12

Projection of simple solids like prisms, pyramids, cylinders, cones when the axis is inclined to one of the principal planes and parallel to the other by rotating object method. Visualization concepts and Free Hand sketching: Visualization principles -Representation of Three Dimensional objects - Layout of views- Freehand sketching of multiple views from pictorial views of objects.

UNIT – IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 6+12

Sectioning of solids (Prisms, pyramids cylinders and cones) in simple vertical position when the cutting plane is inclined to one of the principal planes and perpendicular to the other - Obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids - Prisms, pyramids cylinders and cones. (Inclined to H.P or V.P)

UNIT – V ISOMETRIC AND PERSPECTIVE PROJECTIONS 6+12

Principles of isometric projection - isometric scale - isometric projections of simple solids Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions - Perspective projection of simple Solids-Prisms, pyramids and cylinders by visual ray method.

Total Periods:90

Learning Resources

1	Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 53rd Edition, 2019.
2	Natrajan K.V., “A Text Book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2018.
3	Venugopal K. and Prabhu Raja V., “Engineering Graphics", New Age International (P) Limited, 2008.
4	Basant Agarwal and Agarwal C.M., “Engineering Drawing”, McGraw Hill, 2nd Edition, 2019
5	Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Publications, Bangalore, 27th Edition, 2017.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Construct the conic curves, cycloids and involutes.	Apply
CO2	Solve problems involving projection of points, lines and plane surfaces	Apply
CO3	Construct projection of simple solids and Free hand sketches	Apply
CO4	Construct projection of simple sectioned solids and development of surfaces	Apply
CO5	Solve problems involving isometric and perspective projections of simple solids.	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24HS211	**தமிழரும் தொழில்நுட்பமும் / TAMILS AND TECHNOLOGY**	**L**	**T**	**P**	**C**
		1	**0**	**0**	**1**

Course Objective:

After completing this course, the students will be able to:

- To facilitate the student to understand weaving and technology of sangam age.
- To create an awareness on structural design of Tamils during sangam age.
- To help students to distinguish between all the levels of manufacturing technology in ancient period.
- To understand the ancient knowledge of agriculture and irrigation technology.
- To enable the students to understand the digitalization of Tamil Language.

Detailed 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.
UNIT III MANUFACTURING TECHNOLOGY 3 Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and goldCoins 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.
Total Periods:15

Learning Resources

1	Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
2	Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
3	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
4	The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies).
5	Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu).
6	Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author).
7	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu).
8	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Review the Weaving and Ceramic Technology during Tamil Sangam Age.	Understand
CO2	Describe the Construction Technology and various Architecture during Tamil Sangam Age.	Understand
CO3	Discuss the Manufacturing Technology with Archeological Evidences.	Understand
CO4	Explain the Agriculture and Irrigation Technology during Tamil Sangam Age.	Understand
CO5	Decribe Tamil Software and Digitialization Tamil Literatures.	Understand

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24HS223	**TECHNICAL ENGLISH FOR ENGINEERS**	**L**	**T**	**P**	**C**
		2	**0**	**2**	**3**

Course Objective:

After completing this course, the students will be able to:

- To engage learners in meaningful language activities to improve their LSRW skills.
- To enhance learners' awareness of general rules of writing for specific audiences.
- To help learners understand the purpose, audience, contexts of different types of writing.
- To develop analytical thinking skills for problem solving in communicative contexts.
- To demonstrate an understanding of job applications and interviews for internship and placements.

Detailed Syllabus

UNIT I MAKING COMPARISONS 6

Reading - Reading advertisements, user manuals, brochures; Writing – Professional emails, Email etiquette - Compare and Contrast Essay; Grammar – Mixed Tenses, Prepositional phrases.

UNIT II EXPRESSING CAUSAL RELATIONS IN SPEAKING AND WRITING 6

Reading - Reading longer technical texts– Cause and Effect Essays, and Letters / emails of complaint, Writing - Writing responses to complaints. Grammar - Active Passive Voice transformations, Infinitive and Gerunds

UNIT III PROBLEM SOLVING 6

Reading - Case Studies, excerpts from literary texts, news reports etc. Writing – Letter to the Editor, Checklists, Problem solution essay / Argumentative Essay. Grammar – Error correction; If conditional sentences

UNIT IV REPORTING OF EVENTS AND RESEARCH 6 Reading –Newspaper articles; Writing – Proposal writing - Picture description - Accident Report, Survey Report. Grammar – Reported Speech, Modals Vocabulary – Conjunctions- use of prepositions.
UNIT V THE ABILITY TO PUT IDEAS OR INFORMATION COGENTLY 6 Reading – Company profiles, Statement of Purpose, (SOP), an excerpt of interview with professionals; Writing – Job / Internship application – Cover letter & Resume; Grammar – Numerical adjectives, Relative Clauses.
Total Periods:30

PRACTICAL – LIST OF EXPERIMENTS

Sl. No.	Practical – List of experiments
1	Role Play Exercises Based on Workplace Contexts
2	Understanding lexical items via movie clippings – Individual task
3	Discussing news stories
4	Dialogues (with cue cards)-Understanding common technology terms
5	Pronunciation, Intonation, Stress and Rhythm (Level 1)
6	Pronunciation, Intonation, Stress and Rhythm (Level 2)
7	Public Speech: Talking about self in a Professional Setting, Introduction of Speakers, Vote of thanks - 3 in a team
8	Writing a short article (Can be compiled as a magazine)
9	Verbal ability exercises for competitive examinations
10	Visume
	TOTAL: 30 PERIODS

Learning Resources

1	English for Engineers & Technologists (2020 edition) Orient Blackswan Private Ltd. Department of English, Anna University.
2	English for Science & Technology Cambridge University Press 2021 Authored by Dr.Veena Selvam, Dr.Sujatha Priyadarshini, Dr.Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.
3	Better English Pronunciation, (2005), J.D.O'Connor, Second Edition, and ISBN-13:978-0521682589.
4	Raman. Meenakshi, Sharma. Sangeeta (2019). Professional English. Oxford university press. New Delhi.
5	Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, New Delhi.
6	A Modern Approach to Verbal & Non-Verbal Reasoning - Includes Latest Questions and their Solutions, Revised Edition, R.S.Aggarwal, January 2018.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Articulate English with proper pronunciation, intonation, stress and rhythm.	Apply
CO2	Develop verbal ability skills for attending competitive examinations.	Apply

CO3	Employ speaking and writing skills in professional contexts.	Apply
CO4	Write effective resumes in the context of job search.	Apply
CO5	Interpret the denotative and connotative meanings of technical texts.	Understand

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24CE232	ENGINEERING PRACTICES FOR CIVIL AND MECHANICAL ENGINEERS	L	T	P	C
		0	0	4	2

Course Objective:

After completing this course, the students will be able to:

- Use suitable tools for making carpentry components and pipe connections for plumbing works.
- Apply the welding techniques to join the structures.
- Performing the basic machining operations using Lathe and drilling machine.
- Apply sheet metal and foundry operations to make household products.
- Demonstrating assembly of a Fridge and household washing machine.

List of Experiments

CIVIL ENGINEERING PRACTICES	
Plumbing Works	
	Demonstrating basic plumbing operations
1	Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in households.
2	Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.
Carpentry Works	
	Demonstrating basic carpentry operations
3	Making a T-Joint
4	Making wooden furniture using carpentry operations
MECHANICAL ENGINEERING PRACTICES	
Welding	
	Demonstrating basic welding operations
5	Preparation of butt joint and lap joints by Shielded metal arc welding.
6	Studying on Gas welding practice
Basic Machining	
7	Making (simple)Turning on mild steel rod using Lathe machine
8	Making (simple) Drilling on mild steel plate using drilling machine
Sheet metal Work	
	Demonstrating basic sheet metal operations
9	Model Making of a square Tray

Foundry Work	
	Demonstrating basic foundry operations.
10	Model Making of a computer Mouse
Assembly Work	
	Demonstrating basic assembly operations
11	Study on Assembling a Fridge.
12	Study on Assembling a household washing machine
	Total Periods: 60

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Draw pipe line plan; lay and connect various pipe fittings used in common household plumbing work; Saw; plan; make joints in wood materials used in common household woodwork.	Apply
CO2	Apply weld techniques to join structures using arc welding	Apply
CO3	Practice simple machining work	Apply
CO4	Apply sheet metal and foundry operations to make household products.	Apply
CO5	Demonstrate assembling of a Fridge and household washing machine	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EE222	**BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

Course Objective:

After completing this course, the students will be able to:

- To provide hands-on experience in the operation and testing of basic electrical circuits and components.
- To familiarize students with laboratory equipment and techniques commonly used in electrical engineering
- To promote teamwork, communication, and problem-solving abilities through collaborative laboratory activities and projects.

List of Experiments

S. No.	List of experiments:
1	To identify and understand the use of different electronic and electrical instruments.
2	Load test on separately excited DC generator
3	Load test on DC shunt motor.
4	Load test on Single phase Transformer
5	Load test on Induction motor
6	Verification of Circuit Laws
7	Three-phase Power measurement with two wattmeter methods.

S. No.	List of experiments:
8	Study of half wave and Full-wave (Bridge) rectifiers with and without capacitor filter circuit.
9	Realization of basic logic gates: Truth table verification of OR, AND, NOT, NOT and NAND logic gates
10	Study of CRO and measurement of AC signals
11	Characteristics of LVDT
	TOTAL: 60 PERIODS

Learning Resources

1	Basic Electrical and Electronics Engineering Laboratory Manual" Author: S. K. Bhattacharya, Debabrata Chattopadhyay Publisher: Prentice Hall India Learning Private Limited
2	Sedha R.S., “A text book of Applied Electronics”, S. Chand & Co., 2008.
3	Introduction to Electrical Engineering Laboratory Experiments, Author: Anthony J. Hayter, David T. Hayt Publisher: Wiley.
4	Electrical Engineering Laboratory Experiments, Author: Allen M. Agarwal, Dr. S. T. Kamala, Dr. S. Jayalakshmi Publisher: New Age International Del. Toro, “Principles of Electrical Engineering”, Prentice Hall of India.
5	Fundamentals of Electric Circuits Laboratory Manual" Author: Charles K. Alexander, Matthew N. O. Sadiku Publisher: McGraw-Hill Education.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Draw pipe line plan; lay and connect various pipe fittings used in common household plumbing work; Saw; plan; make joints in wood materials used in common household woodwork.	Apply
CO2	Apply weld techniques to join structures using arc welding	Apply
CO3	Practice simple machining work	Apply
CO4	Apply sheet metal and foundry operations to make household products.	Apply
CO5	Demonstrate assembling of a Fridge and household washing machine	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EM212	PROFESSIONAL DEVELOPMENT	L	T	P	C
		0	0	2	1

Course Objective:

After completing this course, the students will be able to:

- To be proficient in important Microsoft Office tools: MS WORD, EXCEL, and POWERPOINT.
- To be proficient in using MS WORD to create quality technical documents, by using standard templates, widely acceptable styles and formats, variety of features to enhance the presentability and overall utility value of content.
- To be proficient in using MS EXCEL for all data manipulation tasks including the common statistical, logical, mathematical etc., operations, conversion, analytics, search and explore, visualize, interlink, and utilizing many more critical features offered
- To be able to create and share quality presentations by using the features of MS PowerPoint, including: organization of content, presentability, aesthetics, using media elements and enhance the overall quality of presentations.

List of Experiments

S. No.	List of experiments:
1	**MS WORD: (10 Periods)** Create and format a document Working with tables Working with Bullets and Lists Working with styles, shapes, smart art, charts Inserting objects, charts and importing objects from other office tools Creating and Using document templates Inserting equations, symbols and special characters Working with Table of contents and References, citations Insert and review comments Create bookmarks, hyperlinks, endnotes footnote Viewing document in different modes Working with document protection and security Inspect document for accessibility
2	**MS EXCEL: 10 Periods** Create worksheets, insert and format data Work with different types of data: text, currency, date, numeric etc. Split, validate, consolidate, Convert data Sort and filter data Perform calculations and use functions: (Statistical, Logical, Mathematical, date, Time etc.,) Work with Lookup and reference formulae Create and Work with different types of charts Use pivot tables to summarize and analyse data Perform data analysis using own formulae and functions Combine data from multiple worksheets using own formulae and built-in functions to generate results Export data and sheets to other file formats Working with macros Protecting data and Securing the workbook
3	**MS POWERPOINT: 10 Periods** Select slide templates, layout and themes Formatting slide content and using bullets and numbering Insert and format images, smart art, tables, charts



	Using Slide master, notes and handout master Working with animation and transitions Organize and Group slides Import or create and use media objects: audio, video, animation Perform slideshow recording and Record narration and create presentable videos
TOTAL: 30 PERIODS	

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Create quality documents, by structuring and organizing content for their day to day technical and academic requirements using MS Word.	Apply
CO2	Perform data operations and analytics, record, retrieve data as per requirements and visualize data for ease of understanding using MS Excel.	Apply
CO3	Create high quality academic presentations by including common tables, charts, graphs, interlinking other elements, and using media objects using MS Power Point.	Apply
CO4	Prepare an effective report using MS Word and MS Excel on any subject content.	Apply
CO5	Present the report using MS Power Point.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1									2	2		2	
CO2									2	2		2	
CO3									2	2		2	
CO4									2	2		2	
CO5									2	2		2	
Avg.									**2**	**2**		**2**	

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24MA311	Transforms and Partial Differential Equations	BSC	3	1	0	4	4	40	60
2	U24ME311	Engineering Mechanics	ESC	3	0	0	3	3	40	60
3	U24ME321	Engineering Materials and Metallurgy	ESC	3	0	0	4	3	40	60
4	U24ME331	Engineering Thermodynamics	PCC	3	1	0	4	4	40	60
5	U24ME341	Manufacturing Technology I	PCC	3	0	0	3	3	40	60
PRACTICAL COURSES										
6	U24ME352	Computer Aided Machine Drawing	PCC	0	0	4	4	2	60	40
7	U24ME362	Manufacturing Technology Laboratory	PCC	0	0	4	4	2	60	40
8	U24EM312	Design Thinking and Innovation	EEC	0	0	2	2	1	100	-
				15	**2**	**10**	**28**	**22**		

ASSESSMENT SCHEME

Sl. No	Course Type	L	T	P	C	CIA Weightage (Theory)				CIA	ESE		CIA (W)	ESE (W)	Min. Marks to Pass for 100	
						T1	A1	T2	A2	Prac	Th	Prac			ESE	Total
1	U24MA311	3	1	0	4	60	40	60	40	-	100	-	40	60	45	50
2	U24ME311	3	0	0	3	60	40	60	40	-	100	-	40	60	45	50
3	U24ME321	3	0	0	3	60	40	60	40	-	100	-	40	60	45	50
4	U24ME331	3	1	0	4	60	40	60	40	100	-	-	40	60	45	50
5	U24ME341	3	0	0	3	60	40	60	40	100	-	-	40	60	45	50
6	U24ME352	0	0	4	2	-	-	-	-	100	-	100	60	40	45	50
7	U24ME362	0	0	4	2	-	-	-	-	100	-	100	60	40	45	50
8	U24EM312	0	0	2	1	-	-	-	-	-	-	-	100	-	-	50

(W) – Weightage

U24MA311	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS	L	T	P	C
		3	1	0	4

Course Objective:

After completing this course, the students will be able to:

- To introduce the basic concepts of PDE for solving standard partial differential equations.
- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems?
- To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
- To acquaint the student with Fourier transform techniques used in wide variety of situations.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

Detailed Syllabus

UNITI PARTIAL DIFFERENTIAL EQUATIONS 9+3

Formation of partial differential equations–Solutions of standard types of first order partial differential equations - First order partial differential equations reducible to standard types- Lagrange's linear equation-Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNITII FOURIER SERIES 9+3

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series and cosine series – Root mean square value – Parseval's identity – Harmonic analysis.

UNITIII APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9+3

Classification of PDE – Method of separation of variables - Fourier series solutions of one-dimensional wave equation–One dimensional equation of heat conduction –Steady state solution of two-dimensional equation of heat conduction (Cartesian coordinates only).

UNITIV FOURIER TRANSFORMS 9+3

Statement of Fourier integral theorem–Fourier transforms pair–Fourier sine and cosine transforms–Properties–Transforms of simple functions–Convolution theorem– Parseval's identity.

UNITV Z-TRANSFORMS AND DIFFERENCE EQUATIONS 9+3

Z-transforms - Elementary properties – Convergence of Z-transforms – Initial and final value theorems - Inverse Z-transform using partial fraction and convolution theorem - Formation of difference equations – Solution of difference equations using Z - transforms.

Total Periods:60

Learning Resources

1	GrewalB.S.,"Higher Engineering Mathematics", 44th Edition, Khanna Publishers, New Delhi, 2019.
2	Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2022.
3	Veerarajan .T " Transforms and Partial Differential Equation" 3rd Edition McGraw Hill Education
4	Mercy Merlin. R "Transforms and Partial Differential Equation" Charulatha Publication Private limited



5	Narayanan.S. Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S. Viswanathan Publishers Pvt. Ltd, Chennai, 1998.
6	Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics",10th Edition, Laxmi Publications Pvt. Ltd, 2021.
7	James. G., "Advanced Modern Engineering Mathematics", 4thEdition, Pearson Education, New Delhi, 2016.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Apply the concept of partial differential equation to solve the problems.	Apply
CO2	Determine the Fourier coefficients in the Fourier series expansion of the specified function of various complex problems in engineering.	Apply
CO3	Apply the Fourier series techniques in solving one and two dimensional heat flow problems.	Apply
CO4	Solve the problems in Fourier Transforms.	Apply
CO5	Solve partial differential equations using Z transform techniques.	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ME311	**ENGINEERING MECHANICS**	**L**	**T**	**P**	**C**
		3	**0**	**3**	**3**

Course Objective:

After completing this course, the students will be able to:

- To learn the use of scalar and vector analytical techniques for analysing forces in statically determinate structures
- To introduce the equilibrium of rigid bodies, vector methods and free body diagram
- To study and understand the distributed forces, surface, loading on beam and intensity.
- To learn the principles of friction, forces and to determine the apply the concepts of frictional forces at the contact surfaces of various engineering systems.
- To develop basic dynamics concepts – force, momentum, work and energy.

Detailed Syllabus

UNIT I: STATICS OF PARTICLES 9 Fundamental Concepts and Principles, Systems of Units, Method of Problem Solutions, Statics of Particles -Forces in a Plane, Resultant of Forces, Resolution of a Force into Components, Rectangular Components of a Force, Unit Vectors. Equilibrium of a Particle- Newton's First Law of Motion, Space and Free-Body Diagrams, Forces in Space, Equilibrium of a Particle in Space.
UNIT II: EQUILIBRIUM OF RIGID BODIES 9 Principle of Transmissibility, Equivalent Forces, Vector Product of Two Vectors, Moment of a Force about a Point, Varignon's Theorem, Rectangular Components of the Moment of a Force, Scalar Product of Two Vectors, Mixed Triple Product of Three Vectors, Moment of a Force about an Axis, Couple - Moment of a Couple, Equivalent Couples, Addition of Couples, Resolution of a Given Force into a Force -Couple system, Reduction of a System of Forces, Equilibrium in Two and Three Dimensions - Reactions at Supports and Connections.
UNIT III: DISTRIBUTED FORCES 9 Centroids of lines and areas – symmetrical and unsymmetrical shapes. Theorems of Pappus-Guldinus, Distributed Loads on Beams, Centre of Gravity of a Three-Dimensional Body, Centroid of a Volume, Composite Bodies, Moments of Inertia of Areas and Mass - Polar Moment of Inertia, Radius of Gyration of an Area, Parallel-Axis Theorem, Moments of Inertia of Composite Areas, Moments of Inertia of a Mass - Moments of Inertia of Thin Plates.
UNIT IV FRICTION 9 The Laws of Dry Friction, Coefficients of Friction, Angles of Friction, Wedge friction, Wheel Friction, Rolling Resistance, Friction in screw threads, Ladder friction.
UNIT V DYNAMICS OF PARTICLES 9 Kinematics - Rectilinear Motion and Curvilinear Motion of Particles. Kinetics- Newton's Second Law of Motion -Equations of Motions, Dynamic Equilibrium, Energy and Momentum Methods - Work of a Force, Kinetic Energy of a Particle, Principle of Work and Energy, Principle of Impulse and Momentum, Impact of bodies.
Total Periods:45

Learning Resources

1	P .Beer Ferdinand P, Russel Johnston Jr., David F Mazurek, Philip J Cornwell, Sanjeev Sanghi, Vector Mechanics for Engineers: Statics and Dynamics, McGraw Higher Education. 12thEdition, 2019.
2	Hibbeller, R.C., Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 15th edition, Prentice Hall, 2021
3	Boresi P and Schmidt J, Engineering Mechanics: Statics and Dynamics, 1/e, Cengage Learning, 2008
4	Irving H. Shames, Krishna Mohana Rao G, Engineering Mechanics – Statics and Dynamics, 4thEdition, Pearson Education Asia Pvt. Ltd., 2005.
5	Meriam J L and Kraige L G, Engineering Mechanics: Statics and Engineering Mechanics: Dynamics, 9th edition, Wiley student edition, 2020.
6	Timoshenko S, Young D H, Rao J V and Sukumar Pati, Engineering Mechanics, 5thEdition, McGraw Hill Higher Education, 2017

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Determine the force and moment scalar and vector methods of static bodies	Apply
CO2	Construct the free body diagram and analyses the rigid body in equilibrium	Apply
CO3	Evaluate the properties of surfaces and solids	Apply
CO4	Determine the friction and the effects by the laws of friction	Apply
CO5	Calculate dynamic forces exerted in rigid body	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ME321	**ENGINEERING MATERIALS AND METALLURGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

After completing this course, the students will be able to:

- Understand the concept of constructing the phase diagram and using of iron-iron carbide phase diagram for microstructure formation.
- Understand the various heat treatment processes and its microstructure formation.
- Understand the different types of ferrous and non-ferrous alloys and their uses in engineering field.
- Understand the different polymer, ceramics and composites and their uses in engineering field.

Detailed Syllabus

UNIT I CONSTITUTION OF ALLOYS AND PHASE DIAGRAMS 9

Constitution of alloys – Solid solutions, substitutional and interstitial – phase diagrams, Isomorphous, eutectic, eutectoid, peritectic, and peritectoid reactions, Iron – Iron carbide equilibrium diagram. Classification of steel and cast-Iron microstructure, properties and application.

UNIT II HEAT TREATMENT 9

Definition – Full annealing, stress relief, recrystallisation and spheroidising –normalizing, hardening and tempering of steel. Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram – continuous cooling Transformation (CCT) diagram – Austempering, Martempering – Hardenability, Jominy end quench test -case hardening, carburizing, Nitriding, cyaniding,

carbonitriding – Flame and Induction hardening – Vacuum and Plasma hardening – Thermo-mechanical treatments- elementary ideas on sintering

UNIT III FERROUS AND NON-FERROUS METALS 9

Effect of alloying additions on steel (Mn, Si, Cr, Mo, Ni, V,Ti& W) – stainless and tool steels – HSLA - Maraging steels – Grey, white, malleable, spheroidal – alloy cast irons, Copper and its alloys – Brass, Bronze and Cupronickel – Aluminium and its alloys; Al-Cu – precipitation strengthening treatment – Titanium alloys, Mg-alloys, Ni-based super alloys – shape memory alloys- Properties and Applications - overview of materials standards

UNIT IV NON-METALLIC MATERIALS 9

Polymers – types of polymers, commodity and engineering polymers – Properties and applications of PE, PP, PS, PVC, PMMA, PET, PC, PA, ABS, PAI, PPO, PPS, PEEK, PTFE, Thermoset polymers – Urea and Phenol formaldehydes –Nylon, Engineering Ceramics – Properties and applications of Al2O3, SiC, Si3N4, PSZ and SIALON – intermetallics- Metal Matrix Composites (MMCs) and Ceramic Matrix Composites (CMCs) - applications of MMCs and CMCs - Nano composites.

UNIT V MECHANICAL PROPERTIES AND DEFORMATION MECHANISMS 9

Mechanisms of plastic deformation, slip and twinning – Types of fracture – fracture mechanics- Griffith's theory- Testing of materials under tension, compression and shear loads – Hardness tests (Brinell, Vickers and Rockwell), Micro and nano-hardness tests, Impact test Izod and charpy, fatigue and creep failure mechanisms.

Total Periods: 45

Learning Resources

1	Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 9th Edition, 2018.
2	Williams D Callister, "Material Science and Engineering" Wiley India Pvt Ltd, 2nd edition Reprint 2019.
3	A. Alavudeen, N. Venkateshwaran, and J. T.Winowlin Jappes, A Textbook of Engineering Materials and Metallurgy, Laxmi Publications, 2006.
4	Sydney H. Avner, "Introduction to Physical Metallurgy", McGraw Hill Book Company, 2nd Edition, 2017
5	Raghavan.V, "Materials Science and Engineering", Prentice Hall of India Pvt. Ltd. 6th edition,2019.
6	Amandeep Singh Wadhwa, and Harvinder Singh Dhaliwal, A Textbook of Engineering Material and Metallurgy, University Sciences Press, 2008.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Construct phase diagrams of different Alloys and explain the formation microstructure.	Apply
CO2	Explain the various heat treatment process involved in stress relieving of engineering materials	Understand
CO3	Elaborate the properties and applications of ferrous and non-ferrous alloys.	Understand
CO4	Explain the properties and applications of different types of polymers, Ceramics and Composites.	Understand
CO5	Identify the type of failure mechanism of materials under different loads and explain different testing methods of materials	Understand

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ME331	**ENGINEERING THERMODYNAMICS**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

Course Objective:

After completing this course, the students will be able to:

- Understand the basics and application of zeroth and first law of thermodynamics.
- Understand the second law of thermodynamics in analysing the performance of thermal devices.
- Understand availability and applications of second law of thermodynamics
- Understand the properties of steam and processes.
- Understand thermodynamic cycles and its performance

Detailed Syllabus

UNIT I: BASICS, ZEROTH AND FIRST LAW 12

Definition – macroscopic and microscopic viewpoints – Thermodynamic systems, Properties and processes Thermodynamic Equilibrium – Displacement work – P-V diagram. Thermal equilibrium – Zeroth law – Concept of temperature and Temperature Scales. First law – application to closed and open systems – steady and unsteady flow processes.

UNIT II: SECOND LAW AND ENTROPY 12

Heat Engine – Refrigerator – Heat pump. Statements of second law and their equivalence & corollaries. Carnot cycle – Reversed Carnot cycle – Performance – Clausius inequality. Concept of entropy – T-s diagram – Tds Equations – Entropy changes for a pure substance. Ideal gases undergoing different processes – principle of increase in entropy. Applications of II Law.

UNIT III: AVAILABILITY AND GASEOUS MIXTURES 12 High and low-grade energy. Availability and Irreversibility for open and closed system processes – Gibbs and Helmholtz function, Gouy-Stodola theorem, I and II law Efficiency. Properties of gaseous mixtures – Daltons law of partial pressure, Amagat's law of partial volume, gas constant, specific heats, specific heat, internal energy, enthalpy and entropy of gaseous mixtures.
UNIT IV: PROPERTIES OF PURE SUBSTANCES AND RANKINE CYCLE 12 Steam – formation and its thermodynamic properties – p-v, p-T, T-v, T-s, h-s diagrams. PVT surface. Determination of dryness fraction. Calculation of work done and heat transfer in non-flow and flow processes using Steam Table and Mollier Chart. Basic Rankine Cycle, modified, reheat and regenerative cycles.
UNIT V: THERMODYNAMIC CYCLES 12 Air Standard Cycles – Otto cycle, Diesel cycle, Dual cycle, Brayton cycle – modified, reheat and regenerative cycles – Cycle Analysis, Performance and Comparison.
Total Periods: 60

Learning Resources

1	P.K. Nag, "Engineering Thermodynamics", 6th Edition, Tata McGraw Hill (2017), New Delhi.
2	Y. Cengel, and M. Boles, Thermodynamics - An Engineering Approach, Tata McGraw Hill, 9th Edition, 2019.
3	R.K. Rajput, Engineering Thermodynamics, Laxmi Publications, New Delhi, 4th Edition 2016
4	C.P. Arora, Thermodynamics, McGraw Hill Edition, New Delhi. 2017
5	Robert Balmer, Thermodynamics Theory and applications, Jaico Publishing House, 1999

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Apply the first law of thermodynamics for simple open and closed systems	Apply
CO2	Apply the second law of thermodynamics to engineering devices and entropy calculation	Apply
CO3	Calculate the availability and irreversibility for open and closed system processes and properties of gaseous mixture	Apply
CO4	Apply properties of steam to Rankine cycle	Apply
CO5	Determine performance parameter of thermodynamic cycles	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ME341	MANUFACTURING TECHNOLOGY I	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- To illustrate the working principles of various metal casting processes.
- To identify a suitable welding process for an application
- To analyse the working principles of bulk deformation of metals.
- To learn the working principles of the sheet metal forming process.
- To study and practice the working principles of plastics molding and powder metallurgy

Detailed Syllabus

UNIT I: METAL CASTING PROCESSES 9

Types of casting processes and applications; Sand Casting, Sand Mold, Type of patterns; Pattern Materials: Pattern allowances – Molding sand Properties and testing— types and applications – Molding machines types and applications – Design of gating system and riser;

Melting furnaces Cupola and Blast; Principles of special casting processes: Shell, investment – Ceramic mould - Pressure die casting; gravity die casting – centrifugal casting – Defects in Sand casting process and remedies.

UNIT II: METAL JOINING PROCESSES 9

Joining Processes - Classification; Fusion Welding Processes: Gas Welding: oxy fuel welding, types of flames. Arc Welding: GMAW, GTAW, SMAW, plasma arc welding, submerged arc welding; Filler and Flux materials - Electrodes, Coating, and specifications; Resistance Welding, Laser beam Welding, Thermit Welding, and Electroslag Welding.

Solid State Welding Processes: Friction, Friction stir welding, Ultrasonic welding, explosive welding, diffusion welding. Welding defects, causes and remedies; Brazing and Soldering; Adhesive joining

UNIT III: BULK DEFORMATION PROCESSES 9

Hot working and cold working of metals; Forging processes: Open, impression and closed die forging – cold forging- Characteristics of the processes – Typical forging operations; Rolling of metals – Types of Rolling mills – Flat strip rolling – shape rolling operations – Defects in rolled parts; Principle of rod and wire drawing – Tube drawing; Principles of Extrusion – Types – Hot and Cold extrusion. Introduction to shaping operations; Defects in metal working and their causes.

UNIT IV: SHEET METAL PROCESSES 9

Sheet metal characteristics – Typical shearing, bending and drawing operations – Stretch forming operations – Formability of sheet metal – Test methods – Special forming processes - Working principle and applications – Hydro forming – Rubber pad forming – Metal spinning – Introduction of Explosive forming, magnetic pulse forming, peen forming, Super plastic forming – Micro forming – Incremental forming.

UNIT V: MANUFACTURE OF PLASTIC COMPONENTS & POWDER METALLURGY 9

Plastics - Moulding of thermoplastics & Thermosetting polymers; Shaping process for plastics; Extrusion, injection Moulding (Plunger and screw machines), Blow Moulding, Rotational Moulding, Compression Moulding – Transfer Moulding; Calendaring; and thermoforming.

Powder metallurgy: Production of metal powders; Stages in powder metallurgy: compaction and sintering of metals and ceramics; Cold and hot isostatic Pressing; Powder injection molding, Powder rolling, extrusion and forging, liquid phase sintering; Powder Metallurgy defects and their remedies.

Total Periods: 45

Learning Resources

1	Serope Kalpakjian; Steven R. Schmid, Manufacturing Engineering and Technology, 6th Edition, Prentice Hall, ISBN-10 0 13 – 608168-1, 2020
2	Mikell P. Groover; Fundamentals of Modern Manufacturing Materials, Processes, and Systems, 5th Edition; John Wiley & Sons, Incorporated, 2021
3	Hajra Choudhry, Elements of Workshop Technology, Vol – I Media Promoters & Publishers,2008.
4	Khanna, O.P., and Lal, M., A Text Book of Production Technology, Vol I, Dhanpat Rai & Sons,2010.
5	P.N. Rao, Manufacturing Technology Foundry, Forming and Welding, 2nd Edition, McGraw Hill, 2013,
6	Angelo P.C. Ravisankar B. Subramanian R, Powder Metallurgy: Science, Technology and applications PHI Learning Pvt. Ltd, 2022
7	Anish Upadhyaya, Gopal Shankar Upadhyaya, Powder Metallurgy: Science, Technology, and Materials, CRC Press 2018

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Illustrate the working principles of various metal casting processes.	Understand
CO2	Explain the working principles of various metal joining processes	Understand
CO3	Explain the working principles of various for bulk deformation of metals.	Understand
CO4	Discuss the working principles of the sheet metal forming process.	Understand
CO5	Discuss the processes to manufacture plastics for various applications and produce an object using powder metallurgy.	Understand

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ME352	COMPUTER AIDED MACHINE DRAWING	L	T	P	C
		0	0	4	2

Course Objective:

After completing this course, the students will be able to:

- To acquaint the skills and practical experience in handling 2D drafting and3D modelling software systems, standard drawing practices using fits and tolerances.
- To prepare assembly drawings both manually and using standard CAD packages.
- To Preparing standard drawing layout for modelled parts, assemblies with BoM.

PART I: DRAWING STANDARDS & FITS AND TOLERANCES 12

Code of practice for Engineering Drawing, BIS specifications–Welding symbols, riveted joints, keys, fasteners– Reference to handbook for the selection of standard components like bolts, nuts, screws, keys etc.-Limits, Fits–Tolerancing of individual dimensions IS919-Specification of Fits – Preparation of production drawing sand reading of part and assembly drawings, basic principles of Geometric Dimensioning & Tolerancing.

PART II: 2D Drafting 48

Drawing, Editing, Dimensioning, Layering, Hatching, Block, Array, Detailing, Detailed Drawing.

1. Bearings– Bush Bearing,
2. Valves – Safety and Non-return Valves.
3. Couplings– Flange, Oldham's, Muff, Gear couplings.
4. Joints– Universal, Knuckle, Gib & Cotter, Strap, Sleeve & Cotter joints.
5. Engine parts – Piston, Connecting Rod, Crosshead (vertical and horizontal), Stuffing box, multi- plate clutch.
6. Machine Components–Screw Jack, Machine Vice, Lathe Tail Stock, Lathe Chuck, Plummer Block, Vane and Gear pumps.

TOTAL PERIODS: 60

Total: 20% of classes for theory classes and 80%of classes for practice.
Note: 25% of assembly drawings must be done manually and remaining 75% of assembly drawings must be done by using any CAD software. The above tasks can be performed manually and using standard commercial 2D CAD software.

Learning Resources

1	Gopalakrishna K.R,"Machine Drawing", 23rd Edition, Subhas Stores Books Corner, Bangalore, 2017.
2	N. D. Bhattand V.M. Panchal, "Machine Drawing", 51st Edition, Charator Publishers, 2022.
3	K. L Narayana, P. Kannaiah, K. Venkata Reddy, Machine Drawing , 15 Edition , New Age International Publication, New Delhi, India 2012.
4	Goutam Pohit and Goutam Ghosh, "Machine Drawing with AutoCAD", 1st Edition, Pearson Education, New Delhi, India 2004.
5	Junnarkar, N.D., "Machine Drawing", 1st Edition, Pearson Education, New Delhi, India 2004.
6	N. Siddeshwar, P. Kanniah, V.V.S. Sastri," Machine Drawing", published by Tata McGraw Hill, New Delhi, India 2017 edition.

7	S. Trymbaka Murthy, "A Text Book of Computer Aided Machine Drawing", CBS Publishers, New Delhi, 2007.

Course Outcomes:

CO	At the end of the course, the students will be able to	Knowledge Level
CO1	Apply the knowledge on standards in drawing practices to prepare the engineering drawing.	Apply
CO2	Apply the principles behind dimensions and tolerances in an engineering drawing.	Apply
CO3	Explain the commands in CAD for 2D and 3D drafting.	Apply
CO4	Prepare the 2D orthographic views of standard machine components both manually and CAD packages.	Apply
CO5	Prepare the 3D geometric and assembly models of standard machine components using the CAD packages.	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low).

U24ME362	MANUFACTURING TECHNOLOGY LABORATORY	L	T	P	C
		0	0	4	2

Course Objective:

After completing this course, the students will be able to:

- To familiarize students with various turning operations such as taper turning, eccentric turning, knurling, external and internal thread cutting, and grooving using a lathe machine.
- To develop skills in force measurement by using a lathe tool dynamometer to analyze cutting forces and optimize machining parameters for improved efficiency.
- To provide hands-on experience in shaping, planning, and turret/capstan lathe operations for producing precise square and hexagonal profiles on circular components.
- To impart knowledge on gear manufacturing techniques, including spur gear cutting using a milling machine and gear generation using a hobbing machine.
- To enhance competency in grinding and finishing processes, such as cylindrical and surface grinding, to achieve high accuracy and superior surface quality in machined components.

List of Experiments

Sl No	List of Experiments
1	Preparing green sand moulds with cast patterns.
2	Fabricating simple structural shapes using an arc welding machine.



3	Manufacturing of simple sheet metal components using shearing and bending
4	Taper Turning with compound rest swiveling method using a lathe machine.
5	Eccentric turning on circular parts using the lathe machine.
6	Knurling, external and internal thread cutting on circular parts using a lathe machine.
7	Measurement of cutting forces using a lathe tool dynamometer.
8	Knurling, Grooving, Drilling using Capstan and turret Lathe.
9	Shaping square and hexagonal heads on circular parts using a shaper machine.
10	Creating square heads using a Planer machine.
11	Spur gear cutting in a milling machine.
12	Generating gears using gear hobbing machines.
13	Drilling and reaming using a vertical drilling machine.
14	Grinding components using a cylindrical grinding machine.
15	Plain surface grinding of components using a surface grinding machine.
	Total Periods: 60

Course Outcomes

CO	At the end of the course, the students will be able to	Knowledge Level
CO1	Apply casting, welding, and metal forming techniques to fabricate basic mechanical components.	Analyse
CO2	Perform turning operations such as taper turning, eccentric turning, knurling, and thread cutting on a lathe, and evaluate cutting forces using a lathe tool dynamometer.	Analyse
CO3	Operate shaping, planning, and turret/capstan lathes to produce precise square and hexagonal profiles.	Analyse
CO4	Demonstrate gear manufacturing techniques, including spur gear cutting and gear hobbing.	Analyse
CO5	Execute grinding, drilling, and finishing operations to achieve required dimensional accuracy and surface quality.	Analyse

Course Articulation Matrix

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

CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)



U24EM312	DESIGN THINKING AND INNOVATION (Common to B.E. Civil, CSE and Mechanical and B./Tech. AI&DS in Third Semester and B.E. ECE in Fifth Semester)	L	T	P	C
		0	0	2	1

Course Objective:

After completing this course, the students will be able to:

- Empathizing with users to uncover their real problems and desires.
- Promoting out-of-the-box thinking to develop unique and effective solutions.
- Using prototyping, testing, and refining ideas to ensure the best outcome.
- Testing assumptions early to prevent costly mistakes and enhance decision-making.
- Creating innovative products, services, or processes that improve market competitiveness.

Sl No	List of Exercises	No of periods
1	Design Thinking – models – Why design thinking? Case Studies. Innovation – 7Cs of Innovation. Identify a case study.	4
2	Empathize – tools - customer Journey map – case studies – Empathize the identified case study	4
3	Analyze – tools, multi-whys, case study, conflict of interest. Analyze the identified case study	4
4	Ideate and solve – brainstorming – TRIZ method, trial and error method – Solve the identified case study	4
5	Prototype/process and test – tools and methods – create a prototype for the identified case study	4
6	Iterate to improve the prototype/process – revisit the methods to improve the prototype.	8
7	Submit the report and final prototype/process of the case study.	2
	Total Periods	**30**

Learning Resources

1	Pavan Soni, Design your thinking, Penguin Random House India Pvt, Ltd., India, 2022
2	Don Norman, The Desing of everyday things, Basic Books, New York, 2013
3	B.K. Chakravarthy, Janaki Krishnamoorthi, Innovation by Design Lessons from Post Box Design & Development, Springer, New Delhi 2013
4	Balaramadurai, Karmic Design Thinking, 2020
5	Design by Innovation NPTEL Course B.K. Chakravarthy IIT Bombay https:/ /npt el.ac.in/ courses/107 101086
6	Design Thinking and Innovation NPTEL Cours Ravi Poovaiah, IIT Bombay https:/ /onlinecourses.swa yam2.ac.in/ aic23_g e17/preview
7	Design Thinking A Premier NPTEL Course, Prof. Ashwin Mahalingam, Prof. Bala Ramadurai, IIT Madras https:/ /onlinecourses.npt el.a c.in/ noc22 mg32/ preview

Course Outcomes

CO	At the end of the course, the students will be able to	Knowledge Level
CO1	Apply the tools to empathize the identified case study	Apply
CO2	Analyze the data and information to conceptualize the solution for the case study	Analyse
CO3	Ideate and solve the case study using appropriate tools	Apply
CO4	Create a prototype/process of the case study	Analyse
CO5	Iterate to improvise the prototype/process of the case study	Analyse

Course Articulation Matrix

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

CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24ME411	Fluid Mechanics and Machinery	ESC	3	1	0	4	4	40	60
2	U24ME421	Theory of Machines	PCC	3	0	0	3	3	40	60
3	U24ME431	Thermal Engineering	PCC	3	0	0	3	3	40	60
4	U24ME441	Manufacturing Technology -II	PCC	3	0	0	3	3	40	60
5	U24EM411	Aptitude and Reasoning -I	EEC	1	0	0	1	1	100	-
THEORY CUM PRACTICAL COURSES										
6	U24ME453	Strength of Materials	PCC	3	0	2	5	4	50	50
7	U24ME463	CAD /CAM	PCC	3	0	2	5	4	50	50
PRACTICAL COURSES										
8	U24ME472	Fluid Mechanics and Machinery Laboratory	ESC	0	0	2	2	1	60	40
9	U24ME482	Thermal Engineering Laboratory	PCC	0	0	4	4	2	60	40
10	U24EM422	Soft skill and Personality Development - I	EEC	0	0	2	2	1	100	-
				19	**1**	**14**	**32**	**26**		

ASSESSMENT SCHEME

Sl. No	Course Type	L	T	P	C	CIA Weightage (Theory)				CIA	ESE		CIA (W)	ESE (W)	Min. Marks to Pass for 100	
						T1	A1	T2	A2	Prac	Th	Prac			ESE	Total
1	U24ME411	3	1	0	4	60	40	60	40	-	100	-	40	60	45	50
2	U24ME421	3	0	0	3	60	40	60	40	-	100	-	40	60	45	50
3	U24ME431	3	0	0	3	60	40	60	40	-	100	-	40	60	45	50
4	U24ME441	3	0	0	3	60	40	60	40	-	100	-	40	60	45	50
5	U24EM411	1	0	0	1	50	-	50	-	-	-	-	100	-	-	50
6	U24ME453	3	0	2	4	60	40	60	40	100	70	30	50	50	45	50
7	U24ME463	3	0	2	4	60	40	60	40	100	70	30	50	50	45	50
8	U24ME472	0	0	2	1	-	-	-	-	100	-	100	60	40	45	50
9	U24ME482	0	0	4	2	-	-	-	-	100	-	100	60	40	45	50
10	U24EM422	0	0	2	1	-	-	-	-	-	-	-	100	-	-	50

(W) – Weightage

U24ME411	FLUID MECHANICS AND MACHINERY	L	T	P	C
		3	1	0	4

Course Objective:

After completing this course, the students will be able to:

- To introduce the students about properties of the fluids, behavior of fluids under static conditions.
- To impart basic knowledge of the dynamics of fluids and boundary layer concept
- To expose to the applications of the conservation laws to a) flow measurements b) flow through pipes (both laminar and turbulent) and c) forces on pipe bends.
- To exposure to the significance of boundary layer theory and its thicknesses.
- To expose the students to basic principles of working of hydraulic machineries and to design Pelton wheel, Francis and Kaplan turbine, pumps.

Detailed Syllabus

UNIT I FLUID PROPERTIES AND FLOW CHARACTERISTICS 10+3

Properties of fluids – Fluid statics - Pressure Measurements - Buoyancy and floatation - Flow characteristics - Eulerian and Lagrangian approach - Concept of control volume and system - Reynold's transportation theorem - Continuity equation, energy equation and momentum equation - Applications.

UNIT II FLOW THROUGH PIPES AND BOUNDARY LAYER 9+3

Reynold's Experiment - Laminar flow through circular conduits - Darcy Weisbach equation - friction factor - Moody diagram - Major and minor losses - Hydraulic and energy gradient lines - Pipes in series and parallel - Boundary layer concepts - Types of boundary layer thickness.

UNIT III DIMENSIONAL ANALYSIS AND MODEL STUDIES 8+3

Fundamental dimensions - Dimensional homogeneity - Rayleigh's method and Buckingham Pi theorem - Dimensionless parameters - Similitude and model studies - Distorted and undistorted models.

UNIT IV HYDRAULIC TURBINES 9+3

Impact of jets - Velocity triangles - Theory of rotodynamic machines - Classification of turbines - Working principles - Pelton wheel - Modern Francis turbine - Kaplan turbine - Work done - Efficiencies - Draft tube - Specific speed - Performance curves for turbines - Governing of turbines.

UNIT V PUMPS 9+3

Classification of Pumps – NPSH/Cavitations – Pump Impellers and Its Applications – Pump Static Head and Frictional Head – Lubrication (Oil/ Grease Pumps) – Affinity Law – Power Calculations – Pumps Operated in Parallel and Series – Advanced in Mechanical Sealing System –various Flow Control Systems - Selection of Pumps – MOC Of Pumps – Energy Conservation in Pumps.

Total Periods: 60

Learning Resources

1	Jain A. K. Fluid Mechanics including Hydraulic Machines, Khanna Publishers, New Delhi, 2014. 12th Edition 2024
2	Kumar K. L., Engineering Fluid Mechanics, S Chand & Co Ltd, 2016.
3	Cengel Y A and Cimbala J M, Fluid Mechanics, McGraw Hill Education Pvt. Ltd., Fourth Edition, 2017.

4	Streeter, V. L. and Wylie E. B., Fluid Mechanics, McGraw Hill Publishing Co., 9th Edition 2017.
5	Pani B S, Fluid Mechanics: A Concise Introduction, Prentice Hall of India Private Ltd, 2016.
6	S K Som; Gautam Biswas and S Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill Education Pvt. Ltd., Third Edition, 2017.
7	Fox W.R. and McDonald A.T., Introduction to Fluid Mechanics John-Wiley and Sons, Singapore, 2011.

Course Outcomes

CO	At the end of the course, the students will be able to	Knowledge Level
CO1	Solve the problems on fluids under kinematics and dynamics by conservation laws	Apply
CO2	Determine losses in pipelines for both laminar and turbulent conditions. Also, describe the concept of boundary layer and its thickness	Apply
CO3	Apply the relationship among the parameters involved in the given fluid phenomenon and to predict the performances of prototype by model studies	Apply
CO4	Describe the working principles of various turbines and design the various types of turbines.	Analyse
CO5	Explain the working principles of centrifugal, reciprocating and rotary pumps and design the centrifugal and reciprocating pumps	Analyse

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ME421	THEORY OF MACHINES	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- Apply foundational knowledge to analyze simple mechanisms, perform kinematic analysis of basic linkages, and design cam systems.
- Calculate speed ratios for different gear train types and apply toothed gearing concepts to solve mechanical system problems
- Apply friction principles to analyze motion transmission in machine components and solve related engineering problems.
- Understand the concepts of Free body diagram and Principle of superposition, perform dynamic analysis on simple machine elements
- Perform balancing of rotating and reciprocating masses in mechanical systems. Calculate natural frequencies in torsional systems, determine governor effort and power.



Detailed Syllabus

UNIT I KINEMATICS OF MACHINES 9 Mechanisms – Terminology and definitions – kinematic inversions of four bar and slider crank chain – Basics of kinematic analysis in simple mechanisms – Velocity and Acceleration of Links using relative velocity method (Slider crank and Four bar mechanism) – Cams – Terminologies & Classification – Derivatives of follower motion – Cam profiles – Knife edge, Roller & Flat face followers (Inline and offset followers)- Circular Arc and Tangent Cam (Basic Concepts only)
UNIT II GEARS AND GEAR TRAINS 9 Spur gear – Terminology - Law of toothed gearing – Involute and Interchangeable gears – Gear tooth action – Length of path of contact, Length of arc of contact, contact ratio – interference and undercutting – Non-standard teeth – Gear trains -Basics of Gear trains – Calculation of Speed ratio of Simple, Compound and Epicyclic gear trains using tabular method.
UNIT III FRICTION IN MACHINE ELEMENTS 9 Surface contacts – Sliding and Rolling friction – Friction drives – Bearings and lubrication – Friction clutches (Single plate and Multi Plate clutch only) – Belt and rope drives – Friction aspects in brakes– Friction in vehicle propulsion and braking (Basic Concepts only).
UNIT IV FORCE ANALYSIS AND BALANCING OF MASSES 9 Applied and Constrained Forces – Free body diagrams – static Equilibrium conditions – Two, Three and four members – Static Force analysis in simple machine members - Dynamic Force Analysis – Static and Dynamic balancing – Balancing of revolving and reciprocating masses – Balancing of machines.
UNIT V FREE AND FORCED VIBRATION 9 - Free vibrations – Equations of motion – natural Frequency – Damped Vibration – bending critical speed of simple shaft – Torsional vibration – Forced vibration – harmonic Forcing – Vibration isolation (Basic Concepts only) – Gyroscopic Principles (Basic Concepts only)
Total Periods: 45

Learning Resources

1	R.S. Khurmi & J.K. Gupta., “Theory of Machines”, S. Chand & Company Pvt. Ltd., Eurasia publishing house Pvt. Ltd., 2013
2	Shigley J. E., Pennock G.R and Uicker J.J., “Theory of Machines and Mechanisms”, Oxford University Press, 2003
3	Ambekar A.G., “Mechanism and Machine Theory” Prentice Hall of India, New Delhi, 2007
4	Rao.J.S. and Dukkipatti'R.V. "Mechanisms and Machines", Wiley-Eastern Ltd., New Delhi, 1992.
5	V. Ramamurthi, “Mechanisms of Machines” Viva Low Prices Student Edition, 1999.
6	Robert L. Norton, Design of Machinery, McGraw-Hill, 2004

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Solve problems in simple mechanisms and draw the cam profiles.	Apply
CO2	Determine kinematic parameters of spur gears and calculate the speed ratios for different types of gear trains.	Apply
CO3	Compute the power transmission in various friction drives.	Apply
CO4	Draw free body diagrams and determine torque, Calculate the engine forces, balancing mass for rotating and reciprocating parts.	Analyse
CO5	Determine the natural frequency of free and forced vibrations; apply the concepts of Gyroscopic couple.	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ME431	**THERMAL ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

After completing this course, the students will be able to:

- Understand the working of IC engines and its auxiliary systems
- Understand and evaluate performance parameter of IC engine
- Understand theory and design of steam nozzle
- Understand theory and design of steam turbine
- Understand refrigeration and psychrometrics and its applications

Detailed Syllabus

UNIT I INTERNAL COMBUSTION ENGINES – FEATURES AND COMBUSTION 9

IC engine – Classification, working, components and their functions. Ideal and actual: Valve and port timing diagrams, p-v diagrams- two stroke & four stroke, and SI & CI engines – comparison. Geometric, operating, and performance comparison of SI and CI engines. Desirable properties and qualities of fuels. Air-fuel ratio calculation – lean and rich mixtures. Combustion in SI & CI Engines – Knocking – phenomena and control

UNIT II INTERNAL COMBUSTION ENGINE PERFORMANCE AND AUXILIARY SYSTEMS 9

Performance and Emission Testing, Performance parameters and calculations. Morse and Heat Balance tests. Multipoint Fuel Injection system and Common rail direct injection systems. Ignition systems – Magneto, Battery and Electronic. Lubrication and Cooling systems. Concepts of Supercharging and Turbocharging – Emission Norms.

UNIT III STEAM NOZZLES 9 Types and Shapes of nozzles Flow of steam through nozzles, Critical pressure ratio, Variation of mass flow rate with pressure ratio. Effect of friction. Metastable flow.
UNIT IV STEAM AND GAS TURBINES 9 Types, Impulse and reaction principles, Velocity diagrams, Work done and efficiency – optimal operating conditions. Multi-staging, compounding and governing.
UNIT V REFRIGERATION AND AIR – CONDITIONING 9 Refrigeration, ton of refrigeration-Vapour compression refrigeration cycle, Effect of Superheat and Sub-cooling, Performance calculations, and vapour absorption system. Psychrometrics, properties and processes. Psychrometric chart. Air conditioning systems, types, concept of RSHF, GSHF and ESHF, Cooling load calculations.
Total Periods: 45

Learning Resources

1	C.P. Kothandaraman, S. Domkundwar and A.V. Domkundwar, “A course in Thermal Engineering”, Dhanpat Rai & Sons, New Delph 2016.
2	Mahesh. M. Rathore, “Thermal Engineering”, Tata Mc Graw Hill Publications, New Delhi 2010.
3	R.K. Rajput, “Thermal Engineering”, Laxmi Publications, New Delhi 2010
4	V. Ganesan, “Internal Combustion Engines”, Tata Mcgraw-Hill, New Delhi 2020
5	J.B. Heywood, “Fundamentals of IC engines”, Mc Graw Hill Publications, New Delhi 2017
6	C.P. Arora, “Refrigeration and Air Conditioning”, Tata Mc Graw Hill, New Delhi 2008

Course Outcomes

CO	At the end of the course, the students will be able to	Knowledge Level
CO1	Explain the functioning and features of IC engine and combustion phenomenon	Understand
CO2	Discuss auxiliary systems and calculate the various performance parameters of IC engines	Apply
CO3	Determine velocity and area at various sections of nozzle	Apply
CO4	Compare steam turbines and determine various efficiencies	Apply
CO5	Explain refrigeration and air-conditioning system and solve problems	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)



U24ME441	MANUFACTURING TECHNOLOGY – II	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- To study the concepts and basic mechanics of metal cutting and the factors affecting machinability
- To learn the workings of basic and advanced turning machines.
- To teach the basics of machine tools with reciprocating and rotating motions and abrasive finishing processes.
- To classify non-traditional machining processes and describe various machining processes.
- To understand the fundamentals of additive manufacturing, its principles, various processes.

Detailed Syllabus

UNIT I: MECHANICS OF METAL CUTTING 9

Mechanics of chip formation, forces in machining, types of chips, cutting tools—single-point cutting tool nomenclature. Orthogonal and oblique metal cutting, thermal aspects, cutting tool materials, tool wear, tool life, surface finish and cutting fluids.

UNIT II: TURNING MACHINES 9

Centre lathe, constructional features, specifications, operations—taper turning methods, Work holding devices. Special lathes—capstan and turret lathes- tool layout, automatic lathe, Swiss type lathe.

UNIT III: RECIPROCATING MACHINES 9

Reciprocating machine tools: shaper, planer: Types and operations; Hole making: Drilling, reaming, boring, tapping, Milling - types, operations, attachments and types of milling cutters; Gear hobbing and gear shaping – gear finishing methods; Abrasive processes: grinding wheel—specifications and selection, types of grinding process—cylindrical grinding, surface grinding, centerless grinding, internal grinding.

UNIT IV: NON-TRADITIONAL MACHINING PROCESSES 9

Classification of non-traditional machining processes, basic principles, process variables, applications, and limitations of Mechanical Energy-Based Processes: Abrasive Jet Machining (AJM), Water Jet Machining (WJM), Ultrasonic Machining (USM).

Thermo-Electric Energy-Based Processes: Electrical Discharge Machining (EDM), Wire Electrical Discharge Machining (Wire EDM), Laser Beam Machining (LBM). Chemical Energy-Based Processes: Chemical Machining (CHM), Electrochemical Energy-Based Processes: Electrochemical Machining (ECM).

UNIT V: ADDITIVE MANUFACTURING 9

Introduction to Additive Manufacturing (AM)—principles and key features— comparison with traditional manufacturing processes— advantages, limitations, and challenges; Liquid-based systems—Stereolithography (SLA) top-down and bottom-up approach—Advantages—Limitations—Applications.

Powder-based systems: Selective Laser Sintering (SLS), Three-Dimensional Printing (3DP); Molten material systems—Fused-Deposition Modelling (FDM), Solid sheet-based systems—Laminated-Object Manufacturing (LOM)

Total Periods: 45

Learning Resources

1	Serope Kalpakjian; Steven R.Schmid (2023), Manufacturing Engineering and Technology, 8th Edition, Publisher: Prentice Hall, ISBN 13: 978-1-292-42224-4
2	Mikell P. Groover; Fundamentals of Modern Manufacturing Materials, Processes, and Systems, 5th Edition; John Wiley & Sons, Incorporated, 2019
3	Hajra Choudhry, Elements of Workshop Technology, Vol. II Media Promoters & Publishers,
4	Adithan, M., "Unconventional Machining Processes," Atlantic, New Delhi, India, 2018. ISBN-13 : 978-8126910458
5	Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani "Additive manufacturing technologies.". 3rd edition Springer Cham, Switzerland. (2021). ISBN: 978-3-030-56126-0
6	Carl Sommer, "Non-Traditional Machining Handbook," Advance Publishing., United States, 2000, ISBN-13: 978-1575373256.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Apply the mechanics of metal cutting to evaluate cutting forces, tool life, and surface finish using appropriate cutting tool materials and machining conditions.	Apply
CO2	Illustrate the construction and operation of centre lathes, capstan, turret, and automatic lathes to select suitable machines for turning operations	Understand
CO3	Explain the working of reciprocating and rotating machine tools and abrasive machining processes.	Understand
CO4	Apply the principles of non-traditional machining processes to select suitable methods for given engineering applications.	Apply
CO5	Explain the principles, processes, advantages, limitations of various additive manufacturing technologies.	Understand

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	2	2		2			2	2		2	2	2
CO2	2				2			2	2		2	2	2
CO3	2				2			2	2		2	2	2
CO4	2	2	2					2	2		2	2	2
CO5	2							2	2		2	2	2
Avg.	**2.2**	**2**	**2**		**2**			**2**	**2**		**2**	**2**	**2**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EM411	APTITUDE AND REASONING – I	L	T	P	C
		1	0	0	1

Course Objective:

After completing this course, the students will be able to:

- Enhance analytical and logical reasoning skills to solve problems efficiently.
- Strengthen understanding of basic arithmetic, algebra, geometry, and data interpretation.
- Train students to approach problems systematically and apply suitable techniques.
- Foster quick thinking and reduce error rates through practice and time-bound exercises.

Detailed Syllabus

Topic titles	No of periods
Quantitative aptitude • Numbers: Number series, arithmetic progression, geometric progression • HCF and LCM: Highest common factor – split method, division method, Least Common Multiples – prime factor method, division method. • Simplification – BODMAS rule • Average and Percentage • Simple and Compound Interest • Profit, loss and discounts • Ratio and proportion: Ratio – compound ratio, inverse ratio. Proportion – direct proportion, inverse proportion • Mixture and alligation: Mixture, alligation, mean concentration • Problems based on ages • Partnerships: Simple partnership, compound partnership	20
Reasoning: • Number series and letter series • Odd one out • Coding and decoding • Missing characters/numbers and analogies • Blood relations problems • Direction sense tests • Sequencing and ranking test	10
	Total Periods: 30

Learning Resources

1	R.V. Praveen, “Quantitative Aptitude and Reasoning”, 3rd Edition , Eastern Economy Edition, PHI Learning, New Delhi, 2016
2	Dr. R.S. Aggarwal, “ Quantitative Aptitude”, S Chand Publishing, New Delhi 2017
3	Dr. R.S. Aggarwal, “A Modern Approach to Verbal & Non-Verbal Reasoning”, S Chand Publishing, New Delhi 2017
4	https://www.indiabix.com/
5	https://www.geeksforgeeks.org/
6	https://faceprep.in/
7	https://prepinsta.com/
8	https://www.javatpoint.com/

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Solve quantitative aptitude problems involving arithmetic, algebra, percentages, ratios, etc., using logical approaches.	Applying
CO2	Analyze problems and apply reasoning strategies such as deduction, inference, and pattern recognition.	Analysing
CO3	Solve problems in simple and compound interest, profit, loss and discount	Applying
CO4	Solve problems based on ages and partnership	Applying
CO5	Demonstrate improved performance in time-bound aptitude tests through consistent practice.	Applying

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1								2	1		2		
CO2								2	1		2		
CO3								2	1		2		
CO4								2	1		2		
CO5								2	1		2		
Avg.								**2**	**1**		**2**		

For CO-PO/PSO Mapping: 3 – Substantial (High), 2– Moderate (Medium), 1– Slight (Low)

U24ME453	STRENGTH OF MATERIALS	L	T	P	C
		3	0	2	4

Course Objective:

After completing this course, the students will be able to:

- Understand and apply the concepts of stress and strain in simple and compound bars.
- Understand and draw shear force and bending moment diagrams for various types of beams.
- Understand and apply fundamental torsion equations in the design of shafts and helical springs.
- Understand and determine the slope and deflection of beams.
- Understand and evaluate stresses in thin- and thick-walled cylinders and spherical shells.

Detailed 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 - Principal stresses and principal planes - Mohr's circle graphical method.

UNIT II Transverse Loading on Beams and Stresses in Beam 9

Beams – Types - Transverse loading on beams – Shear force and Bending moment in beams – Cantilever, simply supported and over hanging beams. Theory of simple bending – Bending stress distribution – Load carrying capacity - Proportioning of sections - Flitched beams.

UNIT III Torsion 9

Theory of Torsion – Stresses and Deformations in Solid and Hollow Circular Shafts – Combined bending moment and torsion of shafts - Power transmitted to shaft – Shaft in series and parallel – Closed and Open Coiled helical springs – springs in series and parallel.

UNIT IV Deflection of Beams 9 Deflection and slope of a Beam subjected to Uniform Bending Moment - Deflection of a simply supported Beam with a Central Point load, Eccentric Point load and Uniformly Distributed load by Double Integration method, Moment Area Method (Mohr's Theorems) and Macaulay's Method.
UNIT V Thin Cylinders, Spheres and Thick Cylinders 9 Stresses in thin cylindrical shell due to internal pressure - circumferential and longitudinal stresses - Deformation in thin cylinders – Spherical shells subjected to internal pressure – Deformation in spherical shells – Thick cylinders - Lame's theory.
Total Periods: 45

PRACTICAL-LIST OF EXPERIMENT

Sl. No	List of Experiments
1	Tension test on mild steel rod.
2	Torsion test on mild steel rod.
3	Brinell Hardness hardness test on metals.
4	Rockwell hardness test on metals.
5	Compression test on open coil helical spring.
6	Tension test on closed coil helical spring.
7	Impact test on mild steel square rod.
	Total Periods: 30

Course Outcomes

CO	At the end of the course, the students will be able to	Knowledge Level
CO1	Apply the concepts of stress and strain in simple and compound bars and understand principal stresses and principal planes	Apply
CO2	Analysis shears force, bending moment and stress distribution of various beam and draw SF & BM diagrams.	Analyse
CO3	Apply basic equation of simple torsion in designing of shafts and helical spring.	Apply
CO4	Analysis slope and deflection in various beams by different methods.	Analyse
CO5	Apply the concepts of stresses on thin, thick cylinder and spherical shells.	Apply

Learning Resources

1	Rajput R.K. "Strength of Materials (Mechanics of Solids)", S.Chand & company Ltd., New Delhi, 7th edition, 2018.
2	Rattan S.S., "Strength of Materials", Tata McGraw Hill Education Pvt.Ltd., New Delhi, 2017.
3	Singh. D.K., "Strength of Materials", Ane Books Pvt Ltd., New Delhi, 2021.
4	Egor P Popov, "Engineering Mechanics of Solids", 2nd edition, PHI Learning Pvt. Ltd., New Delhi,2015.
5	Beer. F.P. & Johnston. E.R. "Mechanics of Materials", Tata McGraw Hill, 8th Edition, New Delhi 2019.
6	Vazirani. V.N, Ratwani. M.M, Duggal. S.K "Analysis of Structures: Analysis, Design and Detailing of Structures-Vol.1", Khanna Publishers, New Delhi 2014.

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ME463	CAD/CAM	L	T	P	C
		3	0	2	4

Course Objective:

After completing this course, the students will be able to:

- To provide an introduction to the fundamentals of design and to understand the basics of 2D and 3D works.
- To understand the principles of two-dimensional (2D) drafting and the creation of a bill of materials (BOM).
- To provide exposure to three-dimensional (3D) modeling techniques and their advantages in engineering design.
- To undertake the study of basic assembly modeling concepts and understand their purpose in 2D and 3D works.
- To provide exposure to the basics of computer-aided machining and part programming for manufacturing applications.

Detailed Syllabus

UNITI: BASICS OF DESIGN 9

Understanding of Projections, Scales, units, GD & T; its 14 symbols, Special characteristics; Title Block readings. Revision / ECN status of drawings – Customer Specific requirements – Drawing Grid reading. 2D & 3D transformations: Reflection, Translation and Rotation.

UNIT II: 2D DRAFTING 9

Projection views – Orthographic view, Auxiliary view, Full & Half Section views, Broken Section view, Offset Section view – Title Block creation – BOM Creation – Notes creation – Ballooning of 2D drawing and its features for Inspection reporting.

UNIT III: 3D MODELING 9

Conversion of Views – 2D to 3D & 3D to 2D – Parametric and Non-Parametric Modeling – Tree features of 3D Modeling and its advantages – Surface Modeling – BIW (Body in White) – Solid Modeling, Boolean operations like Unites, Subtraction and Intersect.

UNIT IV: ASSEMBLY MODELING 9

Basics of Assembly modeling, Purpose of Assembly modeling and its advantages – Top to Down & Bottom-Up modeling approaches – Analysis of Clearances – Undercuts – Interferences – Stack up analysis –Cumulative effect of Tolerances in after assembly conditions- Motion analysis.

UNIT V: CAM 9 Basics of CNC Machining – 3, 4, 5 Axis machines - CNC and Part Programming, CAM programming 2D & 3D. Elements of CAM Orientation, Boundary Creation, Cutter Path Selection, Cutter Compensation –Machining Stocks, Roughing, Re-roughing, Semi Finishing, Finishing - Tool Path Generation, and Milling Programming. Machining program simulation, integration of program with machine; Estimation of CNC Cycle time. – Post Process NC Code conversion and Setup Sheet Preparation. Work holding methods in turning and machining centres, coolant systems and safety features.
Total Periods: 45

PRACTICAL-LIST OF EXPERIMENT

S.No	ASSEMBLY MODELLING USING ANY 3D MODELLING SOFTWARE'S (CREO, NXCAD AND SOLID WORKS ETC.,)
1	Study of Sketch, Part Modeling & Solid modeling: Extrude Revolve, Sweep, Variational sweep and Loft. Surface modeling: Extrude, Sweep, Trim, Mesh of curves and Free form. Feature manipulation: Copy, Edit, Pattern, Suppress, History operations.
2	a. Study of Assembly Modeling: Constraints, Exploded Views, Interference check b. Study of Drafting: Layouts, Standard & Sectional Views, Detailing & Plotting
3	Creation of 3D assembly model Flange Coupling using 3D Modelling software
4	Creation of 3D assembly model Plummer Block using 3D Modelling software
5	Creation of 3D assembly model Screw Jack using 3D Modelling software
6	Creation of 3D assembly model Universal Joint using 3D Modelling software
7	Creation of 3D assembly model Piston using 3D Modelling software
	MANUAL PART PROGRAMMING
8	CNC Machining Centre a. Write a CNC Part Program to the Linear Cutting using standard G and M codes. Also check the tool path simulation using appropriate CAM software. b. Write a CNC Part Program to the Circular cutting using standard G and M codes. Also check the tool path simulation using appropriate CAM software
9	CNC Turning Centre a. Write a CNC Part Program to the Straight, Taper and Radial Turning using standard G and M codes. Also check the tool path simulation using appropriate CAM software. b. Write a CNC Part Program to the Drilling Cycle using standard G and M codes. Also check the tool path simulation using appropriate CAM software.
10	COMPUTER AIDED PART PROGRAMMING Generate CL Data and Post process data using CAM packages for Machining and Turning Centre
	Total Periods: 30

Learning Resources

1	Ibrahim Zeid ,"Mastering CAD CAM" ,Tata McGraw-Hill Publishing Co.2007
2	Jacob Moses, Ruchi Agarwal "Computer Aided Design; Manufacturing ,Technical Publications" 2020 Edition
3	J. Srinivas, CAD / CAM Principles & Application -Oxford HED, 2016 Edition

4	Ibrahim Zaid, R. Sivasubramanian "CAD / CAM Theory and Practice", Mc Graw Hills (Publisher), Second Edition
5	Chandandeep Grewal & Kuldeep Sareen, CAD / CAM Theory and Concepts, S CHAND Publishing, 2007
6	Anup Goel, A. Jacob Moses & Renjin J. Bright, Computer Aided Design & Manufacturing, Technical Publications,2021 Edition
7	PN Rao, CAD / CAM: Principles and Applications, McGraw Hill Education, Edition 2017

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Understanding the basics of design concepts to solve engineering problems using industry-relevant 2D and 3D practices.	Understand
CO2	Understanding two-dimensional (2D) drafting techniques and generate projection views as per industrial standards.	Understand
CO3	Apply three-dimensional (3D) modeling techniques, including parametric and non-parametric modeling, for industry-oriented product development.	Apply
CO4	Apply assembly modeling principles using top-down and bottom-up approaches for industrial design and manufacturing applications and undertaking project work to enhance modeling skills.	Apply
CO5	Analyze the computer-aided machining techniques for given components and develop industrial part programming for CNC manufacturing.	Analyse

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2				2		2	2	2		2	3	3
CO2	2				2		2	2	2		2	3	3
CO3	3	2			2		2	2	2		2	3	3
CO4	3	2			2		2	2	2		2	3	3
CO5	3	2	2		2		2	2	2		2	3	3
Avg.	**2.6**	**2**	**2**		**2**		**2**	**2**	**2**		**2**	**3**	**3**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ME472	**FLUID MECHANICS AND MACHINERY LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

Course Objective:

After completing this course, the students will be able to:

- Understand and compute material properties: Hardness, Tensile Strength, Young's Modulus, and Toughness.
- Understand and estimate spring deflection under different loads.
- Understand and determine the coefficient of discharge for flow devices and evaluate metacentric height.
- Understand and analyze pump performance characteristics and interpret curves.
- Understand and evaluate hydraulic turbine performance and analyze curves.



List of Experiments

Sl. No	List of Experiments
1	Calculation of the rate of flow using Rota meter
2	Determination of the Coefficient of discharge of given Orifice meter.
3	Determination of coefficient of discharge of a venturimeter.
4	Determination of friction factor for flow through pipes.
5	Determination of metacentric height.
6	Characteristics of centrifugal pumps.
7	Characteristics of reciprocating pump.
8	Characteristics of Pelton wheel turbine.
9	Characteristics curves of Francis turbine.
10	Characteristic curves of Kaplan turbine.
	Total Periods: 30

Course Outcomes

CO	At the end of the course, the students will be able to	Knowledge Level
CO1	Determine the rate of flow and discharge coefficients using flow measuring devices such as rotameter, orifice meter, and venturi meter.	Apply
CO2	Evaluate friction losses and determine the friction factor for flow through pipes under different flow conditions.	Apply
CO3	Apply the concept of buoyancy and determine the metacentric height to study the stability of floating bodies.	Apply
CO4	Analyze the performance characteristics of pumps, including centrifugal and reciprocating types, through experimental testing.	Analyse
CO5	Examine the performance and characteristic curves of hydraulic turbines such as Pelton wheel, Francis, and Kaplan turbines under various operating conditions.	Analyse

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ME482	THERMAL ENGINEERING LABORATORY	L	T	P	C
		0	0	4	2

Course Objective:

After completing this course, the students will be able to:

- To analyze the valve and port timing diagram and performance characteristics of IC engines
- To examine the Performance & retardation characteristics of 4 stroke Engine
- To investigate the Performance & retardation characteristics of 2 stroke Engine
- To analyze the Performance characteristics of Air compressor.
- To determine COP of Refrigeration system.



List of Experiments

Sl No	List of Experiments
1	Valve Timing and Port Timing diagrams.
2	Performance Test on four – stroke Diesel Engine.
3	Heat Balance Test on 4 – stroke Diesel Engine.
4	Retardation Test on a Diesel Engine.
5	Determination of Flash Point and Fire Point of various fuels / lubricants
6	Performance test on a two stage Reciprocating Air compressor
7	Determination of two stroke petrol engine performance using Electrical bulb loading.
8	Determination of four stroke Diesel engine performance using Hydraulic Dynamometer.
9	Study of Steam Generators and Turbines.
10	Actual p-v diagrams of IC engines.
11	Determination of COP of a Refrigeration system
12	Determination of p-θ diagram and heat release characteristics of an IC engine.
	Total Periods: 60

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Draw the valve and port timing diagram of IC engines.	Apply
CO2	Analyze the performance and retardation characteristics of a four-stroke engine.	Analyse
CO3	Evaluate the performance and retardation characteristics of a two-stroke engine.	Analyse
CO4	Analyze the performance characteristics and efficiency of an air compressor.	Analyse
CO5	Analyze performance tests and energy balance analysis on a steam generator.	Analyse

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EM422	SOFT SKILLS AND PERSONALITY DEVELOPMENT – I	L	T	P	C
		0	0	2	1

Course Objective:

After completing this course, the students will be able to:

- To understand and interpret human perception and behavior, enhancing interpersonal awareness.
- To enhance self-management, including habit formation, stress regulation, and personal productivity
- Develop conflict-resolution skills, aiming for win-win outcomes through structured strategies.
- Strengthen communication abilities active listening, telephone etiquette, and overcoming listening barriers.

List of Exercises

Sl. No.	List of Exercises
1	Introduction: A New Approach to Learning, Planning and Goal-Setting
2	Human Perceptions: Understanding People
3	Aiming for Excellence: Developing Potential and Self-Actualisation
4	Self-Management Skills- Time management & Self-motivation
5	Self-Management Skills- Stress management & Adaptability
6	Conflict Resolution Skills
7	Using The Zeigarnik Effect for Productivity and Personal Growth, Forming Habits of Success
8	Communication: Significance of Listening, Active Listening, Barriers to Active Listening
9	Telephone Communication: Basic Telephone Skills, Advanced Telephone Skills , Essential Telephone Skills
10	Profile Building
	Total Periods: 30

Learning Resources

1	Dorch, Patricia. What Are Soft Skills? New York: Execu Dress Publisher, 2013.
2	Kamin, Maxine. Soft Skills Revolution: A Guide for Connecting with Compassion for Trainers, Teams, and Leaders. Washington, DC: Pfeiffer & Company, 2013.
3	Klaus, Peggy, Jane Rohman & Molly Hamaker. The Hard Truth about Soft Skills. London: HarperCollins E-books, 2007.
4	Petes S. J., Francis. Soft Skills and Professional Communication. New Delhi: Tata McGraw-Hill Education, 2011.

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Develop an actionable growth plan aligning self-development with objectives.	Apply
CO2	Analyze the habit loop; design personal interventions to break bad habits.	Analyse
CO3	Analyze examples of interpersonal conflict; propose dual solutions using conflict-model frameworks.	Analyse
CO4	Apply stress-management strategies: reframing, planning, relaxation exercises.	Apply
CO5	Apply techniques to rectify the barriers in active listening	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1							2	2	2		2		
CO2							2	2	2		2		
CO3							2	2	2		2		
CO4							2	2	2		2		
CO5							2	2	2		2		
Avg.							**2**	**2**	**2**		**2**		

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

SEMESTER V

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24ME511	Design of Machine Elements	PCC	3	1	0	4	4	40	60
2	U24ME521	Heat and Mass Transfer	PCC	3	1	0	4	4	40	60
3	U24EM511	Aptitude and Reasoning -II	EEC	2	0	0	2	2	100	
4	U24MG511	Leadership and Team Management	EEC	2	0	0	2	2	40	60
5		Professional Elective – I	PEC							
6		Professional Elective – II	PEC							
7		Professional Elective – III	PEC							
8		Mandatory Course – I*	MC	3	0	0	3	0	100	
PRACTICAL COURSES										
9	U24ME532	Heat Transfer Laboratory	PCC	0	0	4	4	2	60	40
10	U24EM522	Soft skill and Personality Development - II	EEC	0	0	2	2	1	100	
				21	**2**	**6**	**29**	**24**		

ASSESSMENT SCHEME

Sl. No	Course Code	L	T	P	C	CIA Weightage (Theory)				CIA	ESE		CIA (W)	ESE (W)	Min. Marks to Pass for 100	
						T1	A1	T2	A2	Prac	Th	Prac			ESE	Total
1	U24ME511	3	1	0	4	60	40	60	40	-	100	-	40	60	45	50
2	U24ME521	3	1	0	4	60	40	60	40	-	100	-	40	60	45	50
3	U24EM511	2	0	0	2	-	-	-	-	-	-	-	100	-	-	50
4	U24MG511	2	0	0	2	60	40	60	40	-	100	-	40	60	45	50
5	PEC – I															
6	PEC – II															
7	PEC – III															
8	MC	3	0	0	0	-	-	-	-	-	-	-	100	-	-	50
9	U24ME532	0	0	4	2	-	-	-	-	100	-	100	60	40	45	50
10	U24EM522	0	0	2	1	-	-	-	-	-	-	100	-	-	-	50

(W) – Weightage

U24ME511	DESIGN OF MACHINE ELEMENTS	L	T	P	C
		3	1	0	4

Course Objective:

After completing this course, the students will be able to:

- To learn the various steps involved in the Design Process.
- To Learn designing shafts and couplings for various applications.
- To Learn the design of temporary and permanent Joints.
- To Learn designing helical, leaf springs, flywheels, connecting rods and crank shafts for various applications.
- To Learn designing and select sliding and rolling contact bearings, seals and gaskets.

Detailed Syllabus (Approved Design Data book is permitted)

UNIT I FUNDAMENTAL CONCEPTS IN DESIGN 12

Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers- Direct, Bending and torsional loading- Modes of failure - Factor of safety – Combined loads – Principal stresses – Eccentric loading – curved beams – crane hook and 'C' frame- theories of failure – Design based on strength and stiffness – stress concentration – Fluctuating stresses – Endurance limit –Design for finite and infinite life under variable loading - Exposure to standards.

UNIT II DESIGN OF SHAFTS AND COUPLINGS 12

Shafts and Axles - Design of solid and hollow shafts based on strength, rigidity and critical speed – Keys and splines – Rigid and flexible couplings.

UNIT III DESIGN OF TEMPORARY AND PERMANENT JOINTS 12

Threaded fasteners - Bolted joints including eccentric loading, Knuckle joints, Cotter joints – Welded joints- Butt, Fillet and parallel transverse fillet welds – welded joints subjected to bending, torsional and eccentric loads, riveted joints for structures - theory of bonded joints.

UNIT IV DESIGN OF ENERGY STORING ELEMENTS AND ENGINE COMPONENTS 12

Types of springs, design of helical and concentric springs–surge in springs, Design of laminated springs - rubber springs - Flywheels considering stresses in rims and arms for engines and punching machines-- Solid and Rimmed flywheels- connecting rods and crank shafts.

UNIT V DESIGN OF BEARINGS AND MISCELLANEOUS ELEMENTS 12

Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfeld Number, Raimondi & Boyd graphs, -- Selection of Rolling Contact bearings –Design of Seals and Gaskets.

Total Periods:60

Learning Resources

1	Bhandari V B, "Design of Machine Elements", 4th Edition, Tata McGraw-Hill Book Co, 2016
2	Joseph Shigley, Richard G. Budynas and J. Keith Nisbett "Mechanical Engineering Design", 10th Edition, Tata McGraw-Hill, 2015.
3	Ansel C Ugural, "Mechanical Design – An Integral Approach", 1st Edition, Tata McGraw-Hill Book Co, 2004.
4	Merhyle Franklin Spotts, Terry E. Shoup, and Lee EmreyHornberger, "Design of Machine Elements" 8th Edition, Printice Hall, 2004.

5	Sundararajamoorthy T. V. and Shanmugam. N, “Machine Design”, Anuradha Publications, Chennai, 2003.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Apply principal stresses and factor of safety for various theories of failure under different loading conditions.	Apply
CO2	Design the shafts, keys and couplings.	Apply
CO3	Design the permanent and temporary fasteners.	Apply
CO4	Calculate various dimensions of energy storing elements and engine components.	Apply
CO5	Design a bearing for the given application	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ME521	**HEAT AND MASS TRANSFER**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

Course Objective:

After completing this course, the students will be able to:

- To understand the principal mechanism of heat transfer under steady state and transient conditions
- To understand the fundamental concept and principles in convective heat transfer.
- To understand the theory of phase change heat transfer and design of heat exchangers.
- To study the fundamental concept and principles in radiation heat transfer.
- To understand the basic concept of mass transfer and diffusion and convective mass transfer.

Detailed Syllabus (Approved HMT Data book and Steam tables are permitted)

UNIT I CONDUCTION 15

General Differential equation – Cartesian, Cylindrical and Spherical Coordinates – One Dimensional Steady State Heat Conduction –– plane and Composite Systems – Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis – Semi Infinite and Infinite Solids –Use of Heisler’s charts – Methods of enhanced thermal conduction.

UNIT II CONVECTION 12 Conservation Equations, Boundary Layer Concept – Forced Convection: External Flow – Flow over Plates, Cylinders Spheres and Bank of tubes. Internal Flow – Entrance effects. Free Convection – Flow over Vertical Plate, Horizontal Plate, Inclined Plate, Cylinders and Spheres.
UNIT III RADIATION 12 Introduction to Thermal Radiation - Radiation laws and Radiative properties - Black Body and Gray body Radiation - Radiosity - View Factor Relations. Electrical Analogy. Radiation Shields.
UNIT IV PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS 12 Nusselt's theory of condensation- Regimes of Pool boiling and Flow boiling - Correlations in boiling and condensation. Heat Exchanger Types – TEMA Standards - Overall Heat Transfer Coefficient – Fouling Factors. LMTD and NTU methods. Fundamentals of Heat Pipes and its applications.
UNIT V MASS TRANSFER 9 Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state and Transient Diffusion - Stefan flow –Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations.
Total Periods:60

Learning Resources

1	Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley & Sons, 9th Edition, 2024.
2	Yunus A. Cengel, "Heat Transfer a Practical Approach" – Tata McGraw Hill, 5thEdition – 2013
3	Holman, J.P., "Heat and Mass Transfer", Tata McGraw Hill, 10th Edition 2010
4	R.C. Sachdeva, "Fundamentals of Engineering Heat & Mass transfer", New Age International Publishers, 2022
5	Ozisik, M.N., "Heat Transfer – A Basic Approach", McGraw Hill Book Co., 1994.
6	Kothandaraman, C.P., "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, 2024

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Compute rate of heat transfer in solids by conduction	Apply
CO2	Determine heat transfer rate in convection and phase change modes.	Apply
CO3	Compute the rate of heat transfer in radiation	Apply
CO4	Calculate the heat transfer coefficient in nucleate pool boiling and condensation and determine the heat transfer area and exit temperatures in heat exchangers	Apply
CO5	Solve problems in diffusion and convection mass transfer	Apply

CO-PO/PSO Mapping

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EM4511	APTITUDE AND REASONING – II	L	T	P	C
		2	0	0	2

Course Objective:

After completing this course, the students will be able to:

- Enhance analytical and logical reasoning skills to solve problems efficiently.
- Strengthen understanding of basic arithmetic, algebra, geometry, and data interpretation.
- Train students to approach problems systematically and apply suitable techniques.
- Foster quick thinking and reduce error rates through practice and time-bound exercises**.**
- Understand data interpretation using bar chart, pie chart and table chart

Syllabus topics

Topic titles	No of periods
Quantitative aptitude • Time and work • Pipes and Cistern • Chain Rule and wages • Time speed and distance • Train problems • Boats and streams • Races and games • Permutations and Combinations • Probability • Heights and distance • Logarithms • Surds and indices • Mensuration – 2D, 3D • Date interpretation – pie chart, bar chart, table chart. Data sufficiency in logical reasoning	20
Reasoning: • Symbols and notations • Mathematical operators and Venn diagrams • Puzzles • Cubes and Dice • Clocks and Calendars • Critical Reasoning • Non-verbal reasoning • Verbal Ability	10

Learning Resources

1	R.V. Praveen, “Quantitative Aptitude and Reasoning”, 3rd Edition, Eastern Economy Edition, PHI Learning, New Delhi, 2016
2	Dr. R.S. Aggarwal, “Quantitative Aptitude”, S Chand Publishing, New Delhi 2017
3	Dr. R.S. Aggarwal, “A Modern Approach to Verbal & Non-Verbal Reasoning”, S Chand Publishing, New Delhi 2017
4	https://www.indiabix.com/



5	https://www.geeksforgeeks.org/
6	https://faceprep.in/
7	https://prepinsta.com/
8	https://www.javatpoint.com/

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Solve quantitative aptitude problems involving time & work, chain rule and wages etc., using logical approaches.	Apply
CO2	Analyze problems and apply reasoning strategies such as deduction, inference, and pattern recognition.	Analyse
CO3	Solve problems on data interpretation, including bar charts, pie charts, tables, and graphs.	Apply
CO4	Solve problems in probability, height and distance and logarithms logically	Apply
CO5	Demonstrate improved performance in time-bound aptitude tests through consistent practice.	Apply

CO-PO/PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1								2	1		2		
CO2								2	1		2		
CO3								2	1		2		
CO4								2	1		2		
CO5								2	1		2		
Avg.								**2**	**1**		**2**		

U24MG511	**LEADERSHIP AND TEAM MANAGEMENT**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**2**

Course Objective:

After completing this course, the students will be able to:

- To introduce students to fundamental leadership theories, models, and frameworks for understanding leadership effectiveness.
- To develop the ability to analyze leadership styles, personality traits, emotional intelligence, and ethical values in organizational contexts.
- To enhance students' competence in evaluating leadership behavior, decision-making, and crisis management in diverse environments.
- To equip students with skills to lead groups and teams through effective communication, delegation, conflict management, and motivation.
- To enable students to design and apply strategies for developing high-performance, multicultural, and virtual teams using contemporary leadership practices.

Detailed Syllabus

UNIT I INTRODUCTION TO LEADERSHIP & TEAM MANAGEMENT 6

Leadership Myths; Interactional Framework for analyzing leadership; Leadership Development: The First 90 Days as a Leader; Leader Development- The Action-Observation-Reflection Model.

LMX Theory and Normative Decision Model; Situational Leadership Model; Contingency Model and Path Goal Theory.
UNIT II LEADERSHIP TYPES AND ATTRIBUTES 6 Emotional Approach Charismatic and Transformational Leadership; Leadership for Tomorrow, Leadership Attributes; Personality Traits and Leadership; Personality Types and Leadership; Intelligence and Leadership; Emotional Intelligence and Leadership. Power and Leadership; The art of influence in leadership; Leadership and "Doing the Right Things; Character-Based Approach to Leadership; Role of Ethics and Values in Organisational Leadership
UNIT III LEADERSHIP BEHAVIOUR 6 Leadership Behaviour, Assessing Leadership Behaviour: Multi-rater feedback instruments, The Dark Side of Leadership -Destructive Leadership, Managerial Incompetence and Derailment, Negotiation and Leadership, Leadership in Crisis Situation, The Situation and The Environment, Culture and Leadership, Global Leadership, Motivation and Leadership
UNIT IV INTRODUCTION TO GROUPS AND TEAMS 6 Characteristics of Leaders, Followers and Situation, Group Dynamics, Team Formation, Delegation and Empowerment, Leading Teams: Enhancing Teamwork Within a Group, The Leader's Role in Team-Based Organizations, Leader Actions That Foster Team Effectiveness, Offsite Training and Team Development, Understanding Team Processes and Team Coaching, Team Decision Making and Conflict Management, Virtual Teams
UNIT V MANAGING MULTICULTURAL TEAMS 6 Building Great Teams, Experiential Learning, Action Learning, Developmental Planning: Gaps Analysis, Coaching and Mentoring, Women in Leadership Roles, Building Effective Relationship with Subordinates and Peers, Fostering Followers Satisfaction, The Art of Communication, Setting Goals and Providing Constructive Feedback, Enhancing Creativity Problem Solving Skill, Building High-Performance Teams: The Rocket Model, Building Credibility and Trust, Skills for Developing others.
Total Periods:30

Learning Resources

1	Peter G. Northouse, "Leadership: Theory and Practice", 8th Edition, Sage Publications, 2019.
2	Stephen P. Robbins and Timothy A. Judge, "Organizational Behavior", 18th Edition, Pearson Education, 2019.
3	Robert N. Lussier and Christopher F. Achua, "Leadership: Theory, Application, and Skill Development", 6th Edition, Cengage Learning, 2016.
4	Jon R. Katzenbach and Douglas K. Smith, "The Wisdom of Teams", Harvard Business School Press, 2005.
5	Daniel Goleman, "Emotional Intelligence", Bantam Books, 2006.
6	Leadership and Team Effectiveness, Dr. Santosh Rangnekar, IIT Roorkee (NPTEL Course) https://onlinecourses.nptel.ac.in/noc22_mg39/preview

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain and compare major leadership theories, models, and frameworks.	Understand

CO2	Describe leadership styles, attributes, personality, and emotional intelligence in organizational situations.	Understand
CO3	Discuss leadership behavior, ethics, power, and decision-making in complex and crisis situations.	Understand
CO4	illustrate leadership principles to manage groups, teams, conflicts, and motivation effectively.	Understand
CO5	Explain leadership development and team-building strategies for high-performance, multicultural, and virtual teams.	Understand

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1							2	2	2	2		
CO2	1							2	2	2	2		
CO3	1							2	2	2	2		
CO4	1							2	2	2	2		
CO5	1							2	2	2	2		
Avg.	**1**							**2**	**2**	**2**	**2**		

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ME532	HEAT TRANSFER LABORATORY	L	T	P	C
		0	0	4	2

Course Objective:

After completing this course, the students will be able to:

- To gain experimental knowledge of Predicting the thermal conductivity of solids and liquids
- To gain experimental knowledge of Estimating the heat transfer coefficient values of various fluids.
- To gain experimental knowledge of Testing the performance of tubes in tube heat exchangers

List of Experiments (Approved HMT Data book is permitted)

1	Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
2	Determination of thermal conductivity of an Insulating Material by using of Mechanical Guarded Plate.
3	Determination of heat transfer coefficient of air under forced convection by Internal flow.
4	Determination of heat transfer coefficient of air under natural convection by External Flow
5	Heat transfer from pin-fin under natural convection by using Internal flow Air.
6	Heat transfer from pin-fin under forced convection by using Internal flow Air
7	Determination of friction factor, heat transfer coefficient of cold/hot fluid and effectiveness of a tube-in-tube heat exchanger.
8	Determination of Stefan – Boltzmann constant.
9	Determination of emissivity of a grey surface.
10	Calibration of thermocouples / RTDs at standard reference temperatures.
	Total Periods: 60

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Determine thermal conductivity, and heat flux for different materials using standard experimental setups.	Apply
CO2	Analyze convection, boiling, and condensation heat transfer processes by interpreting experimental data and comparing with theoretical predictions.	Analyse
CO3	Evaluate heat exchanger performance, including friction factor and effectiveness, under different operating conditions.	Apply
CO4	Calibrate thermocouples/RTDs and assess the emissivity and radiation characteristics of surfaces using experimental results.	Apply
CO5	Develop structured laboratory reports and construct experimental conclusions to propose improvements in thermal system performance.	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EM522	**SOFT SKILLS AND PERSONALITY DEVELOPMENT – II**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

Course Objective:

After completing this course, the students will be able to:

- To improve written communication etiquette, covering email principles, netiquette, and proper messaging practices.
- To communicate effectively with clarity, active listening, and overcoming sender–receiver barriers.
- To develop non-verbal awareness, interpreting body language and cues, especially in high-stakes contexts (interviews, presentations).
- To enhance public speaking and presentation skills using visuals, confidence building, and anxiety management.
- To cultivate integrity-driven human relations, emphasizing listening, trust, and ethical communication

List of Exercises

Sl. No.	List of Exercises
1	Technology and Communication: Technological Personality, Mobile Personality?
2	Communication Skills: Effective Communication
3	Barriers to Communication: Arising out of Sender/Receiver's Personality, Interpersonal Transactions, Miscommunication
4	Nonverbal Communication: Introduction And Importance, Issues and Types, Basics and Universals
5	Body Language: For Interviews, For Group Discussions

6	Presentation Skills: Overcoming Fear, Becoming A Professional, The Role of Body Language
7	Presentation Skills: Using Visuals
8	Reading Skills: Effective Reading
9	Human Relations: Developing Trust and Integrity
10	Visume
	Total Periods: 30

Learning Resources

1	Dorch, Patricia. What Are Soft Skills? New York: Execu Dress Publisher, 2013.
2	Kamin, Maxine. Soft Skills Revolution: A Guide for Connecting with Compassion for Trainers, Teams, and Leaders. Washington, DC: Pfeiffer & Company, 2013.
3	Klaus, Peggy, Jane Rohman & Molly Hamaker. The Hard Truth about Soft Skills. London: HarperCollins E-books, 2007.
4	Petes S. J., Francis. Soft Skills and Professional Communication. New Delhi: Tata McGraw-Hill Education, 2011.
5	Enhancing Soft Skills and Personality, Dr. T. Ravichandran, IIT Kanpur NPTEL Course: https://onlinecourses.nptel.ac.in/noc26_hs47/preview
6	Developing Soft Skills and Personality, Dr. T. Ravichandran, IIT Kanpur NPTEL Course: https://nptel.ac.in/courses/109104107

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Write effective emails using email principles and etiquette	Apply
CO2	Design visuals using principles of clarity, readability, and relevance (graphs, slides, props).	Apply
CO3	Apply the communication model to real-world situations, accounting for tone, style, barriers	Apply
CO4	Compare self-assessed nonverbal behaviors to standardized benchmarks.	Understand
CO5	Apply confident body language techniques in interviews and group discussion simulations.	Apply

CO-PO/PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1								1	2		2		
CO2								1	2		2		
CO3								1	2		2		
CO4								1	2		2		
CO5								1	2		2		
Avg.								**1**	**2**		**2**		

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)



SEMESTER VI

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24ME611	Design of Transmission Systems	PCC	3	1	0	4	4	40	60
2	U24ME621	Metrology and Measurements	PCC	3	0	0	3	3	40	60
3	U24MG611	Project Management	HSMC	2	0	0	2	2	40	60
4	U24MG621	Entrepreneurship	EEC	2	0	0	2	2	40	60
5		Professional Elective – IV	PEC							
6		Open Elective – I	OEC							
7		Mandatory Course – II*	MC	2	0	0	2	0	100	-
PRACTICAL COURSES										
8	U24ME632	Metrology and Dynamics Laboratory	PCC	0	0	4	4	2	60	40
9	U24ME642	Design and Fabrication Project	EEC	0	0	4	4	2	60	40
				18	**1**	**8**	**27**	**21**		

ASSESSMENT SCHEME

Sl. No	Course Code	L	T	P	C	CIA Weightage (Theory)				CIA	ESE		CIA (W)	ESE (W)	Min. Marks to Pass for 100	
						T1	A1	T2	A2	Prac	Th	Prac			ESE	Total
1	U24ME611	3	1	0	4	60	40	60	40	-	100		40	60	45	50
2	U24ME621	3	0	0	3	60	40	60	40	-	100		40	60	45	50
3	U24MG611	2	0	0	2	60	40	60	40	-	100		40	60	45	50
4	U24MG621	2	0	0	2	60	40	60	40	-	100		40	60	45	50
5	PEC – IV														45	50
6	OEC – I														45	50
7	MC	3	0	0	0	-	-	-	-	-	-	-	100	-	-	50
8	U24ME632	0	0	4	2	-	-	-	-	100	-	100	60	40	45	50
9	U24ME642	0	0	4	2	-	-	-	-	100	-	100	60	40	45	50

(W) – Weightage

U24ME611	DESIGN OF TRANSMISSION SYSTEMS	L	T	P	C
		3	1	0	4

Course Objective:

After completing this course, the students will be able to:

- To gain knowledge on the principles and procedure for the design of Mechanical power Transmission components.
- To understand the standard procedure available for Design of Transmission of Mechanical elements spur gears and parallel axis helical gears.
- To learn the design bevel, worm and cross helical gears of Transmission system.
- To learn the concepts of design multi and variable speed gear box for machine tool applications.
- To learn the concepts of design to cams, brakes and clutches.

Detailed Syllabus (Approved Design Data book is permitted)

UNIT I DESIGN OF FLEXIBLE ELEMENTS 9+3

Design of Flat belts and pulleys - Selection of V belts and pulleys – Selection of hoisting wire ropes and pulleys – Design of Transmission chains and Sprockets.

UNIT II SPUR GEARS AND PARALLEL AXIS HELICAL GEARS 9+3

Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects – Fatigue strength - Factor of safety - Gear materials – Design of straight tooth spur & helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane-Equivalent number of teeth-forces for helical gears.

UNIT III BEVEL, WORM AND CROSS HELICAL GEARS 9+3

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears.

Worm Gear: Merits and demerits terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair. Cross helical: Terminology-helix angles-Estimating the size of the pair of cross helical gears.

UNIT IV GEAR BOXES 9+3

Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box - Design of multi speed gear box for machine tool applications - Constant mesh gear box - Speed reducer unit. – Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications.

UNIT V CAMS, CLUTCHES AND BRAKES 9+3

Cam Design: Types-pressure angle and under cutting base circle determination-forces and surface stresses. 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.

Total Periods:60

Learning Resources

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”, 8th Edition, Tata McGraw-Hill, 2008.

3	Prabhu. T.J., “Design of Transmission Elements”, Mani Offset, Chennai, 2000.
4	Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, “Design of Machine Elements” 8th Edition, Printice Hall, 2003.
5	Orthwein W, “Machine Component Design”, Jaico Publishing Co, 2003.
6	Sundararajamoorthy T. V, Shanmugam. N, “Machine Design”, Anuradha Publications, Chennai, 2003.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Design to belts, chains and rope drives.	Analyse
CO2	Design to spur, helical gears.	Analyse
CO3	Design to worm and bevel gears.	Analyse
CO4	Design gearboxes for mechanical applications.	Analyse
CO5	Design to cams, brakes and clutches	Analyse

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ME621	METROLOGY AND MEASUREMENTS	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- To learn basic concepts of the metrology and importance of measurements.
- To teach measurement of linear and angular dimensions assembly and transmission elements.
- To study the tolerance analysis in manufacturing
- To develop the fundamentals of GD & T and surface metrology.
- To provide the knowledge of the advanced measurements for quality control in manufacturing Industries.

Detailed Syllabus

UNIT I BASICS OF METROLOGY 9

Measurement – Need, Process, Role in quality control; Factors affecting measurement - SWIPE; Errors in Measurements – Types – Control – Measurement uncertainty – Types, Estimation, Problems on Estimation of Uncertainty, Statistical analysis of measurement data, Measurement system analysis, Calibration of measuring instruments, ISO standards.

UNIT II MEASUREMENT OF LINEAR, ANGULAR DIMENSIONS, ASSEMBLY AND TRANSMISSION ELEMENTS 9 Linear Measuring Instruments – Use and precautions, Comparators – Working and advantages Angular measuring instruments – Bevel protractor, Clinometer, Angle gauges, Precision level, Sine bar, Autocollimator, Angle dekkor, Alignment telescope. Measurement of Screw threads - Single element measurements – Pitch Diameter, Lead, Pitch. Measurement of Gears – purpose – Analytical measurement – Runout, Pitch variation, Tooth profile, Tooth thickness, Lead – Functional checking – Rolling gear test.
UNIT III TOLERANCE ANALYSIS 9 Tolerancing– Interchangeability, Selective assembly, Tolerance representation, Terminology, Limits and Fits, Problems (using tables IS919); Design of Limit gauges, Problems. Tolerance analysis in manufacturing, Process capability, tolerance stackup, tolerance charting.
UNIT IV METROLOGY OF SURFACES 9 Fundamentals of GD & T- Conventional vs Geometric tolerance, Datums, Inspection of geometric deviations like straightness, flatness, roundness deviations; Simple problems – Measurement of Surface finish – Functionality of surfaces, Parameters, Comparative, Stylus based and Optical Measurement techniques, Filters, Introduction to 3D surface metrology-Parameters.
UNIT V ADVANCES IN METROLOGY 9 Lasers in metrology - Advantages of lasers – Laser scan micrometers; Laser interferometers – Applications – Straightness, Alignment; Ball bar tests, Computer Aided Metrology - Basic concept of CMM – Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Multisenso CMMs. Machine Vision - Basic concepts of Machine Vision System – Elements – Applications - On-line and in process monitoring in production - Computed tomography – White light Scanners.
Total Periods: 45

Learning Resources

1	Connie L. Dotson, “Fundamentals of Dimensional Metrology: Methods and Materials”, Delmar publications, sixth edition, 2015
2	Mark Curtis, Francis T. Farago, “Handbook of Dimensional Measurement”, Industrial Press, Fifth edition, 2013.
3	Gupta. I.C., “A Text Book of Engineering Metrology”, Dhanpatrai Publications, 2005.
4	Ammar Grous, J “Applied Metrology for Manufacturing Engineering”, Wiley-ISTE, 2013
5	Galyer, J.F.W. Charles Reginald Shotbolt, “Metrology for Engineers”, Cengage Learning EMEA; 5th revised edition, 1990.
6	Raghavendra N.V. and Krishnamurthy. L., Engineering Metrology and Measurements, Oxford University Press, 2013.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Discuss the concepts of measurements to apply in various metrological instruments.	Understand
CO2	Explain the principle and applications of linear and angular measuring instruments, assembly and transmission elements.	Understand

CO3	Apply the tolerance symbols and tolerance analysis for industrial applications.	Apply
CO4	Describe the GD & T and different surface measurement techniques and compare the roughness values obtained by each method.	Apply
CO5	Discuss the advanced measurement tools and techniques and machine vision system.	Understand

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MG611	PROJECT MANAGEMENT	L	T	P	C
		2	0	0	2

Course Objective:

After completing this course, the students will be able to:

- Understand the fundamentals of project management including project characteristics, life cycle phases, and key managerial issues involved in projects.
- Identify, screen, and evaluate projects using qualitative techniques and quantitative financial appraisal methods under certainty and uncertainty conditions.
- Understand project organizational structures and leadership concepts and analyze the roles and responsibilities of a project manager in different organizational settings.
- Apply project planning and control techniques for effective scope, time, and cost management using tools such as WBS, network diagrams, CPM, PERT, and earned value analysis.
- Recognize the importance of quality management in projects and apply quality assurance, quality control, and continuous improvement techniques for successful project execution.

Detailed Syllabus

UNIT I INTRODUCTION TO PROJECT MANAGEMENT 6

Concept of project management - project definition and key features of projects - project life cycle phases - typical project management issues - basic project activities.

UNIT II PROJECT IDENTIFICATION AND SELECTION 6

Identification and screening (brainstorming, strength and weakness in the system, Environmental opportunities and threats) - Project evaluation methods - Payback period - Net present value - internal rate of return and project evaluation under uncertainty.

UNIT III PROJECT ORGANIZATION 6

Roles and responsibilities of a project manager, Project Organization- The project as Part of the Functional Organization - Pure Project Organization - The Matrix organization - leadership styles

UNIT IV SCOPE, TIME AND COST MANAGEMENT 6

Scope Management-define the project-SOW, WBS - Time Management-Network diagram-forward and backward pass - critical path - PERT and CPM - AOA and AON methods - tools for project network - Cost management - earned value method.

UNIT V QUALITY MANAGEMENT 6
Quality assurance and quality control - quality audit- methods of enhancing quality.
Total Periods: 30

Learning Resources

1	R. Panneerselvam and P. Senthil Kumar (2013), Project Management, PHI Learning Private Limited
2	Prasanna Chandra (2014), Projects: Planning, Analysis, Selection, Financing, implementation and Review
3	A Guide to the Project Management Body of Knowledge: (PMBOK Guide) by Project Management Institute, 2013.
4	Gopala Krishnan & Rama Murthy, A Text book of Project Management, McMillan India
5	S. Choudhary (2004), Project Management, Tata McGraw Hill Publication.
6	Clifford F Gray (2014), Project Management: The Managerial Process, (Special Indian Edit.), Oregon State University.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the concepts, characteristics, life cycle phases, and managerial issues of projects.	Understand
CO2	Identify, screen, and evaluate projects using financial appraisal techniques such as Payback Period, NPV, IRR, and evaluation under uncertainty.	Apply
CO3	Analyze different project organizational structures and leadership styles and assess the role of a project manager in achieving project objectives.	Understand
CO4	Develop project plans by defining scope, scheduling activities, identifying critical paths, and controlling cost using CPM, PERT, and earned value techniques.	Analyse
CO5	Apply quality management principles, quality assurance, quality control, and auditing techniques to enhance project performance and outcomes.	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MG621	ENTREPRENEURSHIP	L	T	P	C
		2	0	0	2

Course Objective:

After completing this course, the students will be able to:

- Understand the fundamentals of entrepreneurship including motivation, leadership, social entrepreneurship, and the role of women entrepreneurs in economic development.
- Analyze the entrepreneurial process involved in identifying, evaluating, and selecting viable business opportunities through market research.
- Formulate innovative business ideas using creative problem-solving techniques and understand legal and ownership structures of business organizations.
- Develop and evaluate comprehensive business plans incorporating marketing, financial, organizational, and implementation strategies.
- Acquire knowledge of MSMEs and institutional support systems including government policies, incentives, subsidies, and industrial infrastructure for entrepreneurship development.

Detailed Syllabus

UNIT I INTRODUCTION 6

Understanding entrepreneurship- need for entrepreneurship development - Theory of Entrepreneurial Motivation - Barriers to entrepreneurship - Qualities of a successful entrepreneur - Types of entrepreneurs, Entrepreneurial Leadership- Development of women entrepreneurs and the Future of entrepreneurship- Social Entrepreneurship.

UNIT II ENTREPRENEURIAL PROCESS 6

Identification – Selection of a good Business opportunity - Market survey and Research – developing a business plan -Entrepreneurship Development Programme- Meaning - Objectives - Phases of EDP - Course contents, Target groups.

UNIT III FORMULATION OF BUSINESS IDEA 6

Sources for new ideas & evaluation of new idea for doing business - Creative problem-solving techniques used in entrepreneurial decision making. Formalities for registration of business units - Types of ownership in Business- merits and demerits - business incubators - types by valuation.

UNIT IV THE BUSINESS PLAN 6

Nature and scope of Business plan - Writing Business Plan - Evaluating Business plans - sing and implementing business plans. Application BMC - Marketing plan - financial plan and the organizational plan - Launching formalities

UNIT V MICRO SMALL MEDIUM ENTERPRISE (MSME) 6

Procedures and formalities for registration of business units and its benefits. Types of ownership in Business & its merits and demerits - Reason for business failures - causes and preventive measures. Institutional support to Entrepreneurship - Central and State Level Institutional support for business units. Industrial Estates & Special Economic Zones in India. Incentives and subsidies & bounties for businesses - Policy initiatives.

Total Periods: 30

Learning Resources

1	Anshuja Tiwari, (2015), Entrepreneurship Development in India, Himalaya Publishing House, New Delhi.
2	Nagaraja Prakasam, (2025) Back to Bharath in search of sustainable future, Penguin Business Published, New Delhi.
3	Vasant Desai, Dynamics of Entrepreneurial Development and Management Principles. Projects, Policies, Programmes – 2005, Himalaya Publishing House, New Delhi.

4	Poornima M Charantimath, (2016), Entrepreneurship Development Small Business Enterprises, Dorling Kindersley India Pvt. Ltd, New Delhi.
5	Anshuja Tiwari, (2015), Women Entrepreneurship and Economic Development, Himalaya Publishing House, New Delhi.
6	S. Anil Kumar, (2015), Small Businesses and Entrepreneurship, International Publishing House Private Ltd, New Delhi.
7	Dr. S.S. Khanka, (2012), Entrepreneurial Development, S.Chand, New Delhi.

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Explain the concepts, theories, and motivation behind entrepreneurship, including social and women entrepreneurship, and assess the qualities required for successful entrepreneurs.	Understand
CO2	Explain and evaluate business opportunities using market survey and research techniques and outline the stages of the entrepreneurial process	Understand
CO3	Describe innovative business ideas, apply creative problem-solving tools, and select appropriate ownership and registration procedures for business ventures.	Apply
CO4	Discuss a viable business plan using tools such as the Business Model Canvas, marketing, financial, and organizational plans.	Understand
CO5	Examine MSME policies, institutional support mechanisms, incentives, and causes of business failure to recommend strategies for sustainable entrepreneurial growth.	Understand

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ME632	METROLOGY AND DYNAMICS LABORATORY	L	T	P	C
		0	0	4	2

Course Objective:

After completing this course, the students will be able to:

- To understand and use linear and angular measuring instruments for quality inspection.
- To perform precise angular measurements using sine bars and bevel protractors.
- To measure gear and surface parameters using advanced tools.
- To study the working and performance of governors and inertia of mechanical elements.
- To analyze vibrations, gyroscopic effects, and critical speed in rotating systems.

List of Experiments

Sl No	List of Experiments
	UNIT – I METROLOGY LABORATORY - 30
1	Calibration and use of Vernier caliper and micrometer by using slip gauge
2	Calibration and use of Vernier height gauge and depth gauge by using slip gauge.
3	Measurement of internal diameters of given mechanical components by using bore gauge and telescopic gauge.
4	Measurement of angles using sine bar, sine centre and bevel protractor
5	Measurement of gear parameters using gear tooth vernier caliper.
6	Measurement of screw thread parameters using Profile projector and Toolmaker microscope.
	UNIT – II DYNAMICS LABORATORY- 30
1	Determination of moment of inertia of flywheel and axle system by turntable apparatus & oscillation method.
2	Determination of natural frequency by compound pendulum method
3	Undamped free vibrations of a single degree freedom spring-mass system.
4	Experiment on motorized gyroscope.
5	Determination of critical speed of shafts.
	Total Periods: 60

Learning Resources

1	Connie L. Dotson, “Fundamentals of Dimensional Metrology: Methods and Materials”, Delmar publications, sixth edition, 2015
2	Mark Curtis, Francis T. Farago, “Handbook of Dimensional Measurement”, Industrial Press, Fifth edition, 2013.
3	Gupta. I.C., “A Text Book of Engineering Metrology”, Dhanpatrai Publications, 2005.
4	Ammar Grous, J “Applied Metrology for Manufacturing Engineering”, Wiley-ISTE, 2013
5	Galyer, J.F.W. Charles Reginald Shotbolt, “Metrology for Engineers”, Cengage Learning EMEA; 5th revised edition, 1990.
6	Raghavendra N.V. and Krishnamurthy. L., Engineering Metrology and Measurements, Oxford University Press, 2013.

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Apply linear and angular measuring tools to ensure the quality of products.	Analyse
CO2	Determine angular measurements using sine bar and bevel protractor for quality inspection and compare them.	Analyse
CO3	Estimate gear and surface measurement parameters using advanced instruments.	Apply

CO4	Analyse the range of speed, sensitiveness of governors, and mass moment of inertia of mechanical elements.	Analyse
CO5	Calculate natural frequency, active and reactive gyroscopic couples, and critical speed of shafts.	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ME642	DESIGN AND FABRICATION PROJECT	L	T	P	C
		0	0	4	2

Course Objective:

After completing this course, the students will be able to:

- To provide hands-on experience in the design and fabrication of mechanical components or systems.
- To enable students to apply theoretical knowledge to develop a complete working model.
- To enhance problem-solving skills through real-time project planning, execution, and troubleshooting.
- To develop teamwork, project management, and communication skills through group-based project work.
- To expose students to industry-relevant fabrication practices, documentation, and evaluation procedures.

Guideline for Batch Formation, Review and Evaluation:

1) The students may be grouped with minimum one student to maximum 4 students and work under a project supervisor.
2) The device/system/component/ product to be fabricated may be decided in consultation with the supervisor and if possible, with an industry.
3) The Design and Fabrication project report to be submitted by the Batch with the fabricated model at the end of the semester/time of final Viva-Voce.
4) During the allotted periods the Design and Fabrication project work to be reviewed (Maximum of 4 reviews including Zeroth Review) and evaluated for internal assessment by a committee constituted by the Head of the Department.

Total Periods: 60

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Identify and define a suitable mechanical design problem based on practical or industry requirements.	Understand
CO2	Design mechanical elements or systems using appropriate engineering principles and tools.	Apply
CO3	Fabricate and assemble the designed components into a functional working model.	Analyse
CO4	Analyze and evaluate the performance of the fabricated model through testing and validation.	Analyse
CO5	Prepare a comprehensive project report and effectively present the project work.	Understand

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

SEMESTER VII

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24ME711	Finite Element Analysis	PPC	3	1	0	4	4	40	60
2	U24MG711	Human Values and Ethics	HSMC	2	0	0	2	2	40	60
3	U24MG721	Total Quality Management	HSMC	3	0	0	3	3	40	60
4		Professional Elective – V	PEC							
5		Professional Elective – VI	PEC							
6		Open Elective – II	OEC							
PRACTICAL COURSES										
7	U24ME722	Simulation and Analysis Laboratory	PPC	0	0	4	4	2	60	40
8	U24ME732	Summer Internship	EEC	0	0	4	4	2	100	-
				14	**0**	**8**	**22**	**22**		

ASSESSMENT SCHEME

Sl. No	Course Type	L	T	P	C	CIA Weightage (Theory)				CIA	ESE		CIA (W)	ESE (W)	Min. Marks to Pass for 100	
						T1	A1	T2	A2	Prac	Th	Prac			ESE	Total
1	U24ME711	3	1	0	4	60	40	60	40	-	100	-	40	60	45	50
2	U24MG711	2	0	0	2	60	40	60	40	-	100	-	40	60	45	50
3	U24MG721	3	0	0	3	60	40	60	40	-	100	-	40	60	45	50
4	PEV – V														45	50
5	PEC – VI														45	50
6	OCE - II														45	50
7	U24ME722	0	0	4	2	-	-	-	-	100	-	100	60	40	45	50
8	U24ME732	0	0	4	2	-	-	-	-	-	-	100	-	-	-	50

(W) – Weightage

U24ME711	FINITE ELEMENT ANALYSIS	L	T	P	C
		3	1	0	4

Course Objective:

After completing this course, the students will be able to:

- To provide a strong foundation in finite element formulations for solving one-dimensional engineering problems.
- To develop the ability to apply finite element techniques for solving two-dimensional scalar field problems.
- To introduce tolerance symbols and tolerance analysis concepts relevant to industrial engineering applications.
- To enable students to analyze and solve two-dimensional vector problems using the finite element method.
- To equip students with knowledge on dynamic problem analysis using finite element techniques.

UNIT I INTRODUCTION 9+3

Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Galerkin approach -Basic concepts of the Finite Element Method- Introduction to Analysis software.

UNIT II ONE-DIMENSIONAL PROBLEMS 9+3

One Dimensional Second Order Equations – Discretization – Element types (Linear Element) – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices- Problems on solid mechanics and heat transfer (Using two node bar element-Maximum two Elements)

UNIT III TWO-DIMENSIONAL SCALAR VARIABLE PROBLEMS 9+3

Introduction to two-dimensional problems – Triangular elements – Shape functions for triangular elements – Element stiffness matrix – Assembly procedure – Application to 2D heat conduction problems (Maximum using two CST elements).

UNIT IV TWO-DIMENSIONAL VECTOR VARIABLE PROBLEMS 9+3

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects using triangular elements – Stress calculations. (Maximum using two CST elements)

UNIT V DYNAMIC ANALYSIS 9+3

Introduction to Dynamic Analysis- Formulation of finite element model, element matrices, evaluation of Eigen values and Eigen vectors for a stepped bar and a beam.

Total Periods: 60

Learning Resource:

1	Reddy, J.N., “An Introduction to the Finite Element Method”, 3rd Edition, Tata McGraw
2	Seshu, P., “Text Book of Finite Element Analysis”, Prentice
3	Bhatti Asghar M, “Fundamental Finite Element Analysis and Applications”, John Wiley & Sons, 2005 (Indian Reprint 2013)



4	Chandrupatla & Belagundu, “Introduction to Finite Elements in Engineering”, 3rd Edition, Prentice Hall College Div, 1990
5	Logan, D.L., “A first course in Finite Element Method”, Thomson Asia Pvt. Ltd., 2002
6	Rao, S.S., “The Finite Element Method in Engineering”, 3rd Edition, Butterworth Heinemann, 2004
7	Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, “Concepts and Applications of Finite Element Analysis”, 4th Edition, Wiley Student Edition, 2002.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the fundamental concepts of finite element methods, including governing equations, discretization, and weighted residual techniques.	Understand
CO2	Apply finite element formulations to solve one-dimensional engineering problems using shape functions, stiffness matrices, and assembly procedures.	Apply
CO3	Apply finite element methods to analyze two-dimensional scalar field problems using triangular elements.	Apply
CO4	Apply finite element techniques to solve two-dimensional vector problems involving stress, strain, and elasticity.	Apply
CO5	Apply finite element methods to analyze dynamic behaviour of engineering systems including eigenvalue problems.	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MG711	HUMAN VALUES AND ETHICS	L	T	P	C
		2	0	0	2

Course Objective:

After completing this course, the students will be able to:

- To create awareness about values and ethics enshrined in the Constitution of India
- To sensitize students about the democratic values to be upheld in the modern society.
- To inculcate respect for all people irrespective of their religion or other affiliations.
- To install the scientific temper in the students’ minds and develop their critical thinking.
- To promote sense of responsibility and understanding of the duties of citizen.

Detailed Syllabus

UNIT I DEMOCRATIC VALUES 6 Understanding Democratic values: Equality, Liberty, Fraternity, Freedom, Justice, Pluralism, Tolerance, Respect for All, Freedom of Expression, Citizen Participation in Governance – World Democracies: French Revolution, American Independence, Indian Freedom Movement.
UNIT II SECULAR VALUES 6 Understanding Secular values – Interpretation of secularism in Indian context - Disassociation of state from religion – Acceptance of all faiths – Encouraging non-discriminatory practices.
UNIT III SCIENTIFIC VALUES 6 Scientific thinking and method: Inductive and Deductive thinking, Proposing and testing Hypothesis, validating facts using evidence-based approach – Skepticism and Empiricism – Rationalism and Scientific Temper.
UNIT IV SOCIAL ETHICS 6 Application of ethical reasoning to social problems – Gender bias and issues – Gender violence – Social discrimination – Constitutional protection and policies – Inclusive practices.
UNIT V SCIENTIFIC ETHICS 6 Transparency and Fairness in scientific pursuits – Scientific inventions for the betterment of society - Unfair application of scientific inventions – Role and Responsibility of Scientist in the modern society.
Total Periods: 30

Learning Resources

1	The Nonreligious: Understanding Secular People and Societies, Luke W. Galen Oxford University Press, 2016.
2	Secularism: A Dictionary of Atheism, Bullivant, Stephen; Lee, Lois, Oxford University Press, 2016.
3	The Oxford Handbook of Secularism, John R. Shook, Oxford University Press, 2017.
4	The Civic Culture: Political Attitudes and Democracy in Five Nations by Gabriel A. Almond and Sidney Verba, Princeton University Press,
5	Research Methodology for Natural Sciences by Soumitro Banerjee, IISc Press, January 2022

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the importance of democratic, secular, and scientific values for the harmonious functioning of social life.	Understand
CO2	Describe the role of democratic and scientific values in shaping responsible personal and professional behaviour.	Understand
CO3	Interpret social problems using rational and logical thinking approaches.	Understand
CO4	Explain the principles of ethical behaviour in societal contexts.	Understand
CO5	Discuss the significance of critical thinking and the pursuit of truth in decision-making.	Understand



Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MG721	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objective:

After completion of this course, students will be able to:

- Understand the fundamentals of quality and TQM philosophy, including its evolution, principles, frameworks, and contributions of quality gurus.
- Explain and apply core TQM principles such as leadership, customer focus, employee involvement, continuous improvement, and supplier partnership.
- Analyze and use TQM tools and techniques including traditional quality tools, Six Sigma, benchmarking, FMEA, QFD, TPM, and quality circles.
- Evaluate quality costs and improvement methodologies to enhance organizational performance and process efficiency.
- Understand and implement Quality Management Systems (QMS and EMS) based on ISO 9001 and ISO 14001 standards in manufacturing and service organizations.

Detailed Syllabus

UNIT I INTRODUCTION TO TOTAL QUALITY MANAGEMENT 9

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality –Definition of TQM-- Basic concepts of TQM - Gurus of TQM (Brief introduction) -- TQM Framework- Barriers to TQM –Benefits of TQM.

UNIT II TQM PRINCIPLES 9

Leadership - Deming Philosophy, Quality Council, Quality statements and Strategic planning- Customer Satisfaction –Customer Perception of Quality, Feedback, Customer complaints, Service Quality, Kano Model and Customer retention – Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition & Reward and Performance Appraisal-- Continuous process improvement –Juran Trilogy, PDSA cycle, 5S and Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating and Relationship development.

UNIT III TQM TOOLS & TECHNIQUES I 9

The seven traditional tools of quality - New management tools - Six-sigma Process Capability- Bench marking - Reasons to benchmark, Benchmarking process, What to Bench Mark, Understanding Current Performance, Planning, Studying Others, learning from the data, Using the findings, Pitfalls and Criticisms of Benchmarking - FMEA - Intent, Documentation, Stages: Design FMEA and Process FMEA.

UNIT IV TQM TOOLS & TECHNIQUES II 9

Quality circles – Quality Function Deployment (QFD) - Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures- Cost of Quality - BPR.

UNIT V QUALITY MANAGEMENT SYSTEM 9

Introduction-Benefits of ISO Registration-ISO 9000 Series of Standards-Sector-Specific Standards - AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements-Implementation-Documentation- Internal Audits-Registration-ENVIRONMENTAL MANAGEMENT SYSTEM:

Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001-Benefits of EMS.
Total Periods: 45

Learning Resources

1	Dale H. Besterfiled, Carol B. Michna, Glen H. Bester field, Mary B. Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe, “Total Quality Management”, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression,2013.
2	James R. Evans and William M. Lindsay, “The Management and Control of Quality”, 6th Edition, South-Western (Thomson Learning), 2005.
3	Oakland, J.S. “TQM – Text with Cases”, Butterworth – Heinemann Ltd., Oxford, 3rd Edition, 2003.
4	Suganthi,L and Anand Samuel, “Total Quality Management”, Prentice Hall (India) Pvt. Ltd.,2006.
5	Janakiraman,B and Gopal, R.K, “Total Quality Management – Text and Cases”, Prentice Hall (India) Pvt. Ltd., 2006.

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Explain the concepts of quality, Total Quality Management, quality dimensions, TQM frameworks, benefits, and barriers.	Understand
CO2	Demonstrate TQM principles such as leadership, customer satisfaction models, employee involvement, continuous improvement, and supplier partnership in organizational contexts.	Understand
CO3	Describe TQM tools and techniques (Seven QC tools, Six Sigma, Benchmarking, FMEA, QFD, TPM) to analyze and solve quality-related problems.	Understand
CO4	Describe quality improvement strategies including cost of quality, BPR, Taguchi loss function, and performance measurement systems.	Understand
CO5	Explain Quality Management Systems and Environmental Management Systems, and outline the implementation and audit requirements of ISO 9001 and ISO 14001 standards.	Understand

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ME722	SIMULATION AND ANALYSIS LABORATORY	L	T	P	C
		0	0	4	2

Course Objective:

After completing this course, the students will be able to:

- To introduce students to MATLAB for basic simulation and mathematical problem solving.
- To develop skills in modeling and analysis using engineering software tools.
- To enable understanding of stress, strain, and deformation analysis of structural elements.
- To familiarize students with thermal and vibration analysis using simulation tools.
- To provide hands-on experience in using ANSYS for engineering analysis applications.

Detailed Syllabus

LIST OF EXPERIMENTS

A. SIMULATION

1. MATLAB basics, Dealing with matrices, Graphing-Functions of one variable and two variables.
2. Use of MATLAB to solve simple problems in vibration.

B. ANALYSIS

1. Force and Stress analysis using link elements in Shaft/Bars.
2. Stress and deflection analysis in beams with different support conditions.
3. Stress analysis of flat plates.
4. Stress analysis of axi–symmetric components.
5. Thermal stress and heat transfer analysis of plates.
6. Thermal stress analysis of cylindrical shells.
7. Vibration analysis of spring-mass systems.
8. Modal analysis of Beams.

LIST OF EQUIPMENTS / SOFTWARE: ANSYS, MATLAB

Total Periods: 60

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Apply MATLAB for solving basic engineering problems and simulations.	Analyse
CO2	Perform stress and deformation analysis of structural components using ANSYS.	Analyse
CO3	Analyze thermal stresses and heat transfer in engineering elements.	Analyse
CO4	Evaluate vibration characteristics and modal behavior of mechanical systems.	Analyse
CO5	Apply simulation tools effectively for engineering analysis and interpretation of results.	Analyse

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)



U24ME732	SUMMER INTERNSHIP	L	T	P	C
		0	0	4	2

Course Objective:

After completing this course, the students will be able to:

- To expose students to real-world industrial or research environments.
- To bridge the gap between theoretical knowledge and practical engineering applications.
- To develop professional skills such as teamwork, communication, and work ethics.
- To enable students to understand industrial practices, processes, and organizational culture.
- To enhance report writing and technical presentation skills through internship documentation.

Guideline for Batch Formation, Review and Evaluation:

1) Students shall undergo Industrial Training / Internship during the summer or winter vacation for the duration prescribed in the curriculum.
2) The Industrial training/internship must be carried out continuously for a minimum of four weeks in: Industry, Research Organization, University / R&D Laboratory
3) Prior approval must be obtained from the Head of the Institution before commencement.
4) Students shall maintain a daily logbook/work diary certified by the industry mentor.
5) An Attendance/Internship Certificate signed by the competent authority of the organization must be submitted to the Head of the Department
6) On completion, students must submit: Internship report, Attendance/Internship certificate, Evaluation form (if applicable)
7) At the end of the internship, it is evaluated based on oral presentation and the internship report.

Total Periods: 60

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Explain the structure, functions, and operational practices of the host organization.	Understanding
CO2	Apply engineering knowledge and skills to perform assigned industrial/research tasks.	Apply
CO3	Analyze real-world engineering problems encountered during the internship.	Analyse
CO4	Demonstrate professional ethics, teamwork, and workplace communication skills.	Understand
CO5	Prepare and present a comprehensive internship report documenting the learning outcomes.	Understand

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

SEMESTER VIII

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
PRACTICAL COURSES										
1	U24ME812	Capstone Project/ Industry Internship	EEC	0	0	16	16	8	60	40
				0	**0**	**16**	**16**	**8**		

U24ME812	CAPSTONE PROJECT/ INDUSTRY INTERNSHIP	L	T	P	C
		0	0	16	8

Course Objective:

After completing this course, the students will be able to:

- To develop the ability to identify and define real-world engineering problems through literature review and problem formulation.
- To apply appropriate engineering methodologies and tools to design and implement feasible solutions.
- To enhance analytical, experimental, and problem-solving skills through systematic project execution.
- To develop teamwork, project planning, and time management skills through periodic reviews and supervision.
- To cultivate technical report writing, presentation, and viva-voce skills for professional practice.

Guideline for Batch Formation, Review and Evaluation:

The Capstone Project/Industry Internship in the final semester is designed as a comprehensive learning experience that integrates theoretical knowledge with practical application. Students may undertake the capstone either internally within the institution under faculty supervision or externally in an industry, research organization, or startup. The external project/internship may be secured through the institution's placement cell, faculty references, or by students themselves, subject to departmental approval. At the beginning, the department issues detailed guidelines covering project scope, duration, expected outcomes, and evaluation criteria. Students are required to identify a problem statement, submit a project proposal, and obtain approval. Faculty guides are assigned for internal projects, while external projects involve both a faculty mentor and an industry supervisor. During execution, students carry out design, development, analysis, or implementation work, with periodic reviews to monitor progress. For industry-based projects, regular interaction with the organization ensures alignment with real-world requirements. Students must maintain proper documentation, including progress reports and logs. Upon completion, they submit a detailed project report and present their work through a final review and viva voce evaluation.

Total Periods: 240

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Identify and formulate a relevant engineering problem based on societal or industrial needs.	Understand
CO2	Conduct literature review and select appropriate methodologies to address the defined problem.	Apply
CO3	Design, develop, and implement a working model/solution using suitable engineering tools and techniques.	Analyse
CO4	Analyze, validate, and interpret results to evaluate the effectiveness of the proposed solution.	Analyse
CO5	Prepare a comprehensive technical report and effectively present the project findings.	Understand

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

PROFESSIONAL ELECTIVES

VERTICAL 1: PRODUCT AND PROCESS DEVELOPMENT (PD)

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24MEPD01	Ergonomics in Design	PEC	3	0	0	3	3	40	60
2	U24MEPD02	New Product Development	PEC	3	0	0	3	3	40	60
3	U24MEPD03	Testing of Materials	PEC	3	0	0	3	3	40	60
4	U24MEPD04	Process Planning and Cost Estimation	PEC	3	0	0	3	3	40	60
5	U24MEPD05	Reverse Engineering	PEC	3	0	0	3	3	40	60
6	U24MEPD06	Lean Manufacturing	PEC	3	0	0	3	3	40	60
7	U24MEPD07	Welding Engineering	PEC	3	0	0	3	3	40	60
8	U24MEPD08	Non-Traditional Machining Processes	PEC	3	0	0	3	3	40	60

U24MEPD01	ERGONOMICS IN DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

After completing this course, the students will be able to:

- To understand the fundamentals of ergonomics and industrial design in engineering applications.
- To apply anthropometric and human–machine interaction principles in workplace design.
- To design effective displays and controls based on ergonomic considerations.
- To evaluate environmental factors such as colour and lighting in product and system design.
- To incorporate aesthetic principles in product and plant layout design.

Detailed Syllabus

UNIT – I INTRODUCTION 9

An approach to industrial design, Elements of design structure for industrial design in engineering application in modern manufacturing systems- **Ergonomics and Industrial Design:** Introduction to Ergonomics, Communication system, general approach to the man-machine relationship, Human component of work system, Machine component of work system.

UNIT – II ERGONOMICS AND PRODUCTION 9

Introduction, Anthropometric data and its applications in ergonomic, working postures, Body Movements, Work Station Design, Chair Design. **Visual Effects of Line and Form:** The mechanics of seeing, Psychology of seeing, Figure on ground effect, **Gestalt's perceptions:** Simplicity, Regularity, Proximity, Wholeness. Optical illusions, Influences of line and form.

UNIT – III DESIGN PRINCIPLES FOR DISPLAY AND CONTROLS 9

Displays: Design Principles of visual Displays, Classification, Quantitative displays, Qualitative displays, check readings, Situational awareness, Representative displays, Design of pointers, Signal and warning lights, colour coding of displays, **Design of multiple displays Controls:** Design
considerations, **Controls with little efforts:** Push button, Switches, rotating Knobs. **Controls with muscular effort:** Hand wheel, Crank, Heavy lever, Pedals.

UNIT – IV ENVIRONMENTAL FACTORS 9 **Colour:** Colour and light, Colour and objects, Colour and the eye – after Image, Colour blindness, Colour constancy, Colour terms – Colour circles, Munsel colour notation, reactions to colour and colour combination – colour on engineering equipment's, Colour coding, psychological effects.
UNIT – V AESTHETIC CONCEPTS 9 Concept of unity, Concept of order with variety, Concept of purpose, Style and environment, Aesthetic expressions - Symmetry, Balance, Contrast, Continuity, Proportion. Style - The components of style, House style, Style in capital good Introduction to plant layout software's.
Total Periods: 45

Learning Resources

1	Ergonomics in Design: Methods and Techniques (Human Factors and Ergonomics) by Marcelo M. Soares, Francisco Rebelo.
2	Ergonomics in Product Design by Sendpoints Publishing Co. Ltd.
3	Benjamin W.Niebel, Motion and Time Study, Richard, D. Irwin Inc., 7thEdition, 2002
4	Brain Shakel,"Applied Ergonomics Hand Book", Butterworth Scientific London 1988.
5	Bridger, R.C., Introduction to Ergonomics, 2ndEdition, 2003, McGraw Hill Publications.
6	Martin Helander, A Guide to human factors and Ergonomics, Taylor and Francis, 2006.
7	Mayall W.H. "Industrial design for Engineers", London Hiffee books Ltd., 1988.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the fundamentals of industrial design, ergonomics, and human–machine systems.	Understand
CO2	Apply anthropometric data and ergonomic principles in designing workstations, tools, and work environments.	Apply
CO3	Design effective displays and controls considering human capabilities and limitations.	Apply
CO4	Analyze the influence of environmental factors such as colour, light, and visual perception in engineering design.	Analyse
CO5	Apply aesthetic principles and layout concepts in product design and industrial applications.	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MEPD02	NEW PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- Introduce basic concepts of new product development, engineering documentation, and project planning tools.
- Provide knowledge on material standards, selection methods, analysis techniques, and process feasibility.
- Enable students to perform feasibility studies, RFQ handling, process planning, inspection, and tooling activities
- Explain testing, qualification methods, NDT, risk analysis, and validation of new product samples.
- To Develop understanding of PPAP, APQP, prototyping, reverse engineering, and concurrent engineering.

Detailed Syllabus

UNIT – I FUNDAMENTALS OF NPD 9

Introduction – Reading of Drawing – Grid reading, Revisions, ECN (Engg. Change Note), Component material grade, Specifications, customer specific requirements – **Basics of monitoring** of NPD applying Gantt chart, Critical path analysis – **Fundamentals of BOM (Bill of Materials)**, Engg. BOM & Manufacturing BOM.

Basics of MIS software and their application in industries like SAP, MS Dynamics, Oracle ERP.

UNIT II MATERIAL SPECIFICATIONS, ANALYSIS & PROCESS 9

Material specification standards – ISO, DIN, JIS, ASTM. – Material Selection methodologies-performance indices, cost–performance trade-off Qualifications of parts mechanical, physical & Chemical properties and their test report preparation and submission. Fundamentals of DFMEA & PFMEA, Fundamentals of FEA, Bend Analysis, Hot Distortion, Metal and Material Flow, Fill and Solidification analysis.

UNIT III ESSENTIALS OF NPD 9

RFQ (Request of Quotation) Processing – Feasibility Studies & reporting – CFT (Cross Function Team) discussion on new product and reporting – Concept design, Machine selection for tool making, Machining – Manufacturing Process selection, Machining Planning, cutting tool selection – Various Inspection methods – Manual measuring, CMM – GOM (Geometric Optical Measuring), Lay out marking and Cut section analysis. Tool Design and Detail drawings preparation, release of details to machine shop and CAM programing. Tool assembly and shop floor trials. Initial sample submission with PPAP documents.

UNIT IV CRITERIONS OF NPD 9

New product qualification for Dimensions, Mechanical & Physical Properties, Internal Soundness proving through X-Ray, Radiography, Ultrasonic Testing, MPT, etc. Agreement with customer for testing frequencies. Market Survey on similar products, Risk analysis, validating samples with simulation results, Lesson Learned & Horizontal deployment in NPD.

UNIT V REPORTING & FORWARD-THINKING OF NPD 9

Detailed study on PPAP with 18 elements reporting, APQP and its 5 Sections, APQP vs PPAP, Importance of SOP (Standard Operating Procedure) – Purpose & documents, deployment in shop floor. Prototyping & RPT - Concepts, Application and its advantages, 3D Printing – resin models, Sand cores for foundries; Reverse Engineering. Cloud points generation, converting cloud data to 3D model – Advantages & Limitation of RE, CE (Concurrent Engineering) – Basics, Application and its advantages in NPD (to reduce development lead time, time to Market, Improve productivity and product cost.)

Total Periods: 45

Learning Resources

1	Product Development – Sten Jonsson
2	Product Design & Development – Karl T. Ulrich, Maria C. Young, Steven D. Eppinger
3	Product Design & Value Engineering – Dr. M.A. Bulsara &Dr. H.R. Thakkar
4	Revolutionizing Product Development – Steven C Wheelwright & Kim B. Clark
5	Change by Design
6	Toyota Product Development System – James Morgan & Jeffrey K. Liker
7	Winning at New Products – Robert Brands 3rd Edition

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Explain fundamentals of NPD, engineering documents, BOM, and project monitoring tools.	Understand
CO2	Interpret material standards, perform material selection, and apply basic analysis tools in NPD.	Apply
CO3	Prepare feasibility reports, plan manufacturing and inspection processes, and understand tooling requirements.	Apply
CO4	Assess product qualification, testing methods, market comparison, and risk evaluation.	Apply
CO5	Prepare PPAP/APQP reports, apply prototyping and reverse engineering, and use CE concepts in NPD.	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MEPD03	TESTING OF MATERIALS	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- To understand the fundamentals, standards, and purpose of material testing.
- To learn advanced mechanical testing methods and their applications.
- To understand principles and uses of major NDT techniques.
- To study material characterization tools such as microscopy, diffraction, and spectroscopy.
- To understand the results from thermal and chemical testing for material evaluation.

Detailed Syllabus

UNIT I INTRODUCTION TO MATERIALS TESTING 9

Overview of materials, Classification of material testing, Purpose of testing, Selection of material, Development of testing, testing organizations and its committee, Testing standards, Result Analysis, Advantages of testing.

UNIT II ADVANCED MECHANICAL TESTING 9 Introduction to advanced testing – High-temperature tensile testing – Tribology and wear tests: pin-on-disc, block-on-ring – Corrosion and environmental testing (salt spray, cyclic corrosion) – Residual stress measurement methods (X-ray diffraction) – Sheet metal formability tests: FLD, Erichsen cupping – Adhesion and coating tests: cross-hatch, pull-off adhesion.
UNIT III NON-DESTRUCTIVE TESTING 9 Visual inspection, Liquid penetrant test, Magnetic particle test, Thermography test Principles, Techniques, Advantages and Limitations, Applications. Radiographic test, Eddy current test, Ultrasonic test, Acoustic emission- Principles, Techniques, Methods, Advantages and Limitations, Applications.
UNIT IV MATERIAL CHARACTERIZATION TESTING 9 Macroscopic and Microscopic observations, Optical and Electron microscopy (SEM and TEM) - Principles, Types, Advantages and Limitations, Applications. Diffraction techniques, Spectroscopic Techniques, Electrical and Magnetic Techniques- Principles, Types, Advantages and Limitations, Applications.
UNIT V OTHER TESTING 9 Thermal Testing: Differential scanning calorimetry, Differential thermal analysis. Thermomechanical and Dynamic mechanical analysis: Principles, Advantages, Applications. Chemical Testing: X-Ray Fluorescence, Elemental Analysis by Inductively Coupled Plasma Optical Emission Spectroscopy and Plasma-Mass Spectrometry
Total Periods:45

Learning Resources

1	Baldev Raj, T.Jayakumar, M.Thavasimuthu “Practical Non-Destructive Testing”, Narosa Publishing House, 2009.
2	Cullity, B. D., “Elements of X-ray diffraction”, 3rd Edition, Addison-Wesley Company Inc., NewYork, 2000.
3	P. Field Foster, “The Mechanical Testing of Metals and Alloys” 7th Edition, Cousens Press, 2007.
4	Metals Handbook: Mechanical testing, (Volume 8) ASM Handbook Committee, 9th Edition, American Society for Metals, 1978.
5	ASM Metals Handbook, “Non-Destructive Evaluation and Quality Control”, American Society of Metals, Metals Park, Ohio, USA.
6	Brandon D.G., “Modern Techniques in Metallography”, Von Nostrand Inc. NJ, USA, 1986

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Explain the principles, standards, and procedures involved in materials testing.	Understand
CO2	Apply advanced mechanical testing methods to evaluate strength, wear, corrosion, and residual stresses.	Apply
CO3	Select and interpret appropriate non-destructive testing techniques for defect detection.	Analyse
CO4	Analyze material structure and properties using microscopic and characterization techniques.	Analyse
CO5	Evaluate materials using thermal, thermomechanical, and chemical testing methods.	Analyse



Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MEPD04	PROCESS PLANNING AND COST ESTIMATION	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- To introduce the process planning concepts to make cost estimation for various products after process planning.
- To Learn the various Process Planning Activities.
- To provide the knowledge of importance of costing and estimation.
- To provide the knowledge of estimation of production costing.
- To learn the knowledge of various Machining time calculations

Detailed 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 PLANNING ACTIVITIES 9

Process parameters calculation for various production processes-Selection jigs and fixture selection of quality assurance methods - Set of documents for process planning, case studies.

UNIT – III INTRODUCTION TO COST ESTIMATION 9

Importance of costing and estimation –methods of costing-elements of cost estimation –Types of estimates – Estimating procedure- Estimation labour cost, material cost, allocation of overhead charges- Calculation of depreciation cost.

UNIT – IV PRODUCTION COST ESTIMATION 9

Estimation of Different Types of Jobs - Estimation of Forging Shop, Estimation of Welding Shop, Estimation of Foundry Shop, Estimation of Welding Shop, Estimation of Foundry Shop.

UNIT – V MACHINING TIME CALCULATION 9

Estimation of Machining Time - Importance of Machine Time Calculation- Calculation of Machining Time for Different Lathe Operations, Drilling and Boring - Machining Time Calculation for Milling, Shaping and Planning -Machining Time Calculation for Grinding.

Total Periods: 45

Learning Resources

1	Peter scalon, “Process planning, Design/Manufacture Interface”, Elsevier science technology Books, Dec 2002.
2	Sinha B.P, “Mechanical Estimating and Costing”, Tata-McGraw Hill publishing co, 1995.
3	Chitale A.V. and Gupta R.C., “Product Design and Manufacturing”, 2nd Edition, PHI, 2002.
4	Ostwalal P.F. and Munez J., “Manufacturing Processes and systems”, 9th Edition, John Wiley,1998.
5	Russell R.S and Tailor B.W, “Operations Management”, 4th Edition, PHI, 2003.

6	Mikell P. Groover, “Automation, Production, Systems and Computer Integrated Manufacturing”, Pearson Education 2001.
7	K.C. Jain & L.N. Aggarwal, “Production Planning Control and Industrial Management”, Khanna Publishers 1990.

Course Outcomes:

At the end of the course, the students will be able to:		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Understanding the selection process, equipment and tools for various industrial products.	Understand
CO2	Understanding the prepare process planning activity chart.	Understand
CO3	Understanding the concept of cost estimation.	Apply
CO4	Compute the job order cost for different type of shop floor.	Apply
CO5	Calculate the machining time for various machining operations.	Apply

Course Articulation Matrix:

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MEPD05	REVERSE ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- To understand the fundamentals and process of reverse engineering and geometric reconstruction.
- To analyse material properties and manufacturing processes for product identification.
- To apply statistical and reliability methods for data and performance evaluation.
- To develop skills in 3D scanning, data processing, and geometric modeling.
- To understand industrial applications and legal aspects of reverse engineering.

Detailed Syllabus

UNIT I INTRODUCTION & GEOMETRIC FORM 9

Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering - Surface and Solid Model Reconstruction – Dimensional Measurement – Prototyping.

UNIT II MATERIAL CHARACTERISTICS AND PROCESS IDENTIFICATION 9

Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength – Hardness –Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure Material Specification - Composition Determination - Microstructure Analysis – Manufacturing Process Verification.

UNIT III DATA PROCESSING 9

Statistical Analysis – Data Analysis – Reliability and the Theory of Interference – Weibull Analysis – Data Conformity and Acceptance – Data Report – Performance Criteria – Methodology of Performance Evaluation – System Compatibility.

UNIT IV 3D SCANNING AND MODELLING 9 Introduction, working principle and operations of 3D scanners: Laser, White Light, Blue Light - Applications- Software for scanning and modelling: Types- Applications- Preparation techniques for Scanning objects- Scanning and Measuring strategies - Calibration of 3D Scanner- Step by step procedure: 3D scanning - Geometric modelling – 3D inspection- Case studies.
UNIT V INDUSTRIAL APPLICATIONS 9 Reverse Engineering in the Automotive Industry; Aerospace Industry; Medical Device Industry. Case studies and Solving Industrial projects in Reverse Engineering. Legality: Patent – Copyrights –Trade Secret – Third-Party Materials.
Total Periods: 45

Learning Resources

1	Robert W. Messler, Reverse Engineering: Mechanisms, Structures, Systems & Materials, 1st Edition, McGraw-Hill Education, 2014.
2	Wego Wang, Reverse Engineering Technology of Reinvention, CRC Press, 2011.
3	Scott J. Lawrence, Principles of Reverse Engineering, Kindle Edition, 2022
4	Kevin Otto and Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Prentice Hall, 2001
5	Kathryn, A. Ingle, “Reverse Engineering”, McGraw-Hill, 1994.
6	Linda Wills, “Reverse Engineering”, Kluver Academic Publishers, 1996
7	Vinesh Raj and Kiran Fernandes, “Reverse Engineering: An Industrial Perspective”, Springer- Verlag London Limited 2008.

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Explain the principles and methodology of reverse engineering.	Understand
CO2	Evaluate material characteristics and failure mechanisms of components.	Apply
CO3	Apply statistical and reliability tools for data analysis.	Apply
CO4	Perform 3D scanning, modeling, and inspection using appropriate software.	Analyse
CO5	Analyze industrial applications and legal issues in reverse engineering.	Analyse

Course Articulation Matrix:

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MEPD06	LEAN MANUFACTURING	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- To understand Six Sigma concepts and quality improvement tools.
- To apply Lean manufacturing principles and structured improvement methodologies.
- To develop knowledge of process management and continuous improvement models.
- To understand Lean elements and TPM for waste reduction and productivity enhancement.
- To implement Lean practices using performance metrics and improvement tools.

Detailed Syllabus

UNIT I BASICS OF 6 SIGMA 9

Introduction to 6 Sigma, basic tools of six sigma like problem solving approach, standard deviation, normal distribution, various sigma levels with some examples, value for the enterprise, Variation, and sources of variation, Mean and moving the mean, Various quality costs, cost of poor quality.

UNIT II INTRODUCTION TO LEAN MANUFACTURING TOOLS 9

Process Capability Indices, Cause and Effect diagram, Control Charts, Introduction to FMEA, APQP, PPAP. 3 foundational 6 Sigma methodologies: DMAIC, DMEDI, and Process Management DMEDI for process creation, DMAIC for process improvement and PDCA for sustaining improvements.

UNIT III DEEPER UNDERSTADING METHODOLOGIES 9

What is a process, Why Process management, Keys to process management, Difference between process management and 6 Sigma, Introduction to Deming cycle, PDCA, DMAIC and continuous improvement, DMEDI for creation process, DMAIC Vs DMEDI with examples, Introduction to Toyota Production System, Six Sigma and Production System integration.

UNIT IV LEAN ELEMENTS AND TPM 9

Introduction to Lean Concepts like In-Built Quality, Concept of Right Part at the Right Time, Lead Time reduction, Optimum utilization of Capital, Optimum utilization of People. Understanding the Zero-defect concept and Metrics, Focus on Human Resources, Quality, Delivery, Cost. Building Zero defect capabilities, Cultural and Organizational aspects. Concepts and principles of TPM(Total Productive Maintainence)

UNIT V IMPLEMENTATION AND CHALLENGES 9

Implementing Checks and Balances in the process, Robust Information Systems, Dashboard, follow up and robust corrective and preventive mechanism. Concept of Audits, and continuous improvement from gap analysis, risk assessments etc

Total Periods: 45

Learning Resources

1	Quality Planning and Analysis- JM Juran & FM Gryna. Tata Mc Graw Hill
2	Lean Manufacturing: Principles to Practice by Akhilesh N. Singh, Bibliophile South Asia
3	The Toyota Way: 14 Management Principles
4	Gemba Kaizen: A Commonsense Approach to a Continuous Improvement Strategy, Masaki Imai
5	International Society of Six Sigma Professionals: https://isssp.org/about-us/
6	NPTEL / SWAYAM: https://nptel.ac.in/courses/110105123: Six Sigma, Prof. Jitesh J Thakkar, IIT Kharagpur, Certification course. (Self- Learning).
7	Older / Previous editions of AIAG manuals on APQP, FMEA and PPAP. These are great sources of information on Quality Planning and has basics of Project Management and required skills.

8	Quality Management for Organizations Using Lean Six Sigma Techniques- Erick C Jones

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain Six Sigma tools and sources of variation.	Understand
CO2	Apply Lean and Six Sigma methodologies for process improvement.	Apply
CO3	Analyze process capability and quality control techniques.	Analyse
CO4	Implement Lean elements and TPM to improve productivity.	Apply
CO5	Evaluate organizational performance using continuous improvement practices.	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MEPD07	**WELDING ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

After completing this course, the students will be able to:

- Understand the physics of welding arcs, heat sources, and welding parameters essential for controlling weld quality.
- Explain the metallurgical principles governing weld metal and HAZ transformations during solidification and thermal cycles.
- Understand residual stresses, distortion, and apply weld design principles for structural and industrial applications.
- Identify weld defects and apply destructive and non-destructive testing methods for inspection and quality assurance.
- Apply repair welding techniques, automation, robotic welding, and simulation concepts for advanced industrial welding challenges.

Detailed Syllabus

UNIT I ARC PHYSICS, HEAT SOURCES & WELDING PARAMETERS 9

Classification of welding processes; Arc initiation, maintenance, ionization processes; Arc characteristics, arc blow, polarity, electrode efficiency; Power sources: drooping, flat, constant current/constant voltage; V–I characteristics;

Heat sources: heat generation in arc, energy distribution; Heat input, melting rate, penetration mechanisms; Metal transfer modes short-circuiting, globular, spray, pulsed; Filler metals, electrode coatings, flux behaviour

UNIT II WELDING METALLURGY: SOLIDIFICATION & PHASE TRANSFORMATIONS 9

Thermal cycles during welding; Solidification of weld metal: nucleation, grain growth, epitaxy; Segregation, dendritic growth, microstructural evolution; HAZ: transformations, grain coarsening, dissolution/precipitation; Cracking phenomena (Kou Type I, II hot cracking, cold cracking,

solidification cracking); Role of cooling rate, thermal gradients (G) and growth rate (R); Carbon equivalent & hardenability; Metallurgical weldability of steels, stainless steels & non-ferrous alloys.
UNIT III RESIDUAL STRESSES, DISTORTION & WELD DESIGN 9 Origin of residual stresses, longitudinal & transverse stresses; Distortion types: angular, longitudinal, buckling, bending; Heat flow in welding: temperature distribution in welding, heat flow equations, metallurgical effects of heat flow in welding. Techniques to control distortion: presetting, sequencing, clamping; Weld joint design: fillet, butt, edge, corner, T-joints; Strength of welded joints: static, fatigue & creep considerations; Design of weld size, throat thickness calculations; Weld failure modes & prevention.
UNIT IV WELD DEFECTS, INSPECTION & QUALITY CONTROL 9 Classification of weld defects: porosity, slag inclusion, undercut, overlaps, incomplete fusion, cracks; Causes, prevention & corrective actions; Destructive testing: tensile, bend, impact, hardness, macro/micro examination; NDT: Pressure and Leak Testing Radiography, Ultrasonic, Magnetic Particle, Dye Penetrant; Acceptance criteria (AWS/ASME standards); Basic Welding Symbols; Welding Procedure Specification (WPS); PQR (Procedure Qualification Record)
UNIT V REPAIR WELDING ADVANCED WELDING ENGINEERING 9 Engineering Aspects of Repair Welding; Failure Analysis & Integrity Assessment; Factors Affecting Repair Welding; Techno-Economics of Repair; Repair of Steel Castings & Cast Iron; Half-Bead & Temper-Bead Techniques; Pipeline Bend Repair Methods; Heat Exchanger Repair Techniques; Robotic Welding, Automation & Simulation.
Total Periods: 45

Learning Resources

1	Parmar,R.S., “Welding Processes and Technology”, Khanna Publishers, 1997.
2	Kou S., Welding Metallurgy, 2002, John Wiley, 2002.
3	Khanna O. P., A Textbook of Welding Technology, 2009, Dhanpat Rai Publishers.
4	Radhakrishnan V. M. Welding Technology and Design 2005, Revised Second Ed., New Age International Publishers.
5	Nadkarni S.V., Modern Arc Welding Technology, 2010, Oxford and IBH Publishing.
6	John Norrish. Advanced welding processes Technologies and process control, 2006, Wood head Publishing and Maney Publishing. Cambridge, England.
7	Bhattacharya M. Weldment Design, Association of Engineers, 1991.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the principles of arc welding, power sources, heat input, and electrode characteristics.	Understand
CO2	Describe weld metal and HAZ metallurgical transformations during different welding processes	Understand
CO3	Apply the concepts of heat flow, residual stress, and distortion control in welded joints.	Apply
CO4	Describe weld defects and testing results using destructive and NDT inspection techniques.	Understand
CO5	Apply repair welding, welding automation, robotic welding, and simulation concepts for industrial practices	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MEPD08	NON-TRADITIONAL MACHINING PROCESSES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

After completing this course, the students will be able to:

- To classify non-traditional machining processes and describe mechanical energy based nontraditional machining processes.
- To differentiate chemical and electro chemical energy-based processes.
- To describe thermo-electric energy-based processes.
- To explain nano finishing processes.
- To introduce hybrid non-traditional machining processes and differentiate hybrid non-traditional machining processes.

Detailed Syllabus

UNIT – I INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES 9

Introduction - Need for non-traditional machining processes - Classification of non-traditional machining processes - Applications, advantages and limitations of non-traditional machining processes - Abrasive jet machining, Abrasive water jet machining, Ultrasonic machining their principles, equipment, effect of process parameters, applications, advantages and limitations.

UNIT – II CHEMICAL AND ELECTRO CHEMICAL ENERGY BASED PROCESSES 9

Principles, equipment's, effect of process parameters, applications, advantages and limitations of Chemical machining, Electro-chemical machining, Electro-chemical honing, Electro-chemical grinding, Electro chemical deburring.

UNIT – III THERMO-ELECTRIC ENERGY BASED PROCESSES 9

Principles, equipment's, effect of process parameters, applications, advantages and limitations of Electric discharge machining, Wire electric discharge machining, Laser beam machining, Plasma arc machining, Electron beam machining, Ion beam machining.

UNIT – IV NANO FINISHING PROCESSES 9

Principles, equipment's, effect of process parameters, applications, advantages and limitations of Abrasive flow machining – Chemo mechanical polishing, Magnetic abrasive finishing, Magnetorheological finishing, Magneto rheological abrasive flow finishing.

UNIT – V HYBRID NON-TRADITIONAL MACHINING PROCESSES 9

Introduction - Various hybrid non-traditional machining processes, their working principles, equipment's, effect of process parameters, applications, advantages and limitations. Selection and comparison of different nontraditional machining processes.

Total Periods: 45

Learning Resources:

1	Adithan. M., "Unconventional Machining Processes", Atlantic, New Delhi, India, 2009. ISBN 13: 9788126910458



2	Anand Pandey, “Modern Machining Processes”, Ane Books Pvt. Ltd., New Delhi, India, 2019.
3	Benedict, G.F., “Non-traditional Manufacturing Processes”, Marcel Dekker Inc., New York 1987.ISBN-13: 978-0824773526.
4	Carl Sommer, “Non-Traditional Machining Handbook”, Advance Publishing., United States, 2000, ISBN-13: 978-1575373256.
5	Golam Kibria, Bhattacharyya B. and Paulo Davim J., “Non-traditional Micromachining Processes: Fundamentals and Applications”, Springer International Publishing., Switzerland, 2017, ISBN:978-3-319-52008-7.
6	Jagadeesha T., “Non-Traditional Machining Processes”, I.K. International Publishing House Pvt. Ltd., New Delhi, India, 2017, ISBN-13: 978-9385909122.
7	Kapil Gupta, Neelesh K. Jain and Laubscher R.F., “Hybrid Machining Processes: Perspectives on Machining and Finishing”, 1st edition, Springer International Publishing., Switzerland, 2016, ISBN13: 978-3319259208

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Classify non-traditional machining processes and explain mechanical energy–based non-traditional machining processes.	Understand
CO2	Differentiate chemical and electrochemical energy–based machining processes with suitable examples.	Understand
CO3	Describe the principles and applications of thermo-electric energy–based machining processes.	Understand
CO4	Explain the concepts, mechanisms, and applications of nano finishing processes.	Understand
CO5	Identify hybrid non-traditional machining processes and differentiate various hybrid machining techniques.	Understand

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2							2	2		1	1	2
CO2	2							2	2		1	1	2
CO3	2							2	2		1	1	2
CO4	2							2	2		1	1	2
CO5	2							2	2		1	1	2
Avg.	**2**							**2**	**2**		**1**	**1**	**2**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

PROFESSIONAL ELECTIVES

VERTICAL 2: THERMAL SYSTEMS (TS)

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24METS01	Computational Fluid Dynamics	PEC	3	0	0	3	3	40	60
2	U24METS02	Gas Dynamics and Jet Propulsion	PEC	3	0	0	3	3	40	60
3	U24METS03	Energy Engineering	PEC	3	0	0	3	3	40	60
4	U24METS04	Refrigeration and Air Conditioning	PEC	3	0	0	3	3	40	60
5	U24METS05	Thermal Power Engineering	PEC	3	0	0	3	3	40	60
6	U24METS06	Batteries and Management system	PEC	3	0	0	3	3	40	60
7	U24METS07	Mechanical Measurements	PEC	3	0	0	3	3	40	60
8	U24METS08	Equipment for Pollution Control	PEC	3	0	0	3	3	40	60

U24METS01	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- To study the fluid flow simulation techniques and its mathematical behaviour.
- To learn the Discretise 1D and 2D systems using finite difference and finite volume techniques.
- To Formulate diffusion –convection problems using finite volume method.
- To study the flow field for different types of grids.
- To learn the need for turbulence models and its types.

Detailed Syllabus

UNIT I INTRODUCTION 9

Basics of Computational Fluid Dynamics – Governing equations– Continuity, Momentum and Energy equations – Boundary conditions & Types– Time-averaged equations for Turbulent Flow – Classification and Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations, comparison between Analytical, Experimental and Numerical techniques, Techniques of Discretisation and Numerical errors.

UNIT II FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION 9

Derivation of finite difference equations– General Methods for first and second order accuracy – Finite volume formulation for steady and transient diffusion 1D and 2D problems – Use of Finite Difference and Finite Volume methods, Accuracy of solution, optimum step-size, Euler, Crank-Nickolson, and pure implicit methods, stability of schemes.

UNIT III FINITE VOLUME METHOD FOR CONVECTION DIFFUSION 9

Steady one-dimensional convection and diffusion – Central, upwind differencing schemes, properties of discretization schemes, Hybrid, Power-law, QUICK Schemes, Computation of Boundary layer flow, von Neumann stability analysis.

UNIT IV FLOW FIELD ANALYSIS 9

Stream function and vorticity, Representation of the pressure gradient term, Staggered grid – Momentum equations, Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants – PISO Algorithms, Computation of internal and external thermal boundary layer.

UNIT V TURBULENCE MODELLING 9
Turbulence model requirement and types, mixing length model, Two equation (k-Є) models – High and low Reynolds number models, LES, DNS, Mesh Generation and refinement Techniques-software tools, Stability of solver, Courant Fredrick Levy number, relaxation factor, and grid independence test.
Total Periods: 45

Learning Resources

1	Versteeg, H.K., and Malalasekera, W.,"An Introduction to Computational Fluid Dynamics": The finite volume Method, Pearson Education, 2014.
2	Ghoshdastidar, P.S., "Computational Fluid Dynamics and Heat Transfer", Cengage Learning, 2017.
3	John. F. Wendt, "Computational Fluid Dynamics – An Introduction", Springer, 2013.
4	K. Muralidhar & T.Sundararajan, Computational Fluid Flow and Heat Transfer, Narora Publishing House, 1994.
5	Suhas V, Patankar, "Numerical Heat transfer and Fluid flow", Taylor & Francis, 2009.
6	Yogesh Jaluria & Kenneth E. Torrance, "Computational Heat Transfer", CRC press, 2002.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Apply the fundamentals of CFD, and develop case specific governing equations.	Analyse
CO2	Discuss finite difference and finite volume-based analysis for steady and transient diffusion problems.	Analyse
CO3	Apply various mathematical schemes under finite volume method for convention diffusion.	Apply
CO4	Solve complex problems in the field of fluid flow and heat transfer with the support of high-speed computers.	Apply
CO5	Apply the various discretization methods, solution procedure and the concept of turbulence modelling.	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24METS02	GAS DYNAMICS AND JET PROPULSION	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- To study the fundamentals of compressible flow concepts and the use of gas tables.
- To learn the compressible flow behaviour in constant area ducts.
- To study the development of shock waves and its effects.
- To study the types of jet engines and their performance parameters.
- To learn the types of rocket engines and their performance parameters.

Detailed syllabus

UNIT I BASIC CONCEPTS AND ISENTROPIC FLOWS 9

Energy and momentum equations of compressible fluid flows, Concepts of compressible flow – Mach waves and Mach cone. Flow regimes, effect of Mach number on compressibility. Stagnation, static, critical properties and their interrelationship. Isentropic flow and its relations. Isentropic flow through variable area ducts – nozzles and diffusers. Use of Gas tables.

UNIT II COMPRESSIBLE FLOW THROUGH DUCTS 9

Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – variation of flow properties. Choking. Isothermal flow with friction. Use of Gas tables.

UNIT III NORMAL AND OBLIQUE SHOCKS 9

Governing equations - Rankine-Hugoniot Relation. Variation of flow parameters across the normal and oblique shocks. Prandtl – Meyer expansion and relation. Use of Gas tables.

UNIT IV JET PROPULSION 9

Theory of jet propulsion – thrust equation – Performance parameters - thrust, power and efficiency. Operation, cycle analysis and performance of ram jet, turbojet, turbofan, turbo prop and pulse jet engines.

UNIT V SPACE PROPULSION 9

Types of rocket engines and propellants. Characteristic velocity – thrust equation. Theory of single and multistage rocket propulsion. Liquid fuel feeding systems. Solid propellant geometries. Orbital and escape velocity. Rocket performance calculations.

Total Periods:45

Course Outcomes

CO	At the end of the course, the students will be able to	Knowledge Level
CO1	Apply the fundamentals of compressible flow concepts and the use of gas tables.	Apply
CO2	Analyse the compressible flow behaviour in constant area ducts.	Analyse
CO3	Analyse the development of shock waves and its effects.	Analyse
CO4	Explain the types of jet engines and their performance parameters.	Apply
CO5	Explain the types of rocket engines and their performance parameters.	Apply

Learning Resources

1	Anderson, J.D., “Modern Compressible flow”, Third Edition, McGraw Hill, 2003.
2	S.M . Yahya, “Fundamentals of Compressible Flow with Aircraft and Rocket propulsion”, New Age International (P) Limited, 4th Edition, 2012.
3	R. D. Zucker and O Biblarz, “Fundamentals of Gas Dynamics”, 2nd edition, Wiley, 2011.
4	Balachandran, P., “Fundamentals of Compressible Fluid Dynamics”, Prentice-Hall of India, 2007.
5	Radhakrishnan, E., “Gas Dynamics”, Printice Hall of India, 2006.

6	Babu, V., “Fundamentals of Compressible Flow”, CRC Press, 1st Edition, 2008.

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24METS03	ENERGY ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- To provide fundamental knowledge of conventional energy sources and their role in power generation.
- To introduce various non-conventional and renewable energy sources along with their operating principles and applications.
- To familiarize students with emerging and alternative energy technologies and future energy systems.
- To develop understanding of energy conversion processes, energy management, and conservation techniques.
- To analyze the techno-economic, environmental, and sustainability aspects of power plants.

Detailed Syllabus

Unit I Conventional Energy Sources

Overview of global and Indian energy scenario – Classification of energy sources – Role of conventional energy sources in power generation. Thermal Nuclear, Diesel and Gas turbine power plants: Layout, working, applications, advantages and limitations.

Unit II Non-Conventional Energy Sources

Introduction to non-conventional energy sources – Need and potential of renewable energy in India. Solar energy systems, wind energy conversion systems, hydro power plants, and bio-energy technologies with their layout, basic working principles, applications, advantages and limitations.

Unit III Other Types of Energies

Hydrogen energy and fuel cells: basic principles and applications. Geothermal energy: resources and power generation methods. Ocean energy systems including tidal, wave, and OTEC. MHD power generation principles and emerging energy technologies.

Unit IV Energy Conversion and Management

Energy conversion systems and performance evaluation. Cogeneration, combined cycle, and waste heat recovery systems. Energy storage technologies. Energy conservation, auditing, management practices, demand-side management, and energy efficiency standards.

Unit V Techno-Economics of Power Plants

Cost of power generation – Fixed and variable costs – Operating and maintenance costs. Load curves – Load duration curve – Capacity factor, plant load factor and utilization factor. Economic analysis of power plants – Tariff methods – Break-even analysis. Comparison and selection of power plants based on technical and economic criteria. Environmental impact assessment – Sustainability and safety aspects of power plants.

Total Periods: 45

Learning Resources

1	D.P.Kothari, K.C.Singhal,'Renewable energy sources and emerging technologies' PHI Learning, 2011
2	R.K. Rajput., "A Textbook of Power Plant Engineering" fifth Edition, Laxmi Publications, 1 January 2016
3	Arora, S.C. and Domkundwar, S., Power Plant Engineering, Dhanpat Rai, 11 December 2022.
4	El-Wakil. M.M., "Power Plant Technology", Tata McGraw – Hill Publishing Company Ltd., 2017.
5	Godfrey Boyle, "Renewable Energy: Power for a Sustainable Future ", Third Edition, Oxford University Press, 27 December 2012.
6	D.S.Chauhan, S.K. Srivastava, 'Non – Conventional Energy Resources', Fourth Edition, New Age Publishers, Dec 2021.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the global and Indian energy scenario and describe the working principles of conventional power plants.	Understand
CO2	Describe various non-conventional energy sources such as solar, wind, bio-energy, and hydro power systems with their applications.	Understand
CO3	Explain the principles and applications of alternative and emerging energy technologies including hydrogen, fuel cells, geothermal, ocean, and MHD systems.	Understand
CO4	Describe energy conversion systems and apply energy management, conservation, and efficiency improvement techniques.	Apply
CO5	Evaluate techno-economic parameters, load characteristics, and environmental impacts for the selection and operation of power plants.	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24METS04	REFRIGERATION AND AIR CONDITIONING	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- To introduce the underlying principles of operations in different Refrigeration & Air conditioning systems and components.
- To provide knowledge on design aspects of Refrigeration & Air conditioning systems.
- To study the Vapour absorption and air refrigeration systems.
- To learn the psychrometric properties and processes.
- To study the air conditioning systems and load estimation.

Detailed syllabus

UNIT I INTRODUCTION 9 Introduction – Unit of refrigeration – Refrigeration systems – Refrigeration cycles and concepts – Coefficient of Performance – Reversed Carnot cycle – Refrigeration System - Heat pump – Air Refrigeration – types – problems – Aircraft Refrigeration system.
UNIT II VAPOUR COMPRESSION AND OTHER REFRIGERATION SYSTEMS 9 Introduction to Steam Jet Refrigeration, vapour absorption refrigeration and solar refrigeration – performance Analysis of vapour compression cycle – Ideal and actual conditions – Problems – Representation of cycle on p-h and T-s diagram – Properties of refrigerants and their choice for different applications – Eco friendly refrigerant.
UNIT III REFRIGERATION SYSTEM COMPONENTS AND CONTROLS 9 Refrigeration equipment – Compressors – Reciprocating, centrifugal and screw – open, hermetic and semi-hermetic Units – condensers – air- and water-cooled condensers, evaporative condensers – Evaporators – Double tube, shell and tube, dry and flooded types – Expansion devices – Protection devices – High and Low pressure cut out Thermostat – solenoid valve.
UNIT IV PSYCHROMETRIC PROPERTIES AND PROCESSES 9 Psychrometry of Airconditioning Processes – sensible heating and cooling, latent heat process, total heat process, sensible heat factor – bypass factor – cooling and Dehumidifying coil, heat coils, air washer, adiabatic dehumidifiers, water and steam injection – Adiabatic mixing – Problems on Psychrometric processes.
UNIT V AIR CONDITIONING SYSTEMS AND LOAD ESTIMATION 9 Air-conditioning system – classification – Unitary, packaged and central type summer and winter air conditioning systems – merits and demerits – Comfort indices – Air purification – Air-conditioning – Heat gain and load calculations – Room Sensible Heat Factor, Grand Sensible Heat Factor and Effective Room Sensible Heat Factor – energy efficiency in building – Need for reheating.
Total Periods:45

Course Outcomes

CO	At the end of the course, the students will be able to	Knowledge Level
CO1	Explain the basic concepts of Refrigeration and determine the COP and tone of Refrigeration	Apply
CO2	Explain the Vapour compression Refrigeration systems and to solve problems	Analyse
CO3	Discuss the various types of Refrigeration systems	Understand
CO4	Calculate the Psychrometric properties and its use in psychrometric processes	Apply
CO5	Explain the concepts of Air conditioning and to solve problems	Apply

Learning Resources

1	Arora, C.P., "Refrigeration and Air Conditioning", 3rd edition, McGraw Hill, New Delhi,2010
2	Textbook of Refrigeration and Air-Conditioning by R.S. Khurmi | 10 February,2019
3	ASHRAE Hand book, Fundamentals, 2010
4	Jones W.P., "Air conditioning engineering", 5th edition, Elsevier Butterworth-Heinemann, 2007
5	Roy J. Dossat, "Principles of Refrigeration", 4th edition, Pearson Education Asia, 2009.
6	Stoecker,W.F. and Jones J.W., "Refrigeration and Air Conditioning", McGraw Hill, New

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24METS05	THERMAL POWER ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- To understand different types of fuels, their properties, and fundamentals of combustion.
- To develop knowledge of coal-based thermal power plants, Rankine cycle, boilers, and auxiliaries.
- To understand the layout, working, and systems of diesel power plants.
- To introduce gas turbine and combined cycle power plants with performance considerations.
- To provide basic knowledge of nuclear power plants, reactor types, and safety measures.

Detailed Syllabus

UNIT – I FUELS AND COMBUSTION 9

Fuels - Types and Characteristics of Fuels - Determination of Properties of Fuels – Fuels Analysis – Proximate and Ultimate Analysis - Moisture Determination - Calorific Value -Gross & Net Calorific Values

UNIT II COAL BASED THERMAL POWER PLANTS 9

Thermal plant layout – working – Auxiliaries - Rankine cycle – improvement and limitations – Boiler types, circulation systems – Efficiency calculation - supercritical boilers – Fluidized bed boilers – Fuel and ash handling – combined cycle power generation.

UNIT III DIESEL POWER PLANT 9

Diesel power plants – layout – working, Different systems – Fuel system, lubrication system, Air intake system, Exhaust system, cooling system. Starting system.

UNIT IV GAS TURBINE AND COMBINED CYCLE POWER PLANTS 9

Gas turbine power plants – Thermodynamic fundamentals, application, combined cycle configurations, cogeneration, major components, factors influencing performance of GT plants.

UNIT V NUCLEAR POWER PLANTS 9

Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors: Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium- Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants.

Total Periods: 45

Learning Resources

1	Mahesh. M. Rathore, “Thermal Engineering”, 1st Edition, Tata McGraw Hill, 2010.
2	Ballaney. P, “Thermal Engineering”, 25th Edition, Khanna Publishers, 2017
3	Nag P.K, “Basic and Applied Thermodynamics”, 2nd Edition, Tata McGraw Hill, 2010
4	Mathur M.L and Mehta F.S., “Thermal Science and Engineering”, 3rd Edition, Jain Brothers Pvt. Ltd, 2017.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain fuel characteristics, fuel analysis, and calorific value determination.	Understand
CO2	Describe the working and performance of coal-based thermal power plants and boiler systems.	Apply
CO3	Describe the layout, components, and operation of diesel power plants.	Understand
CO4	Explain gas turbine and combined cycle power plants for power generation applications.	Understand
CO5	Explain the working principles, reactor types, and safety aspects of nuclear power plants.	Understand

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24METS06	**BATTERIES AND MANAGEMENT SYSTEM**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

After completing this course, the students will be able to:

- To understand advanced battery technologies, characteristics, performance parameters, and balancing techniques.
- To develop knowledge in battery pack design, sizing, testing methods, and smart charging systems.
- To introduce battery modelling approaches including equivalent circuit, electrochemical, and data-driven models.
- To provide understanding of battery state estimation techniques such as SOC, SOH, and advanced estimation algorithms.
- To familiarize students with BMS architecture, real-time components, communication systems, and model-based design approaches.

Detailed Syllabus

UNIT I ADVANCED BATTERIES 9

Li-ion Batteries-different formats, chemistry, safe operating area, efficiency, aging. Characteristics-SOC, DOD, SOH. Balancing-Passive Balancing Vs Active Balancing. Other Batteries-NCM and NCA Batteries. *NCR18650B* specifications.

UNIT II BATTERY PACK 9

Battery Pack- design, sizing, calculations, flow chart, real and simulation Model. Peak power – definition, testing methods-relationships with Power, Temperature and ohmic Internal Resistance. Cloud based and Local Smart charging.

UNIT III BATTERY MODELLING 9 Battery Modelling Methods-Equivalent Circuit Models, Electrochemical Model, Neural Network Model. ECM Comparisons- Rint model, Thevenin model, PNGV model. State space Models-Introduction. Battery Modelling software/simulation frameworks
UNIT IV BATTERY STATE ESTIMATION 9 SOC Estimation- Definition, importance, single cell Vs series batteries SOC. Estimation Methods-Load voltage, Electromotive force, AC impedance, Ah counting, Neural networks, Neuro-fuzzy forecast method, Kalman filter. Estimation Algorithms.
UNIT V BMS ARCHITECTURE AND REAL TIME COMPONENTS 9 Battery Management System- need, operation, classification. BMS ASIC-bq76PL536A-Q1 Battery Monitor IC- CC2662R-Q1 Wireless BMS MCU. Communication Modules- CAN Open-Flex Ray- CANedge1 package. ARBIN Battery Tester. BMS Development with Modeling software and Model-Based Design.
Total Periods: 45

Learning Resources

1	Jiuchun Jiang and Caiping Zhang, “Fundamentals and applications of Lithium-Ion batteriesin Electric Drive Vehicles’’, Wiley, 2015.
2	Davide Andrea, “Battery Management Systems for Large Lithium-Ion Battery Packs” ARTECH House, 2010.
3	Developing Battery Management Systems with Simulink and Model-Based Design-whitepaper
4	Panasonic NCR18650B- Datasheet
5	bq76PL536A-Q1- IC Datasheet
6	CC2662R-Q1- IC Datasheet

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the characteristics, chemistry, and performance parameters of advanced battery systems.	Understand
CO2	Design and analyze battery packs considering power, temperature, and internal resistance constraints.	Analyse
CO3	Compare battery models using equivalent circuit and advanced modelling techniques.	Analyse
CO4	Apply appropriate algorithms for SOC and SOH estimation in battery systems.	Analyse
CO5	Analyze and implement Battery Management System architecture using real-time components and communication protocols.	Analyse

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)



U24METS07	MECHANICAL MEASUREMENTS	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- To learn the basic ideas of measurement and measuring instruments.
- To understand sensors, transducers, and how instruments behave.
- To learn different methods of measuring pressure and how to calibrate them
- To understand how temperature is measured using various instruments.
- To learn how flow, viscosity, and fuel properties are measured.

Detailed Syllabus

UNIT I BASIC CONCEPTS OF MEASUREMENTS 9

Introduction to measurement and measuring instruments, Methods and modes of measurement, generalized measuring system and functional elements, Instruments and their classifications, Sensors and Transducers – classification, Static and dynamic performance characteristics, Sources of error, classification and elimination of errors, Uncertainty in measurements

UNIT II DISPLACEMENT, VELOCITY/SPEED & ACCELERATION MEASUREMENT 9

Working principle of-Resistive Potentiometer, Linear Variable Differential Transformer (LVDT), Electromagnetic Transducers, Mechanical, Electrical & Photoelectric Tachometers, Piezoelectric and Seismic Accelerometers.

UNIT III PRESSURE MEASUREMENT 9

Pressure standards and measurement methods, Manometers, Elastic pressure transducers, Vacuum measurement, Force balance pressure gauges, Electrical pressure transducers, Pressure switches Calibration of pressure measuring instruments.

UNIT IV TEMPERATURE MEASUREMENT 9

Methods of temperature measurement-Expansion thermometers: Bi-metallic, Liquid-in-glass, Filled system, Electrical temperature measurement-Thermocouples, RTD, Thermistors-Pyrometers-Calibration of temperature measuring instruments.

UNIT V MISCELLANEOUS MEASUREMENTS 9

Flow Measurement-Rotameter, Magnetic, Ultrasonic, Turbine flow meter
Hot-wire anemometer, Laser Doppler Anemometer (LDA), Pitot-static tube, Viscosity Measurement- Viscometers, Fuel & Fuel Gas Analysis-Calorific value measurement-Junker calorimeter, Bomb calorimeter, Flash and fire points, Gas analyzer.

Total Periods: 45

Learning Resources

1	B.C. Nakra, K.K. Choudhary, Instrumentation Measurement and Analysis, McGraw-Hill, 2009.
2	R.K. Rajput, Mechanical Measurements and Instrumentation, S.K. Kataria & Sons, 2006.
3	D.S. Kumar, “Mechanical Measurement & Control”, 4th Edition, Metropolitan Book Co, New Delhi, 2006.
4	Thomas G. Beckwith, Roy D. Marangoni, John H. Lienhard V, Mechanical Measurements, Addison Wesley.

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Explain measurement fundamentals, elements, errors & uncertainty	Understand



CO2	Describe displacement, velocity, and acceleration measuring devices.	Understand
CO3	Describe principles of pressure measurement and procedure for calibration.	Understand
CO4	Explain temperature measurement systems and procedure for calibration.	Understand
CO5	Describe various instruments and choose suitable instruments for flow, viscosity & calorific value measurement.	Understand

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24METS08	EQUIPMENT FOR POLLUTION CONTROL	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- To study the pollution control regulation and standards, water and wastewater.
- To study the equipment for various water pollution.
- To study the equipment for air pollution control.
- To study the equipment for solid waste processing
- To study the pollution monitoring equipment

Detailed Syllabus

UNIT – I POLLUTION CONTROL REGULATIONS AND STANDARDS 9

Pollutants in water and wastewater – sources and impacts-Characteristics and impacts of solid and hazardous wastes - Indian Constitution and Environmental Protection Legislations – Environmental Standards under different Environmental legislations - Water Act (1974), Air Act (1981),Environmental Protection Act (1986) and major Notifications, Municipal solid Wastes (Management and Handling) Rules -Bio Medical Wastes (Management and Handling) Rules - Hazardous Wastes(Management and Handling Rules),Environment Impact Assessment Notifications - Unit operations and unit processes in Pollution Control- - Selection criteria for Pollution Control Equipment.

UNIT – II EQUIPMENT FOR WATER POLLUTION CONTROL 9

Operational principles and Design criteria of Flash mixers, Flocculates, Clarifiers, Sand Filters, Adsorption Columns, Aerators, Air blowers, Distillation units, Centrifugal and Reciprocating Pumps, Chemical dosing systems, Motors, Pipes, valves and Fittings. - Filed visit to a wastewater treatment plant.

UNIT – III EQUIPMENT FOR AIR POLLUTION CONTROL 9

Operational principles and Design criteria of Cyclone separators, gravity settlers, Wet Scrubbers, Air strippers, Bag Filters, Electrostatic precipitators, Bio filters - Filed visit to an industry with air pollution control systems.

UNIT – IV EQUIPMENT FOR SOLID WASTE PROCESSING 9 Operational principles and Design criteria of Dewatering equipment – centrifuge, Vacuum Filter, Filter Press- Size Reduction equipment – shredders, grinders – Trommel and Disc Screens – Air Classifiers- bailing and briquetting – incinerators –Pyrolysis – field visit to a solid waste processing facility.
UNIT – V POLLUTION MONITORING EQUIPMENT 9 Equipment's for sampling of water, solids and air- Sample preservation Equipment – incubators –Cold Storage systems- equipment for analysis of water and air samples- Ambient air and flue gas sampling and monitoring equipment.
Total Periods: 45

Learning Resources

1	George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, "Integrated Solid Waste Management, Mc-Graw Hill India, First edition, 2015.
2	Rao. C.S (2006)., "Environmental Pollution and Control Engineering", 2nd Edition, Revised, Wiley Eastern Limited, India.
3	Shyam Diwan and Armin Rosencranz, Enviromental Law and Policy in India, Oxford, 2001
4	Metcalf & Eddy, INC, „Wastewater Engineering – Treatment and Reuse, Fourth Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2014.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the different types of pollution, their sources and effects.	Understand
CO2	Discuss the pollution control regulations and standards	Understand
CO3	Design equipment for pollution control	Understand
CO4	Discuss different methods of pollution control from various sources in air, water and soil	Understand
CO5	Discuss the Conduct performance assessment of pollution control equipment.	Understand

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2							2	2				
CO2	2							2	2				
CO3	2							2	2				
CO4	2							2	2				
CO5	2							2	2				
Avg.	**2**							**2**	**2**				

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

PROFESSIONAL ELECTIVES

VERTICAL 3: INDUSTRY 4.0 AND AUTOMATION (IA)

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24MEIA01	Additive Manufacturing	PEC	2	0	2	4	3	50	50
2	U24MEIA02	Design for Manufacturing	PEC	3	0	0	3	3	40	60
3	U24MEIA03	Industrial Automation Systems	PEC	3	0	0	3	3	40	60
4	U24MEIA04	Industrial safety	PEC	3	0	0	3	3	40	60
5	U24MEIA05	Digital Enterprise for Industry 4.0	PEC	3	0	0	3	3	40	60
6	U24MEIA06	Industrial Robotics	PEC	3	0	0	3	3	40	60
7	U24MEIA07	Quality Engineering	PEC	3	0	0	3	3	40	60
8	U24MEIA08	Material Handling and Solid Processing Equipment	PEC	3	0	0	3	3	40	60

U24MEIA01	ADDITIVE MANUFACTURING	L	T	P	C
		2	0	2	3

Course Objective:

After completing this course, the students will be able to:

- To understand the fundamentals, evolution, classification, and applications of Additive Manufacturing (AM).
- To develop knowledge of Design for Additive Manufacturing (DfAM) principles and data preparation techniques.
- To introduce vat polymerization and directed energy deposition processes and their industrial applications.
- To understand powder bed fusion and material extrusion technologies.
- To familiarize students with other AM processes and emerging trends in industrial applications.

Detailed Syllabus

UNIT I INTRODUCTION 6

Overview - Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping- Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain- ASTM/ISO 52900 Classification - Benefits. Applications: Building Printing - Bio Printing - Food Printing- Electronics Printing. Business Opportunities and Future Directions – Case studies: Automobile, Aerospace, Healthcare.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING (DfAM) 6

Concepts and Objectives - AM Unique Capabilities - Part Consolidation – Topology Optimization- Generative design - Lattice Structures - Multi-Material Parts and Graded Materials - Data Processing: CAD Model Preparation - AM File formats: STL-Problems with STL- AMF Design for Part Quality Improvement: Part Orientation - Support Structure - Slicing - Tool Path Generation – Design rules for Extrusion based AM.

UNIT III VAT POLYMERIZATION AND DIRECTED ENERGY DEPOSITION 6

Photo polymerization: Stereolithography Apparatus (SLA)- Materials -Process – top down and bottom-up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications. Continuous Liquid Interface Production (CLIP)Technology. Directed Energy Deposition: Laser Engineered Net Shaping (LENS)- Process - Material Delivery -Materials -Benefits -Applications.

UNIT IV POWDER BED FUSION AND MATERIAL EXTRUSION 6 Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials - Process - Advantages and Applications. Material Extrusion: Fused Deposition Modeling (FDM)- Process-Materials -Applications and Limitations.
UNIT V OTHER ADDITIVE MANUFACTURING PROCESSES 6 Binder Jetting: Three-Dimensional Printing - Materials - Process - Benefits- Limitations - Applications. Material Jetting: Multijet Modeling- Materials - Process - Benefits - Applications. Sheet Lamination: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding - Thermal Bonding- Materials-Application and Limitation.
Total Periods: 30

PRACTICAL-LIST OF EXPERIMENT

LIST OF EXPERIMENT
1. Modelling and converting CAD models into STL file.
2. Manipulation and error fixing of STL file.
3. Design and fabrication of parts by varying part orientation and support structures.
4. Fabrication of parts with material extrusion AM process.
5. Fabrication of parts with vat polymerization AM process.
6. Design and fabrication of topology optimized parts.
Total Periods: 30

Learning Resources

1	Ian Gibson, David Rosen, Brent Stucker, MahyarKhorasani “Additive manufacturing technologies”. 3rd edition Springer Cham, Switzerland. (2021). ISBN: 978-3-030-56126-0
2	Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015, ISBN: 978-1-56990-582-1.
3	Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
4	2. Milan Brandt, “Laser Additive Manufacturing: Materials, Design, Technologies, and Applications”, Woodhead Publishing., United Kingdom, 2016, ISBN: 9780081004333.
5	3. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590.
6	4. Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer., United States ,2006, ISBN: 978-1-4614-9842-1.
7	5. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press., United States, 2011, ISBN: 9780849334092.

Course Outcomes

At the end of the course, the students will be able to		
CO	Course Outcome Statement	Knowledge Level
CO1	Explain AM process chain, classification (ASTM/ISO), and applications in various industries.	Understand
CO2	Apply DfAM principles including topology optimization, lattice design, and file preparation techniques.	Apply
CO3	Design and fabrication parts by vat polymerization and directed energy deposition processes for suitable applications.	Apply

CO4	Compare powder bed fusion and material extrusion processes and Fabrication of parts with material extrusion AM process.	Apply
CO5	Evaluate various AM technologies and select appropriate processes for specific engineering applications.	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MEIA02	DESIGN FOR MANUFACTURING	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- To learn selection of cost-effective manufacturing processes and design for manufacturability, along with applying casting design principles in developing cast products.
- To learn design consideration principles of forming in the design of extruded, stamped, and forged products.
- To learn design consideration principles of machining in the design of turned, drilled, milled, planed, shaped, slotted, and ground products.
- To learn design consideration principles of welding in the design of welded products.
- To learn design consideration principles of assembly in the design of assembled products.

Detailed Syllabus

UNIT I INTRODUCTION AND CASTING 9

Introduction - Economics of process selection - General design principles for manufacturability; Design considerations for: Sand cast – Die cast – Permanent mold cast parts.

UNIT II FORMING 9

Design considerations for: Metal extruded parts – Impact/Cold extruded parts – Stamped parts – Forged parts.

UNIT III MACHINING 9

Design considerations for: Turned parts – Drilled parts – Milled, planed, shaped and slotted parts– Ground parts.

UNIT IV WELDING 9

Arc welding – Design considerations for: Cost reduction – Minimizing distortion – Weld strength – Weldment & heat treatment. Resistance welding – Design considerations for: Spot – Seam – Projection – Flash & Upset weldment.

UNIT V ASSEMBLY 9

Design for assembly – General assembly recommendations – Minimizing the no. of parts – Design considerations for: Rivets – Screw fasteners – Gasket & Seals – Press fits – Snap fits – Automatic assembly.

Total Periods: 45

Learning Resources

1	James G. Bralla, “Handbook of Product Design for Manufacture”, McGraw Hill, 1986.
2	O. Molloy, E.A. Warman, S. Tilley, Design for Manufacturing and Assembly: Concepts, Architectures and Implementation, Springer, 1998.
3	CorradoPoli, Design for Manufacturing: A Structured Approach, Butterworth-Heinemann Ltd, Nov 2001.
4	David M. Anderson, Design for Manufacturability & Concurrent Engineering: How to Design for Low Cost, Design in High Quality, Design for Lean Manufacture, and Design Quickly for Fast Production, CRC Press Taylor & Francis Group, 2014
5	Erik Tempelman, Hugh Shercliff, Bruno Ninaber van Eyben, Manufacturing and Design: Understanding the Principles of How Things Are Made, Butterworth-Heinemann, Elsevier, 2014.

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Apply economic process selection and manufacturability principles in product design, incorporating casting design considerations for cast products.	Apply
CO2	Apply design consideration principles of forming in developing extruded, stamped, and forged products.	Apply
CO3	Apply design consideration principles of machining in creating turned, drilled, milled, planed, shaped, slotted, and ground products.	Apply
CO4	Apply design consideration principles of welding in designing welded products.	Apply
CO5	Apply design consideration principles of assembly in developing assembled products.	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MEIA03	INDUSTRIAL AUTOMATION SYSTEMS	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

To understand the fundamentals and architecture of industrial automation systems.

To learn sensors, actuators, power electronics, and servo drives used in automation.

To understand computer-aided measurement, control systems, and IoT applications.

To develop knowledge of PLC programming and industrial applications.

To familiarize with BMS architecture and communication systems.

Detailed Syllabus

UNIT I INTRODUCTION 9 Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA). Industrial bus systems: Modbus & Profibus
UNIT II AUTOMATION COMPONENTS 9 Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.
UNIT III COMPUTER AIDED MEASUREMENT AND CONTROL SYSTEMS 9 Role of computers in measurement and control, Elements of computer aided measurement and control, man-machine interface, computer aided process control hardware, process related interfaces, Communication and networking, Industrial communication systems, Data transfer techniques, Computer aided process control software, and Computer based data acquisition system, Internet of things (IoT) for plant automation.
UNIT IV PROGRAMMABLE LOGIC CONTROLLERS 9 Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.
UNIT V BMS ARCHITECTURE AND REAL TIME COMPONENTS 9 Battery Management System- need, operation, classification. BMS ASIC-bq76PL536A-Q1 Battery Monitor IC- CC2662R-Q1 Wireless BMS MCU. Communication Modules- CAN Open-Flex Ray- CANedge1 package. ARBIN Battery Tester. BMS Development with Modeling software and Model-Based Design.
Total Periods: 45

Learning Resources

1	S.K.Singh, “Industrial Instrumentation”, Tata Mcgraw Hill, 2nd edition companies,2003.
2	C D Johnson, “Process Control Instrumentation Technology”, Prentice Hall India,8th Edition, 2006.
3	E.A.Parr, Newnes ,NewDelhi,“Industrial Control Handbook”,3rd Edition, 2000.
4	John W. Webb and Ronald A. Reis, “Programmable Logic Controllers: Principles and Applications”, 5th Edition, Prentice Hall Inc., New Jersey, 2003.
5	Frank D. Petruzella, “Programmable Logic Controllers”, 5th Edition, McGraw- Hill, New York, 2016.
6	Krishna Kant, “Computer - Based Industrial Control”, 2nd Edition, Prentice Hall, New Delhi, 2011.
7	Gary Dunning, Thomson Delmar,” Programmable Logic Controller”, Ceneage Learning, 3 rd Edition,2005.

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Explain industrial automation systems, PLC, SCADA, and communication protocols.	Understand
CO2	Demonstrate suitable sensors, actuators, and power devices for automation.	Understand
CO3	Describe computer-based measurement and IoT-enabled control systems.	Understand



CO4	Discuss about programmable logic controllers for various industrial applications.	Understand
CO5	Describe Battery Management System components and communication frameworks.	Understand

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3							2	2		2	2	2
CO2	3							2	2		2	2	2
CO3	3							2	2		2	2	2
CO4	3							2	2		2	2	2
CO5	3							2	2		2	2	2
Avg.	3							2	2		2	2	2

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MEIA04	INDUSTRIAL SAFETY	L	T	P	C
		3	0	0	3

Course Objectives

After completing this course, the students will be able to:

- To understand safety terminologies, hazard types, risk assessment concepts, and control measures.
- To develop knowledge of safety standards, regulations, and occupational health policies.
- To familiarize students with safety management practices and emergency preparedness activities.
- To understand workplace health hazards, ergonomics, and industrial safety measures.
- To introduce hazard identification techniques and risk analysis methods for industrial applications.

Detailed Syllabus:

UNIT I SAFETY TERMINOLOGIES 9

Hazard-Types of Hazards- Risk-Hierarchy of Hazards Control Measures-Lead indicators- lag Indicators-Flammability- Toxicity Time-weighted Average (TWA) - Threshold Limit Value (TLV) - Short Term Exposure Limit (STEL)- Immediately dangerous to life or health (IDLH)- acute and chronic Effects- Routes of Chemical Entry-Personnel Protective Equipment- Health and Safety Policy-Material Safety Data Sheet MSDS.

UNIT II STANDARDS AND REGULATIONS 9

Indian Factories Act-1948- Health- Safety- Hazardous materials and Welfare- ISO 45001:2018 occupational health and safety (OH&S) - Occupational Safety and Health Audit IS14489:1998- Hazard Identification and Risk Analysis- code of practice IS 15656:2006

UNIT III SAFETY ACTIVITIES 9

Toolbox Talk- Role of safety Committee- Responsibilities of Safety Officers and Safety Representatives- Safety Training and Safety Incentives- Mock Drills- On-site Emergency Action Plan- Off-site Emergency Action Plan- Safety poster and Display- Human Error Assessment.

UNIT IV WORKPLACE HEALTH AND SAFETY 9

Noise hazard- Particulate matter- musculoskeletal disorder improper sitting poster and lifting Ergonomics RULE & REBA- Unsafe act & Unsafe Condition- Electrical Hazards- Crane Safety- Toxic gas Release.

UNIT V HAZARD IDENTIFICATION TECHNIQUES 9
Job Safety Analysis-Preliminary Hazard Analysis-Failure mode and Effects Analysis- Hazard and Operability- Fault Tree Analysis- Event Tree Analysis Qualitative and Quantitative Risk Assessment- Checklist Analysis- Root cause analysis- What-If Analysis- and Hazard Identification and Risk Assessment.
Total Periods: 45

Learning Resources

1	R.K. Jain and Prof. Sunil S. Rao Industrial Safety, Health and Environment Management Systems KHANNA PUBLISHER
2	L. M. Deshmukh Industrial Safety Management: Hazard Identification and Risk Control McGraw-Hill Education
3	Frank Lees (2012) 'Lees' Loss Prevention in Process Industries. Butterworth-Heinemann publications, UK, 4th Edition.
4	John Ridley & John Channing (2008) Safety at Work: Routledge, 7th Edition.
5	Dan Petersen (2003) Techniques of Safety Management: A System Approach.
6	Alan Waring. (1996). Safety management system: Chapman &Hall, England
7	Society of Safety Engineers, USA

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain safety terms, hazard classifications, exposure limits, and control strategies.	Understand
CO2	Discuss safety standards, legal regulations, and audit requirements in industries.	Understand
CO3	Describe safety activities including training, emergency planning, and safety management systems.	Understand
CO4	Explain workplace health hazards and recommend appropriate preventive measures.	Understand
CO5	Discuss hazard identification and risk assessment techniques to improve industrial safety.	Understand

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MEIA05	DIGITAL ENTERPRISE FOR INDUSTRY 4.0	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- To know about Industry 4.0 and its scope.
- To explain conceptual framework of Industry 4.0 and its usage for problem solution
- To use various technology roadmap.
- To apply learned skills to approach problems that exists in real life.
- To learn the real-world cast studies.

Detailed Syllabus

UNIT I INTRODUCTION 9

Introduction- Core idea of Industry 4.0 - origin - concept of industry 4.0 - Industry 4.0 production system - current state of industry 4.0 – Technologies - How is India preparing for Industry 4.0

UNIT II A CONCEPTUAL FRAMEWORK 9

Introduction, Main Concepts and Components of Industry 4.0, State of Art, Supportive Technologies, Proposed Framework for Industry 4.0.

UNIT III TECHNOLOGY ROADMAP 9

Introduction, Proposed Framework for Technology Roadmap, Strategy Phase, Strategy Phase, New Product and Process Development Phase.

UNIT IV ADVANCES IN ROBOTICS AND AUGMENTED REALITY 9

Introduction, Recent Technological Components of Robots- Advanced Sensor Technologies, Internet of Robotic Things, Cloud Robotics, and Cognitive Architecture for Cyber-Physical Robotics, Industrial Robotic Applications- Manufacturing, Maintenance and Assembly. Role of Augmented Reality (AR) - Introduction, AR Hardware and Software Technology, Industrial Applications of AR.

UNIT V OBSTACLES AND FRAMEWORK CONDITIONS 9

Lack of A Digital Strategy alongside Resource Scarcity, Lack of standards and poor data security, Financing conditions, availability of skilled workers, comprehensive broadband infra-structure, state support, legal framework, protection of corporate data, liability, handling personal data.

Total Periods: 45

Learning Resources

1	Alp Ustundag and Emre Cevikcan," Industry 4.0: Managing the Digital Transformation", Springer, 2017.
2	Ortiz, Jesús Hamilton, "Industry 4.0: Current Status and Future Trends", InTech Open, 2020.
3	Bartodziej, Christoph Jan,"The Concept Industry 4.0: An Empirical Analysis of Technologies and Applications in Production Logistics", Springer, 2017.
4	Klaus Schwab,"The Fourth Industrial Revolution", Currency, 2017.
5	Christian Schröder," The Challenges of Industry 4.0 for Small and Medium-sized Enterprises", Friedrich-Ebert-Stiftung, 2017.

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Describe Industry 4.0 and scope for Indian Industry	Understand
CO2	Demonstrate conceptual framework and road map of Industry 4.0	Understand
CO3	Demonstrate road map of Industry 4.0	Understand



CO4	Describe Robotic technology and Augmented reality for Industry 4.0	Understand
CO5	Demonstrate obstacle and framework and cast studies for Industry 4.0	Understand

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MEIA06	INDUSTRIAL ROBOTICS	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- To provide fundamental knowledge of industrial robots, including their anatomy, coordinate systems, and technical specifications.
- To impart understanding of various robot drives, actuators, and end effectors used in industrial applications.
- To introduce the principles of robot kinematics, dynamics, and control systems.
- To develop the ability to analyze robot motion, trajectory planning, and stability.
- To familiarize students with robot programming techniques, mobile robotics, industrial applications, and safety considerations.

Detailed Syllabus

UNIT I – INTRODUCTION TO ROBOTICS 9

Robot definition – Robot anatomy – Coordinate systems – Work envelope – Robot specifications – Pitch, yaw, roll – Joint notations – Speed of motion – Payload – Robot parts and functions– Robot design and control basics – Introduction to mobile robots – Locomotion – Stability – Legged and wheeled robots

UNIT II – ROBOT DRIVES AND END EFFECTORS 9

Pneumatic drives – Hydraulic drives – Mechanical drives – Electrical drives – DC servo motors – AC servo motors – Stepper motors – Drive comparison and applications – End effectors – Mechanical grippers – Pneumatic and hydraulic grippers – Magnetic and vacuum grippers – Two finger and three finger grippers – Internal and external grippers – Selection and design considerations.

UNIT III – ROBOT KINEMATICS AND CONTROL 9

Forward kinematics – Inverse kinematics – Degrees of freedom – Homogeneous transformation – Denavit- Hartenberg representation.

UNIT IV – ROBOT DYNAMICS AND CONTROL 9

Robot dynamics – Newton-Euler method – Lagrange-Euler method – Jacobian – Singularities – Trajectory planning – Robot control – Position control – Force control – Stability concepts.

UNIT V – ROBOT PROGRAMMING AND APPLICATIONS 9

Teach pendant programming – Lead through programming – Robot programming languages – VAL programming basics – AGV and RGV systems – Need and applications of robots - Industrial robot implementation – Safety considerations

Total Periods: 45

Learning Resources

1	John.J.Craig, " Introduction to Robotics: Mechanics & control", Pearson Publication, Fourth edition, 2018.
2	K.S.Fu, R.C.Gonzalez, C.S.G.Lee, "Robotics: Sensing, Vision & Intelligence", Tata McGraw-Hill Publication, First Edition, 1987.
3	Roland Siegwart and IllahR.Nourbakish, “Introduction to Autonomous Mobile Robots” MIT Press, Cambridge, 2004.
4	M.P.Groover, M.Weiss , R.N. Nagal, N.G.Odrey, "Industrial Robotics - Technology, programming and Applications" Tata, McGraw-Hill Education Pvt Limited 2ndEdition, 2012.
5	Jazar, "Theory of Applied Robotics: Kinematics, Dynamics and Control", Springer, 2ndEdition, 2010
6	S K Saha, Introduction to Robotics, Tata McGraw-Hill, ISBN: 9789332902800, Second Edition, 9789332902800
7	Sathya Ranjan Deb, "Robotics Technology & flexible Automation" Second edition, Tata McGraw-Hill Publication, 2009.

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Explain the structure, components, and working principles of industrial robots.	Understand
CO2	Select appropriate robot drives and end effectors for specific industrial applications.	Understand
CO3	Discuss basic concepts of sensors, kinematics, and control in robotic systems.	Understand
CO4	Apply dynamic modelling, Jacobian analysis, trajectory planning, and control techniques for robot motion.	Apply
CO5	Write basic robot programs and evaluate industrial applications with safety considerations.	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MEIA07	QUALITY ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- To develop a clear understanding of fundamental quality management concepts and principles.
- To enable students to apply control charts and related statistical quality control techniques.

- To introduce special control procedures for service and process-oriented industries.
- To analyze and interpret process capability studies for performance evaluation.
- To develop knowledge of acceptance sampling procedures for inspection of incoming raw materials.

Detailed Syllabus

UNIT I INTRODUCTION 9 Quality Dimensions-Quality Definitions-Inspection-Quality Control-Quality Assurance-Quality Planning-Quality Costs-Economics of quality- Quality loss function
UNIT II CONTROL CHARTS 9 Chance and assignable causes of process variation, statistical basis of the control chart, control charts for variables- X, R and S charts, attribute control charts – p, np, c and u- Construction and application.
UNIT III SPECIAL CONTROL PROCEDURES 9 Warning and modified control limits, control chart for individual measurements, multi-vari chart, X chart with a linear trend, chart for moving averages and ranges, cumulative-sum and exponentially weighted moving average control charts.
UNIT IV STATISTICAL PROCESS CONTROL 9 Process stability, process capability analysis using a Histogram or probability plots and control chart. Gauge capability studies, setting specification limits.
UNIT V ACCEPTANCE SAMPLING 9 The acceptance sampling fundamental, OC curve, sampling plans for attributes, simple, double, multiple and sequential, sampling plans for variables, MIL-STD-105D and MIL-STD-414E & IS2500 standards.
Total Periods: 45

Learning Resources

1	Douglas C. Montgomery, "Introduction to Statistical Quality Control", 7th Edition, John Wiley & Sons, 2012. (Covers all units, especially Units II, III, and IV).
2	Grant, E.L. and Leavenworth, R.S., "Statistical Quality Control", 7th Edition, McGraw Hill, 2000. (Comprehensive for Unit V and classical control charts).
3	Mahajan. M, "Statistical Quality Control", Dhanpati Rai & Co. (P) Ltd., New Delhi. (Highly recommended for AU students due to its exam-oriented approach and numerical coverage).
4	Phillip J. Ross, "Taguchi Techniques for Quality Engineering", 2nd Edition, McGraw Hill, 1996. (Specific to Unit I: Quality Loss Function and Economics of Quality).
5	Dale H. Besterfield, "Total Quality Management", 3rd Edition, Pearson Education, 2011. (Useful for Unit I concepts such as Quality Dimensions and Planning).
6	Feigenbaum. A.V., "Total Quality Control", McGraw Hill, 1991.
7	J.M. Juran and Frank M. Gryna, "Quality Planning and Analysis", Tata McGraw Hill, 2001
8	Amitava Mitra, "Fundamentals of Quality Control and Improvement", 3rd Edition, John Wiley & Sons, 2008.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain quality management concepts, cost of quality, and quality loss function.	Understand
CO2	Construct and interpret control charts for variables and attributes.	Apply
CO3	Apply special control chart techniques for effective process monitoring.	Apply



CO4	Analyze process stability and evaluate process capability using statistical methods.	Analyse
CO5	Design and evaluate acceptance sampling plans based on standard procedures.	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MEIA08	MATERIAL HANDLING AND SOLID PROCESSING EQUIPMENT	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- To provide knowledge on materials handling equipment.
- To provide knowledge on Industrial Vehicles
- To provide knowledge on conveyor equipment.
- To provide knowledge on Auxiliary Equipment and Hoisting Equipment.
- To provide knowledge on Bulk Handling Equipment and Systems

Detailed Syllabus

UNIT – I INTRODUCTION TO MATERIALS HANDLING 9

Basic principles &objectives in material handling and its benefits - Classification of material handling equipment - selection of material handling equipments - guidelines for effective utilisation of material handling equipments -unit load concept

UNIT – II INDUSTRIAL VEHICLES 9

Material specification standards – ISO, ASTM, EN– Awareness on various manufacturing process like Metal castings & Forming, Machining (Conventional, 3 Axis, 4 Axis, 5 Axis), Fabrications, Welding process. Qualifications of parts mechanical, physical & Chemical properties and their test report preparation and submission. Fundamentals of DFMEA & PFMEA, Fundamentals of FEA, Bend Analysis, Hot Distortion, Metal and Material Flow, Fill and Solidification analysis.

UNIT – III CONVEYORS 9

Classification of conveyors- Definition - Description - General Characteristics - types and uses of belt Conveyors - Roller conveyors - Haulage Conveyors - Screw Conveyors - Bucket Conveyors - Chain Conveyors - Cable Conveyors - Pneumatic and Hydraulic conveyors - Computer controlled conveyor system.

UNIT – IV AUXILIARY EQUIPMENTAND HOISTING EQUIPMENT 9

Hoppers - Gates- Feeders- Chutes-positioners- Ball Table- Weighing and Control Equipment- Pallet loaders and unloaders -applications and advancements. - Hoisting Equipment - parts of hoisting equipment - Description and uses of hoists - Description and uses of ropes - description and purpose of crane hooks - Elevators - Cranes - Derricks - and its types

UNIT – V BULK HANDLING EQUIPMENT AND SYSTEMS 9
Storage of bulk solids - bulk handling equipment - Robotic handling - Materials handling at the workplace- Robots and their classification - Major components of a robot - classification of Robotic manipulators - Robotic handling applications
Total Periods: 45

Learning Resources:

1.	Bolz, H. A and Hagemann, G. E (ed.), ‘‘Materials Handling Handbook’’, Ronald Press
2.	8005:1976, Classification of Unit Loads, Bureau of Indian Standards.
3.	Apple, J.A., ‘‘Material Handling System Design’’, John Wiley & Sons
4.	Theodore H., Allegre Sr., Material Handling Principles and Practice, CBS Publishers and Distributors
5.	Immer J. R., Material Handling, Tata McGraw Hill Publication.
6	Allegri (Sr.), T.H., Material Handling – Principles and Practices, CBS Publishers and Distributors,Delhi, 1987.
7	Siddharta Ray, Introduction to Materials Handling, New Age International Publishers

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Discuss the basic concepts of material handling equipment.	Understand
CO2	Explain the basic working principles of various industrial Vehicles.	Understand
CO3	Describe the basic working principles of various conveyors.	Understand
CO4	Elaborate the basic working principles of various Auxiliary Equipment and Hoisting Equipment.	Understand
CO5	Explain the basic working principles of various Bulk Handling Equipment and Systems.	Understand

Course Articulation Matrix

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2							2	2		2	2	2
CO2	2							2	2		2	2	2
CO3	2							2	2		2	2	2
CO4	2							2	2		2	2	2
CO5	2							2	2		2	2	2
Avg.	**2**							**2**	**2**		**2**	**2**	**2**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

PROFESSIONAL ELECTIVES

VERTICAL 4: MODERN MOBILITY SYSTEMS (MM)

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24MEMM01	Automobile Engineering	PEC	3	0	0	3	3	40	60
2	U24MEMM02	Hybrid and Electric Vehicle Technology	PEC	3	0	0	3	3	40	60
3	U24MEMM03	Vehicle Health Monitoring, Maintenance and Safety	PEC	3	0	0	3	3	40	60
4	U24MEMM04	CAE and CFD Approach in Future Mobility	PEC	3	0	0	3	3	40	60
5	U24MEMM05	Automotive Materials, Components, Design and Testing	PEC	2	0	2	4	3	50	50
6	U24MEMM06	Advanced Vehicle Engineering	PEC	3	0	0	3	3	40	60
7	U24MEMM07	Drone Technologies	PEC	3	0	0	3	3	40	60
8	U24MEMM08	Conventional and Futuristic Vehicle Technology	PEC	3	0	0	3	3	40	60

U24MEMM01	AUTOMOBILE ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- To study the construction and working principle of various parts of an automobile.
- To study the practice for assembling and dismantling of engine parts and transmission system
- To study various transmission systems of automobile.
- To study about steering, brakes and suspension systems
- To study alternative energy sources

Detailed Syllabus

UNIT I VEHICLE STRUCTURE AND ENGINES 9

Types of automobiles vehicle construction and different layouts, chassis, frame and body, Vehicle aerodynamics (various resistances and moments involved) - Basics of CFD applications in automobiles, IC engines – components-functions and materials, variable valve timing (VVT), Variable Valve Lift (VVL).

UNIT II ENGINE AUXILIARY SYSTEMS 9
Electronically controlled gasoline injection system for SI engines, electronically controlled diesel injection system (Unit injector system, Rotary distributor type and common rail direct injection system), Electronic ignition system (Transistorized coil ignition system, capacitive discharge ignition system), Turbo chargers (WGT, VGT), Engine emission control by three-way catalytic converter system, Emission norms (Euro and BS).
UNIT III TRANSMISSION SYSTEMS 9
Clutch-types and construction, gear boxes- manual and automatic, Dual clutch transmission, gear shift mechanisms, Overdrive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.
UNIT IV STEERING, BRAKES AND SUSPENSION SYSTEMS 9
Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Types of Suspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System (ABS), Introduction to electronic stability control (ESC), electronic brake force distribution (EBD) and Traction Control.
UNIT V ALTERNATIVE ENERGY SOURCES 9
Use of Natural Gas, Liquefied Petroleum Gas, Bio-diesel, Bio-ethanol, Gasohol and Hydrogen in Automobiles- Engine modifications required –Performance, Combustion and Emission Characteristics of SI and CI engines with these alternate fuels - Electric and Hybrid Vehicles, Fuel Cell Note: Practical Training in dismantling and assembling of Engine parts and Transmission Systems should be given to the students.
Total Periods: 45

Learning Resources

1	Jain K.K. and Asthana. R.B, “Automobile Engineering” Tata McGraw Hill Publishers, New Delhi, 2002.
2	Kirpal Singh, “Automobile Engineering”, Vol 1 & 2, Seventh Edition, Standard Publishers, New Delhi, 13th Edition 2014.
3	Ganesan V. “Internal Combustion Engines”, Third Edition, Tata McGraw-Hill, 2012.
4	Heinz Heisler, “Advanced Engine Technology,” SAE International Publications USA, 1998.
5	Joseph Heitner, “Automotive Mechanics,” Second Edition, East-West Press, 1999.
6	Martin W, Stockel and Martin T Stockle, “Automotive Mechanics Fundamentals,” The Good heart - Will Cox Company Inc, USA ,1978.
7	Newton, Steeds and Garet, “Motor Vehicles”, Butterworth Publishers, 1989.
8	Crouse, W.H., and Anglin, D.L., "Automotive Mechanics", 10th Edition, Tata McGraw Hill, 2006. (Highly recommended for clear illustrations of Transmission and Steering systems).

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Recognize the various parts of the automobile and their functions and materials.	Understand
CO2	Discuss the engine auxiliary systems and engine emission control.	Understand
CO3	Distinguish the working of different types of transmission systems.	Understand
CO4	Explain the Steering, Brakes and Suspension Systems.	Understand
CO5	Describe possible alternate sources of energy for IC Engines.	Understand

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MEMM02	**HYBRID AND ELECTRIC VEHICLE TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

After completing this course, the students will be able to:

- To introduce the concept of hybrid and electric drive trains.
- To elaborate on the types and utilisation of hybrid and electric drive trains.
- To expose on different types of AC and DC drives for electric vehicles.
- To learn and utilise different types of energy storage systems
- To introduce concept of energy management strategies and drive sizing

Detailed Syllabus

UNIT I INTRODUCTION 9

Basics of vehicle performance, vehicle power source characterization, transmission characteristics, History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

UNIT II HYBRID ELECTRIC DRIVE TRAINS 9

Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Drive-trains: Basic concept electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

UNIT III ENERGY STORAGE 9

Introduction to electric components used in hybrid and electric vehicles, Configuration, and control DC Motor drives, Induction Motor drives, Permanent Magnet Motor drive, and Switch Reluctance Motor drives, drive system efficiency.

UNIT IV ENERGY STORAGE 9 Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Energy storage and its analysis - Battery based, Fuel Cell based, and Super Capacitor based, Hybridization of different energy storage devices.
UNIT V DRIVE SIZING AND ENERGY MANAGEMENT STRATEGIES 9 Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE)Sizing the propulsion motor, sizing the power electronics, selection of appropriate energy storage technology, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification, and comparison of energy management strategies, Implementation issues.
Total Periods: 45

Learning Resources

1	Iqbal Husain, —Electric and Hybrid Vehicles: Design Fundamentalsll, Third Edition, 2021
2	James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003
3	Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
4	Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons, 1998
5	Hybrid, Electric and Fuel-Cell Vehicles, International Edition by Jack Erjavec | 6 June2012
6	Energy Management in Hybrid Electric Vehicles using Co-Simulation by Christian Paar | 11 February 2011

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Discuss Characterise and configure hybrid drivetrains requirement for a vehicle.	Understand
CO2	Design and apply appropriate hybrid and electric drive trains in a vehicle.	Apply
CO3	Design and install suitable AC and DC drives for electric vehicles.	Apply
CO4	Discuss arrive at a suitable energy storage system for a hybrid / electric vehicle.	Understand
CO5	Apply energy management strategies to ensure better economy and efficiency.	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MEMM03	VEHICLE HEALTH MONITORING, MAINTENANCE AND SAFETY	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- To enable the student to understand the principles, functions and practices adapted in maintenance activities of vehicles.
- To study the powertrain maintenance, fault diagnosis, maintenance of Batteries
- To develop vehicle system maintenance and service of clutch, brake.
- To study the concepts of vehicle safety and regulations.
- To study and understand the simulation of safety concepts.

Detailed Syllabus

UNIT I INTRODUCTION 9

Need for Maintenance – importance, classification of maintenance work-basic problem diagnosis. Maintenance of vehicle systems – power pack, tyres, safety systems. Scheduled maintenance services – service intervals – On-board diagnostics, Computerized engine analyser study and practice- OBD and scan Tools.

UNIT II POWERTRAIN MAINTENANCE 9

Exhaust emission test of petrol and diesel engine; - Electronic fuel injection and engine management service - fault diagnosis- OBD-III and scan tool, identifying DTC and servicing emission controls, Maintenance of Batteries, Starting System, Charging System and Body Electrical -Fault Diagnosis Using
Scan Tools.

UNIT III VEHICLE SYSTEM MAINTENANCE 9

Clutch- adjustment and service, Maintenance and Service of Hydraulic brake, Bleeding of brakes, Checking ABS and components. Maintenance and Service of McPherson strut, coil spring. tyre wear, measurement of read depth and tyre rotation, Computerized wheel balancing & wheel alignment, Maintenance and
Service of steering linkage, steering column, Rack and pinion steering.

UNIT IV VEHICLE SAFETY 9

Concepts of vehicle safety -Seat belt, regulations, automatic seat belt tightener system, collapsible steering column, air bags, electronic system for activating air bags, bumper design for safety, Active Safety - ABS, EBD, CSC, Traction control system, Modern electronic features in vehicles like tyre pressure monitoring, Automatic headlamp ON, Rain sensing wipers.

UNIT V SIMULATION OF SAFETY CONCEPTS 9

Active safety: driving safety, conditional safety, perceptibility safety, operating safety passive safety: exterior safety, interior safety, deformation behavior of vehicle body, speed and acceleration characteristics of passenger compartment on impact. Collision warning system, causes of rear end collision, frontal object
detection, rear vehicle object detection system, object detection system with braking system Interactions.

Total Periods: 45

Learning Resources

1	Tom Denton, “Advanced Automotive Fault Diagnosis Automotive Technology: Vehicle Maintenance and Repair” 5th Edition, Routledge, September 2020.
2	S. V. Paul, Safety Management System and Documentation Training Programme Handbook, CBS, June 2019
3	Ed May, "Automotive Mechanics Volume One" and Two, Mc Graw Hill Publications, Tenth edition, 2018

4	William H. Crouse and Donald L. Anglin, “Automotive Mechanics”, McGraw Hill Education, 10th Edition, 2007.
5	Jack Erjavek, “A systems approach to Automotive Technology”, Cengage Learning, 5th Edition, 2012

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the principles, functions, and practices involved in vehicle maintenance activities.	Understand
CO2	Apply maintenance and fault diagnosis techniques for powertrain components and batteries.	Apply
CO3	Describe the various maintenance and servicing procedures for vehicle systems such as clutch and brake assemblies.	Understand
CO4	Explain the concepts of vehicle safety, standards, and regulatory requirements.	Understand
CO5	Apply simulation techniques to analyse and evaluate vehicle safety concepts.	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MEMM04	**CAE AND CFD APPROACH IN FUTURE MOBILITY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

After completing this course, the students will be able to:

- To understand the role of CAE tools and computational methods in mobility engineering.
- To learn CAD data exchange formats and interoperability between software systems.
- To gain knowledge of numerical methods and governing equations used in CFD.
- To understand the fundamental concepts and modelling techniques in CFD.
- To explore CFD applications in mobility and various industrial sectors.

Detailed Syllabus

UNIT – I INTRODUCTION TO CAE /CFD 9

Introduction to computer applications in mobility product life cycle, software tools in mobility engineering, design process and role of computational tools, concept of modelling and simulation, overview of CAE tools, CFD as a design and research tool, applications of CFD in mobility engineering.

UNIT – II CAD DATA EXCHANGE FORMATS 9

CAD/CAM data exchange formats, types of file formats and their exchange, graphics standards in CAD systems, neutral file formats such as IGES, STEP and STL, interoperability in CAD systems, data exchange challenges and basic solutions.

UNIT – III FUNDAMENTALS SUPPORTING CFD 9 Numerical methods in engineering, concept of discretization, governing differential equations, mesh and grid generation concepts, boundary and initial conditions, overview of numerical solution approaches.
UNIT – IV INTRODUCTION TO CFD 9 CFD and experimental methods, continuity, momentum and energy equations, classification of fluid flows, discretization techniques overview, dimensionless parameters such as Reynolds number and Mach number, grid generation techniques, convergence and stability concepts.
UNIT – V CFD APPLICATIONS AND MODELLING 9 Turbulence modelling concepts, types of turbulence models overview, internal and external flows, boundary layer theory, vehicle aerodynamics fundamentals, wind tunnel simulation concepts, industrial applications in automotive, aerospace, oil and gas and chemical sectors, UAV applications.
Total Periods: 30

Learning Resources

1	Computational Fluid Dynamics: A Practical Approach by Jiyuan Tu, Guan Heng Yeoh, Chaoqun Liu
2	Applied Computational Fluid Dynamics by S. C. Gupta
3	Ibrahim Zeid “Mastering CAD CAM” Tata McGraw-Hill Publishing Co.2007
4	Groover, M. P., CAD/CAM: Computer-Aided Design and Manufacturing, Pearson Education, 2008
5	Tirupathi R.Chandrupatla and Ashok D.Belegundu, “Introduction to Finite Elements in Engineering”, International Edition, Pearson Education Limited, 2014.
6	Dhanaraj. R and Prabhakaran Nair. K, “Finite Element Analysis”, Oxford Publications, 2015.
7	Versteeg, H.K., and Malalasekera, W.,”An Introduction to Computational Fluid Dynamics”: The finite volume Method, Pearson Education, 2014
8	Ghoshdastidar, P.S., “Computer Simulation of flow and heat transfer”, Tata McGraw Hill, 1998

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the role of CAE and CFD tools in mobility product design and analysis.	Understand
CO2	Describe CAD data exchange formats and issues related to interoperability.	Understand
CO3	Apply basic numerical methods and discretization concepts in CFD analysis.	Apply
CO4	Analyse fluid flow problems using fundamental CFD equations and concepts.	Analyse
CO5	Discuss CFD applications in mobility sectors such as automotive, aerospace, and UAV systems.	Understand

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MEMM05	AUTOMOTIVE MATERIALS, COMPONENTS, DESIGN AND TESTING	L	T	P	C
		2	0	2	3

Course Objectives

After completing this course, the students will be able to:

To study the functional requirements of engine components and suitable materials

To learn to design of cylinder and piston components

To learn to design of connecting rod and crank shaft

To learn to design of flywheel and valve train

To study the Engine Testing cycles, Emission measurement technologies

Detailed Syllabus:

UNIT – I FUNCTIONAL REQUIREMENTS OF ENGINE COMPONENTS AND SUITABLE MATERIALS 6

Functional requirements of engine components – Piston, piston pin, cylinder liner, connecting rod, crank shaft, valves, spring, engine block, cylinder head, and flywheel. Suitable materials for engine components.

UNIT – II DESIGN OF CYLINDER AND PISTON COMPONENTS 6

Design of cylinder, cylinder head, piston, piston rings and piston pin – more details in necessary.

UNIT – III DESIGN OF CONNECTING ROD AND CRANK SHAFT 6

Design of connecting rod – Shank design – small end design – big end design – bolts design. Design of overhang crank shaft under bending and twisting – Crank pin design – Crank web design – Shaft design.

UNIT – IV DESIGN OF FLYWHEEL AND VALVE TRAIN 6

Design of valve – inlet valve – exhaust valve - Valve springs – tappet – rocker arm. Determination of mass of flywheel for a given coefficient of fluctuation of speed. Design of flywheel - rim - hub - arm.

UNIT – V ENGINE TESTING 6

Engine test cycles – WLTC – WHSC – WHVC – NRTC – ISO 8178. Dynamometer - Chassis dynamometer - transient dynamometer. Emission measurement technologies and instruments - NOX – Smoke – Particulate matter – CO – CO2 - HC. -Particle counter.

Total Periods: 30

PRACTICAL-LIST OF EXPERIMENT

LIST OF EXPERIMENT
1. Design and animate Piston Cylinder assembly and motion study using CAD software.
2. Design and simulate Connecting rod and crank shaft
3. Design flywheel and valve
4. Design and simulate Two Cylinder Engine assembly using CAD software.

5.	Conduct the engine performance test using analysis software
6.	Conduct the emission test using analysis software
	Total Periods: 30

Learning Resources

1	Khurmi. R.S. & Gupta. J.K., "A text book of Machine Design", Eurasia Publishing House (Pvt) Ltd, 2001.
2	The Automotive Chassis: Volume 1: Components Design (Mechanical Engineering Series) by Giancarlo Genta and Lorenzo Morello | 24 December 2019
3	Hiroshima Yamagata, “The science and technology of materials in automotive engines”, Woodhead Publishing Limited, Cambridge, England
4	Hong Cheng, —Autonomous Intelligent Vehicles: Theory, Algorithms & Implementation‖, Springer, 2011
5	Advanced Technology Vehicles Manufacturing (ATVM) Loan Program (Energy Science, Engineering and Technology: Congressional Policies, Practices and Procedures) by Andrew M Wright and Harrison R Scott | 5 September 2012
6	Advanced Vehicle Technology by Heinz Heisler MSc BSc FIMI MIRTE MCIT | 17 July 2002
7	Advanced Motorsport Engineering: Units for Study at Level 3by Andrew Livesey | 1 September 2011

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Discuss the requirements of engine components and select suitable materials.	Understand
CO2	Apply the concept of design to cylinder and piston components and solve problems.	Apply
CO3	Apply the concept of design to Connecting rod and crank shaft and solve problems.	Apply
CO4	Apply the concept of design to flywheel and valve train and solve problems.	Apply
CO5	Discuss engine test cycles, dynamometer and emission measurement technologies and instruments	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MEMM06	ADVANCED VEHICLE ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives

After completing this course, the students will be able to:

- To introduce the basic concepts of electric vehicle and their characteristics
- To introduce different types of motors and the selection of motor for vehicle applications.
- To acquaint the student with different sensors and systems used in autonomous and connected vehicles.
- To give an overview of networking with sensors and systems.
- To introduce the modern methods of diagnosing on-board the vehicle troubles.

Detailed Syllabus

UNIT – I ELECTRIC VEHICLES 9

EV architectures, advantages and disadvantages, Electrical and mechanical energy storage technologies, battery management. Performance of Electric Vehicles, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving.

UNIT – II ELECTRIC VEHICLE MOTORS 9

Electric Propulsion basics, motor capacity determination, Induction motor, DC motor, Permanent Magnet Motor, Switch Reluctance Motor, Configuration, Characteristics, Performance and control of Drives.

UNIT – III AUTONOMOUS AND CONNECTED VEHICLES 9

Vehicle-to-Vehicle Technology, Vehicle to Road and Vehicle to Vehicle Infrastructure, Basic Control System, Surroundings Sensing Systems, Role of Wireless Data Networks, Advanced Driver Assistance Systems, Basics of Radar System, Ultrasonic Sonar Systems, Lidar System, Camera Technology, Basics of Wireless Technology, Receiver System.

UNIT – IV AUTOMOTIVE NETWORKING 9

Bus Systems – Classification, Applications in the vehicle, Coupling of networks, networked vehicles, Buses - CAN Bus, LIN Bus, MOST Bus, Bluetooth, Flex Ray, Diagnostic Interfaces.

UNIT – V ON-BOARD TESTING 9

Integration of Sensor Data to On-Board Control Systems (OBD), OBD requirements, certification, enforcement, systems, testing, Catalytic converter and Exhaust Gas Recirculation system monitoring, Introduction to Cyber-physical system.

Total Periods: 45

Learning Resources

1	John G Hayes and G Abaas Goodarzi, Electric Powertrain -, 1st Edition, John Wiley & Sons Ltd., 2018
2	Hussain T Mouftah, Melike Erol-kantarci and Samesh Sorour, Connected and Autonomous Vehicles in Smart Cities Press, 1st Edition, 2020.
3	Dominique Paret, Multiplexed Networks for Embedded Systems, John Wiley & Sons Ltd., 2007.
4	Hong Cheng, —Autonomous Intelligent Vehicles: Theory, Algorithms & Implementation‖, Springer, 2011
5	Advanced Technology Vehicles Manufacturing (ATVM) Loan Program (Energy Science, Engineering and Technology: Congressional Policies, Practices and Procedures) by Andrew M Wright and Harrison R Scott | 5 September 2012
6	Advanced Vehicle Technology by Heinz Heisler MSc BSc FIMI MIRTE MCIT | 17 July 2002
7	Advanced Motorsport Engineering: Units for Study at Level 3by Andrew Livesey | 1 September 2011

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the fundamental concepts and characteristics of electric vehicles.	Understand
CO2	Describe different types of electric motors and select suitable motors for vehicle applications.	Understand
CO3	Explain various sensors and systems used in autonomous and connected vehicles.	Understand
CO4	Describe automotive networking systems and integration of sensors and control units.	Understand
CO5	Apply modern on-board diagnostic methods for vehicle fault detection and monitoring.	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MEMM07	**DRONE TECHNOLOGIES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

After completing this course, the students will be able to:

- To understand the fundamentals and evolution of drone technology.
- To learn UAV components, design, fabrication, and programming.
- To develop skills in drone operation and flight control.
- To explore commercial applications of drones in various sectors.
- To understand drone safety regulations and emerging technologies.

Detailed Syllabus

UNIT – I INTRODUCTION TO DRONE TECHNOLOGY 9

Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability.

UNIT – II DRONE DESIGN, FABRICATION AND PROGRAMMING 9

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts -Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations -The methods of programming drone- Download program - Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

UNIT – III DRONE FLYING AND OPERATION 9

Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment- Drone controls Flight operations –management tool –Sensors-Onboard storage capacity -Removable storage devices- Linked mobile devices and applications.

UNIT – IV DRONE COMMERCIAL APPLICATIONS 9 Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing.
UNIT – V FUTURE DRONES AND SAFETY 9 The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms.
Total Periods: 45

Learning Resources

1	Daniel Tal and John Altschuld, “Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation”, 2021 John Wiley & Sons, Inc.
2	Terry Kilby and Belinda Kilby, “Make: Getting Started with Drones “, Maker Media, Inc, 2016.
3	John Baichtal, “Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs”, Que Publishing, 2016.
4	Zavrsnik, “Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance”, Springer, 2018.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the concepts, classifications, and technological evolution of drones.	Understand
CO2	Design, assemble, and program basic UAV systems with appropriate configurations.	Apply
CO3	Apply drones safely using suitable flight modes, sensors, and control systems.	Apply
CO4	Identify drones for various commercial and industrial applications.	Understand
CO5	Describe safety regulations and future trends in drone technology including autonomous and swarm systems.	Understand

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MEMM08	CONVENTIONAL AND FUTURISTIC VEHICLE TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- To study the advanced engine technologies
- To learn various advanced combustion technologies and its benefits
- To learn the methods of using low carbon fuels and its significance
- To learn and understand the hybrid and electric vehicle configurations
- To study the application of fuel cell technology in automotives

Detailed Syllabus

UNIT – I ADVANCED ENGINE TECHNOLOGY 9 Gasoline Direct Injection, Common Rail Direct Injection, Variable Compression Ratio Turbocharged Engines, Electric Turbochargers, VVT, Intelligent Cylinder De-activation, After Treatment Technologies, Electric EGR, Current EMS architecture.
UNIT – II COMBUSTION TECHNOLOGY 9 Spark Ignition combustion, Compression Ignition Combustion, Conventional Dual Fuel Combustion, Low Temperature Combustion Concepts– Controlled Auto Ignition, Homogeneous Charge Compression Ignition, Premixed Charge Compression Ignition, Partially Premixed Compression Ignition, Reactivity Controlled Compression Ignition, Gasoline Direct Injection Compression Ignition.
UNIT – III LOW CARBON FUEL TECHNOLOGY 9 Alcohol Fuels, Ammonia Fuel and Combustion, Methane Technology, Dimethyl Ether, Hydrogen Fuel Technology, Challenges, and way forward
UNIT – IV HYBRID AND ELECTRIC VEHICLE (BATTERY POWERED) 9 Conventional Hybrids (Conventional ICE + Battery), Modern Hybrids (RCCI/GDCI Engine + Battery), Pure Electric Vehicle Technology – Challenges and Way forward
UNIT – V FUEL CELL TECHNOLOGY 9 Fuel cells for automotive applications - Technology advances in fuel cell vehicle systems - Onboard hydrogen storage - Liquid hydrogen and compressed hydrogen - Metal hydrides, Fuel cell control system - Alkaline fuel cell - Road map to market.
Total Periods: 45

Learning Resources

1	Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
2	Rakesh Kumar Maurya, Characteristics and Control of Low Temperature Combustion Engines. ISBN 978-3-319-68507-6 , SPRINGER
3	Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
4	James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003
5	Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons, 1998
6	Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
7	James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statements**	**Knowledge Level**
CO1	Discuss the latest trends in engine technology	Understand
CO2	Discuss the need of advanced combustion technologies and its impact on reducing carbon foot-print on the environment.	Understand
CO3	Describe the basic characteristics of low carbon fuels, its impact over conventional fuels and in achieving sustainable development goals.	Understand
CO4	Discuss the working and energy flow in various hybrid and electric configurations.	Understand
CO5	Describe the need for fuel cell technology in automotive applications.	Understand

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

OPEN ELECTIVES

Mechanical Engineering Open Elective Courses offer to other Departments

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24OEME01	Automobile Systems	OEC	2	0	2	3	3	50	50
2	U24OEME02	Renewable Energy System	OEC	2	0	2	3	3	50	50
3	U24OEME03	Robotics	OEC	2	0	2	3	3	50	50
4	U24OEME04	Production Planning and Control	OEC	2	0	2	3	3	50	50
5	U24OEME05	Non-Destructive Testing	OEC	3	0	0	3	3	40	60

U24OEME01	AUTOMOBILE SYSTEMS	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- Introduce students to the basic concepts and components of automobile systems.
- Provide understanding of engine systems, transmission, and vehicle subsystems.
- Familiarize students with modern automotive technologies and electronics.
- Explain the working principles of electric and hybrid vehicles.
- Enable students from non-mechanical backgrounds to understand system integration in automobiles.

Detailed Syllabus

UNIT I – INTRODUCTION TO AUTOMOBILES 9

History and evolution of automobiles, classification of vehicles based on fuel type and application, basic layout of automobile systems (front engine, rear engine, four-wheel drive), overview of major components such as engine, transmission, chassis, and body.

UNIT II – ENGINE SYSTEMS 9

Types of engines: Spark Ignition (SI) and Compression Ignition (CI), two-stroke and four-stroke engines. Detailed study of engine components such as cylinder, piston, crankshaft, valves, and camshaft. Working principles of IC engines with diagrams. Overview of fuel supply systems (carburetor and fuel injection), cooling systems (air and water cooling), and lubrication systems.

UNIT III – TRANSMISSION AND CHASSIS SYSTEMS 9

Function and types of clutches, gearboxes (manual and automatic), and transmission systems. Working of driveshaft and differential. Introduction to chassis and frame construction, types of suspension systems (independent and dependent), and braking systems (mechanical, hydraulic, disc, drum, ABS). Basic concepts of vehicle stability and ride comfort.

UNIT IV – AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEMS 9

Automotive electrical system components such as battery, alternator, starter motor, and wiring. Ignition systems (conventional and electronic). Introduction to sensors and actuators used in automobiles. Basics of Electronic Control Units (ECU), embedded systems in vehicles, and introduction to in-vehicle communication networks such as CAN bus.

UNIT V – MODERN AUTOMOTIVE TECHNOLOGIES 9

Overview of electric vehicles (EVs), hybrid electric vehicles (HEVs), and their components such as battery, motor, and controller. Introduction to autonomous vehicles, advanced driver assistance systems (ADAS) like lane assist and adaptive cruise control. Concepts of connected vehicles, IoT in automobiles, and future trends in smart mobility.

Total Periods: 45

Learning Resources

1	George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, “Integrated Solid Waste Management, Mc-Graw Hill India, First edition, 2015.
2	Rao. C.S (2006)., “Environmental Pollution and Control Engineering”, 2nd Edition, Revised, Wiley Eastern Limited, India.
3	Shyam Diwan and Armin Rosencranz, Environmental Law and Policy in India, Oxford, 2001
4	Metcalf & Eddy, INC, „Wastewater Engineering – Treatment and Reuse, Fourth Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2014.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO 1	Describe the structure and working of major automobile systems.	Understand
CO 2	Explain engine operations and supporting systems such as cooling and lubrication.	Understand
CO 3	Describe transmission, chassis, suspension, and braking systems.	Understand
CO 4	Discuss automotive electrical and electronic systems including ECUs and sensors.	Understand
CO 5	Explain modern automotive technologies such as EVs, ADAS, and smart vehicles.	Understand

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2							2	2		2		
CO2	2							2	2		2		
CO3	2							2	2		2		
CO4	2							2	2		2		
CO5	2							2	2		2		
Avg.	**2**							**2**	**2**		**2**		

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24OEME02	**RENEWABLE ENERGY SYSTEM**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

After completing this course, the students will be able to:

- To Provide knowledge about various renewable energy technologies
- To enable students to understand and design a PV system.
- To provide knowledge about wind energy system.
- To Provide knowledge about various possible hybrid energy systems
- To gain knowledge about application of various renewable energy technologies

Detailed Syllabus

UNIT I – INTRODUCTION 9

Primary energy sources, renewable vs. non-renewable primary energy sources, renewable energy resources in India, Current usage of renewable energy sources in India, future potential of renewable energy in power production and development of renewable energy technologies

UNIT II SOLAR ENERGY 9

Solar Radiation and its measurements, Solar Thermal Energy Conversion from plate Solar Collectors, Concentrating Collectors and its Types, Efficiency and performance of collectors,

Direct Solar Electricity Conversion from Photovoltaic, types of solar cells and its application of battery charger, domestic lighting, street lighting, and water pumping, power generation schemes. Recent Advances in PV Applications: Building Integrated PV, Grid Connected PV Systems.
UNIT III WIND ENERGY 9 Wind energy principles, wind site and its resource assessment, wind assessment, Factors influencing wind, wind turbine components, wind energy conversion systems (WECS), Classification of WECS devices, wind electric generating and control systems, characteristics and applications.
UNIT IV BIO-ENERGY 9 Energy from biomass, Principle of biomass conversion technologies/process and their classification, Bio gas generation, types of biogas plants, selection of site for biogas plant, classification of biogas plants, Advantage and disadvantages of biogas generation, thermal gasification of biomass, biomass gasifies, Application of biomass and biogas plants and their economics.
UNIT V OTHER TYPES OF ENERGY 9 Energy conversion from Hydrogen and Fuel cells, Geo thermal energy Resources, types of wells, methods of harnessing the energy, potential in India. OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, minihydel power plants and their economics.
Total Periods: 45

Learning Resources

1	Twidell & Wier,'Renewable Energy Resources' CRC Press (Taylor & Francis).
2	Tiwari and Ghosal/ Narosa,'Renewable energy resources'
3	D.P.Kothari, K.C.Singhal,'Renewable energy sources and emerging technologies', P.H.I.
4	D.S.Chauhan, S.K. Srivastava, 'Non – Conventional Energy Resources', New Age Publishers, 2006.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO 1	Describe about various renewable energy technologies.	Understand
CO 2	Explain solar thermal energy conversion and performance of solar collectors.	Apply
CO 3	Describe the concept of various wind energy system.	Understand
CO 4	Discuss various possible hybrid energy systems	Understand
CO 5	Explain various application of renewable energy technologies.	Understand

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2						2	2	2		2		
CO2	2	2					2	2	2		2		
CO3	2						2	2	2		2		
CO4	2						2	2	2		2		
CO5	2						2	2	2		2		
Avg.	**2**	**2**					**2**	**2**	**2**		**2**		

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24OEME03	ROBOTICS	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- Provide fundamental knowledge of industrial robots, their anatomy, coordinate systems, and specifications.
- Impart understanding of various robot drives, actuators, and end effectors used in industrial applications.
- Introduce the principles of robot kinematics, dynamics, and control techniques.
- Develop the ability to analyze robot motion, trajectory planning, and stability concepts.
- Familiarize students with robot programming methods, mobile robots, and real-world industrial applications with safety considerations.

Detailed Syllabus

UNIT I – INTRODUCTION TO ROBOTICS 9

Robot definition – Robot anatomy – Coordinate systems – Work envelope – Robot specifications – Pitch, yaw, roll – Joint notations – Speed of motion – Payload – Robot parts and functions– Robot design and control basics – Introduction to mobile robots – Locomotion – Stability – Legged and wheeled robots.

UNIT II – ROBOT DRIVES AND END EFFECTORS 9

Pneumatic drives – Hydraulic drives – Mechanical drives – Electrical drives – DC servo motors – AC servo motors – Stepper motors – Drive comparison and applications – End effectors – Mechanical grippers – Pneumatic and hydraulic grippers – Magnetic and vacuum grippers – Two finger and three finger grippers – Internal and external grippers – Selection and design considerations.

UNIT III – ROBOT KINEMATICS AND CONTROL 9

Forward kinematics – Inverse kinematics – Degrees of freedom – Homogeneous transformation – Denavit-Hartenberg representation.

UNIT IV – ROBOT DYNAMICS AND CONTROL 9

Robot dynamics – Newton-Euler method – Lagrange-Euler method – Jacobian – Singularities – Trajectory planning – Robot control – Position control – Force control – Stability concepts.

UNIT V – ROBOT PROGRAMMING AND APPLICATIONS 9

Teach pendant programming – Lead through programming – Robot programming languages – VAL programming basics – AGV and RGV systems – Need and applications of robots -Industrial robot implementation – Safety considerations.

Total Periods: 45

Learning Resources

1	John.J.Craig, " Introduction to Robotics: Mechanics & control", Pearson Publication, Fourth edition, 2018.
2	K.S.Fu, R.C.Gonzalez, C.S.G.Lee, "Robotics: Sensing, Vision & Intelligence", Tata McGraw-Hill Publication, First Edition, 1987.
3	Roland Siegwart and IllahR.Nourbakish, “Introduction to Autonomous Mobile Robots” MIT Press, Cambridge, 2004.
4	M.P.Groover, M.Weiss , R.N. Nagal, N.G.Odrey, "Industrial Robotics - Technology, programming and Applications" Tata, McGraw-Hill Education Pvt Limited 2ndEdition, 2012.
5	Jazar, "Theory of Applied Robotics: Kinematics, Dynamics and Control", Springer, 2ndEdition, 2010

6	S K Saha, Introduction to Robotics, Tata McGraw-Hill, ISBN: 9789332902800, Second Edition, 9789332902800
7	Sathya Ranjan Deb, "Robotics Technology & flexible Automation" Second edition, Tata McGraw-Hill Publication, 2009.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	Knowledge Level
CO1	Explain the structure, components, and working principles of industrial robots.	Understand
CO2	Select appropriate robot drives and end effectors for specific industrial applications.	Understand
CO3	Discuss basic concepts of sensors, kinematics, and control in robotic systems.	Understand
CO4	Explain dynamic principles for robot motion and trajectory control.	Understand
CO5	Describe industrial robot applications, mobile robots, and advanced robotic systems.	Understand

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2							2	2		2	2	2
CO2	2							2	2		2	2	2
CO3	2							2	2		2	2	2
CO4	2							2	2		2	2	2
CO5	2							2	2		2	2	2
Avg.	**2**							**2**	**2**		**2**	**2**	**2**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24OEME04	PRODUCTION PLANNING AND CONTROL	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- To understand the basics of production planning and control and its functions.
- To learn work study techniques for productivity improvement.
- To gain knowledge of product and process planning methods.
- To understand production scheduling and control techniques.
- To study inventory control and modern PPC systems like JIT and ERP.

Detailed Syllabus

UNIT I – INTRODUCTION 9

Objectives and benefits of planning and control-Functions of production control-Types of production-job- batch and continuous-Product development and design-Marketing aspect - Functional aspects- Operational aspect-Durability and dependability aspect aesthetic aspect. Profit consideration- Standardization, Simplification & specialization- Break even analysis-Economics of a new design.

UNIT II – WORK STUDY 9

Method study, basic procedure-Selection-Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards.

UNIT III – PRODUCT PLANNING AND PROCESS PLANNING 9 Product planning-Extending the original product information-value analysis-Problems in lack of product planning-Process planning and routing-Pre requisite information needed for process planning- Steps in process planning-Quantity determination in batch production-Machine capacity, balancing- Analysis of process capabilities in a multi-product system.
UNIT IV – PRODUCTION SCHEDULING 9 Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules-Gantt charts-Perpetual loading-Basic scheduling problems - Line of balance – Flow production scheduling- Batch production scheduling-Product sequencing – Production Control systems-Periodic batch control- Material requirement planning kanban – Dispatching-Progress reporting and expediting- Manufacturing lead time-Techniques for aligning completion times and due dates.
UNIT V – INVENTORY CONTROL AND RECENT TRENDS IN PPC 9 Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures. Two bin system - Ordering cycle system-Determination of Economic order quantity and economic lot size- ABC analysis - Recorder Procedure-Introduction to computer integrated production planning systems-elements of JUST IN TIME SYSTEMS-Fundamentals of MRP II and ERP.
Total Periods: 45

Learning Resources:

1	James. B. Dilworth," Operations management – Design, Planning and Control for manufacturing and services" Mcgraw Hill International edition 1992.
2	Martand Telsang, "Industrial Engineering and Production Management", First edition, S. Chand and Company, 2000.
3	Chary. S.N., "Theory and Problems in Production & Operations Management", Tata McGraw Hill, 1995.
4	Elwood S.Buffa, and Rakesh K.Sarin, "Modern Production / Operations Management", 8th Edition John Wiley and Sons, 2000
5	Jain. K.C. & Aggarwal. L.N., "Production Planning Control and Industrial Management", Khanna Publishers, 1990
6	Kanishka Bedi, "Production and Operations management", 2nd Edition, Oxford university press, 2007.
7	Melynk, Denzler, "Operations management – A value driven approach" Irwin Mcgraw hill.
8	Norman Gaither, G. Frazier, "Operations Management" 9th Edition, Thomson learning IE, 2007
9	Samson Eilon, "Elements of Production Planning and Control", Universal Book Corpn.1984

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	Knowledge Level
CO1	Explain the fundamentals and functions of production planning and control.	Understand
CO2	Apply work study techniques to improve efficiency.	Apply
CO3	Describe the product and process planning activities.	Understand
CO4	Develop production schedules using suitable methods.	Apply
CO5	Describe the inventory control techniques and modern PPC systems.	Understand



Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2							2	2	2	2		
CO2	2	2	2					2	2		2		
CO3	2							2	2		2		
CO4	2	2	2					2	2		2		
CO5	2							2	2	2	2		
Avg.	**2**	**2**	**2**					**2**	**2**	**2**	**2**		

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24OEME05	NON-DESTRUCTIVE TESTING	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able to:

- Understand the significance of Non-Destructive Testing (NDT) in quality assurance.
- Learn the principles, applications, limitations, codes, and standards of various NDT techniques.
- Develop the ability to detect and locate defects in different materials and products.
- Apply appropriate NDT methods in accordance with industry standards and specifications.
- Gain knowledge to select suitable NDT techniques for specific engineering applications.

Detailed Syllabus

UNIT I – INTRODUCTION TO NDT & VISUAL TESTING 9

Concepts of Non-destructive testing-relative merits and limitations-NDT Versus mechanical testing, Fundamentals of Visual Testing – vision, lighting, material attributes, environmental factors, visual perception, direct and indirect methods – mirrors, magnifiers, boroscopes and fibroscopes – light sources and special lighting.

UNIT II – LIQUID PENERATE AND MAGNETIC PARTICLE TESTING 9

Liquid Penetrant Inspection: principle, applications, advantages and limitations, dyes, developers and cleaners, Methods & Interpretation. Magnetic Particle Inspection: Principles, applications, magnetization methods, magnetic particles, Testing Procedure, demagnetization, advantages and limitations, – Interpretation and evaluation of test indications.

UNIT III – EDDY CURRENT TESTING & THERMOGRAPHY 9

Eddy Current Testing: Generation of eddy currents– properties– eddy current sensing elements, probes, Instrumentation, Types of arrangement, applications, advantages, limitations – Factors affecting sensing elements and coil impedance, calibration, Interpretation/Evaluation.

Thermography- Principle, Contact & Non-Contact inspection methods, Active & Passive methods, Liquid Crystal – Concept, example, advantages & limitations. Electromagnetic spectrum, infrared thermography- approaches, IR detectors, Instrumentation and methods, applications.

UNIT IV – ULTRASONIC TESTING & AET 9

Ultrasonic Testing: Types of ultrasonic waves, characteristics, attenuation, couplants, probes, EMAT. Inspection methods-pulse echo, transmission and phased array techniques, types of scanning and displays, angle beam inspection of welds, time of flight diffraction (TOFD) technique, Thickness determination by ultrasonic method, Study of A, B and C scan presentations, calibration.

Acoustic Emission Technique – Introduction, Types of AE signal, AE wave propagation, Source location, Kaiser effect, AE transducers, Principle, AE parameters, AE instrumentation, Advantages & Limitations, Interpretation of Results, Applications.

UNIT V – RADIOGRAPHY TESTING 9
Sources-X-rays and Gamma rays and their characteristics-absorption, scattering. Filters and screens, Imaging modalities-film radiography and digital radiography (Computed, Direct, Real Time, CT scan). Problems in shadow formation, exposure factors, inverse square law, exposure charts, Penetrameters, safety in radiography.
Total Periods: 45

Learning Resources

1	Baldev Raj, T. Jayakumar and M. Thavasimuthu, Practical Non-Destructive Testing, Alpha Science International Limited, 3rd edition, 2002.
2	J. Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-Hill Education, 2nd edition, 2011.
3	Ravi Prakash, “Non-Destructive Testing Techniques”, 1st revised edition, New Age International Publishers, 2010.
4	ASM Metals Handbook, V-17, "Nondestructive Evaluation and Quality Control", American Society of Metals, USA, 2001.
5	Barry Hull and Vernon John,"Nondestructive Testing", Macmillan, 1989.
6	Chuck Hellier, “Handbook of Nondestructive Evaluation”, Mc Graw Hill, 2012.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	Knowledge Level
CO1	Explain the importance of NDT in various engineering applications.	Understand
CO2	Describe surface NDE techniques to perform inspections as per established procedures.	Understand
CO3	Calibrate instruments and evaluate in-service defects using Eddy Current Testing and Thermography.	Apply
CO4	Differentiate UT and AET techniques and select suitable methods for effective evaluation.	Understand
CO5	Describe the radiographic testing and its various parameters.	Understand

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2							2	2		2		
CO2	2							2	2		2		
CO3	2	2	2					2	2		2		
CO4	2							2	2		2		
CO5	2							2	2		2		
Avg.	**2**	**2**	**2**					**2**	**2**		**2**		

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

MANDATORY COURSES

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24MC11	Disaster Risk Reduction and Management	MC	3	0	0	3	0	100	-
2	U24MC21	Environmental Science	MC	3	0	0	3	0	100	-
3	U24MC31	History of Science and Technology in India	MC	3	0	0	3	0	100	-
4	U24MC41	Personal Finance	MC	3	0	0	3	0	100	-
5	U24MC51	Well-Being with Traditional Practices-Yoga, Ayurveda and Siddha	MC	3	0	0	3	0	100	-

U24MC11	DISASTER RISK REDUCTION AND MANAGEMENT	L	T	P	C
		3	0	0	0

Course Objective:

After completing this course, the students will be able to:

- To introduce the basic concepts of disasters, hazards, vulnerability, and disaster risks.
- To understand different types of disasters and their impacts on society and the environment.
- To study the principles and strategies of disaster risk reduction (DRR).
- To learn the disaster management framework, policies, and institutional mechanisms in India.
- To understand the use of modern tools, technology, and case studies in disaster management.

Detailed Syllabus

UNIT I: HAZRADS, VULNERABILITY AND DISASTER RISKS 9

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Types of Disasters: Natural, Humaninduced, Climate change induced –Earthquake, Landslide, Flood, Drought, Fire etc – Technological disasters- Structural collapse, Industrial accidents, oil spills -Causes, Impacts including social, Economic, political, environmental, health, psychosocial, etc.- Disaster vulnerability profile of India and Tamil Nadu - Global trends in disasters: urban disasters, pandemics, Complex emergencies, Inter relations between Disasters and Sustainable development Goals.

UNIT II: DISASTER RISK REDUCTION (DRR) 9

Sendai Framework for Disaster Risk Reduction, Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community Based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions / Urban Local Bodies (PRIs/ULBs), States, Centre, and other stakeholders- Early Warning System – Advisories from Appropriate Agencies. - Relevance of indigenous Knowledge, appropriate technology and Local resources.

UNIT III: DISASTER MANAGEMENT 9

Components of Disaster Management – Preparedness of rescue and relief, mitigation, rehabilitation and reconstruction- Disaster Risk Management and post disaster management – Compensation and Insurance- Disaster Management Act (2005) and Policy - Other related policies, plans, programmers and legislation - Institutional Processes and Framework at State and Central Level- (NDMA –SDMA-DDMA-NRDF- Civic Volunteers)

UNIT IV: TOOLS AND TECHNOLOGY FOR DISASTER MANAGEMENT 9

Early warning systems -Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment. - Elements of Climate Resilient Development –Standard operation Procedure for disaster response – Financial planning for disaster Management.

UNIT V: DISASTER MANAGEMENT: CASE STUDIES 9

Discussion on selected case studies to analyse the potential impacts and actions in the contest of disasters-Landslide Hazard Zonation: Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field work related to disaster management. - Field Work-Mock drill.

Total Periods: 45

Learning Recourses

1	Taimpo (2016), Disaster Management and Preparedness, CRC Publications
2	Singh R (2017), Disaster Management Guidelines for earthquakes, Landslides, Avalanches and tsunami, Horizon Press Publications
3	Singhal J.P. “Disaster Management”, Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN13:978-9380386423
4	Govt. of India: Disaster Management Act, Government of India, New Delhi, 2005

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Explain the concepts of disasters, hazards, vulnerability, and disaster risks.	Understand
CO2	Describe different types of disasters and their impacts on society and the environment.	Understand
CO3	Explain the principles and strategies of disaster risk reduction.	Understand
CO4	Discuss disaster management policies, institutions, and frameworks in India.	Understand
CO5	Describe the disaster management tools, technologies, and case study knowledge to disaster situations.	Understand

U24MC21	ENVIRONMENTAL SCIENCE	L	T	P	C
		3	0	0	0

Course Objective:

After completing this course, the students will be able to:

- To introduce the basic concepts and importance of Environmental Science and natural resources.
- To understand ecosystem structure, energy flow, and the importance of biodiversity.
- To study different types of environmental pollution and their control measures.

- To understand major environmental issues and the concept of sustainable development.
- To understand environmental laws, policies, and the role of public participation in environmental protection.

Detailed Syllabus

UNIT I: INTRODUCTION TO ENVIRONMENT AND NATURAL RESOURCES 8

Definition, scope, and importance of Environmental Science. Components of the environment: lithosphere, hydrosphere, atmosphere, and biosphere. Structure and functions of the environment. Natural resources: renewable and non-renewable resources. Resource distribution and utilization. Resource depletion and conservation strategies. Sustainable use of natural resources and the concept of equitable resource sharing. Importance of environmental awareness and responsibility.

UNIT II: ECOSYSTEMS AND BIODIVERSITY 10

Concept, structure, and functions of ecosystems. Types of ecosystems: terrestrial and aquatic ecosystems. Food chains, food webs, and ecological pyramids. Energy flow in ecosystems. Biogeochemical cycles: water cycle, carbon cycle, and nitrogen cycle. Biodiversity: definition, types (genetic, species, and ecosystem diversity), values of biodiversity. Threats to biodiversity such as habitat destruction, overexploitation, pollution, and climate change. Biodiversity conservation methods: in-situ and ex-situ conservation strategies.

UNIT III: ENVIRONMENTAL POLLUTION 10

Definition and types of environmental pollution: air pollution, water pollution, soil pollution, noise pollution, thermal pollution, and radioactive pollution. Sources, causes, effects, and control measures for different types of pollution. Solid waste management: types of waste, waste segregation, recycling, and disposal methods. Management of e-waste and plastic waste. Importance of pollution prevention and environmental protection practices.

UNIT IV: ENVIRONMENTAL ISSUES AND SUSTAINABLE DEVELOPMENT 9

Major environmental issues: climate change, global warming, ozone layer depletion, acid rain, deforestation, land degradation, urbanization, and population growth. Impact of environmental issues on ecosystems and human health. Concept of sustainable development and sustainable lifestyles. Sustainable Development Goals (SDGs). Sustainable agriculture, renewable energy sources, and green buildings. Carbon footprint, life cycle assessment (LCA), environmental ethics, and green campus initiatives.

UNIT V: ENVIRONMENTAL POLICIES, LEGISLATION AND FIELDWORK 8

Environmental policies and legislation in India: Environmental (Protection) Act, 1986; Air (Prevention and Control of Pollution) Act; Water (Prevention and Control of Pollution) Act; Forest Conservation Act; Biological Diversity Act. Role of National Green Tribunal (NGT). Environmental Impact Assessment (EIA). Role of government agencies, NGOs, and public participation in environmental protection. Fieldwork/Project component: campus environmental audit, biodiversity survey, waste segregation activity, case study analysis, or visit to a pollution control facility.

Total Periods: 45

Learning Recourses

1	Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition,New Age International Publishers ,2018.

2	Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3	R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38 . Edition 2010.
4	Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
5	Govt. of India: Disaster Management Act, Government of India, New Delhi, 2005
6	https://moef.gov.in — Ministry of Environment, Forest and Climate Change, India
7	https://sdgs.un.org/goals — UN Sustainable Development Goals
8	https://niti.gov.in — NITI Aayog's SDG India Index

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Explain the basic concepts of environment and natural resources.	Understand
CO2	Describe ecosystem structure, functions, and biodiversity conservation.	Understand
CO3	Describe different types of environmental pollution and their control methods.	Understand
CO4	Discuss major environmental issues and principles of sustainable development.	Understand
CO5	Explain environmental policies, legislation, and apply environmental practices through field activities.	Understand

U24MC31	HISTORY OF SCIENCE AND TECHNOLOGY IN INDIA	L	T	P	C
		3	0	0	0

Course Objective:

After completing this course, the students will be able to:

- To introduce the basic concepts and perspectives of the history of science and technology.
- To understand the contributions of important scholars in the study of science and technology in India.
- To study the development of science and technology in ancient and medieval India.
- To understand the influence of colonial rule on science and technology in India.
- To understand the growth and impact of science and technology in post-independent India.

Detailed Syllabus

UNIT I: CONCEPTS AND PERSPECTIVES 9

Meaning and Nature of History Objectivity, Determinism, Relativism, Causation, Generalization in History; Moral judgment in history Extent of subjectivity, contrast with physical sciences, interpretation and speculation, causation verses evidence, concept of historical inevitability, Historical Positivism. Science and Technology-Meaning, Scope and Importance, Interaction between science, technology & society, Sources for the history of science and technology in India.

UNIT II: HISTORIOGRAPHY OF SCIENCE AND TECHNOLOGY IN INDIA 9 Introduction to the Major Historians and their works of D.D. Kosambi, Dharmpal, Debiprasad Chattopadhyay, Rehman, S. Irfan Habib, Deepak Kumar, Dhruv Raina, and others; Approaches to the study of science and technology in Indian Historiography
UNIT III: SCIENCE AND TECHNOLOGY IN ANCIENT AND MEDIEVAL INDIA 9 Technology in pre-historic period- Origin of agriculture and its technological impact – Science and Technology during Vedic and Later Vedic periods – Development from 1st century AD to 1200 CE – Technological legacy of Medieval India – Interaction with Arab world and knowledge exchange – Medical traditions: Ayurvedic and Unani – Alchemy and early chemistry – Developments in Astronomy and Mathematics – Science and Technology on the eve of British conquest.
UNIT IV: SCIENCE AND TECHNOLOGY IN COLONIAL INDIA 9 Science under colonial rule: Science and the Empire – Introduction to Western science in India – Indian responses to modern science – Growth of techno-scientific and educational development – Role of colonial policies in shaping scientific development.
UNIT V: SCIENCE AND TECHNOLOGY IN A POST-INDEPENDENT INDIA 9 Science, Technology and Development discourse- Evolution of science and Technology policies in India – Growth of scientific institutions and research – Advances in modern fields: Space, information technology, biotechnology – Science and technology in a globalized India – Social implications of emerging technologies.
Total Periods: 45

Learning Recourses

1	Deepak Kumar, Science and the Raj: A Study of British India, Oxford University Press, New Delhi, 1995.
2	S. Irfan Habib and Dhruv Raina, Social History of Science in Colonial India, Oxford University Press, New Delhi, 2007.
3	D. D. Kosambi, The Culture and Civilization of Ancient India in Historical Outline, Vikas Publishing House, New Delhi, 1997.
4	Dhruv Raina, Images and Contexts: The Historiography of Science and Modernity in India, Oxford University Press, 2003.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the basic concepts and sources of the history of science and technology.	Understand
CO2	Discuss the contributions of major scholars in the historiography of science and technology in India.	Understand
CO3	Describe the development of science and technology in ancient and medieval India.	Understand
CO4	Discuss the impact of colonial rule on scientific development in India.	Understand
CO5	Explain the role of science and technology in post-independent India.	Understand

U24MC541	PERSONAL FINANCE	L	T	P	C
		3	0	0	0

Course Objective:

After completing this course, the students will be able to:

- To introduce students to the principles and importance of financial planning, goal setting, risk–return relationship, and informed financial decision-making.
- To develop the ability to apply time value of money concepts, compounding principles, and asset allocation strategies in evaluating savings and investment alternatives.
- To familiarize students with various financial assets and investment avenues such as bank deposits, mutual funds, equity, bonds, gold, real estate, and small savings instruments.
- To create awareness about responsible borrowing, credit management, loan evaluation, and debt control strategies.
- To enable students to design a comprehensive personal financial plan incorporating insurance, retirement planning, tax planning, and periodic review mechanisms for long-term financial security.

Detailed Syllabus

UNIT I: FINANCIAL PLANNING 9

Importance of Financial Planning – Steps involved in Financial Planning – SMART Goals – Achieving Goals – Risk & Returns – Savings & Investment – Loans & Investment.

UNIT II: ANALYZING SAVING & INVESTMENT 9

Time value of money – Power of Compounding – Rule of 72 and other rules like 69, 70, 144 – Personal Balance sheet and net worth – Inflation effect on Investment – Asset Allocation – Systematic Investment Planning.

UNIT III: FINANCIAL ASSETS 9

Investment avenues , Small Savings – Post Office Savings Schemes – Company Fixed Deposits – Bank Deposits –Gold – Gold ETF – Mutual Funds – ELSS – Investing in Equity - Investment in Commodities – Government and Corporate Bonds – Collecting Antiques and artifacts – Real Estate – Chit Funds.

UNIT IV: MANAGING LOANS 9

Personal Loan – Housing Loan – Reverse Mortgage – Education Loan – Gold Pledging – Basics & dangers of Credit Card Debts –CIBIL Score – Steps to avoid excess debt.

UNIT V: PROTECTION RELATED PRODUCTS 9

Insurance – Life Insurance – Importance of Term Life Insurance – Pension Schemes – Health Insurance - start early and peaceful retirement – Tracking and reviewing financial plan – Danger of Dipping your retirement savings, Basic of tax planning income tax.

Total Periods: 45

Learning Resources

1	Tyco Press (2014), “Personal Finance Simplified”, Callisto Publishing, 20th Edition
2	Robert Kiyosaki, Rich Dad Poor Dad (2017), Plata Publishing , New Delhi
3	Madura, Jeff. (2013), ‘Personal Finance’, Pearson Education, 5th Edition
4	Jack Kapoor, Les Dlabay, Rober J. Huges, (2010), ‘Personal Finance ’, McGraw Hill

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the importance of financial planning, goal setting, risk-return relationship, and the role of savings and investment in personal finance.	Understand
CO2	Apply time value of money concepts, compounding principles, and asset allocation strategies to evaluate personal financial decisions.	Apply
CO3	Analyse various financial assets and investment avenues (bank deposits, mutual funds, equity, bonds, gold, real estate, etc.) to select suitable options based on risk profile and financial goals.	Analyze
CO4	Evaluate loan options, credit management practices, and debt risks to make responsible borrowing decisions and maintain financial stability.	Evaluate
CO5	Develop a comprehensive personal financial plan incorporating insurance, retirement planning, tax planning, and periodic review mechanisms.	Create

U24MC51	**WELL-BEING WITH TRADITIONAL PRACTICES-YOGA, AYURVEDA AND SIDDHA**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**0**

Course Objective:

After completing this course, the students will be able to:

- To enjoy life happily with fun filled new style activities that help to maintain health also
- To adapt a few lifestyle changes that will prevent many health disorders
- To be cool and handbill every emotion very smoothly in every walk of life
- To learn to eat cost effective but healthy foods that are rich in essential nutrients
- To develop immunity naturally that will improve resistance against many health disorders

Detailed Syllabus

UNIT I: HEALTH AND ITS IMPORTANCE 6

Health: Definition - Importance of maintaining health - More importance on prevention than treatment Ten types of health one has to maintain - Physical health - Mental health - Social health - Financial health - Emotional health - Spiritual health - Intellectual health - Relationship health - Environmental health - Occupational/Professional heath. **Present health status -** The life expectancy-present status - mortality rate - dreadful diseases - non-communicable diseases (NCDs) the leading cause of death - 60% - heart disease – cancer – diabetes - chronic pulmonary diseases - risk factors – tobacco – alcohol - unhealthy diet - lack of physical activities. **Types of diseases and disorders -** Lifestyle disorders – Obesity – Diabetes - cardiovascular diseases – Cancer – Strokes – COPD - Arthritis - Mental health issues. **Causes of the above diseases / disorders -** Importance of prevention of illness - Takes care of health - Improves quality of life - Reduces absenteeism - Increase satisfaction - Saves time. **Simple lifestyle modifications to maintain health -** Healthy Eating habits (Balanced diet according to age) Physical Activities (Stretching exercise, aerobics, resisting exercise) – Maintaining BMI-Importance and actions to be taken.

UNIT II: DIET 10

Role of diet in maintaining health - energy one needs to keep active throughout the day - nutrients one needs for growth and repair - helps one to stay strong and healthy - helps to prevent diet-related illness, such as some cancers - keeps active and - helps one to maintain a healthy weight - helps to reduce risk of developing lifestyle disorders like diabetes – arthritis – hypertension – PCOD – infertility – ADHD – sleeplessness -helps to reduce the risk of heart diseases - keeps the teeth and bones strong. **Balanced Diet and its 7 Components -** Carbohydrates – Proteins – Fats – Vitamins – Minerals - Fibre and Water. **Food additives and their merits & demerits -** Effects of food additives - Types of food additives - Food additives and processed foods - Food additives and their reactions. **Definition of BMI and maintaining it with diet** - Importance - Consequences of not maintaining BMI - different steps to maintain optimal BM. **Common cooking mistakes -** Different cooking methods, merits and demerits of each method.

UNIT III: ROLE OF AYURVEDA & SIDDHA SYSTEMS IN MAINTAINING HEALTH 8

AYUSH systems and their role in maintaining health - preventive aspect of AYUSH - AYUSH as a soft therapy. **Secrets of traditional healthy living -** Traditional Diet and Nutrition - Regimen of Personal and Social Hygiene - Daily routine (Dinacharya) - Seasonal regimens (Ritucharya) - basic sanitation and healthy living environment - Sadvritta (good conduct) - for conducive social life. **Principles of Siddha & Ayurveda systems -** Macrocosm and Microcosm theory - Pancheekarana Theory / (Five Element Theory) 96 fundamental Principles - Uyir Thathukkal (TriDosha Theory) -Udal Thathukkal **Prevention of illness with our traditional system of medicine -** Primary Prevention - To decrease the number of new cases of a disorder or illness - Health promotion/education, and - Specific protective measures - Secondary Prevention - To lower the rate of established cases of a disorder or illness in the population (prevalence) - Tertiary Prevention - To decrease the amount of disability associated with an existing disorder.

UNIT IV: MENTAL WELLNESS 7

Emotional health - Definition and types - Three key elements: the subjective experience - the physiological response - the behavioral response - Importance of maintaining emotional health - Role of emotions in daily life -short term and long-term effects of emotional disturbances - Leading a healthy life with emotions - Practices for emotional health - Recognize how thoughts influence emotions - Cultivate positive thoughts - Practice self-compassion - Expressing a full range of emotions. **Stress management -** Stress definition - Stress in daily life - How stress affects one's life - Identifying the cause of stress - Symptoms of stress - Managing stress (habits, tools, training, professional help) - Complications of stress mismanagement. **Sleep -** Sleep and its importance for mental wellness - Sleep and digestion. **Immunity -** Types and importance - Ways to develop immunity

UNIT V: YOGA 2+12

Definition and importance of yoga - Types of yoga - How to Choose the Right Kind for individuals according to their age - The Eight Limbs of Yoga - Simple yogasanas for cure and prevention of health disorders - What yoga can bring to our life.

Total Periods: 45

Learning Recourses

1	Nutrition and Dietetics - Ashley Martin, Published by White Word Publications, New York, NY 10001, USA
2	Yoga for Beginners_ 35 Simple Yoga Poses to Calm Your Mind and Strengthen Your

	Body, by Cory Martin, Copyright © 2015 by Althea Press, Berkeley, California
3	WHAT WE KNOW ABOUT EMOTIONAL INTELLIGENCE How It Affects Learning, Work, Relationships, and Our Mental Health, by Moshe Zeidner, Gerald Matthews, and Richard D. Roberts, A Bradford Book, The MIT Press, Cambridge, Massachusetts, London, England
4	The Mindful Self-Compassion Workbook, Kristin Neff, Ph.D Christopher Germer, Ph.D, Published by The Guilford Press A Division of Guilford Publications, Inc.370 Seventh Avenue, Suite 1200, New York, NY 10001
5	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4799645/
6	Simple lifestyle modifications to maintain health. https://www.niddk.nih.gov/health-information/diet-nutrition/changing-habits-better-health#:~:text=Make%20your%20new%20healthy%20habit,t%20have%20time%20to%20cook
7	Read more: https://www.legit.ng/1163909-classes-food-examples-functions.html
8	https://www.yaclass.in/p/science-state-board/class-9/nutrition-and-health-5926
9	Benefits of healthy eating https://www.cdc.gov/nutrition/resources-publications/benefitsof-healthy-eating.html
10	Food additives: https://www.betterhealth.vic.gov.au/health/conditionsandtreatments/foodadditives
11	BMI:https://www.hsph.harvard.edu/nutritionsource/healthy-weight/ https://www.who.int/europe/news-room/fact-sheets/item/a-healthy-lifestyle---recommendations
12	Yoga https://www.healthifyme.com/blog/types-of-yoga/ https://yogamedicine.com/guide-types-yoga-styles/ Ayurveda: https://vikaspedia.in/health/ayush/ayurveda-1/concept-of-healthy-living-inayurveda
13	Siddha : http://www.tkdl.res.in/tkdl/langdefault/Siddha/Sid_Siddha_Concepts.asp
14	CAM : https://www.hindawi.com/journals/ecam/2013/376327/
15	Preventive herbs : https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3847409/

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the meaning of health, its types, and common lifestyle diseases.	Understand
CO2	Describe the importance of diet, balanced nutrition, and BMI for maintaining good health.	Understand
CO3	Explain the basic principles of Ayurveda and Siddha systems for disease prevention.	Understand
CO4	Discuss the importance of mental wellness, stress management, sleep, and immunity.	Understand
CO5	Describe the importance of yoga and practice simple yogasanas for a healthy life.	Understand