ANNA UNIVERSITY, CHENNAI
NON-AUTONOMOUS AFFILIATED COLLEGES
REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM

B. E. PRODUCTION ENGINEERING

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

I. Graduates are able to develop, evaluate, and find solutions to challenges in manufacturing and industrial engineering.

II. Graduates will be qualified to find work in the manufacturing sector and become specialists in product and process design for environmentally responsible production.

III. Graduates become Production Engineering entrepreneurs via academic research and industry.

IV. To gain knowledge and experience in the fields of Materials, Management and Manufacturing respectively.

V. Communicate well, lead ethically, and behave responsibly with Lifelong learning which helps graduates adapt to changing technology.

PROGRAM OUTCOMES (POs)

PO#	Graduate Attribute
1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and

write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

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

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

I. PROGRAM SPECIFIC OUTCOMES (PSOs)

1.	*Knowledge of the Production system includes being familiar with both fundamental and advanced techniques.*
2.	*The knowledge necessary for the design, analysis, and development of production processes, automation systems, and quality control systems.*
3.	*Knowledge on the application of materials, manufacturing processes, and production systems, as well as the creation of an ideal solution to accomplish continuous improvement in order to meet the requirements of industry and society, constitutes the foundation of continuous improvement.*

PEO's – PO's& PSO's MAPPING:

PEO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
I.	3	3	3	2	3	2	3	1	1	1	1	3	3	3	3
II.	3	3	3	3	3	3	3	2	2	1	2	3	3	3	2
III.	2	2	2	1	1	3	3	3	3	2	2	3	1	2	3
IV.	3	3	3	3	3	3	3	2	2	1	2	3	3	3	2
V.	2	2	2	1	1	3	3	3	3	2	2	3	1	2	3

ANNA UNIVERSITY, CHENNAI
NON-AUTONOMOUS AFFILIATED COLLEGES
REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM
B.E. PRODUCTION ENGINEERING
CURRICULA FOR SEMESTERS I TO VIII AND SYLLABI FOR SEMESTERS III AND IV

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	IP3151	Induction Programme	-	-	-	-	-	0
THEORY								
2.	HS3151	Professional English - I	HSMC	3	0	0	3	3
3.	MA3151	Matrices and Calculus	BSC	3	1	0	4	4
4.	PH3151	Engineering Physics	BSC	3	0	0	3	3
5.	CY3151	Engineering Chemistry	BSC	3	0	0	3	3
6.	GE3151	Problem Solving and Python Programming	ESC	3	0	0	3	3
7.	GE3152	**அறிவியல் தமிழ்** /Scientific Thoughts in Tamil	HSMC	1	0	0	1	1
PRACTICAL								
7	GE3171	Problem Solving and Python Programming Laboratory	ESC	0	0	4	4	2
8	BS3171	Physics and Chemistry Laboratory	BSC	0	0	4	4	2
9	GE3172	English Laboratory [$]	EEC	0	0	2	2	1
			TOTAL	**16**	**1**	**10**	**27**	**22**

[$] Skill Based Course

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	HS3251	Professional English - II	HSMC	2	0	0	2	2
2.	MA3251	Statistics and Numerical Methods	BSC	3	1	0	4	4
3.	PH3251	Materials Science	BSC	3	0	0	3	3
4.	BE3251	Basic Electrical and Electronics Engineering	ESC	3	0	0	3	3
5.	GE3251	Engineering Graphics	ESC	2	0	4	6	4
6.	GE3252	**தமிழர் மரபு** /Heritage of Tamils	HSMC	1	0	0	1	1
7.		NCC Credit Course Level 1*	-	2	0	0	2	-
PRACTICAL								
8.	GE3271	Engineering Practices Laboratory	ESC	0	0	4	4	2
9.	BE3271	Basic Electrical and Electronics Engineering Laboratory	ESC	0	0	4	4	2
10.	GE3272	Communication Laboratory / Foreign Language [$]	EEC	0	0	4	4	2
			TOTAL	**14**	**1**	**16**	**31**	**23**

[#] NCC Credit Course level 1 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.
[$] Skill Based Course

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA3351	Transforms and Partial Differential Equations	BSC	3	1	0	4	4
2.	ME3351	Engineering Mechanics	ESC	3	0	0	3	3
3.	PR3351	Thermodynamics and Thermal Engineering	PCC	3	0	0	3	3
4.	PR3001	Machining Processes and Machine Tools	ESC	3	0	0	3	3
5.	PR3002	Engineering Materials	PCC	3	0	0	3	3
6.	CE3391	Fluid Mechanics and Machinery	PCC	3	1	0	4	4
PRACTICAL								
7.	MF3361	Machining Technology Laboratory	PCC	0	0	4	4	2
8.	PR3311	Metallurgy and Materials Testing Laboratory	PCC	0	0	4	4	2
9.	GE3361	Professional Development[$]	EEC	0	0	2	2	1
			TOTAL	**18**	**2**	**10**	**30**	**25**

[$] Skill Based Course

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PR3401	Metal Casting Technology	PCC	3	0	0	3	3
2.	PR3451	Materials Joining Technology	PCC	3	0	0	3	3
3.	ML3391	Mechanics of Solids	PCC	3	0	0	3	3
4.	PR3402	Fluid Power Automation	PCC	3	0	0	3	3
5.	MR3451	Kinematics and Dynamics of Machinery	PCC	4	0	0	4	4
6.	GE3451	Environmental Sciences and Sustainability	BSC	2	0	0	2	2
7.		NCC Credit Course Level 2[#]	-	3	0	0	3	3#
PRACTICAL								
8.	PR3411	Foundry and Welding Laboratory	PCC	0	0	4	4	2
9.	PR3412	Dynamics of Machines Laboratory	PCC	0	0	4	4	2
10.	CE3481	Strength of Materials and Fluid Machinery Laboratory	ESC	0	0	4	4	2
			TOTAL	**18**	**0**	**12**	**30**	**24**

[#] NCC Credit Course level 2 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA

SEMESTER V

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PR3501	Engineering Metrology	PCC	3	0	0	3	3
2.		Professional Elective I	PEC	-	-	-	-	3
3.		Professional Elective II	PEC	-	-	-	-	3
4.		Professional Elective III	PEC	-	-	-	-	3
5.		Professional Elective IV	PEC	-	-	-	-	3
6.		Mandatory Course-I[&]	MC	3	0	0	3	0
PRACTICAL								
7.	PR3511	Summer internship	EEC	0	0	0	0	1
8.	PR3512	Fluid Power Systems Laboratory	PCC	0	0	4	4	2
9.	PR3513	Engineering Metrology Laboratory	PCC	0	0	4	4	2
			TOTAL	-	-	-	-	**20**

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

SEMESTER VI

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PR3601	Metal Forming Technology	PCC	3	0	0	3	3
2.		Professional Elective V	PEC	-	-	-	-	3
3.		Professional Elective VI	PEC	-	-	-	-	3
4.		Professional Elective VII	PEC	-	-	-	-	3
5.		Open Elective – I*	OEC	3	0	0	3	3
6.		Mandatory Course-II[&]	MC	3	0	0	3	
7.		NCC Credit Course Level 3[#]		3	0	0	3	3#
PRACTICAL								
8.	PR3611	Metal Forming Lab and Special Machine Laboratory	PCC	0	0	4	4	2
9.	PR3612	CAD and CAM Laboratory	PCC	0	0	4	4	2
			TOTAL	-	-	-	-	**19**

***Open Elective – I shall be chosen from the emerging technologies**

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

[#] NCC Credit Course level 3 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA

SEMESTER VII /VIII*

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MF3691	Mechatronics	PCC	3	0	0	3	3
2.	ME3792	Computer Integrated Manufacturing	PCC	3	0	0	3	3
3.	GE3791	Human Values and Ethics	HSMC	2	0	0	2	2
4.	GE3752	Total Quality Management	HSMC	3	0	0	3	3
5.		Open Elective – II**	OEC	3	0	0	3	3
6.		Open Elective – III***	OEC	3	0	0	3	3
7.		Open Elective – IV***	OEC	3	0	0	3	3
PRACTICAL								
8.	MF3681	Mechatronics Laboratory	PCC	0	0	4	4	2
			TOTAL	**20**	**0**	**4**	**24**	**22**

***If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.**

****Open Elective – II shall be chosen from the emerging technologies**

*****Open Elective III and IV (Shall be chosen from the list of open electives offered by other Programmes**

SEMESTER VIII / VII*

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PR3811	Project Work / Internship	EEC	0	0	20	20	10
			TOTAL	**0**	**0**	**20**	**20**	**10**

***If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII**

TOTAL : 165 CREDITS

MANDATORY COURSES I

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX3081	Introduction to Women and Gender Studies	MC	3	0	0	3	0
2.	MX3082	Elements of Literature	MC	3	0	0	3	0
3.	MX3083	Film Appreciation	MC	3	0	0	3	0
4.	MX3084	Disaster Management	MC	3	0	0	3	0

MANDATORY COURSES II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX3085	Well Being with Traditional Practices (Yoga, Ayurveda and Siddha)	MC	3	0	0	3	0
2.	MX3086	History of Science and Technology in India	MC	3	0	0	3	0
3.	MX3087	Political and Economic Thought for a Humane Society	MC	3	0	0	3	0
4.	MX3088	State, Nation Building and Politics in India	MC	3	0	0	3	0
5.	MX3089	Industrial Safety	MC	3	0	0	3	0

PROFESSIONAL ELECTIVE COURSES: VERTICALS						
Vertical 1	**Vertical 2**	**Vertical 3**	**Vertical 4**	**Vertical 5**	**Vertical 6**	**Vertical 7**
ROBOTICS AND AUTOMATION	**OPERATIONS AND SUPPLY CHAIN MANAGEMENT**	**MATERIALS PROCESSING TECHNIQUES**	**TOOL ENGINEERING**	**LOGISTICS AND SUPPLY CHAIN MANAGEMENT**	**DIVERSIFIED COURSES GROUP 1**	**DIVERSIFIED COURSES GROUP 2**
Sensors and Instrumentation	Project Management	Processing and Properties of Composites	Design of Jigs and Fixtures	Automation in Manufacturing	Elements of Green Manufacturing	Surface Modifications and Analytical Techniques
Electrical Drives and Actuators	Product Design and Value Engineering	Smart Materials for Manufacturing	Design of Press Tools	Warehousing Automation	Unconventional Machining Processes	Processing of Composites
Embedded Systems and Programming	Facility Design	MEMS and Nanotechnology	Design of Cutting Tools	Material Handling Equipment, Repair and Maintenance	Non-Destructive Testing Evaluation	Computer Aided Product Design
Robotics	Business Process Re-Engineering	Micromachining and Fabrication	Design of Tooling for Thermoplastics	Robotics	Production of Automotive Components	Finite Element Analysis
Smart mobility and Intelligent Vehicles	Enterprise Resource Planning	Additive Manufacturing	Design of Tooling for Die Casting	Container Logistics	Robotic Technology	CNC Machining Technology
Haptics and Immersive Technologies	Cost Estimation and Control	Material Testing and Characterization	Design of Tooling for Thermosets	Logistics in Manufacturing, Supply Chain and Distribution	Machine Vision	Quality Control and Reliability Engineering
Drone Technologies	Supply Chain Risk Management	Surface Engineering	Design of Gauges	Data Science	Instrumentation and Control	Machine Design
-	Logistics Management	-	-	-	-	-

Registration of Professional Elective Courses from Verticals:

Professional Elective Courses will be registered in Semesters V and VI. These courses are listed in groups called verticals that represent a particular area of specialisation / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, two courses are permitted from the same row, provided one course is enrolled in Semester V and another in semester VI.

The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E/B.Tech (Honours) or Minor degree also. For more details on B.E./B.Tech (Honours) or Minor degree refer to the Regulations 2021, Clause 4.10.

Total number of courses per vertical may change as 6 or 7 or 8. If there is shortage of courses in a vertical then necessary courses may be chosen from another vertical of the same programme.

PROFESSIONAL ELECTIVE COURSES : VERTICALS

VERTICAL 1 : ROBOTICS AND AUTOMATION

Sl. No.	Course Code	Course Title	Category	Periods Per week			Total Contact period	Credits
				L	T	P		
1.	MR3491	Sensors and Instrumentation	PEC	3	0	0	3	3
2.	MR3392	Electrical Drives and Actuators	PEC	3	0	0	3	3
3.	MR3492	Embedded Systems and Programming	PEC	3	0	0	3	3
4.	MR3691	Robotics	PEC	3	0	0	3	3
5.	CMR338	Smart mobility and Intelligent Vehicles	PEC	3	0	0	3	3
6.	CME345	Haptics and Immersive Technologies	PEC	3	0	0	3	3
7.	CRA332	Drone Technologies	PEC	3	0	0	3	3

VERTICAL 2 - OPERATIONS AND SUPPLY CHAIN MANAGEMENT

Sl. No.	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1.	CIE331	Project Management	PEC	3	0	0	3	3
2.	CIE332	Product Design and Value Engineering	PEC	3	0	0	3	3
3.	CIE333	Facility Design	PEC	3	0	0	3	3
4.	CIE334	Business Process Re-Engineering	PEC	3	0	0	3	3
5.	CIE335	Enterprise Resource Planning	PEC	3	0	0	3	3
6.	CIE336	Cost Estimation and Control	PEC	3	0	0	3	3
7.	CIE337	Supply Chain Risk Management	PEC	3	0	0	3	3
8.	CIE338	Logistics Management	PEC	3	0	0	3	3

VERTICAL 3–MATERIALS PROCESSING TECHNIQUES

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	PR3001	Processing and Properties of Composites	PEC	3	0	0	3	3
2.	PR3002	Smart Materials for Manufacturing	PEC	3	0	0	3	3
3.	PR3003	MEMS and Nanotechnology	PEC	3	0	0	3	3
4.	PR3004	Micromachining and Fabrication	PEC	3	0	0	3	3
5.	CME339	Additive Manufacturing	PEC	2	0	2	4	3
6.	PR3005	Material Testing and Characterization	PEC	3	0	0	3	3
7.	CME397	Surface Engineering	PEC	3	0	0	3	3

VERTICAL 4 - TOOL ENGINEERING

Sl. No.	Course code	Course title	Category	Periods Per week			Total conta periods	Credits
				L	T	P		
1.	CMF331	Design of Jigs and Fixtures	PEC	3	0	0	3	3
2.	CMF332	Design of Press Tools	PEC	3	0	0	3	3
3.	CMF333	Design of Cutting Tools	PEC	3	0	0	3	3
4.	CMF334	Design of Tooling forThermoplastics	PEC	3	0	0	3	3
5.	CMF335	Design of Tooling for Die Casting	PEC	3	0	0	3	3
6.	CMF336	Design of Tooling forThermosets	PEC	3	0	0	3	3
7.	CMF337	Design of Gauges	PEC	3	0	0	3	3

VERTICAL 5: LOGISTICS AND SUPPLY CHAIN MANAGEMENT

Sl. No.	Course code	Course title	Category	Periods Per week			Total contact periods	Credits
				L	T	P		
1.	CME373	Automation in Manufacturing	PEC	3	0	0	3	3
2.	CME374	Warehousing Automation	PEC	3	0	0	3	3
3.	CME375	Material Handling Equipment, Repair and Maintenance	PEC	3	0	0	3	3
4.	CME378	Robotics	PEC	2	0	2	4	3
5.	CME377	Container Logistics	PEC	3	0	0	3	3
6.	CME376	Logistics in Manufacturing, Supply Chain and Distribution	PEC	3	0	0	3	3
7.	CME379	Data Science	PEC	3	0	0	3	3

VERTICAL 6: DIVERSIFIED COURSES GROUP 1

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CPR331	Elements of Green Manufacturing	PEC	3	0	0	3	3
2.	CMF339	Unconventional Machining Processes	PEC	3	0	0	3	3
3.	CMF338	Non-Destructive Testing and Evaluation	PEC	3	0	0	3	3
4.	PR3006	Production of Automotive Components	PEC	3	0	0	3	3
5.	PR3007	Robotic Technology	PEC	3	0	0	3	3
6.	PR3008	Machine Vision	PEC	3	0	0	3	3
7.	PR3009	Instrumentation and Control	PEC	3	0	0	3	3

VERTICAL 7: DIVERSIFIED COURSES GROUP 2

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	PR3010	Surface Modifications and Analytical Techniques	PEC	3	0	0	3	3
2.	PR3011	Processing of Composites	PEC	3	0	0	3	3
3.	PR3012	Computer Aided Product Design	PEC	3	0	0	3	3
4.	CPR332	Finite Element Analysis	PEC	3	0	0	3	3
5.	MF3491	CNC Machining Technology	PEC	3	0	0	3	3
6.	PR3013	Quality Control and Reliability Engineering	PEC	3	0	0	3	3
7.	CPR333	Machine Design	PEC	3	0	0	3	3

OPEN ELECTIVES

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

OPEN ELECTIVE I AND II

(EMERGING TECHNOLOGIES)

To be offered other than Faculty of Information and Communication Engineering

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OCS351	Artificial Intelligence and Machine Learning Fundamentals	OEC	2	0	2	4	3
2.	OCS352	IoT Concepts and Applications	OEC	2	0	2	4	3
3.	OCS353	Data Science Fundamentals	OEC	2	0	2	4	3
4.	OCS354	Augmented and Virtual Reality	OEC	2	0	2	4	3

OPEN ELECTIVES – III

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OHS351	English for Competitive Examinations	OEC	3	0	0	3	3
2.	OCE353	Lean Concepts, Tools And Practices	OEC	3	0	0	3	3
3.	OMG352	NGOs and Sustainable Development	OEC	3	0	0	3	3
4.	OMG353	Democracy and Good Governance	OEC	3	0	0	3	3
5.	OME353	Renewable Energy Technologies	OEC	3	0	0	3	3
6.	OME354	Applied Design Thinking	OEC	2	0	2	4	3
7.	OMF351	Reverse Engineering	OEC	3	0	0	3	3
8.	OAU351	Electric and Hybrid Vehicle	OEC	3	0	0	3	3
9.	OAS352	Space Engineering	OEC	3	0	0	3	3
10.	OIM351	Industrial Management	OEC	3	0	0	3	3
11.	OIE354	Quality Engineering	OEC	3	0	0	3	3
12.	OSF351	Fire Safety Engineering	OEC	3	0	0	3	3

13.	OML351	Introduction to non-destructive testing	OEC	3	0	0	3	3
14.	OMR351	Mechatronics	OEC	3	0	0	3	3
15.	ORA351	Foundation of Robotics	OEC	3	0	0	3	3
16.	OAE352	Fundamentals of Aeronautical engineering	OEC	3	0	0	3	3
17.	OGI351	Remote Sensing Concepts	OEC	3	0	0	3	3
18.	OAI351	Urban Agriculture	OEC	3	0	0	3	3
19.	OEN351	Drinking Water Supply and Treatment	OEC	3	0	0	3	3
20.	OEE352	Electric Vehicle technology	OEC	3	0	0	3	3
21.	OEI353	Introduction to PLC Programming	OEC	3	0	0	3	3
22.	OCH351	Nano Technology	OEC	3	0	0	3	3
23.	OCH352	Functional Materials	OEC	3	0	0	3	3
24.	OBT352	Biomedical Instrumentation	OEC	3	0	0	3	3
25.	OFD352	Traditional Indian Foods	OEC	3	0	0	3	3
26.	OFD353	Introduction to food processing	OEC	3	0	0	3	3
27.	OPY352	IPR for Pharma Industry	OEC	3	0	0	3	3
28.	OTT351	Basics of Textile Finishing	OEC	3	0	0	3	3
29.	OTT352	Industrial Engineering for Garment Industry	OEC	3	0	0	3	3
30.	OTT353	Basics of Textile Manufacture	OEC	3	0	0	3	3
31.	OPE351	Introduction to Petroleum Refining and Petrochemicals	OEC	3	0	0	3	3
32.	OPE352	Energy Conservation and Management	OEC	3	0	0	3	3
33.	OPT351	Basics of Plastics Processing	OEC	3	0	0	3	3
34.	OEC351	Signals and Systems	OEC	3	0	0	3	3
35.	OEC352	Fundamentals of Electronic Devices and Circuits	OEC	3	0	0	3	3
36.	OBM351	Foundation Skills in integrated product Development	OEC	3	0	0	3	3
37.	OBM352	Assistive Technology	OEC	3	0	0	3	3

38.	OMA352	Operations Research	OEC	3	0	0	3	3
39.	OMA353	Algebra and Number Theory	OEC	3	0	0	3	3
40.	OMA354	Linear Algebra	OEC	3	0	0	3	3

OPEN ELECTIVES – IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OHS352	Project Report Writing	OEC	3	0	0	3	3
2.	OCE354	Basics of Integrated Water Resources Management	OEC	3	0	0	3	3
3.	OMA355	Advanced Numerical Methods	OEC	3	0	0	3	3
4.	OMA356	Random Processes	OEC	3	0	0	3	3
5.	OMA357	Queuing and Reliability Modelling	OEC	3	0	0	3	3
6.	OMG354	Production and Operations Management for Entrepreneurs	OEC	3	0	0	3	3
7.	OMG355	Multivariate Data Analysis	OEC	3	0	0	3	3
8.	OME352	Additive Manufacturing	OEC	3	0	0	3	3
9.	OME353	New Product Development	OEC	3	0	0	3	3
10.	OME355	Industrial Design & Rapid Prototyping Techniques	OEC	2	0	2	4	3
11.	OMF352	Micro and Precision Engineering	OEC	3	0	0	3	3
12.	OAU352	Batteries and Management system	OEC	3	0	0	3	3
13.	OAU353	Sensors and Actuators	OEC	3	0	0	3	3
14.	OAS353	Space Vehicles	OEC	3	0	0	3	3
15.	OIM352	Management Science	OEC	3	0	0	3	3
16.	OIE353	Operations Management	OEC	3	0	0	3	3
17.	OSF352	Industrial Hygiene	OEC	3	0	0	3	3
18.	OSF353	Chemical Process Safety	OEC	3	0	0	3	3
19.	OML352	Electrical, Electronic and Magnetic materials	OEC	3	0	0	3	3
20.	OML353	Nanomaterials and applications	OEC	3	0	0	3	3

21.	OMR352	Hydraulics and Pneumatics	OEC	3	0	0	3	3
22.	OMR353	Sensors	OEC	3	0	0	3	3
23.	ORA352	Foundation of Automation	OEC	3	0	0	3	3
24.	ORA353	Concepts in Mobile Robotics	OEC	3	0	0	3	3
25.	OMV351	Marine Propulsion	OEC	3	0	0	3	3
26.	OMV352	Marine Merchant Vehicles	OEC	3	0	0	3	3
27.	OMV353	Elements of Marine Engineering	OEC	3	0	0	3	3
28.	OAE353	Drone Technologies	OEC	3	0	0	3	3
29.	OGI352	Geographical Information System	OEC	3	0	0	3	3
30.	OAI352	Agriculture Entrepreneurship Development	OEC	3	0	0	3	3
31.	OEN352	Biodiversity Conservation	OEC	3	0	0	3	3
32.	OEE353	Introduction to control systems	OEC	3	0	0	3	3
33.	OEI354	Introduction to Industrial Automation Systems	OEC	3	0	0	3	3
34.	OCH353	Energy Technology	OEC	3	0	0	3	3
35.	OCH354	Surface Science	OEC	3	0	0	3	3
36.	OBT353	Environment and Agriculture	OEC	3	0	0	3	3
37.	OFD354	Fundamentals of Food Engineering	OEC	3	0	0	3	3
38.	OFD355	Food safety and Quality Regulations	OEC	3	0	0	3	3
39.	OPY353	Nutraceuticals	OEC	3	0	0	3	3
40.	OTT354	Basics of Dyeing and Printing	OEC	3	0	0	3	3
41.	OTT355	Fibre Science	OEC	3	0	0	3	3
42.	OTT356	Garment Manufacturing Technology	OEC	3	0	0	3	3
43.	OPE353	Industrial safety	OEC	3	0	0	3	3
44.	OPE354	Unit Operations in Petro Chemical Industries	OEC	3	0	0	3	3
45.	OPT352	Plastic Materials for Engineers	OEC	3	0	0	3	3
46.	OPT353	Properties and Testing of Plastics	OEC	3	0	0	3	3
47.	OEC353	VLSI Design	OEC	3	0	0	3	3

48.	OEC354	Industrial IoT and Industry 4.0	OEC	2	0	2	4	3
49.	OBM353	Wearable devices	OEC	3	0	0	3	3
50.	OBM354	Medical Informatics	OEC	3	0	0	3	3

B.E. PRODUCTION ENGINEERING										
S.No	**Subject Area**	**Credits per Semester**								**Total Credits**
		I	**II**	**III**	**IV**	**V**	**VI**	**VII/VIII**	**VIII/VII**	
1	**HSMC**	**4**	**3**					**5**		**12**
2	**BSC**	**12**	**7**	**4**	**2**					**25**
3	**ESC**	**5**	**11**	**6**	**2**					**24**
4	**PCC**			**14**	**20**	**7**	**7**	**8**		**56**
5	**PEC**					**12**	**9**			**21**
6	**OEC**						**3**	**9**		**12**
7	**EEC**	**1**	**2**	**1**		**1**			**10**	**15**
8	**Non-Credit /(Mandatory)**					√	√			
Total		**22**	**23**	**25**	**24**	**20**	**19**	**22**	**10**	**165**

ENROLLMENT FOR B.E. / B. TECH. (HONOURS) / MINOR DEGREE (OPTIONAL)

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E. / B. Tech. (Honours) or Minor Degree.

For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only.

For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes, Moreover, for minor degree the student can register for courses from any one of the following verticals also.

Complete details are available in clause 4.10 of Regulations 2021.

VERTICALS FOR MINOR DEGREE
(In addition to all the verticals of other programmes)

Vertical I	Vertical II	Vertical III	Vertical IV	Vertical V
Fintech and Block Chain	**Entrepreneurship**	**Public Administration**	**Business Data Analytics**	**Environment and Sustainability**
Financial Management	Foundations of Entrepreneurship	Principles of Public Administration	Statistics for Management	Sustainable infrastructure Development
Fundamentals of Investment	Team Building and Leadership Management for Business	Constitution of India	Datamining for Business Intelligence	Sustainable Agriculture and Environmental Management
Banking, Financial Services and Insurance	Creativity and Innovation in Entrepreneurship	Public Personnel Administration	Human Resource Analytics	Sustainable Bio Materials
Introduction to Blockchain and its Applications	Principles of Marketing Management for Business	Administrative Theories	Marketing and Social Media Web Analytics	Materials for Energy Sustainability
Fintech Personal Finance and Payments	Human Resource Management for Entrepreneurship	Indian Administrative System	Operation and Supply Chain Analytics	Green Technology
Introduction to Fintech	Financing New Business Ventures	Public Policy Administration	Financial Analytics	Environmental Quality Monitoring and Analysis
-	-	-	-	Integrated Energy Planning for Sustainable Development
-	-	-	-	Energy Efficiency for Sustainable Development

(Choice of courses for Minor degree is to be made from any one vertical of other programmes or from anyone of the following verticals)

VERTICAL 1: FINTECH AND BLOCK CHAIN

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG331	Financial Management	PEC	3	0	0	3	3
2.	CMG332	Fundamentals of Investment	PEC	3	0	0	3	3
3.	CMG333	Banking, Financial Services and Insurance	PEC	3	0	0	3	3
4.	CMG334	Introduction to Blockchain and its Applications	PEC	3	0	0	3	3
5.	CMG335	Fintech Personal Finance and Payments	PEC	3	0	0	3	3
6.	CMG336	Introduction to Fintech	PEC	3	0	0	3	3

VERTICAL 2: ENTREPRENEURSHIP

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG337	Foundations of Entrepreneurship	PEC	3	0	0	3	3
2.	CMG338	Team Building and Leadership Management for Business	PEC	3	0	0	3	3
3.	CMG339	Creativity and Innovation in Entrepreneurship	PEC	3	0	0	3	3
4.	CMG340	Principles of Marketing Management for Business	PEC	3	0	0	3	3
5.	CMG341	Human Resource Management for Entrepreneurship	PEC	3	0	0	3	3
6.	CMG342	Financing New Business Ventures	PEC	3	0	0	3	3

VERTICAL 3: PUBLIC ADMINISTRATION

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG343	Principles of Public Administration	PEC	3	0	0	3	3
2.	CMG344	Constitution of India	PEC	3	0	0	3	3
3.	CMG345	Public Personnel Administration	PEC	3	0	0	3	3
4.	CMG346	Administrative Theories	PEC	3	0	0	3	3
5.	CMG347	Indian Administrative System	PEC	3	0	0	3	3
6.	CMG348	Public Policy Administration	PEC	3	0	0	3	3

VERTICAL 4: BUSINESS DATA ANALYTICS

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG349	Statistics for Management	PEC	3	0	0	3	3
2.	CMG350	Datamining for Business Intelligence	PEC	3	0	0	3	3
3.	CMG351	Human Resource Analytics	PEC	3	0	0	3	3
4.	CMG352	Marketing and Social Media Web Analytics	PEC	3	0	0	3	3
5.	CMG353	Operation and Supply Chain Analytics	PEC	3	0	0	3	3
6.	CMG354	Financial Analytics	PEC	3	0	0	3	3

VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CES331	Sustainable infrastructure Development	PEC	3	0	0	3	3
2.	CES332	Sustainable Agriculture and Environmental Management	PEC	3	0	0	3	3
3.	CES333	Sustainable Bio Materials	PEC	3	0	0	3	3
4.	CES334	Materials for Energy Sustainability	PEC	3	0	0	3	3
5.	CES335	Green Technology	PEC	3	0	0	3	3
6.	CES336	Environmental Quality Monitoring and Analysis	PEC	3	0	0	3	3
7.	CES337	Integrated Energy Planning for Sustainable Development	PEC	3	0	0	3	3
8.	CES338	Energy Efficiency for Sustainable Development	PEC	3	0	0	3	3

MA3351 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS L T P C
3 1 0 4

OBJECTIVES

- 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.

UNIT I 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.

UNIT II 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.

UNIT III 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).

UNIT IV FOURIER TRANSFORMS 9+3

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

UNIT V 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: 60 PERIODS

OUTCOMES:

Upon successful completion of the course, students should be able to:

- Understand how to solve the given standard partial differential equations.
- Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.
- Appreciate the physical significance of Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.
- Understand the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.
- Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", 44thEdition, Khanna Publishers, New Delhi, 2018.
2. Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2016.

REFERENCES:

1. Andrews. L.C and Shivamoggi. B, "Integral Transforms for Engineers" SPIE Press, 1999.
2. Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 10th Edition, Laxmi Publications Pvt. Ltd, 2015.
3. James. G., "Advanced Modern Engineering Mathematics", 4thEdition, Pearson Education, New Delhi, 2016.
4. Narayanan. S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2018.
6. Wylie. R.C. and Barrett . L.C., "Advanced Engineering Mathematics "Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.

ME3351	ENGINEERING MECHANICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1 To Learn the use scalar and vector analytical techniques for analyzing forces in statically determinate structures
2 To introduce the equilibrium of rigid bodies , vector methods and free body diagram
3 To study and understand the distributed forces, surface, loading on beam and intensity.
4 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.
5 To develop basic dynamics concepts – force, momentum, work and energy;

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, Further 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, Determination of Centroids by Integration , Theorems of Pappus-Guldinus, Distributed Loads on Beams, Centre of Gravity of a Three-Dimensional Body, Centroid of a Volume, Composite Bodies , Determination of Centroids of Volumes by Integration. Moments of Inertia of Areas and Mass - Determination of the Moment of Inertia of an Area by Integration, 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 , Determination of the Moment of Inertia of a Three-Dimensional Body by Integration.

UNIT IV FRICTION 9

The Laws of Dry Friction, Coefficients of Friction, Angles of Friction, Wedge friction, Wheel Friction, Rolling Resistance, 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 : 45 PERIODS

OUTCOMES:

At the end of the course the students would be able to

1. Illustrate the vector and scalar representation of forces and moments
2. Analyse the rigid body in equilibrium
3. Evaluate the properties of distributed forces
4. Determine the friction and the effects by the laws of friction
5. Calculate dynamic forces exerted in rigid body

TEXTBOOKS:

1. 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. Vela Murali, "Engineering Mechanics-Statics and Dynamics", Oxford University Press, 2018.

REFERENCES:

1. Boresi P and Schmidt J, Engineering Mechanics: Statics and Dynamics, 1/e, Cengage learning, 2008.
2. Hibbeller, R.C., Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 13th edition, Prentice Hall, 2013.
3. Irving H. Shames, Krishna Mohana Rao G, Engineering Mechanics – Statics and Dynamics, 4thEdition, Pearson Education Asia Pvt. Ltd., 2005.
4. Meriam J L and Kraige L G, Engineering Mechanics: Statics and Engineering Mechanics: Dynamics, 7th edition, Wiley student edition, 2013.
5. Timoshenko S, Young D H, Rao J V and SukumarPati, Engineering Mechanics, 5thEdition, McGraw Hill Higher Education, 2013.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	1	2							2	3	1	1
2	3	2	2	1	2							2	3	1	1
3	3	2	3	1	2							2	3	1	2
4	3	2	3	1	2							2	3	1	2
5	3	2	3	1	2							2	3	1	2
Low (1) ; Medium (2) ; High (3)															

PR3351 THERMODYNAMICS AND THERMAL ENGINEERING

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To impart knowledge of basic principles of thermodynamics via real world engineering examples.
2. To analyse and evaluate air standard cycles.
3. To analyse and evaluate Steam power cycles.
4. Summarize the governing concepts of Refrigeration and Air conditioning.
5. To introduce various modes of heat transfer, related to real time scenarios of thermodynamics applied in engineering practice.

UNIT – I BASICS OF THERMODYNAMICS **9**

Systems, Zeroth law, first law. Heat and work transfer in flow and non-flow processes. Second law-Kelvin-Planck and Clausius statement, Concept of Entropy -Clausius inequality, Entropy change in non-flow processes.

UNIT – II AIR STANDARD CYCLE **7**

Otto, Diesel, Dual and Brayton cycles - Air standard efficiency and Mean effective pressure.

UNIT – III VAPOUR POWER CYCLES **11**

Properties of steam – Rankine cycle – Steam Nozzles Principles of Psychrometry and refrigeration systems- Vapour compression - Vapour absorption - Coefficient of performance, Properties of refrigerants – Basic Principle and types Air conditioning systems.

UNIT – IV COMPRESSORS AND JET PROPULSION **9**

Compressors types - performance of Reciprocating compressors – Simple jet propulsion system – Thrust rocket motor – Specific impulse.

UNIT – V HEAT TRANSFER **9**

Conduction in simple plane, radial and composite walls – Basics of Convective heat transfer - Fundamentals of Radioactive heat transfer – Flow through heat exchangers (LMTD and NTU).

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Will demonstrate understanding of the nature of the thermodynamic processes for pure substances and interpret the Laws of Thermodynamics
CO2: Will analyses and evaluate air standard cycles
CO3: Will understand the vapour power cycles.
CO4: Will learn the air compressors for pneumatic applications and aircraft vehicle
CO5: Will get exposed to the basics and modes of heat transfer.

Mapping of COs with POs and PSOs															
COs/Pos&PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	1	1	2	2	-	1	-	-	-	-	1	1	1	1
CO2	3	1	1	2	2	-	1	-	-	-	-	1	1	1	1
CO3	3	1	1	2	2	-	1	-	-	-	-	1	1	1	1
CO4	3	1	1	2	2	-	1	-	-	-	-	1	1	1	1
CO5	3	1	1	2	2	-	1	-	-	-	-	1	1	1	1
CO/PO & PSO Average	3	1	1	2	2	-	1	-	-	-	-	1	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. Nag.P.K. “Engineering Thermodynamics”, Tata McGraw-Hill, New Delhi, Sixth edition, 2017.
2. Rathakrishnan. E., “Fundamentals of Engineering Thermodynamics”, McGraw Hill Education; Sixth edition, 2017.

REFERENCES:

1. Holman.J.P. “Heat Transfer”, 10th Ed. McGraw-Hill, 2017.
2. Mahesh M. Rathore, “Thermal Engineering Vol I and II ” Tata McGraw-Hill Education, 2018
3. Venwylen and Sontag, “Classical Thermodynamics”, Wiley Eastern, 1987
4. Arora C.P, “Refrigeration and Air Conditioning”, Tata McGraw-Hill, New Delhi, 2013.
5. Merala C, Pother, Craig W, Somerton, “Thermodynamics for Engineers”, Schaum Outline Series, Tata McGraw-Hill, New Delhi, 2013.

PR3001 MACHINING PROCESSES AND MACHINE TOOLS

L	**T**	**P**	**C**
3	**0**	**0**	**3**

COURSE OBJECTIVES:

1. To provide students with fundamental knowledge and principles in material removal processes.
2. To understand the fundamentals aspects of metal cutting principles by studying various machining processes.
3. To study the constructional features and various operations related to milling, drilling and grinding.
4. To know the factors influencing the processes and their applications.
5. To recommend appropriate manufacturing process when provided a set of functional requirements and constraints.

UNIT – I LATHE 9

Introduction to production processes – types of production (job, batch and mass) – production processes – Casting, Forming, Machining and Welding, Machine Tool – Lathe – Engine Lathe – block diagram – sketch – functions of each part – work holding devices in lathe – functions – Chuck, Centre, Dogs, Steady Rest and Follower Rest, mechanism of lathe – Apron, Feed, Tumbler Gear, various operations performed in Lathe – facing, turning, chamfering and knurling – relative positions of tool and job – Taper turning operations (three methods)_ thread cutting – RH and LH thread, single start and multi start with application – Method of thread cutting – selection and arrangement of tool and work. Problems in metric and inch thread conversion – Specifications of Lathe – Burnishing.

UNIT – II SHAPER, PLANER and SLOTTER 9

Purpose of shaping – block diagram – functions of each part. Purpose of planer – block diagram – functions of each part. Purpose of slotting machine – block diagram – functions and working principle. Operations carried out – horizontal plane, vertical plane, v type with relative position – Comparison of planer with shaper – work holding devices in shaper and planer – Quick return mechanism in shaper – mechanical and hydraulic – cross feed mechanism – Types of planer with application – Comparison of shaping with slotting – tool holding devices in shaper, planer and slotter – specifications of shaper, planer and slotter simple problems to calculate the velocity – speed, feed and depth of cut.

UNIT – III DRILLING 9

Purpose of drilling – block diagram and function – types of drilling machines – portable drilling – bench type – sensitive drilling – radial arm drilling – functions of parts – purpose and operation – gang drilling, multiple drill head, upright drilling, relative operations – reaming, boring, tapping, counter boring, courses sinking, trepanning and spot facing (with simple sketch, purpose and application). Work holding devices – specification torque calculation – speed, feed and depth of cut.

UNIT – IV MILLING 9

Milling machine purpose – up and down milling – classification of milling machines – slot, keyway machining – methods of milling – single piece, string, rotary, index, gang, progressive, copy. Horizontal milling machine – block diagram – functions of each part- applications – Vertical milling machine – block diagram – functions of each part applications – Gear cutting using milling machine – procedure with neat sketch – milling cutters – peripheral, face, end T slot, form etc. – attachments and special accessories for milling – rotary, slotting attachment – indexing mechanism – methods of indexing – direct, plain, compound and differential indexing – problems – specifications – cutting conditions and parameters.

UNIT – V GRINDING 9

Purpose – classification – surface finish – applications – grinding wheel – types – specifications – selection – surface grinding machine – block diagram – functions of each part – cylindrical grinding – Centre less grinding – Comparison – in-feed, end feed and through feed. Balancing, dressing, loading and Truing of wheel – special grinding machines – specification of machine – cutting condition.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Explain the features and applications of lathe, milling, drilling and grinding machines

CO2: Discuss the features and applications of reciprocating machine tools and like shaper, planer and slotting machine.

CO3: Explain the machine tool structures and machining economics.
CO4: Explain the working principles of various machines used in manufacturing.
CO5: Identify the appropriate production process and machines.

Mapping of COs with POs and PSOs

COs/Pos&PSOs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	2	1	2	1	-	-	-	-	1	1	1	2	2
CO2	3	3	3	3	3	1	-	-	-	-	1	2	2	2	2
CO3	2	2	2	2	2	1	-	-	-	-	3	2	3	2	1
CO4	3	3	3	2	2	1	-	-	-	-	2	2	2	2	2
CO5	2	2	2	2	2	1	-	-	-	-	1	1	2	2	2
CO/PO & PSO Average	2	2	2	2	2	1	-	-	-	-	2	2	2	2	2
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. HMT Bangalore, “Production Technology”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2017.
2. Sharma.P.C. “A Text Book of Production Technology”, S.Chand and Company, 2014.

REFERENCES:

1. HajraChoudharyet.al, “Elements of Workshop Technology –Vol.II”, Asia Publishing House, 2017.
2. Jain.R.K. “Production Technology”, Khanna Publishers, New Delhi, 19th Edition, 2019.
3. Kalpakjain, “Manufacturing Process for Engineering Material”, Addison –Wesley Publication, 2018.
4. Kumar B., “Manufacturing Technology”, Khanna Publishers, New Delhi 2014.
5. Radhakrishnan P., “Manufacturing Technology, Vol.I”, SciTech Publications, edition-1, 2002.

PR3002 ENGINEERING MATERIALS **L T P C**
3 0 0 3

COURSE OBJECTIVES:

1. To impart knowledge on the various microstructural features of metallic materials.
2. To illustrate the role of heat treatment on microstructure and properties.
3. To desire the various non-ferrous alloys and their applications.
4. To introduce the concepts of mechanical behaviour of the materials.
5. To describe the properties and applications of polymers and ceramics.

UNIT – I MICROSTRUCTURAL DEVELOPMENT AND METALLOGRAPHY 9

Basics of Metallographic microscopy -sample preparation – resolution – contrast – Metallographic microscope - Homogenous and Heterogeneous nucleation - grain growth-directional solidification- cast and weld microstructure- ingot and continuous casting - microstructures of Steels and Cast irons - spinodal decomposition - Pearlitic, bainitic and martensitic transformations - Effect of alloying elements on steel (Mn, Si, Cr, Ni, Mo, V, Ti and W).

UNIT – II HEAT TREATMENT AND KINETICS 9

Diffusion in solids - Fick's law - - Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram CCR - Types and stages of annealing, stress relief, recrystallization and spheroidizing – normalizing, Hardenability, Jominy end quench test - hardening and tempering of steel –Cryotreatment, Austempering, martempering – case hardening, carburizing, nitriding cyaniding, carbonitriding – Flame, Induction Laser and Electron beam and plasma hardening

UNIT – III NON-FERROUS METALS 9

Specification, Properties and application: Copper and Copper alloys, Brass, Bronze and Cupronickel – Aluminum alloys and Al-Cu –precipitation strengthening treatment – Bearing alloys, Alloys of Titanium, Zinc, Magnesium and Nickel –Intermetallics - Ni, Ti Aluminides – Refractory alloys- Super alloys- Shape memory alloys- high entropy alloys- Bulk Metallic glasses.

UNIT – IV DEFORMATION AND FAILURE OF METALS 9

Elastic, inelastic and viscoelastic behavior - Dislocation in FCC,BCC,HCP – stress field - interaction between dislocations -Strengthening mechanism- effect of temperature- cyclic loading - Types of Fracture – Fracture mechanics - fracture toughness ductile-brittle transition - types of wear - corrosion - Basics of Scanning electron microscope (SEM)- Energy Dispersive Spectroscopy (EDS)- Failure analysis

UNIT – V NON-METALLIC MATERIALS 9

Polymers- Thermo, Thermoset Polymers, Co and mixed Polymers- Commodity Polymers, PE, PS,PVS PMMA, PC, PET, ABS- Engineering Polymers, PA, PPS, PI, PFE- Natural and Synthetic rubbers, Elastomers- Adhesives- Ceramics- Natural and Synthetic Ceramic- Feldspar, Corundum, Garnet- WC, TC,TiC, Si_3N_4,Al_2O_3, CBN, PCD, Uses of abrasives and cutting tools.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Identify the microstructural features of ferrous materials.
CO2: Relate the heat treatment, microstructure and properties.
CO3: Understand the properties and uses of nonferrous alloys.
CO4: Correlate the mechanical behavior with the mechanisms of strengthening.
CO5: Suggest suitable polymer and ceramic for a given application.

Mapping of COs with POs and PSOs															
COs/Pos&PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	-	2	1	2	2	2	-	-	2	2	2	2	2	3
CO2	2	-	3	1	2	3	2	-	-	2	2	2	2	2	3
CO3	3	1	3	1	3	2	3	-	-	2	2	3	2	3	2
CO4	2	1	3	1	3	2	3	-	-	2	2	3	3	3	2
CO5	3	1	3	1	3	2	3	-	-	2	2	3	3	3	2
CO/PO & PSO Average	2	1	3	1	3	2	3	-	-	2	2	3	2	3	2
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. Kenneth G.Budinski and Michael K.Budinski ”Engineering Materials”, 9th Indian Reprint, Prentice-Hall of India Private Limited, 2016.
2. Balasubramanian.R, Callister’s ‘Materials Science and Engineering’, 7th Edition, Wiley India Pvt. Limited, 2014.

REFERENCES:

1. Callisers’s Jr. W.D, Rethuish, D.G, Materials Science and Engineering, 9th Edition, Wiley, 2014.
2. Donald R. Askeland, Pradeep P. Fulay and Wendelin J. Wright, “The Science and Engineering of Materials”, 7th Edition, Cengage Learning, Inc. 2017.
3. Raghavan V., “Materials Science and Engg: A first Course”, 6th Edition, Prentice Hall of India Pvt Ltd., 5th edition, 2004.
4. Sidney H. Avner, “Introduction to Physical Metallurgy”, McGraw Hill Book Company, 2nd Edition, 2008.
5. Yang Leng, “Materials Characterization: Introduction to Microscopic and Spectroscopic Methods”, John Wiley and Sons, 2nd edition, 2013.

CE3391 FLUID MECHANICS AND MACHINERY L T P C
3 1 0 4

COURSE OBJECTIVES:

1. To introduce the students about properties of the fluids, behaviour of fluids under static conditions.
2. To impart basic knowledge of the dynamics of fluids and boundary layer concept.
3. 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.
4. To exposure to the significance of boundary layer theory and its thicknesses.
5. To expose the students to basic principles of working of hydraulic machineries and to design Pelton wheel, Francis and Kaplan turbine, centrifugal and reciprocating pumps.

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 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 - Centrifugal pumps - Working principle - Heads and efficiencies– Velocity triangles - Work done by the impeller - Performance curves - Reciprocating pump working principle - Indicator diagram and it's variations - Work saved by fitting air vessels - Rotary pumps.

TOTAL: 60 PERIODS

OUTCOMES:

On completion of the course, the student is expected to be able to

1. Understand the properties and behaviour in static conditions. Also, to understand the conservation laws applicable to fluids and its application through fluid kinematics and dynamics
2. Estimate losses in pipelines for both laminar and turbulent conditions and analysis of pipes connected in series and parallel. Also, to understand the concept of boundary layer and its thickness on the flat solid surface.
3. Formulate the relationship among the parameters involved in the given fluid phenomenon and to predict the performances of prototype by model studies
4. Explain the working principles of various turbines and design the various types of turbines.
5. Explain the working principles of centrifugal, reciprocating and rotary pumps and design the centrifugal and reciprocating pumps

TEXT BOOKS:

1. Modi P.N. and Seth, S.M. Hydraulics and Fluid Mechanics, Standard Book House, New Delhi, 22nd edition (2019)
2. Jain A. K. Fluid Mechanics including Hydraulic Machines, Khanna Publishers, New Delhi, 2014.
3. Kumar K. L., Engineering Fluid Mechanics, Eurasia Publishing House(p) Ltd. New Delhi, 2016.

REFERENCES:

1. Fox W.R. and McDonald A.T., Introduction to Fluid Mechanics John-Wiley and Sons, Singapore, 2011.
2. Pani B S, Fluid Mechanics: A Concise Introduction, Prentice Hall of India Private Ltd, 2016.
3. Cengel Y A and Cimbala J M, Fluid Mechanics, McGraw Hill Education Pvt. Ltd., 2014.
4. S K Som; Gautam Biswas and S Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill Education Pvt. Ltd., 2012.
5. Streeter, V. L. and Wylie E. B., Fluid Mechanics, McGraw Hill Publishing Co., 2010.

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	2	1	2	2	1	2	1	1	2	3	2	3
2	3	3	3	2	1	2	2	1	2	1	1	2	3	2	3
3	3	3	3	3	1	2	2	1	2	1	1	2	3	3	3
4	3	3	3	3	1	2	2	1	2	1	1	3	3	2	2
5	3	3	3	3	1	2	2	1	2	1	1	3	3	2	2
Low (1); Medium (2) ; High (3)															

MF3361 MACHINING TECHNOLOGY LABORATORY LT P C

0 0 4 2

COURSE OBJECTIVES:

- To Study and practice the various operations that can be performed in lathe, shaper, drilling, milling machines etc.
- To equip with the practical knowledge required in the core industries.
- To prepare the process planning sheets for all the operations and then follow the sequences during the machining processes.

LIST OF EXPERIMENTS

1. Lathe: Facing, Plain turning, Step Turning
2. Lathe: Taper Turning, Threading, Knurling
3. Lathe: Multi start Threading, Burnishing
4. Shaper: Cube
5. Shaper: Cube, V-Block
6. Drilling: Counter sinking, Counter Boring, Tapping
7. Milling Vertical: Surfacing, Pocket Milling
8. Milling Horizontal: Polygonal shape milling
9. Grinding: Surface & Cylindrical grinding
10. Slotting: Machining an internal spline

11. Tool angle grinding with tool and Cutter Grinder
12. Measurement of cutting forces in Milling / Turning Process

TOTAL : 60 PERIODS

COURSE OUTCOMES:

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

- Select appropriate turning process to obtain finished components.
- Select appropriate milling process to obtain finished components.
- Select appropriate shaper and slotting process to obtain finished components.
- Select appropriate grinding process to obtain optimum surface finish.
- Coordinate various machining process in sequence to get desired design in final components.

PR3311	METALLURGY AND MATERIALS TESTING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

1. To study the testing methods and quantifying techniques for the mechanical properties of engineering materials.
2. To study the property changes by various heat treatments.
3. To gain practical knowledge in Microstructural analysis of various steels, cast iron, Nonferrous Materials and Heat-Treated steels.

LIST OF EXPERIMENTS

1. Cooling curve- Pure metal and alloy (Pb-Sn).
2. Specimen preparation for macro – examination.
3. Specimen preparation for micro examination (steel/cast iron/non-ferrous alloys).
4. Quantitative metallography – Estimation of volume fraction, particle size, shape and distribution.
5. Heat treatments of Steel-Micro structural study: Annealing/ Normalising / Quench Hardening/Tempering.
6. Jominy End Quench Test.
7. Tension test of mild steel.
8. Torsion test of mild steel.
9. Impact test- Izod and Charpy.
10. Hardness test – Vickers /Brinell.
11. Compression test for Helical spring.
12. Fatigue test
13. Creep test.
14. Pin on Disc Wear test.

TOTAL: 60 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Awareness of procedure and methods of testing materials for evaluation of mechanical properties.

CO2: Experience in metallographic techniques and familiarization of microstructure of typical ferrous and non-ferrous alloys.
CO3:Ability to interpret the experimental results in relation with the applications.

Mapping of COs with POs and PSOs															
COs/Pos &PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	3	3	2	2	2	-	2	1	1	2	3	2	2
CO2	3	3	3	3	2	1	1	-	1	1	-	1	2	2	1
CO3	3	3	3	3	2	2	2	-	1	2	-	2	3	2	1
CO/PO & PSO Average	3	3	3	3	2	2	2	-	1	1	1	2	3	2	1
1 – Slight, 2 – Moderate, 3 – Substantial															

PR3401 METAL CASTING TECHNOLOGY

L	**T**	**P**	**C**
3	**0**	**0**	**3**

COURSE OBJECTIVES:

1. To impart knowledge about principles/methods of casting with detail design of gating/riser system needed for casting, defects in cast objects and requirements for achieving better casting.
2. To understand the basic principle, procedure and applications of various Foundry and Welding methods.
3. To inculcate the principle, thermal and metallurgical aspects during solidification of metal and alloys.
4. To impart knowledge to the students about the principles of melting and pouring.
5. To impart knowledge on casting design.

UNIT – I CASTING PROCESSES **9**

Introduction to casting – pattern – materials allowances – coding – types – moulds – mould making, sand – properties, types and testing of sands – core making – type of cores – single box, two box and three box moulding processes, runner, riser and gate and chills chaplets.

UNIT – II SPECIAL CASTING PROCESSES **9**

Pressure die casting – Centrifugal – continuous – investment – shell moulding – squeeze – electro slag casting – CO2 moulding – Plaster Mould castings – Antioch process – Slush casting- Counter gravity low pressure casting - electro-magnetic casting.

UNIT – III SOLIDIFICATION PROCESS **9**

Solidification - Definition, nucleation, solidification variables. Directional solidification-need and methods. Degasification in liquid metals-sources of gas, degasification methods. Fettling and cleaning of castings - Basic steps involved. Sand Casting defects- causes, features and remedies. Advantages & limitations of casting process.

UNIT – IV MELTING AND POURING 9

Principles of melting practice-fluxing- Degasification and inoculation- Types of furnaces- Crucibles, Cupola, Oil fired furnaces – Electric arc and induction furnaces –Melting practice of cast iron, S G iron, steel, aluminum and copper alloys.

UNIT – V CASTING DESIGN 9

Solidification of pure metals and alloys-shrinkage in cast metals-design of sprue, runner, gate and risers-problems in design and manufacture of thin and unequal sections - design for directional solidification, minimum distortion and for overall economy - design problems of L,T,V,X and Y junctions.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Understand the process of Pattern making, Moulding and core making

CO2: Analyze the thermal, metallurgical aspects during solidification in casting and welding and their role on quality of cast or weld objects.

CO3: Understand the process of solidification of casting process.

CO4: The student will be able to melt and pour metals.

CO5: The student will be able design cast alloys.

Mapping of COs with POs and PSOs															
COs/Pos&PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	3	1	1	1	2	2	1	2	2	3	2	2	2
CO2	3	2	3	1	1	1	2	2	1	2	2	3	3	3	2
CO3	3	2	3	1	1	1	-	-	-	-	-	1	2	-	1
CO4	3	2	3	1	1	1	-	-	-	-	-	1	2	-	1
CO5	3	2	2	1	1	1	-	-	-	-	-	1	2	-	1
CO/PO & PSO Average	3	2	3	1	1	1	2	2	1	2	2	2	2	3	1
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. John Campbell. “Complete Casting Handbook Metal Casting Processes, Metallurgy, Techniques and Design, Elsevier Science, 2015, ISBN: 9780444635099.
2. Jain.P.L., “Principle of Foundry Technology”, Tata McGraw Hill ,4th edition, 2004.

REFERENCES:

1. Taylor HF Fleming, “Foundry Engineering”, M.C. and Wiley Eastern Ltd., 2003.
2. Heime, Looper and Rosenthal, “Principle of metal casting”, Tata McGraw Hill, 2nd edition2002.

PR3451	MATERIALS JOINING TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To study SMAW, GMAW, GTAW, Oxy-acetylene welding and resistance spot welding processes.
2. To study the various types of resistance welding process.
3. To study the various solid state welding process.
4. To study advanced welding process.
5. To study the various welding design and testing methods.

UNIT – I GAS AND ARC WELDING PROCESSES 9

Fundamental principles – Air Acetylene welding, Oxyacetylene welding, Carbon arc welding, shielded metal arc welding, Submerged arc welding, TIG and MIG welding, Plasma arc welding and Electro slag welding processes - advantages, limitations and applications.

UNIT – II RESISTANCE WELDING PROCESSES 9

Spot welding, Seam welding, Projection welding, Resistance Butt welding, Flash Butt welding, Percussion welding and High frequency resistance welding processes - advantages, limitations and applications.

UNIT – III SOLID STATE WELDING PROCESSES 9

Cold welding, Diffusion bonding, Explosive welding, Ultrasonic welding, Friction welding, Forge welding, Roll welding and Hot pressure welding processes - advantages, limitations and applications.

UNIT – IV OTHER WELDING PROCESSES 9

Thermit welding, atomic hydrogen welding, Electron beam welding, Laser Beam welding, Friction stir welding, Under Water welding, Welding automation in aerospace, nuclear and surface transport vehicles.

UNIT – V DESIGN OF WELD JOINTS, WELDABILITY AND TESTING OF WELDMENTS 9

Various weld joint designs – Welding defects – causes and remedies - Weldability of Aluminium, Copper, and Stainless steels. Destructive and nondestructive testing of weldments.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: To understand the basic working principles SMAW, GMAW, GTAW, Oxy-acetylene welding and resistance spot welding processes
CO2: To know the various types of the resistance welding process
CO3: To familiarise about the various solid state welding process
CO4: To know the advanced welding process
CO5: To apply the various welding design and testing methods

Mapping of COs with POs and PSOs															
COs/Pos&PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	2	3	2	1	-	-	-	-	1	3	2	3	2
CO2	2	2	2	3	2	1	-	-	-	-	1	3	2	3	2
CO3	2	2	2	2	2	1	-	-	-	-	1	3	2	2	2
CO4	3	3	3	3	2	1	-	-	-	-	1	3	2	3	2
CO5	3	3	3	3	2	2	-	-	-	-	1	3	2	2	2
CO/PO & PSO Average	2	2	2	3	2	1	0	0	0	0	1	3	2	3	2
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. Parmer. R.S, "Welding Processes and Technology", Khanna Publishers,2018.
2. O P Khanna, "A text book of Welding Technology", Dhanpat Rai Publication Edition 2011.

REFERENCES:

1. Curry.B., "Modern Welding Technology", Prentice Hall ,2011.
2. Little, "Welding Technology", Tata McGraw Hill, 2017.
3. Larry Jeff, "Welding Principle & applications", Delmar Cengage Learning,2021.
4. Sharma P. C "A Textbook of Production Technology", S Chand & Co Ltd, 2014.
5. Parmer. R.S, "Welding Engineering and Technology", Khanna Publishers,2013

ML3391 **MECHANICS OF SOLIDS** **L T P C**

3 0 0 3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare students for:

1. Applying the principle concepts behind stress, strain and deformation of solids for various engineering applications.
2. Analyzing the transverse loading on beams and stresses in beam for various engineering applications.
3. Understanding the torsion principles on shafts and springs for various engineering applications.
4. Acquiring knowledge on the deflection of beams for various engineering applications.
5. Interpreting the thin and thick shells and principal stresses in beam for various engineering applications

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS 9

Rigid and Deformable bodies – Strength, Stiffness and Stability – Stresses and Strains: Tensile, Compressive and Shear – Material Behaviour- Elastic Vs Plastic – Response of Real Materials: TensileTest, Compressive Test, Shear Test, Cyclic Tests - strain gauges and rosettes – Deformation of Statically determinate and Inderterminate bars of variable cross-section & Composite section under axial load – Thermal stress – Elastic constants – Plane Strain – Volumetric Strain.

UNIT II TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM 9

Beams – types transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over – hanging beams. Theory of simple bending– Bending stress distribution – Flitched beams – Shear stress distribution.

UNIT III TORSION 9

Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts – Deflection in shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs, – Closed and Open Coiled helical springs – springs in series and parallel,carriage springs.

UNIT IV DEFLECTION OF BEAMS 9

Slope, Deflection and Radius of Curvature – Methods of Determination of Slope and Deflection-Double Integration method – Macaulay's method – Area moment Theorems for computation of slopes and deflections in beams - Conjugate beam and strain energy – Maxwell's reciprocal theorems.

UNIT V THICK & THIN SHELLS & PRINCIPAL STRESSES 9

Stresses in thin cylindrical shell due to internal pressure, circumferential and longitudinal stresses and deformation in thin cylinders – spherical shells subjected to internal pressure – Deformation in spherical shells – Lame's theory – Application of theories of failure – Stresses on inclined planes –principal stresses and principal planes – Mohr's circle of stress.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Apply the principle concepts behind stress, strain and deformation of solids for various engineering applications.
2. Analyze the transverse loading on beams and stresses in beam for various engineering applications.
3. Solve problems based on the torsion principles involved in shafts and springs for various engineering applications.
4. Interpret the results of the deflection of beams.
5. Analyze the thin and thick shells and principal stresses in beam for various engineering applications

TEXT BOOKS:

1. Egor P. Popov, Toader A. Balan., "Engineering Mechanics of Solids", Pearson India Education Services, 2018.
2. Ferdinand P. Beer, E. Russell Johnston, Jr., John T. DeWolf, David Mazurek "Mechanics of Materials", McGraw-Hill Education, 2015.

REFERENCES:

1. R. K. Bansal," A Textbook of Strength of Materials" Laxmi Publications 2010.
2. R. K. Rajput., "Strength of Materials", Shree Publishers, 2015.
3. Hibbeler, R.C., Mechanics of Materials, Pearson Education, 2018.

4. Subramanian R., Strength of Materials, oxford University Press, Oxford Higher Education Series,2010
5. Nash, W.A., “Theory and Problems in Strength of Materials”, 6th Edition, Schaum Outline Series, McGraw-Hill Book Co, 2013.

	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	3	1	1							1	3	2	1
CO2	3	3	3	2	2							1	3	2	1
CO3	3	3	3	2	2							1	3	2	1
CO4	3	3	3	2	2							1	3	2	1
CO5	3	3	3	2	2							1	3	2	1
Avg	3	3	3	1.8	1.8							1	3	2	1

PR3402 FLUID POWER AUTOMATION L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To understand the basic principles of fluid power.
2. Know the different properties of hydraulic fluids and their effects.
3. Explain the working principles of various pumps.
4. To understand the working principle of hydraulic and pneumatic components and its selection.
5. To design hydraulic and pneumatic circuits for different applications.

UNIT – I INTRODUCTION TO FLUID POWER 9

Introduction to fluid power controls - Hydraulics and pneumatics - Selection criteria, Application of Fluid power, Application of Pascal’s Law, equation, Transmission and multiplication of force - Pressure Losses - Fluids, selection & properties - ISO symbols. Pumps - working principle and construction details of Gear, vane and piston pumps.

UNIT – II FLUID POWER ACTUATORS 9

Fluid Power drives - Hydraulic motors, Pneumatic power supply - compressors, air distribution, air motors. Actuators - Selection and specification, cylinders, mounting, cushioning- Hydrostatic transmission drives and characteristics; Accumulators –Intensifiers.

UNIT – III FLUID POWER CONTROL ELEMENTS 9

Control valves - pressure, flow, direction - working principle and construction - Special type - valves - Cartridge, modular, proportional, and servo - Selection and actuation method - Hydraulic supply components -pipe fittings - Fluid conditioning elements.

UNIT – IV HYDRAULIC AND PNEUMATIC CIRCUITS DESIGN 9

Regenerative, speed control and synchronizing circuits - Design of Hydraulic and pneumatic circuits for automation, selection and specification of circuit components, sequencing circuits, cascade, and Karnaugh - Veitch map method.

UNIT – V ELECTRO PNEUMATICS AND PLC CIRCUITS 9

Use of electrical timers, switches, solenoid, relays and proximity sensors electro pneumatic sequencing - PLC - elements, functions and selection - PLC programming - Ladder diagram and different programming methods - Sequencing circuits.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: To understand the fundamentals of pneumatics and hydraulics and its principles.

CO2: To understand constructional and operational features about the hydraulic and pneumatic drives system.

CO3: To identify pneumatic and hydraulic components and their functions.

CO4: To design basic and advanced pneumatic and hydraulic circuits for industrial applications.

CO5: To understand the basic concepts, elements and functions of Programmable Logic Controller.

Mapping of COs with POs and PSOs															
COs/Pos &PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	1	2	1	1	1	1	3	2	2	2	3	3
CO2	3	3	2	2	2	1	1	1	1	2	2	2	3	3	2
CO3	3	2	2	2	2	1	1	1	1	1	2	2	2	3	2
CO4	3	2	3	2	3	1	1	1	2	3	3	3	3	3	3
CO5	3	2	3	2	3	1	1	1	1	3	3	3	3	3	3
CO/PO & PSO Average	3	2	2	2	2	1	1	1	1	2	2	2	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. Anthony Esposito "Fluid power with applications",7th Edition, Pearson education 2014.
2. Majumdar, "Pneumatic system: Principles and Maintenance", Tata McGraw Hill, 2006.
3. Majumdar, "Oil hydraulics: Principles and Maintenance",7th Edition, Tata McGraw Hill, 2005.

REFERENCES:

1. Srinivasan. R., "Hydraulic and Pneumatic Controls", Vijay Nicole Imprints Private Limited, 2011.
2. Andrew Parr "Hydraulics & Pneumatics, Jaico Publishing House, 2004
3. William W.Reaves, "Technology of Fluid Power", Delmer Publishers, 1997.
4. PeterRohner, "Fluid Power Logic circuit", Design Macmillon Press Ltd., 1990.

MR3451 KINEMATICS AND DYNAMICS OF MACHINERY

L	T	P	C
4	0	0	4

COURSE OBJECTIVES:

1. To understand the basic components and layout of linkages in the assembly of a system/ machine and also learn about the mechanisms
2. To understand the basic concepts of toothed gearing and kinematics of gear trains and the effects of friction in motion transmission and in machine components.
3. To learn about the concepts in friction
4. To understand the principles in force analysis
5. To learn about the basic concept of static and dynamic balancing and vibration

UNIT – I KINEMATIC OF MACHINES 12

Mechanisms – Terminology and definitions – kinematics inversions of 4 bar and slide crank chain kinematics analysis in simple mechanisms – velocity and acceleration polygons – Analytical methods – computer approach – cams – classifications – displacement diagrams - layout of plate cam profiles – derivatives of followers motion – circular arc and tangent cams.

UNIT – II GEARS AND GEAR TRAINS 12

Spur gear – law of toothed gearing – involute gearing – Interchangeable gears – Gear tooth action interference and undercutting – nonstandard teeth – gear trains – parallel axis gears trains – epicyclic gear trains – automotive transmission gear trains.

UNIT – III FRICTION 12

Sliding and Rolling Friction angle – friction in threads – Friction Drives – Belt and rope drives.

UNIT – IV FORCE ANALYSIS 12

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 Inertia Forces and Inertia Torque – D'Alembert's principle – superposition principle – dynamic Force Analysis in simple machine members.

UNIT – V BALANCING AND VIBRATION 12

Static and Dynamic balancing – Balancing of revolving and reciprocating masses – Balancing machines – free vibrations – Equations of motion – natural Frequency – Damped Vibration – bending critical speed of simple shaft.

TOTAL: 60 PERIODS

COURSE OUTCOMES

At the end of the course, the student able to:

CO 1: Recognize the basic terminologies of kinematics and dynamics of machines
CO 2: Interpret the various concepts of kinematics and dynamics including forces and frictions
CO 3: Show the motions parameters on the various mechanisms, gears and gear trains.
CO 4: Apply the mechanism, gears and gear train for the design of new machines.
CO 5: Analyze the working of various mechanism, gears and gear train.

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1	2	1						1	2	1	3
CO2	3	2	1	1	2	1						1	2	1	3
CO3	3	2	1	1	2	1						1	2	1	3
CO4	3	2	1	1	2	1						1	2	1	3
CO5	3	2	1	1	2	1						1	2	1	3
CO/PO & PSO Average	3	2	1	1	2	1						1	2	1	3
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. Rattan, S.S, "Theory of Machines", 4th Edition, Tata McGraw-Hill, 2014.
2. Bansal R.K., "Theory of Machines", Laxmi Publications Pvt Ltd., New Delhi, 20th edition 2009.

REFERENCES:

1. Thomas Bevan, "Theory of Machines", CBS Publishers and Distributors, 1984.
2. Ghosh. A, and A.K. Mallick, "Theory and Machine", Affiliated East-West Pvt. Ltd., New Delhi, 1988.
3. Rao. J. S. and Dukkipatti R.V. "Mechanisms and Machines", Wiley-Eastern Ltd., New Delhi, 1992.
4. John Hannah and Stephens R.C., "Mechanics of Machines", Viva Low Prices Student Edition, 1999.
5. V. Ramamurthi, Mechanisms of Machine, Narosa Publishing House, 2002.
6. Ambekar A. G., "Mechanism and Machine Theory" Prentice Hall of India, New Delhi, 2007

GE3451 ENVIRONMENTAL SCIENCES AND SUSTAINABILITY

L	**T**	**P**	**C**
2	**0**	**0**	**2**

UNIT - I : ENVIRONMENT AND BIODIVERSITY

Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ.

UNIT – II : ENVIRONMENTAL POLLUTION

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts .

UNIT – III : RENEWABLE SOURCES OF ENERGY .

Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

UNIT - IV : SUSTAINABILITY AND MANAGEMENT

Development , GDP ,Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols-Sustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study.

UNIT - V : SUSTAINABILITY PRACTICES

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non-conventional Sources, Energy Cycles-carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio-economical and technological change.

TOTAL: 45 PERIODS

TEXT BOOKS:

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. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
7. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.

REFERENCES :

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38 .
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 2005.
5. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

PR3411 FOUNDRY AND WELDING LABORATORY

L	T	P	C
0	0	4	2

COURSE OBJECTIVES:

1. To train the students to make the simple joints by various welding techniques.
2. To train the students to make the simple standard grill structures.
3. To train the students in the area of non-ferrous metal casting with the simple shapes.
4. To study the basic requirements of given moulding sand by standard tests.
5. To train the students to make the simple casting demonstration.

WELDING

1. Welding of basic joints using gas and arc welding.
2. Welding of pipes in different positions.
3. GTAW / GMAW of ferrous and non - ferrous metals.
4. Spot welding of plates.
5. Brazing practice – Dissimilar metals.
6. Welding of standard grill structures.

FOUNDRY

1. Green and Dry Strength of Moulding sand.
2. Permeability testing.
3. Determining the clay content.
4. Sieve analysis of dry silica sand.
5. Determining the moisture content.
6. Melting any non-ferrous metal and making simple castings – Demonstration.

TOTAL: 60 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: The students would gain practical knowledge on welding of simple weld joints.

CO2: The students would gain practical knowledge on making simple grill.

CO3:The students to Understand the casting procedure of different methods and quality of moulding sand tests.

Mapping of COs with POs and PSOs

COs/Pos &PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	2	-	-	1	-	-	-	-	2	2	1	2	3
CO2	2	1	2	-	-	2	-	-	-	-	2	2	3	2	1
CO3	2	2	2	-	-	1	-	-	-	-	2	2	1	2	1
CO/PO & PSO Average	2	2	2	0	0	1	0	0	0	0	2	2	2	2	2
1 – Slight, 2 – Moderate, 3 – Substantial															

PR3412	DYNAMICS OF MACHINES LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

1. To supplement the principles learnt in kinematics and Dynamics of Machinery.
2. To understand how certain measuring devices are used for dynamic testing.

LIST OF EXPERIMENTS

1. a) Study of gear parameters.
b) Experimental study of velocity ratios of simple, compound, Epicyclic and differential gear trains.
2. a) Kinematics of Four Bar, Slider Crank, Crank Rocker, Double crank, Double rocker, Oscillating cylinder Mechanisms.
b) Kinematics of single and double universal joints.
3. a) Determination of Mass moment of inertia of Fly wheel and Axle system.
b) Determination of Mass Moment of Inertia of axisymmetric bodies using Turn Table apparatus.
c) Determination of Mass Moment of Inertia using bifilar suspension and compound pendulum.
4. Motorized gyroscope – Study of gyroscopic effect and couple.
5. Governor - Determination of range sensitivity, effort etc., for Watts, Porter, Proell, and Hartnell Governors.
6. Cams – Cam profile drawing, Motion curves and study of jump phenomenon
7. a) Single degree of freedom Spring Mass System – Determination of natural Frequency and verification of Laws of springs – Damping coefficient determination.
b) Multi degree freedom suspension system – Determination of influence coefficient.
8. a) Determination of torsional natural frequency of single and Double Rotor systems – Undamped and Damped Natural frequencies. b) Vibration Absorber – Tuned vibration absorber.
8. Vibration of Equivalent Spring mass system – undamped and damped vibration.
9. Whirling of shafts – Determination of critical speeds of shafts with concentrated loads.
11. a) Balancing of rotating masses.
b) Balancing of reciprocating masses.
12. a)Transverse vibration of Free-Free beam – with and without concentrated masses.
b) Forced Vibration of Cantilever beam – Mode shapes and natural frequencies.
c) Determination of transmissibility ratio using vibrating table.

TOTAL: 60 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:
CO1: Ability to demonstrate the principles of kinematics and dynamics of machinery.
CO2: Ability to use the measuring devices for dynamic testing.
CO3:Ability to develop models.

Mapping of COs with POs and PSOs															
COs/Pos&PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	1	3	1	2	1	2	1	2	1	2	2	1	1
CO2	3	2	1	3	1	2	1	2	1	2	1	2	3	1	1
CO3	3	3	2	3	1	3	1	2	1	2	1	2	3	2	1
CO/PO & PSO Average	3	2	1	3	1	2	1	2	1	2	1	2	3	1	1
1 – Slight, 2 – Moderate, 3 – Substantial															

CE3481 STRENGTH OF MATERIALS AND FLUID MACHINERY LABORATORY L T P C
0 0 4 2

COURSE OBJECTIVE:
1. To study the mechanical properties of metals, wood and spring by testing in laboratory.
2. To verify the principles studied in fluid mechanics and machinery theory by performing experiments in laboratory.

UNIT – I STRENGTH OF MATERIALS **30**

LIST OF EXPERIMENTS
1. Tension test on mild steel rod
2. Torsion test on mild steel rod
3. Hardness test on metal (Rockwell and Brinell Hardness)
4. Compression test on helical spring
5. Deflection test on carriage spring

UNIT – II FLUID MECHANICS AND MACHINES LABORATORY **30**

LIST OF EXPERIMENTS
1. (a) Determination of coefficient of discharge of a venturimeter
   (b) Determination of friction factor for flow through pipes
2. (a) Determination of metacentric height
   (b) Determination of forces due to impact of jet on a fixed plate
3. Characteristics of centrifugal pumps
4. Characteristics of reciprocating pump
5. Characteristics of Pelton wheel turbine

TOTAL: 60 PERIODS

OUTCOMES: On completion of the course, the student is expected to be able to

1. Determine the tensile, torsion and hardness properties of metals by testing
2. Determine the stiffness properties of helical and carriage spring
3. Apply the conservation laws to determine the coefficient of discharge of a venturimeter and finding the friction factor of given pipe
4. Apply the fluid static and momentum principles to determine the metacentric height and forces due to impact of jet

5. Determine the performance characteristics of turbine, rotodynamic pump and positive displacement pump.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	3	3	1	1	1	3	1	1	2	2	2	1
2	3	2	1	3	3	1	1	1	3	1	1	2	3	2	1
3	3	3	2	3	2	1	1	1	3	1	1	2	3	2	1
Low (1) ; Medium (2) ; High (3)															