R.M.K. ENGINEERING COLLEGE

(An Autonomous Institution)

R.S.M Nagar, Kavaraipettai, Gummidipoondi Taluk,
Thiruvallur District, Tamil Nadu- 601206

Affiliated to Anna University, Chennai / Approved by AICTE, New Delhi / Accredited by NAAC with A+ Grade /
An ISO 9001:2015 Certified Institution /
All the Eligible UG Programs are Accredited by NBA, New Delhi.

B.E. Degree in

MECHANICAL ENGINEERING

CURRICULUM AND SYLLABI

REGULATIONS – 2020

CHOICE BASED CREDIT SYSTEM

(For the students admitted from the Academic year 2020 – 2021 onwards)

DEPARTMENT OF MECHANICAL ENGINEERING

R.M.K. ENGINEERING COLLEGE

KAVARAIPETTAI – 601 206

TAMILNADU, INDIA.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

Bachelor of Mechanical Engineering curriculum is designed to impart Knowledge, Skill and Attitude on the graduates.

I. Graduates will apply the knowledge of Mechanical Engineering Sciences and innovative methods to solve real world Engineering problems.

II. Graduates will have the required attributes for a successful career in Mechanical Engineering and allied fields.

III. Graduates will exhibit the managerial skills with ethical values and team spirit.

PROGRAMME OUTCOMES (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

b. **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.

c. **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.

d. **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.

e. **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.

f. **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.

g. **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.

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

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

j. **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.

k. **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.

l. **Lifelong learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

PEO / PO Mapping

The B.E. Mechanical Engineering Program outcomes leading to the achievement of the objectives are summarized in the following Table.

Program Educational Objectives (PEOs)	POs											
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
I	✓	✓	✓	✓	✓					✓		✓
II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
III						✓	✓	✓	✓		✓	

		COURSE TITLE / POs	a	b	c	d	e	f	g	h	i	j	k	l
YEAR 1	SEM 1	Communicative English and Life skills		✓							✓	✓		✓
		Engineering Mathematics – I	✓	✓	✓	✓	✓	✓	✓					✓
		Computer Aided Engineering Graphics	✓		✓		✓					✓		
		Environmental Science and Engineering	✓	✓				✓	✓			✓		✓
		Problem Solving and C Programming	✓	✓	✓						✓			✓
		Core I: Basic Electrical, Electronics and Instrumentation Engineering	✓	✓	✓	✓	✓							
		Engineering Practices Laboratory	✓	✓	✓	✓		✓		✓	✓	✓	✓	
		C Programming Laboratory	✓	✓	✓						✓			✓
		Interpersonal Skill - Listening and Speaking Laboratory									✓	✓		✓
		COURSE TITLE / POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
	SEM 2	Technical English									✓		✓	✓
		Engineering Mathematics - II	✓	✓	✓	✓	✓	✓						✓
		Physics for Mechanical Engineering	✓	✓	✓	✓	✓							
		Chemistry for Mechanical Engineering	✓	✓				✓	✓					✓
		Core II: Engineering Mechanics	✓	✓	✓									
		Core III: Fundamentals of Manufacturing Processes	✓		✓						✓	✓	✓	✓
		Physics and Chemistry Laboratory	✓	✓			✓				✓			✓
		Advanced C Programming Laboratory	✓	✓	✓					✓	✓	✓		✓
		Advanced Reading and Writing									✓	✓		✓

		COURSE TITLE / POs	a	b	c	d	e	f	g	h	i	j	k	l
YEAR 2	SEM 3	Transforms and Partial Differential Equations	✓	✓	✓	✓								✓
		Engineering Thermodynamics	✓	✓	✓	✓	✓				✓	✓	✓	✓
		Fluid Mechanics and Machinery	✓	✓							✓	✓	✓	✓
		Machine Tool Technology	✓	✓	✓		✓				✓	✓	✓	✓
		JAVA Programming	✓	✓	✓									
		Universal Human Values – 2: Understanding Harmony						✓	✓	✓	✓	✓	✓	✓
		Manufacturing Processes Laboratory and Mini project	✓	✓	✓	✓	✓				✓	✓	✓	✓
		Computer Aided Machine Drawing	✓	✓	✓	✓	✓				✓	✓		✓
		JAVA Programming Laboratory	✓	✓	✓					✓	✓	✓		✓
		Aptitude and Coding Skills - I	✓	✓							✓	✓		
		COURSE TITLE / POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
	SEM 4	Statistics and Numerical Methods	✓	✓	✓	✓								✓
		Kinematics of Machinery	✓	✓	✓						✓	✓	✓	✓
		Engineering Materials and Metallurgy	✓	✓	✓		✓				✓	✓	✓	✓
		Strength of Materials	✓	✓	✓	✓					✓	✓	✓	✓
		Thermal Engineering- I	✓	✓	✓						✓	✓	✓	✓
		Engineering Metrology and Measurement (Laboratory Integrated Course)	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓
		Machine Tool Laboratory	✓	✓	✓		✓			✓	✓	✓	✓	✓
		Strength of Materials and Fluid Mechanics and Machinery Laboratory	✓	✓		✓		✓		✓	✓	✓	✓	✓
		Applications of Programming in Mechanical Engineering	✓	✓	✓	✓	✓			✓	✓	✓		✓
		Aptitude and Coding Skills - II	✓	✓							✓	✓		

		COURSE TITLE / POs	a	b	c	d	e	f	g	h	i	j	k	l
YEAR 3	SEM 5	Thermal Engineering- II	✓	✓	✓	✓		✓	✓					✓
		Design of Machine Elements	✓	✓	✓	✓								✓
		Dynamics of Machines	✓	✓	✓	✓								✓
		Fundamentals of New product Development and Product life cycle Management	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓
		Product Data Management	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓
		Professional Elective – I												
		Kinematics and Dynamics Laboratory	✓	✓	✓	✓					✓			✓
		Thermal Engineering Laboratory	✓	✓	✓	✓					✓			✓
		Product data management and PLM laboratory	✓	✓	✓	✓	✓				✓			✓
		Advanced Aptitude and Coding Skills - I	✓	✓							✓	✓		
		COURSE TITLE / POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
	SEM 6	Design of Transmission Systems	✓	✓	✓	✓		✓						✓
		Computer Aided Design and Manufacturing	✓	✓	✓	✓	✓				✓			✓
		Heat and Mass Transfer	✓	✓	✓	✓		✓	✓					✓
		Advanced PLM and product Master Management	✓	✓	✓	✓	✓				✓		✓	✓
		Open Elective – I *												
		Professional Elective – I												
		CAD / CAM Laboratory	✓	✓	✓	✓	✓				✓			✓
		Design and Fabrication Project and Internship	✓	✓	✓	✓	✓		✓		✓		✓	✓
		Advanced PLM and product Master Management Laboratory	✓	✓	✓	✓	✓				✓		✓	✓
		Advanced Aptitude and Coding Skills - II	✓	✓							✓	✓		

***** offered by other Departments

		COURSE TITLE / POs	a	b	c	d	e	f	g	h	i	j	k	l
YEAR 4	SEM 7	Power Plant Engineering	✓	✓	✓	✓		✓	✓				✓	✓
		Process Planning and Cost Estimation	✓	✓	✓	✓	✓	✓		✓				✓
		Introduction to Business Intelligence and Analytics, Advanced Integration techniques	✓	✓	✓		✓							✓
		Open Elective – II *												
		Professional Elective – III												
		Professional Elective – IV												
		Simulation and Analysis Laboratory	✓	✓	✓	✓	✓				✓			✓
		Mechatronics Laboratory	✓	✓	✓	✓	✓				✓			✓
		Mini project and Comprehension	✓	✓	✓	✓	✓		✓		✓		✓	✓
		COURSE TITLE / POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
	SEM 8	Project Work	✓	✓	✓	✓	✓		✓		✓		✓	✓

***** offered by other Departments

B.E. MECHANICAL ENGINEERING
REGULATIONS – 2020
CHOICE BASED CREDIT SYSTEM
I TO VIII SEMESTERS CURRICULUM AND SYLLABI
SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	20EL101	Communicative English and Life Skills	HS	2	2	0	0	2
2.	20MA101	Engineering Mathematics - I	BS	5	3	2	0	4
3.	20ME103	Computer Aided Engineering Graphics	ES	6	2	0	4	4
4.	20CH102	Environmental Science and Engineering	HS	3	3	0	0	3
5.	20GE101	Problem Solving and C Programming	ES	3	3	0	0	3
6.	20EE101	**Core I:** Basic Electrical, Electronics and Instrumentation Engineering	ES	3	3	0	0	3
PRACTICALS								
7.	20EM111	Engineering Practices Laboratory	ES	4	0	0	4	2
8.	20GE111	C Programming Laboratory	ES	4	0	0	4	2
9.	20EL111	Interpersonal Skills - Listening and Speaking Laboratory	HS	2	0	0	2	1
10.		Induction Program	MC	3 Weeks				
			TOTAL	**32**	**16**	**2**	**14**	**24**

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	20EL201	Technical English	HS	2	2	0	0	2
2.	20MA201	Engineering Mathematics - II	BS	5	3	2	0	4
3.	20PH202	Physics for Mechanical Engineering	BS	3	3	0	0	3
4.	20CH202	Chemistry for Mechanical Engineering	BS	3	3	0	0	3
5.	20ME205	**Core II:** Engineering Mechanics	ES	5	3	2	0	4
6.	20ME206	**Core III:** Fundamentals of Manufacturing Processes	PC	3	3	0	0	3
PRACTICALS								
7.	20PC111	Physics and Chemistry Laboratory	BS	4	0	0	4	2
8.	20CS212	Advanced C Programming Laboratory	ES	4	0	0	4	2
9.	20EL211	Advanced Reading and Writing	HS	2	0	0	2	1
			TOTAL	**31**	**17**	**04**	**10**	**24**

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	20MA301	Transforms and Partial Differential Equations	BS	5	3	2	0	4
2.	20ME302	Engineering Thermodynamics	PC	3	3	0	0	3
3.	20ME303	Fluid Mechanics and Machinery	ES	3	3	0	0	3
4.	20ME304	Machine Tool Technology	PC	3	3	0	0	3
5.	20CS304	JAVA Programming	ES	3	3	0	0	3
6.	20GE301	Universal Human Values – 2: Understanding Harmony	HS	4	2	2	0	3
PRACTICALS								
7.	20ME311	Manufacturing Processes Laboratory and Mini Project	PC	4	0	0	4	2
8.	20ME312	Computer Aided Machine Drawing	PC	4	0	0	4	2
9.	20CS314	JAVA Programming Laboratory	ES	4	0	0	4	2
10.	20CS313	Aptitude and Coding Skills – I	EEC	2	0	0	2	1
			TOTAL	**35**	**17**	**04**	**14**	**26**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	20MA404	Statistics and Numerical Methods	BS	5	3	2	0	4
2.	20ME402	Kinematics of Machinery	PC	3	3	0	0	3
3.	20ME403	Engineering Materials and Metallurgy	ES	3	3	0	0	3
4.	20ME404	Strength of Materials	ES	3	3	0	0	3
5.	20ME405	Thermal Engineering- I	PC	3	3	0	0	3
6.	20ME406	Engineering Metrology and Measurement (Laboratory Integrated Course)	PC	4	2	0	2	3
PRACTICALS								
6.	20ME411	Machine Tool Laboratory	PC	4	0	0	4	2
7.	20ME412	Strength of Materials and Fluid Mechanics and Machinery Laboratory	ES	4	0	0	4	2
9.	20CS415	Applications of Programming in Mechanical Engineering	ES	4	0	0	4	2
10.	20CS414	Aptitude and Coding Skills - II	EEC	2	0	0	2	1
			TOTAL	**35**	**17**	**02**	**16**	**26**

SEMESTER V

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	20ME501	Thermal Engineering- II	PC	5	3	2	0	4
2.	20ME502	Design of Machine Elements	PC	3	3	0	0	3
3.	20ME503	Dynamics of Machines	PC	4	2	2	0	3
4.	20ME504	Fundamentals of New product Development and Product life cycle Management	PC	3	3	0	0	3
5.	20ME505	Product Data Management	PC	3	3	0	0	3
6.		Professional Elective – I	PE	3	3	0	0	3
PRACTICALS								
7.	20ME511	Kinematics and Dynamics Laboratory	PC	4	0	0	4	2
8.	20ME512	Thermal Engineering Laboratory	PC	4	0	0	4	2
9.	20ME513	Product data management and PLM laboratory	PC	4	0	0	4	2
10.	20CS512	Advanced Aptitude and Coding Skills – I	EEC	2	0	0	2	1
			TOTAL	**35**	**17**	**04**	**14**	**26**

SEMESTER VI

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	20ME601	Design of Transmission Systems	PC	4	2	2	0	3
2.	20ME602	Computer Aided Design and Manufacturing	PC	3	3	0	0	3
3.	20ME603	Heat and Mass Transfer	PC	4	2	2	0	3
4.	20ME604	Advanced PLM and product Master Management	PC	3	3	0	0	3
5.		Open Elective – I *****	OE	3	3	0	0	3
6.		Professional Elective – II	PE	3	3	0	0	3
PRACTICALS								
7.	20ME611	CAD / CAM Laboratory	PC	4	0	0	4	2
8.	20ME612	Design and Fabrication Project and Internship	EEC	4	0	0	4	2
9.	20ME613	Advanced PLM and product Master Management Laboratory	PC	4	0	0	4	2
10.	20CS614	Advanced Aptitude and Coding Skills - II	EEC	2	0	0	2	1
			TOTAL	**34**	**16**	**04**	**14**	**25**

***** offered by other Departments

SEMESTER VII

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	20ME701	Power Plant Engineering	PC	3	3	0	0	3
2.	20ME702	Process Planning and Cost Estimation	PC	3	3	0	0	3
3.	20ME703	Introduction to Business Intelligence and Analytics, Advanced Integration techniques	PC	3	3	0	0	3
4.		Open Elective – II *****	OE	3	3	0	0	3
5.		Professional Elective – III	PE	3	3	0	0	3
6.		Professional Elective – IV	PE	3	3	0	0	3
PRACTICALS								
7.	20ME711	Simulation and Analysis Laboratory	PC	4	0	0	4	2
8.	20ME712	Mechatronics Laboratory	PC	4	0	0	4	2
9.	20ME713	Mini project and Comprehension	EEC	2	0	0	2	1
			TOTAL	**28**	**18**	**0**	**10**	**23**

***** offered by other Departments

SEMESTER VIII

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICAL								
1.	20ME811	Project Work	EEC	20	0	0	20	10
			TOTAL	**20**	**0**	**0**	**20**	**10**

TOTAL NUMBER OF CREDITS = 184

HUMANITIES AND SOCIAL SCIENCES (HS)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20EL101	Communicative English and Life Skills	HS	2	2	0	0	2
2.	20CH102	Environmental Science and Engineering	HS	3	3	0	0	3
3.	20EL111	Interpersonal Skills - Listening and Speaking Laboratory	HS	2	0	0	2	1
4.	20EL201	Technical English	HS	2	2	0	0	2
5.	20EL211	Advanced Reading and Writing	HS	2	0	0	2	1
6.	20GE301	Universal Human Values – 2: Understanding Harmony	HS	4	2	2	0	3

BASIC SCIENCE (BS)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20MA101	Engineering Mathematics - I	BS	5	3	2	0	4
2.	20MA201	Engineering Mathematics - II	BS	5	3	2	0	4
3.	20PH202	Physics for Mechanical Engineering	BS	3	3	0	0	3
4.	20CH202	Chemistry for Mechanical Engineering	BS	3	3	0	0	3
5.	20PC111	Physics and Chemistry Laboratory	BS	4	0	0	4	2
6.	20MA301	Transforms and Partial Differential Equations	BS	5	3	2	0	4
7.	20MA404	Statistics and Numerical Methods	BS	5	3	2	0	4

ENGINEERING SCIENCES (ES)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20ME103	Computer Aided Engineering Graphics	ES	6	2	0	4	4
2.	20GE101	Problem Solving and C Programming	ES	3	3	0	0	3
3.	20EE101	Basic Electrical, Electronics and Instrumentation Engineering	ES	3	3	0	0	3
4.	20EM111	Engineering Practices Laboratory	ES	4	0	0	4	2
5.	20GE111	C Programming Laboratory	ES	4	0	0	4	2
6.	20ME205	Engineering Mechanics	ES	5	3	2	0	4
7.	20CS212	Advanced C Programming Laboratory	ES	4	0	0	4	2
8.	20ME303	Fluid Mechanics and Machinery	ES	3	3	0	0	3
9.	20CS304	JAVA Programming	ES	3	3	0	0	3
10.	20CS314	JAVA Programming Laboratory	ES	4	0	0	4	2
11.	20ME403	Engineering Materials and Metallurgy	ES	3	3	0	0	3
12.	20ME404	Strength of Materials	ES	3	3	0	0	3
13.	20ME412	Strength of Materials and Fluid Mechanics and Machinery Laboratory	ES	4	0	0	4	2
14.	20CS415	Applications of Programming in Mechanical Engineering	ES	4	0	0	4	2

PROFESSIONAL CORE (PC)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20ME206	Fundamentals of Manufacturing Processes	PC	3	3	0	0	3
2.	20ME302	Engineering Thermodynamics	PC	3	3	0	0	3
3.	20ME304	Machine Tool Technology	PC	3	3	0	0	3
4.	20ME311	Manufacturing Processes Laboratory and Mini Project	PC	4	0	0	4	2
5.	20ME312	Computer Aided Machine Drawing	PC	4	0	0	4	2
6.	20ME402	Kinematics of Machinery	PC	3	3	0	0	3
7.	20ME405	Thermal Engineering- I	PC	3	3	0	0	3
8.	20ME406	Engineering Metrology and Measurement (Laboratory Integrated Course)	PC	4	2	0	2	3
9..	20ME411	Machine Tool Laboratory	PC	4	0	0	4	2
10.	20ME501	Thermal Engineering- II	PC	5	3	2	0	4
11.	20ME502	Design of Machine Elements	PC	3	3	0	0	3
12.	20ME503	Dynamics of Machines	PC	4	2	2	0	3
13.	20ME504	Fundamentals of New product Development and Product life cycle Management	PC	3	3	0	0	3
14.	20ME505	Product Data Management	PC	3	3	0	0	3
15.	20ME511	Kinematics and Dynamics Laboratory	PC	4	0	0	4	2
16.	20ME512	Thermal Engineering Laboratory	PC	4	0	0	4	2
17.	20ME513	Product data management and PLM laboratory	PC	4	0	0	4	2
18.	20ME601	Design of Transmission Systems	PC	4	2	2	0	3
19.	20ME602	Computer Aided Design and Manufacturing	PC	3	3	0	0	3
20.	20ME603	Heat and Mass Transfer	PC	4	2	2	0	3
21.	20ME604	Advanced PLM and product Master Management	PC	3	3	0	0	3
22.	20ME611	CAD / CAM Laboratory	PC	4	0	0	4	2
23.	20ME613	Advanced PLM and product Master Management Laboratory	PC	4	0	0	4	2
24.	20ME701	Power Plant Engineering	PC	3	3	0	0	3
25.	20ME702	Process Planning and Cost Estimation	PC	3	3	0	0	3
26.	20ME703	Introduction to Business Intelligence and Analytics, Advanced Integration techniques	PC	3	3	0	0	3
27.	20ME711	Simulation and Analysis Laboratory	PC	4	0	0	4	2
28.	20ME712	Mechatronics Laboratory	PC	4	0	0	4	2

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20CS313	Aptitude and Coding Skills – I	EEC	2	0	0	2	1
2.	20CS414	Aptitude and Coding Skills - II	EEC	2	0	0	2	1
3.	20CS512	Advanced Aptitude and Coding Skills – I	EEC	2	0	0	2	1
4.	20ME612	Design and Fabrication Project and Internship	EEC	4	0	0	4	2
5.	20CS614	Advanced Aptitude and Coding Skills - II	EEC	2	0	0	2	1
6.	20ME713	Mini project and Comprehension	EEC	2	0	0	2	1
7.	20ME811	Project Work	EEC	20	0	0	20	10

PROFESSIONAL ELECTIVES FOR B.E. MECHANICAL ENGINEERING

SEMESTER V, ELECTIVE I

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20ME901	Automobile Engineering	PE	3	3	0	0	3
2.	20ME902	Gas Dynamics and Jet Propulsion	PE	3	3	0	0	3
3.	20ME903	Hydraulics and Pneumatics Control	PE	3	3	0	0	3
4.	20ME904	Tool Design	PE	3	3	0	0	3
5.	20ME905	Welding Technology	PE	3	3	0	0	3
6.	20ME906	Engineering Tribology	PE	3	3	0	0	3
7.	20ME907	Fundamentals of Nano Science	PE	3	3	0	0	3
8.	20ME908	Intellectual Property Rights	PE	3	3	0	0	3
9.	20ME909	Indian Constitution	PE	3	3	0	0	3

SEMESTER VI, ELECTIVE II

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20ME910	Finite Element Analysis	PE	3	3	0	0	3
2.	20ME911	Unconventional Machining Processes	PE	3	3	0	0	3
3.	20ME912	Renewable Sources of Energy	PE	3	3	0	0	3
4.	20ME913	Refrigeration and Air Conditioning	PE	3	3	0	0	3
5.	20ME914	Quality Control and Reliability Engineering	PE	3	3	0	0	3
6.	20ME915	Operations Research	PE	3	3	0	0	3
7.	20ME916	Design of Jigs, Fixtures and Press Tools	PE	3	3	0	0	3
8.	20ME917	Alternate Energy sources for Automobiles	PE	3	3	0	0	3
9.	20ME918	Essence of Indian Traditional Knowledge	PE	3	3	0	0	3

SEMESTER VII, ELECTIVE III

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20ME919	Mechatronics	PE	3	3	0	0	3
2.	20ME920	Robotics	PE	3	3	0	0	3
3.	20CE917	Professional Ethics in Engineering	PE	3	3	0	0	3
4.	20ME922	Computational Fluid Dynamics	PE	3	3	0	0	3
5.	20ME923	Composite Materials and Mechanics	PE	3	3	0	0	3
6.	20ME924	Cryogenic Engineering	PE	3	3	0	0	3
7.	20CB404	Introduction to Innovation, IP Management and Entrepreneurship	PE	3	3	0	0	3
8.	20ME926	Principles of Management	PE	3	3	0	0	3
9.	20ME927	Total Quality Management	PE	3	3	0	0	3

SEMESTER VII, ELECTIVE IV

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20ME928	Entrepreneurship Development	PE	3	3	0	0	3
2.	20ME929	Production Planning and Control	PE	3	3	0	0	3
3.	20ME930	Computer Integrated Manufacturing Systems	PE	3	3	0	0	3
4.	20ME931	Vibration and Noise Control	PE	3	3	0	0	3
5.	20ME932	Micro Electro Mechanical Systems	PE	3	3	0	0	3
6.	20ME933	Lean Sigma and Agile Manufacturing	PE	3	3	0	0	3
7.	20ME934	Fundamentals of Additive Manufacturing	PE	3	3	0	0	3
8.	20ME935	Non Destructive Testing and Evaluation	PE	3	3	0	0	3
9.	20ME936	Engineering Management and Financial Accounting	PE	3	3	0	0	3
10.	20ME937	Industrial Safety Engineering	PE	3	3	0	0	3

LIST OF OPEN ELECTIVES OFFERED TO OTHER DEPARTMENT

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20ME001	Introduction to Nanotechnology	OE	3	3	0	0	3
2.	20ME002	Design Thinking	OE	3	3	0	0	3
3.	20ME003	Industrial Engineering and Operation Management	OE	3	3	0	0	3
4.	20ME004	Composite Materials	OE	3	3	0	0	3
5.	20ME005	Vehicle Styling and Design	OE	3	3	0	0	3
6.	20ME006	Testing of Materials	OE	3	3	0	0	3
7.	20ME007	Lean six sigma and Supply chain Management	OE	3	3	0	0	3
8.	20M008	Product Design and Development	OE	3	3	0	0	3

DISTRIBUTION OF CREDITS ON SUBJECT CATEGORY
SUMMARY

SL. NO.	SUBJECT CATEGORY	CREDITS PER SEMESTER								CREDITS TOTAL	Percentage %
		I	II	III	IV	V	VI	VII	VIII		
1.	**HS**	6	3	3	-	-		-	-	**12**	**6.52 %**
2.	**BS**	4	12	4	4	-	-	-	-	**24**	**13.04 %**
3.	**ES**	14	6	8	10	-	-	-	-	**38**	**20.65 %**
4.	**PC**	-	3	10	11	22	16	13	-	**75**	**40.76 %**
5.	**PE**	-	-	-	-	3	3	6	-	**12**	**6.52 %**
6.	**OE**	-	-	-	-	-	3	3	-	**06**	**3.26 %**
7.	**EEC**	-	-	1	1	1	3	1	10	**17**	**9.24 %**
	Total	**24**	**24**	**26**	**26**	**26**	**25**	**23**	**10**	**184**	**100%**

SYLLABI: SEMESTER I to IV

SEMESTER - I

20EL101 - COMMUNICATIVE ENGLISH AND LIFE SKILLS

L	T	P	C
2	0	0	2

OBJECTIVES:

The Course will enable learners to:

- Strengthen their basic reading and writing skills.
- Comprehend listening contexts competently.
- Improve their speaking skills to speak fluently in real contexts.
- Develop vocabulary of a general kind and enhance their grammatical accuracy.

UNIT I COMMUNICATION BASICS **06**

Listening - short texts - short formal and informal conversations. Speaking- introducing oneself - exchanging personal information. Reading - practice in skimming - scanning and predicting. Writing-completing sentences - developing hints - free writing - Everyday expressions- collocations. Life Skills - Overview of Life Skills: significance of life skills.

UNIT II COMMUNICATION INTERMEDIATE **06**

Listening - telephonic conversations. **Speaking** – sharing information of a personal kind - greeting – taking leave. **Reading** – short comprehension passages - pre-reading-post reading- comprehension questions (multiple choice questions and /or short questions / open-ended questions) - **Writing** – paragraph writing- topic sentence - main ideas, short narrative descriptions using some suggested vocabulary and structures**. Life skills** – Self-awareness: definition, need for self-awareness; Coping with Stress and Emotions.

UNIT III COMMUNICATION VANTAGE **06**

Listening – listening to longer texts and filling up the table – **Speaking** - asking about routine actions and expressing opinions. **Reading** - Long texts (cloze reading) – **Writing** - jumbled sentences - product description - use of reference words and discourse markers. Grammar – Tenses - phrasal verbs - Wh – Questions, yes or no questions and direct / indirect questions – countable & uncountable nouns – modal verbs. **Life skills** – Assertiveness vs Aggressiveness.

UNIT IV SYNERGISTIC COMMUNICATION **06**

Listening - listening to dialogues or conversations and completing exercises based on them – **Speaking** - speaking about oneself- speaking about one's friend – **Reading** - different types of texts- magazines - **Writing** - letter writing, informal or personal letters - e-mails-conventions of personal email - Language development - synonyms – antonyms. **Life Skills** –Problem Solving Techniques.

UNIT V COMMUNICATION HIGHER **06**

Listening – listening to TED talks - **Speaking** – role play – **Reading** - Biographies – **Writing** - writing short essays (analytical & issue-based essays) – dialogue writing. **Life Skills** – Leadership & Decision making.

TOTAL: 30 PERIODS

OUTCOMES:

At the end of the course, learners will be able to:

- Read articles of a general kind in magazines and newspapers efficiently and identify different life skills.
- Participate efficiently in informal conversations and develop an awareness of the self and apply well-defined techniques to cope with emotions and stress.
- Comprehend conversations and short talks delivered in English.
- Write short essays of a general kind and personal letters and emails in English.
- Develop vocabulary of a general kind by enriching their reading skills.
- Use appropriate thinking and problem - solving techniques to solve new problems.

TEXT BOOKS:

1. Kumar, Suresh E and Sreehari, P. Communicative English. Orient Black Swan, 2007.
2. Richards, C. Jack. Interchange Students' Book-2 New Delhi: CUP, 2015.

REFERENCES:

1. Bailey, Stephen. Academic Writing: A practical guide for students. New York: Rutledge, 2011.
2. Dhanavel, S P. English and Soft Skills, Volume Two, Orient Black Swan, ISBN 978 93 528769142.
3. Elbow, Peter. Writing Without Teachers. London: Oxford University Press, 1973. Print.
4. Larry James, The First Book of Life Skills; First Edition, Embassy Books, 2016.
5. Larsen, Kristine, Stephen Hawking: A Biography, Greenwood: Publishing Group, 2005.
6. Redston, Chris & Gillies Cunningham Face2Face (Pre-intermediate Student 's Book & Workbook) Cambridge University Press, New Delhi: 2005.

20MA101 - ENGINEERING MATHEMATICS – I

L	T	P	C
3	2	0	4

OBJECTIVES:

The syllabus is designed to:

- Explain the concepts of matrix algebra.
- Make the students understand the idea of curvature, evolutes and envelopes.
- Impart the knowledge of functions of several variables.
- Introduce the concepts of Gamma and Beta integral.
- Develop an understanding on the basics of multiple integrals.

UNIT I MATRICES 9+6

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of eigenvalues and eigenvectors – Statement and applications of Cayley-Hamilton Theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

UNIT II APPLICATIONS OF DIFFERENTIAL CALCULUS 9+6

Curvature in Cartesian and Polar Co-ordinates – Centre and radius of curvature – Circle of curvature – Evolutes – Envelopes (excluding Evolute as envelope of normals).

UNIT III FUNCTIONS OF SEVERAL VARIABLES 9+6

Limits – Continuity – Partial derivatives (excluding Euler's theorem) – Total derivative – Differentiation of implicit functions – Jacobian and properties – Taylor's series for functions of two variables – Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.

UNIT IV GAMMA, BETA INTEGRALS AND APPLICATIONS 9+6

Gamma and Beta Integrals – Properties – Relation between Gamma and Beta functions, Evaluation of integrals using Gamma and Beta functions

UNIT V MULTIPLE INTEGRALS 9+6

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids.

TOTAL: 75 PERIODS

OUTCOMES:

After the successful completion of the course, the student will be able to:

- Diagonalize a matrix by orthogonal transformation.
- Determine the Evolute and Envelope of curves.
- Examine the maxima and minima of function of several variables.
- Apply Gamma and Beta integrals to evaluate improper integrals.
- Evaluate the area and volume by using multiple integrals.

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TEXT BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
3. T. Veerarajan, "Engineering Mathematics", Tata McGraw Hill, 2nd Edition, New Delhi, 2011.

REFERENCES:

1. M. K. Venkataraman, “Engineering Mathematics, Volume I”, 4th Edition, The National Publication Company, Chennai, 2003.
2. Sivaramakrishna Dass, C. Vijayakumari, “Engineering Mathematics”, Pearson Education India, 4th Edition 2019.
3. H. K. Dass, and Er. Rajnish Verma, ”Higher Engineering Mathematics”, S. Chand Private Limited, 3rd Edition 2014.
4. B.V. Ramana, “Higher Engineering Mathematics”, Tata McGraw Hill Publishing Company, 6th Edition, New Delhi, 2008.
5. S.S. Sastry, “Engineering Mathematics", Vol. I & II, PHI Learning Private Limited, 4th Edition, New Delhi, 2014.

20ME103 - COMPUTER AIDED ENGINEERING GRAPHICS

L	T	P	C
2	0	4	4

OBJECTIVES:

- To develop in students, graphic skills for communication of concepts, ideas and design of engineering products.
- To expose them to existing national standards related to technical drawings.

UNIT I INTRODUCTION TO CONVENTIONS IN ENGINEERING DRAWING AND CAD COMMANDS 18

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning. Introduction to CAD commands- CAD user interface- coordinate systems, object selection methods, selection of units and precession. Sketching – line, circle, arc, polygon, rectangle and ellipse. Working with object snaps, layers and object properties. Editing the objects – copy, move, trim, extend, working with arrays, mirror, scale, hatch, fillet and chamfer. Conversion of simple pictorial diagrams to orthographic view using CAD software

UNIT II PLANE CURVES 16

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

UNIT III PROJECTION OF POINTS, LINES AND PLANE SURFACES 18

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 and traces Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT IV PROJECTION OF SOLIDS AND PROJECTION OF SECTIONED SOLIDS 20

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method. Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section.

UNIT V DEVELOPMENT OF SURFACES AND ISOMETRIC PROJECTION 18

Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones. Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions.

TOTAL: 90 PERIODS

OUTCOMES:

At the end of the course, learners will be able to:

- Illustrate the fundamentals and standards of engineering drawing and apply the concepts of orthographic projections using CAD software.
- Interpret and construct various plane curves.
- Develop orthographic projections of points, lines and plane surfaces.
- Make use of concepts in projection to draw projections of solids and interpret the concept in section of solids.
- Interpret and visualize development of surfaces.
- Interpret and visualize isometric projection of simple solids.

TEXT BOOKS:

1. Natarajan K.V., “A text book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 33rd Edition, 2020.
2. Venugopal K. and Prabhu Raja V., “Engineering Graphics”, New Age International (P) Limited, 15th Edition, 2019.

REFERENCES:

1. Bhatt N.D. “Engineering Drawing”, Charotar Publishing House, 53rd edition 2019.
2. Basant Agarwal and Agarwal C.M., “Engineering Drawing”, Tata McGraw Hill Publishing Company Limited, New Delhi, 3rd Edition, 2019.
3. Engineering Drawing Practice for Schools and Colleges BIS SP46:2003 (R2008), Published by Bureau of Indian Standards (BIS), 2008.
4. Parthasarathy. N.S and Vela Murali, “Engineering Graphics”, Oxford University, Press, New Delhi, 2019.
5. Gopalakrishna. K.R., Engineering Drawing Vol 1 & 2, Subhas Publications, 27th Edition, 2017.

20CH102 - ENVIRONMENTAL SCIENCE AND ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

The goal of this course is to enlighten and sensitize the students on environmental conservation and social issues. The course is designed to:

- Appreciate the natural resources of environment, which are inherently created for supporting life.
- Learn scientific and technological solutions to current day pollution issues.
- Study the interrelationship between living organisms and environment
- Understand the integrated themes of biodiversity.
- Appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.

UNIT I NATURAL RESOURCES 11

Introduction - scope and importance of environment – need for public awareness. Forest resources- Use and over-exploitation, deforestation - timber extraction, mining, dams and their effects on forests and tribal people. Water resources - Use and over- utilization of surface and ground water, conflicts over water, dams-benefits and problems. Mineral resources- Use and exploitation, environmental effects of extracting and using mineral resources. Food resources- World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer- pesticide problems, water logging, salinity. Energy resources - Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Land resources- Land as a resource, land degradation, soil erosion and desertification – role of an individual in conservation of natural resources - case studies.

UNIT II POLLUTION AND ITS MANAGEMENT 11

Pollution – causes, effects and control measures - Air pollution- Water pollution - Soil pollution - Marine pollution - Noise pollution - Thermal pollution - Nuclear hazards - nuclear accidents and holocaust - role of an individual in prevention of pollution – case studies. Waste management - causes, effects and control measures of municipal solid wastes, e-waste, plastic waste.

UNIT III ECOSYSTEMS AND BIODIVERSITY 9

Introduction to ecosystems – structure and function of an ecosystem – energy flow in the ecosystem- ecological succession – food chains, food webs and ecological pyramids - types, characteristic features, structure and functions of - Forest ecosystem - Grassland ecosystem - Desert ecosystem - Aquatic ecosystems (lakes, oceans)

Introduction to biodiversity – types (genetic, species and ecosystem diversity) –values of biodiversity- threats to biodiversity - endangered and endemic species – conservation of biodiversity (in-situ and ex-situ conservation) - India as a mega-diversity nation – hot-spots of biodiversity in India

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 8

Sustainable development – sustainable development goals - water conservation, rain water harvesting, watershed management – resettlement and rehabilitation - consumerism and waste products, value education.

Disaster management- floods, drought, earthquake, tsunami, cyclone and landslides - case studies. Environmental ethics- issues and possible solutions – environment protection act – air (prevention and control of pollution) act – water (prevention and control of pollution) act – wildlife protection act – forest conservation act.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

Introduction - population growth, variation among nations, population explosion, family welfare programme – women and child welfare - environment and human health – endemic/epidemic/pandemic, COVID – 19, HIV / AIDS– role of information technology in environment and human health – environmental impact assessment- case studies.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Illustrate the importance and conservation of natural resources.
- Assess the impact of various pollutants and suggest appropriate pollution control methods.
- Explain the basic structure of ecosystem and the conservation of biodiversity.
- Analyze the social issues related to environment and recommend suitable solutions.
- Investigate the trends in population explosion and assess its impact.

TEXT BOOKS:

1. Anubha Kaushik and C. P. Kaushik, “Perspectives in environmental studies”, New Age International, 6th edition, 2018.
2. Benny Joseph, “Environmental Science and Engineering”, Tata McGraw-Hill, New Delhi, 2017.
3. Gilbert M. Masters, Wendell P. Ela “Introduction to Environmental Engineering and Science”, 3rd edition, Pearson Education, 2015.

REFERENCES:

1. William P. Cunningham and Mary Ann Cunningham, “Environmental Science: A Global Concern”, McGraw Hill, 14th edition, 2017.
2. G. Tyler Miller and Scott E. Spoolman, “Environmental Science”, Cengage Learning India Pvt. Ltd., Delhi, 14th edition, 2014.
3. Erach Bharucha, “Text book of Environmental Studies”, Universities Press Pvt. Ltd., Hyderabad, 2nd edition, 2015.

20GE101 - PROBLEM SOLVING AND C PROGRAMMING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To make the students understand the fundamentals of problem solving using Algorithm and Flowchart
- To teach the basic programming constructs for solving simple problems
- To introduce the basic concepts of arrays and strings
- To acquaint the students about functions, pointers, structures and their relationship
- To impart knowledge on the concepts of file handling

UNIT I INTRODUCTION TO ALGORITHM AND C 9

Introduction to Computer System – Block diagram, Program Development Life Cycle. General problem Solving concepts: Algorithm and Flowchart for problem solving with Sequential Logic Structure, Decisions and Loops.

Imperative languages: Introduction to imperative language, syntax and constructs of a specific language (ANSI C), Applications.

Types, Operators: Variable Names, Data Type and Sizes (Little Endian Big Endian), Constants, Declarations, Basic I/O using scanf, printf, Operators – Types, Precedence, Associativity, Proper variable naming and Hungarian Notation.

UNIT II CONTROL FLOW STATEMENTS 7

Control Flow with discussion on structured and unstructured programming: Statements and Blocks, If-Else-If, Switch, Loops – while, do, for, break and continue, goto labels, structured and unstructured programming.

UNIT III ARRAYS AND FUNCTIONS 10

Arrays and Strings – Initialization, Declaration – One Dimensional and Two Dimensional arrays – Linear search, Binary Search, Matrix Operations (Addition and Subtraction). Basics of functions, parameter passing and returning type, C main return as integer, External, Auto, Local, Static, Register Variables, Scope Rules, Block structure, Initialisation, Recursion, Pre-processor, Standard Library Functions and return types.

UNIT IV STRUCTURES AND POINTERS 10

Basic Structures, Structures and Functions, Array of structures. Pointers and address, Pointers and Function Arguments, Pointers and Arrays, Address Arithmetic, character Pointers and Functions, Pointer Arrays, Pointer to Pointer, Initialisation of Pointer Arrays, Command line arguments, Pointer to functions, complicated declarations and how they are evaluated. Pointer of structures, Self-referential structures, Table look up, typedef, unions, Bit-fields.

UNIT V FORMATED I/O AND FILE PROCESSING 9

Formatted Output – fprintf, Formated Input – fscanf, Variable length argument list. Files - file access including FILE structure, fopen, fread, fwrite, stdin, sdtout and stderr, File Types – Text, Binary - Error Handling including exit, perror and error.h, Line I/O, related miscellaneous functions.

TOTAL: 45 PERIODS

OUTCOMES

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

- Develop algorithmic solutions to simple computational problems
- Develop simple applications using basic constructs
- Write programs using arrays and strings
- Design and implement applications using functions, pointers and structures.
- Design applications using sequential and random access file processing.

TEXT BOOKS:

1. Brian W Kernighan and Dennis M Ritchie, The C Programming Language, Pearson Education India, 2nd Edition, 2015.
2. Anita Goel and Ajay Mittal, "Computer Fundamentals and Programming in C", Dorling Kindersley (India) Pvt. Ltd., Pearson Education in South Asia, 2011.

REFERENCES:

1. B. Gottfried, Programming with C, Schaum Outline Series, Fourth Edition, 2018
2. Herbert Schildt, C: The Complete Reference, McGraw Hill, Fourth Edition, 2017
3. Yashavant Kanetkar, Let Us C, BPB Publications, 16th Edition, 2018.
4. Reema Thareja, "Programming in C", 2nd Edition, Oxford University Press, 2018.
5. Zed A. Shaw, "Learn C the Hard Way: Practical Exercises on the Computational Subjects You Keep Avoiding (like C)", (Zed Shaw's Hard Way Series), 1st Edition, Addison- Wesley Professional, 2015.

20EE101 - BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

To impart knowledge on

- Basics of DC and AC Electrical circuits
- Principle of operation of Electrical Machines
- Operation of Electron Devices
- Design Concept of Digital Circuits
- Working principle of measuring instruments and transducers

UNIT I ELECTRICAL CIRCUITS 9

Basic circuit components -, Ohms Law - Kirchoff's Law – Instantaneous Power – Inductors - Capacitors – Independent and Dependent Sources - steady state solution of DC circuits - Nodal analysis, Mesh analysis- Introduction to AC circuits – waveforms and RMS value – power and power factor, single phase and three-phase balanced circuits.

UNIT II ELECTRICAL MACHINES 9

Principles of operation and characteristics of; DC machines, Transformers (single and three phase), Synchronous machines, three phase and single-phase induction motors.

UNIT III ELECTRONIC DEVICES AND CIRCUITS 9

Introduction –Characteristics of PN junction Diode-Zener effect-Zener Diode and its characteristics-Half wave and Full wave Rectifiers-Voltage regulation-Bipolar Junction Transistor – Characteristics – Field Effect Transistors – Transistor Biasing–Introduction to operational Amplifier –Inverting Amplifier –Non Inverting Amplifier.

UNIT IV DIGITAL ELECTRONICS 9

Binary number system-Boolean algebra theorems- Digital circuits-Introduction to sequential circuits-Flip flops- Registers and counters- ADC-DAC

UNIT V MEASUREMENTS & INSTRUMENTATION 9

Introduction to transducers - Classification of Transducers: Resistive, Inductive, Capacitive, Thermoelectric, piezoelectric, photoelectric, Hall Effect and Mechanical-Classification of instruments - Types of indicating Instruments - Multimeters –Oscilloscopes.

TOTAL: 45 PERIODS

OUTCOMES:

After the completion of the course, students should be able to

- Understand concept of DC and AC electric circuits
- Identify appropriate machine for a given application
- Understand the working of electron devices
- Demonstrate the concept of digital logic circuits
- Choose appropriate instruments and transducers for specific application

TEXT BOOKS

1. S.K. Bhattacharya, "Basic Electrical & Electronics Engineering", Pearson Education.

REFERENCES

1. Del Toro, “Electrical Engineering Fundamentals”, Pearson Education, New Delhi, 2007.
2. John Bird, “Electrical Circuit Theory and Technology”, Elsevier, First Indian Edition, 2006
3. Allan S Moris, “Measurement and Instrumentation Principles”, Elsevier, First Indian Edition, 2006
4. Rajendra Prasad, “Fundamentals of Electrical Engineering”, Prentice Hall of India, 2006
5. A.E.Fitzgerald, David E Higginbotham and Arvin Grabel, “Basic Electrical Engineering”, McGraw Hill Education (India) Private Limited, 2009
6. N K De, Dipu Sarkar, “Basic Electrical Engineering”, Universities Press (India) Private Limited 2016

20EM111 - ENGINEERING PRACTICES LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.

GROUP A (CIVIL & MECHANICAL)

I CIVIL ENGINEERING PRACTICE **15**

Buildings:

(a) Study of plumbing and carpentry components of residential and industrial buildings. Safety aspects.

Plumbing Works:

(a) Study of pipeline joints, its location and functions: valves, taps,couplings, unions, reducers, elbows in household fittings.
(b) Study of pipe connections requirements for pumps and turbines.
(c) Preparation of plumbing line sketches for water supply and sewageworks.
(d) Hands-on-exercise:
Basic pipe connections – Mixed pipe material connection – Pipeconnections with different joining components.
(e) Demonstration of plumbing requirements of high-rise buildings.

Carpentry using Power Tools only:

(a) Study of the joints in roofs, doors, windows and furniture.
(b) Hands-on-exercise:
Woodwork, joints by sawing, planing and cutting.

II MECHANICAL ENGINEERING PRACTICE **15**

Welding:

(a) Preparation of butt joints, lap joints and T- joints by Shielded metalarc welding.
(b) Gas welding practice

Basic Machining:

(a) Simple Turning and Taper turning
(b) Drilling Practice

Sheet Metal Work:

(a) Forming & Bending:
(b) Model making – Trays and funnels.
(c) Different type of joints

Machine assembly practice:

(a) Study of centrifugal pump
(b) Study of air conditioner

Demonstration on:

(a) Smithy operations, upsetting, swaging, setting down and bending.Example Exercise – Production of hexagonal headed bolt.
(b) Foundry operations like mould preparation for gear and step conepulley.
(c) Fitting: Exercises – Preparation of square fitting and V – fittingmodels.

GROUP B (ELECTRICAL & ELECTRONICS)

III ELECTRICAL ENGINEERING PRACTICE 15

1. Study of various safety measures in Electrical System
2. Draw and demonstrate the layout for a residential house wiring using energy meter, switches, fuse, indicator, LED lamp, fluorescent lamp with one of the lamps to be controlled by 2 different switches
3. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit (series and parallel circuit).
4. Measurement of energy using single-phase energy meter for incandescent lamp and LED lamp.
5. Measurement of resistance to earth of an electrical equipment

IV ELECTRONICS ENGINEERING PRACTICE 15

1. Study of Electronic components (fixed and Variable):
    i. Resistor – Measurement of resistance using colour coding and digital multimeter.
    ii. Capacitor – Measurement of capacitance using identification code, LCR meter
    iii. Inductor – Measurement of inductance using colour coding and LCR meter

2. Study of Electronic equipment:
    i. Signal generation using AFO (sine, square, triangle for various frequency and amplitude ranges)
    ii. Measurement of amplitude, frequency, peak-peak, RMS, period, DC level of sine, square and triangle waveform using CRO and DSO.
    iii. Measurement of DC voltage and current using analog and digital meters

3. Study of Electronic accessories:
    i. Circuit connection using Breadboard and wires.
    ii. Circuit connection using general purpose PCB by Soldering practice techniques.

4. Study of logic gates AND, OR, EX-OR and NOT by demonstration.
5. Generation of Clock Signal.
6. Measurement of ripple factor of HWR and FWR.
7. Study of Iron box, fan and regulator (resistive and electronics type), emergency lamp, Power Tools: (a) Range Finder (b) Digital Live-wire detector

TOTAL: 60 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Develop carpentry components and pipe connections including plumbing works.
- Make use of welding equipments to join the structures
- Analyse the basic machining operations
- Develop the models using sheet metal works
- Illustrate on centrifugal pump, Air conditioner, operations of smithy, foundry and fittings
- Carry out simple wiring as per the layout given
- Measures various electrical parameters like Voltage, Current, Power factor, Power, Energy, Resistance to earth etc.
- Calculate ripple factor of a given waveform, use logic gates for simple applications.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

CIVIL

1. Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings.	15 Sets.
2. Carpentry vice (fitted to work bench)	15 Nos.
3. Standard woodworking tools	15 Sets.
4. Models of industrial trusses, door joints, furniture joints	5 each
5. Power Tools: (a) Rotary Hammer	2 Nos
(b) Demolition Hammer	2 Nos
(c) Circular Saw	2 Nos
(d) Planer	2 Nos
(e) Hand Drilling Machine	2 Nos
(f) Jig saw	2 Nos

MECHANICAL

1. Arc welding transformer with cables and holders	5 Nos.
2. Welding booth with exhaust facility	5 Nos.
3. Welding accessories like welding shield, chipping hammer, wire brush, etc.	5 Sets.
4. Oxygen and acetylene gas cylinders, blow pipe and other welding outfit.	2 Nos.
5. Centre lathe	2 Nos.
6. Hearth furnace, anvil and smithy tools	2 Sets.
7. Moulding table, foundry tools	2 Sets.
8. Power Tool: Angle Grinder	2 Nos
9. Study-purpose items: centrifugal pump, air-conditioner	One each.

ELECTRICAL

1. Assorted electrical components for house wiring (One Way Switch, Two Way Switch, Lamp Holder, Ceiling rose, LED lamp, fluorescent lamp etc) - 15 Nos.
2. Electrical measuring instruments (Ammeter, Voltmeter, DRB, DIB etc) - 1 each
3. Earth Tester - 1 No.
4. Energy Meter, Ammeter, Voltmeter, Lamp load / Resistive load - 1 each

ELECTRONICS

1. Soldering guns - 10 No.
2. Assorted electronic components for making circuits (Resistor, Capacitor, Inductor, logic gates etc) - 50 Nos.
3. Small PCBs, Breadboard - 10 Nos.
4. Multimeters - 10 Nos.
5. LCR Meter, DSO - 1 No.
6. CRO, AFO - 5 Nos.
7. Study purpose items: Iron box, fan and regulator, emergency lamp, Range Finder, Digital Live-wire detector - 1 each

20GE111 - C PROGRAMMING LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

- To make the students write simple programs using basic constructs
- To familiarize the concepts of strings, pointers, functions and structures
- To equip the students on the knowledge of file processing concepts

LIST OF EXPERIMENTS

1. Constructing Flow charts using RAPTOR tools.
2. Programs using I/O statements and expression
3. Write a program to find whether the given line is horizontal or vertical.
4. Write a program to calculate the distance between two points p1(x1,y1), p2(x2,y2).
5. Write a program to calculate the force for the given mass and acceleration.
6. Write a program to calculate the Young's modulus.
7. Write a program to calculate the type of solution based on its pH value.
8. Write a program to temperature conversion (Fahrenheit to Celsius and vice versa)
9. Programs using decision-making constructs.
10. Write a program to find whether the given year is leap year or Not?

(Hint: not every centurion year is a leap. For example 1700, 1800 and 1900 is not a leap year)

11. Design a calculator to perform the operations, namely, addition, subtraction, multiplication, division and square of a number.
12. Check whether a given number is Armstrong number or not?

13. Given a set of numbers like, find sum of weights based on the following conditions.

- 5 if it is a perfect cube.
- 4 if it is a multiple of 4 and divisible by 6.
- 3 if it is a prime number.

Sort the numbers based on the weight in the increasing order as shown below

<10,its weight>, <36,its weight>, <89,its weight>

14. Populate an array with height of persons and find how many persons are above the average height.

15. Populate a two dimensional array with height and weight of persons and compute the Body Mass Index of the individuals.

16. Given a string —a$bcd./fgll find its reverse without changing the position of special characters. (Example input:a@gh%;j and output:j@hg%;a)

17. Convert the given decimal number into binary, octal and hexadecimal numbers using user defined functions.

18. From a given paragraph perform the following using built-in functions:

a. Find the total number of words.

b. Capitalize the first word of each sentence.

c. Replace a given word with another word.

19. Solve towers of Hanoi using recursion.

20. Sort the list of numbers using pass by reference.

21. Generate salary slip of employees using structures and pointers. Create a structure Employee with the following members:

EID, E name, Designation, DOB, DOJ, Basic pay

Note that DOB and DOJ should be implemented using structure within structure.

22. Compute internal marks of students for five different subjects using structures and functions.

23. Insert, update, delete and append telephone details of an individual or a company into a telephone directory using random access file.

24. Count the number of account holders whose balance is less than the minimum balance using sequential access file.

25. Mini project: Create a —Railway reservation system with the following modules

- Booking
- Availability checking
- Cancellation
- Prepare chart

TOTAL: 60 PERIODS

OUTCOMES

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

- Write programs for simple applications making use of basic constructs, arrays and strings.
- Develop programs involving functions, recursion, pointers, and structures.
- Create applications using sequential and random access file processing.

TEXT BOOKS:

1. Brian W Kernighan and Dennis M Ritchie, The C Programming Language, Pearson Education India, 2nd Edition, 2015.
2. Anita Goel and Ajay Mittal, "Computer Fundamentals and Programming in C", Dorling Kindersley (India) Pvt. Ltd., Pearson Education in South Asia, 2011.

REFERENCES:

1. B. Gottfried, Programming with C, Schaum Outline Series, Fourth Edition, 2018
2. Herbert Schildt, C: The Complete Reference, McGraw Hill, Fourth Edition, 2017
3. Yashavant Kanetkar, Let Us C, BPB Publications, 16th Edition, 2018.
4. Reema Thareja, "Programming in C", 2nd Edition, Oxford University Press, 2018.
5. Zed A. Shaw, "Learn C the Hard Way: Practical Exercises on the Computational Subjects You Keep Avoiding (like C)", (Zed Shaw's Hard Way Series), 1st Edition, Addison- Wesley Professional, 2015.

20EL111 - INTERPERSONAL SKILLS - LISTENING AND SPEAKING LABORATORY

L	T	P	C
0	0	2	1

OBJECTIVES:

The Course will enable learners to:

- Equip and strengthen the English language skills.
- Provide guidance and practice to engage in specific academic speaking activities and enhance writing skills with specific reference to technical writing (interview skills).
- Improve general and academic listening skills.
- Demonstrate their presentation skills competently.

UNIT I **6**

Listening as a key skill- its importance- speaking - give personal information - ask for personal information - express ability - enquire about ability - ask for clarification Improving pronunciation - pronunciation basics - taking lecture notes - preparing to listen to a lecture - articulate a complete idea as opposed to producing fragmented utterances.

UNIT II **6**

Listen to a process information- give information, as part of a simple explanation – conversation starters: small talk - stressing syllables and speaking clearly - intonation patterns - compare and contrast information and ideas from multiple sources - converse with reasonable accuracy over a wide range of everyday topics.

UNIT III **6**

Deliver a five-minute informal talk - greet - respond to greetings - describe health and symptoms - invite and offer - accept - decline - take leave - listen for and follow the gist- listen for detail.

UNIT IV **6**

Being an active listener: giving verbal and non-verbal feedback - participating in a group discussion - summarizing academic readings and participating in conversations.

UNIT V **6**

Formal and informal talk - listen to follow and respond to explanations, directions and instructions in academic and business contexts - strategies for presentations and interactive communication - group/pair presentations - negotiate disagreement in group work.

TOTAL: 30 PERIODS

OUTCOMES:

At the end of the course, learners will be able to:

- Listen and respond appropriately.
- Participate in-group discussions.
- Make effective presentations.
- Participate confidently and appropriately in conversations both formal and informal.

TEXT BOOKS

1. Brooks, Margret. Skills for Success. Listening and Speaking. Level 4 Oxford University Press, Oxford: 2011.
2. Dhanavel, S P. English and Soft Skills, Volume Two, Orient Black Swan, ISBN 978 93 528769142.

REFERENCES

1. Bhatnagar, Nitin and Mamta Bhatnagar. Communicative English for Engineers and Professionals. Pearson: New Delhi, 2010.
2. Hughes, Glyn and Josephine Moate. Practical English Classroom. Oxford University Press: Oxford, 2014.
3. Ladousse, Gillian Porter. Role Play. Oxford University Press: Oxford, 2014.
4. Richards, C. Jack. & David Bholke. Speak Now Level 3. Oxford University Press, Oxford: 2010
5. Vargo, Mari. Speak Now Level 4. Oxford University Press: Oxford, 2013.

SEMESTER - II

20EL201 - TECHNICAL ENGLISH

L	T	P	C
2	0	0	2

OBJECTIVES:

The Course prepares second semester Engineering and Technology students to:

- Develop strategies and skills to enhance their ability to read and comprehend engineering and technology texts.
- Foster their ability to write convincing job applications and effective reports.
- Demonstrate their speaking skills to make technical presentations, participate in group discussions.
- Strengthen their listening skill, which will help them comprehend lectures and talks in their areas of specialization.

UNIT I INTRODUCTION - TECHNICAL ENGLISH 06

Listening - Listening to talks mostly of a scientific/technical nature and completing information-gap exercises - Speaking – Asking for and giving directions- Reading – reading short technical texts from journals – newspapers - Writing- purpose statements – extended definitions – writing instructions – checklists – recommendations-Vocabulary Development-technical vocabulary. Language Development –subject verb agreement - compound words.

UNIT II READING AND STUDY SKILLS 06

Listening - Listening to longer technical talks and completing exercises based on them-Speaking - describing a process-Reading – reading longer technical texts - identifying the various transitions in a text – paragraphing – Writing - interpreting charts, graphs - Vocabulary Development-vocabulary used in formal letters/emails and reports Language Development - impersonal passive voice, numerical adjectives.

UNIT III TECHNICAL WRITING AND GRAMMAR 06

Listening- Listening to classroom lectures/ talks on engineering/technology - Speaking – introduction to technical presentations - Reading – longer texts both general and technical, practice in speed reading; Writing-Describing a process, use of sequence words - Vocabulary Development - sequence words - Misspelled words. Language Development - embedded sentences

UNIT IV REPORT WRITING 06

Listening- Listening to documentaries and making notes. Speaking – mechanics of presentations-Reading – reading for detailed comprehension- Writing - Report Writing (accident and survey) - minutes of a meeting - Vocabulary Development - finding suitable synonyms-paraphrasing. Language Development-reported speech.

UNIT V GROUP DISCUSSION AND JOB APPLICATIONS 06

Listening- TED talks; Speaking – participating in a group discussion - Reading– reading and understanding technical articles Writing – email etiquette - job application – cover letter – Résumé preparation (via email and hard copy)- Vocabulary Development- verbal analogies - Language Development- clauses- if conditionals.

TOTAL: 30 PERIODS

OUTCOMES:

At the end of the course, learners will be able to:

- Read technical texts and write area- specific texts effortlessly.
- Listen and comprehend lectures and talks in their area of specialization successfully.
- Speak appropriately and effectively in varied formal and informal contexts.
- Write reports and winning job applications.

TEXT BOOKS:

1. Booth-L. Diana, Project Work, Oxford University Press, Oxford: 2014.
2. Sudharshana. N.P and Saveetha C. English for Technical Communication. Cambridge University Press: New Delhi, 2016.

REFERENCES:

1. Grussendorf, Marion, English for Presentations, Oxford University Press, Oxford: 2007.
2. Herbert, A. J. The Structure of Technical English.Longman.1976.
3. Kumar, Suresh. E. Engineering English. Orient Black swan: Hyderabad, 2015.
4. Means, L. Thomas and Elaine Langlois, English & Communication for Colleges. Cengage Learning, USA: 2007.
5. Raman, Meenakshi and Sharma, Sangeetha- Technical Communication Principles and Practice. Oxford University Press: New Delhi, 2014.

20MA201 - ENGINEERING MATHEMATICS - II

L	T	P	C
3	2	0	4

OBJECTIVES:

The syllabus is designed to:

- Explain various techniques in solving ordinary differential equations.
- Make the students understand the concepts of vector differentiation and integration.
- Introduce the concepts of Laplace transforms and its applications.
- Develop an understanding on analytic function, conformal mapping and complex integration.

UNIT I ORDINARY DIFFERENTIAL EQUATIONS 9+6

Higher order linear differential equations with constant coefficients – Method of variation of parameters – Cauchy's and Legendre's linear equations – Simultaneous first order linear equations with constant coefficients**.**

UNIT II VECTOR CALCULUS 9+6

Gradient, divergence and curl (excluding vector identities) – Directional derivative – Irrotational and solenoidal vector fields – Vector integration – Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem (Statement only) – Simple applications involving cubes and rectangular parallelopipeds.

UNIT III LAPLACE TRANSFORMS 9+6

Laplace transforms – Sufficient condition for existence – Transform of elementary functions - Basic properties – Transforms of derivatives and integrals of functions – Derivatives and integrals of transforms –Transforms of unit step function and impulse functions – Transform of periodic functions. Inverse Laplace transform – Convolution theorem (Statement only) – Initial and final value theorems – Solution of linear ordinary

differential equation of second order with constant coefficients using Laplace transformation techniques.

UNIT IV COMPLEX DIFFERENTIATION AND CONFORMAL MAPPING 9+6

Functions of a complex variable – Analytic functions: Necessary conditions – Cauchy-Riemann equations and sufficient conditions (Statement only) – Harmonic and orthogonal properties of analytic function – Harmonic conjugate – Construction of analytic functions – Conformal mapping: $w = z + k$, kz, $1/z$, z^2 and bilinear transformation.

UNIT V COMPLEX INTEGRATION 9+6

Complex integration – Statement and applications of Cauchy's integral theorem and Cauchy's integral formula – Taylor's and Laurent's series expansions – Singular points – Residues – Statement and applications of Cauchy's residue theorem – Evaluation of real definite integrals as contour integrals around unit circle and semi-circle (excluding poles on the real axis).

TOTAL: 75 PERIODS

OUTCOMES:

After the successful completion of the course, the student will be able to

- Solve the higher order linear differential equations.
- Determine the gradient of a scalar field, divergence and curl of a vector fields and interpret their physical meaning and evaluate line, surface and volume integrals by vector integration.
- Apply Laplace Transforms method for solving linear ordinary differential equation.
- Construct an analytic function and analyze conformal mapping.
- Evaluate the real integrals using complex integration.

TEXT BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
3. T. Veerarajan, "Engineering Mathematics", Tata McGraw Hill, 2nd Edition, New Delhi, 2011.

REFERENCES:

1. M. K. Venkataraman, "Engineering Mathematics, Volume II", 4th Edition, The National Publication Company, Chennai, 2003.
2. Sivaramakrishna Dass, C. Vijayakumari, "Engineering Mathematics", Pearson Education India, 4th Edition 2019.
3. H. K. Dass, and Er. Rajnish Verma, "Higher Engineering Mathematics", S. Chand Private Limited, 3rd Edition 2014.
4. B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, 6th Edition, New Delhi, 2008.
5. S.S. Sastry, "Engineering Mathematics", Vol. I & II, PHI Learning Private Limited, 4th Edition, New Delhi, 2014.

20PH202 - PHYSICS FOR MECHANICAL ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES

- To introduce the notions of light matter interaction, fabrication of lasers, light propagation in waveguides, applications of lasers and optical fibres to engineering students.
- To enrich basic knowledge in various fields such as thermal physics, properties of matter and crystal physics.
- To apply the Physics concepts in solving Mechanical engineering problems.

UNIT I LASER AND FIBRE OPTICS 9

Population of energy levels - Einstein's A and B coefficients derivation - resonant cavity, optical amplification (qualitative) - Semiconductor lasers: homo junction and heterojunction- Engineering applications – Material processing.

Fibre optics - principle, numerical aperture and acceptance angle, V-number - Types of optical fibres (Material, Refractive index and Mode) - Fibre optic communication - Fibre optic sensors (pressure and displacement).

UNIT II PROPERTIES OF MATTER AND THERMAL PHYSICS 9

Elasticity- Hooke's law - Stress - strain diagram - Poisson's ratio - Factors affecting elasticity - Torsional pendulum: theory and experiment - Bending moment - Depression of a cantilever - Young's modulus by uniform and non-uniform bending - I-shaped girders.

Modes of heat transfer - Thermal conductivity- Newton's law of cooling - Linear heat flow - Lee's disc method - Radial heat flow - Rubber tube method - Conduction through compound media (series and parallel).

UNIT III CRYSTAL PHYSICS 9

Space lattice, Crystallographic axes, Unit cell, Lattice parameters, Crystal systems, Bravais lattices, Miller indices, Crystal planes and directions, Inter-planar spacing of cubic lattice, Atomic radius, Co-ordination number and Atomic packing fraction of SC, BCC, FCC, HCP and Diamond cubic structures - crystal imperfections: point defects, line defects - Burgers vector, stacking faults -Role of imperfections in plastic deformation.

UNIT IV MAGNETIC AND SUPERCONDUCTING MATERIALS 9

Introduction- Bohr magneton - Classification of Dia, Para and Ferromagnetic materials on the basis of magnetic moment - Hard and soft magnetic materials - Ferromagnetism -Domain theory - types of energy in domain growth - Hysteresis - Hysteresis curve based on domain theory - Properties of anti-ferromagnetic materials - Ferrites – structures, applications - Superconducting materials – properties, applications - SQUIDs and MAGLEV trains.

UNIT V NANO AND NOVEL ENGINEERING MATERIALS 9

Nanomaterials - Introduction - properties - preparation (bottom up and top down approaches) - applications – carbon nanotubes: types - Shape memory alloys: phases, shape memory effect, pseudo elastic effect, Ni-Ti alloy, applications - Metallic glasses: types, glass forming ability of alloys, melt spinning process, applications - Ceramics: types and applications - Composites: classification, role of matrix and reinforcement, processing of fibre reinforced plastics.

TOTAL: 45 PERIODS

OUTCOMES

On completion of this course, the students will be able to

- Know the principle, construction and working of lasers and their applications in fibre optic communication.
- Comprehend the concepts of thermal properties of materials and properties of matter.
- Recognize and apply basic knowledge of crystals, their structures and defects.
- Analyze the properties of magnetic and superconducting materials.
- Understand and apply the basics of nanomaterials and carbon nanotubes.
- Understand the basics of properties of various materials and apply knowledge for various applications thereby helps in finding the solution for specific needs by design.

TEXT BOOKS:

1. M. N. Avadhanulu, Engineering Physics, S. Chand and Company, New Delhi, 2007.

2. M. Arumugam, Engineering Physics, Anuradha Publications, 2010

REFERENCES

1. Halliday, Resnick and Walker, Fundamentals of Physics, 9th Ed., John Wiley & sons, 2011.
2. Richard P. Feynman, The Feynman Lectures on Physics - Vol. I, II and III: The New Millennium Edition, 2012.
3. S.O. Pillai “Solid State Physics” New Age International Publishers 8th Edition, 2018.
4. C. S Kumar, K.Takayama and K. P. J Reddy “Shock waves made simple” Wiley India Pvt. Ltd. New Delhi, 2014.
5. B.B. Laud “Lasers and Non Linear Optics” New Age International Publishers, 3rd Edition, 2011.

20CH202 - CHEMISTRY FOR MECHANICAL ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

The goal of this course is to achieve conceptual understanding of the applications of chemistry in the field of Mechanical Engineering. The syllabus is designed to:

- Be conversant with hardness of water, its implications in boilers and water treatment techniques.
- Acquaint with the basic concepts of thermodynamics and their functions in different processes.
- Impart knowledge on fuels and their properties for various applications.
- Develop an understanding of the basics of different types of engineering materials.
- Acquire knowledge on heat treatment methods of steels.
- Develop an understanding of phase rule, and its applications to one and two component systems**.**

UNIT I WATER TECHNOLOGY 9

Hardness of water – types –expression of hardness – units – estimation of hardness of water by EDTA method – numerical problems - boiler troubles (scale and sludge formation, priming and foaming, boiler corrosion, caustic embrittlement) – treatment of boiler feed water - internal treatment (colloidal, phosphate, calgon) – external treatment (zeolite, demineralization) – desalination of brackish water (reverse osmosis) - qualities of drinking water – domestic water treatment.

UNIT II CHEMICAL THERMODYNAMICS 10

Introduction- terminology - systems, processes, and properties - laws of thermodynamics - second law - entropy - entropy change for an ideal gas, reversible and irreversible processes - Helmholtz and Gibbs free energy functions - criteria of spontaneity (problems) - Gibbs-Helmholtz equation- Clausius- Clapeyron equation - Maxwell relations -Van't Hoff isotherm and isochore.

UNIT III FUELS AND COMBUSTION 10

Introduction - classification of fuels - coal - analysis of coal (proximate and ultimate), carbonization, manufacture of metallurgical coke (Otto Hoffmann method) – petroleum - manufacture of synthetic petrol (fixed bed catalytic cracking, Bergius) - power alcohol – biodiesel - knocking - octane number, cetane number - Gaseous fuels – natural gas, CNG, LPG.

Combustion - calorific value - higher and lower calorific values (problems) - ignition temperature - spontaneous ignition temperature - explosive range - flue gas analysis (ORSAT method).

UNIT IV ENGINEERING MATERIALS 9

Lubricants - characteristics of lubricants - viscosity, viscosity index, oiliness, flash point and fire point, cloud point and pour point - additives to lubricants- semi-solid (grease) - solid lubricant (graphite)

Refractories - characteristics-classification- properties – refractoriness, RUL, dimensional stability, thermal spalling, thermal expansion, porosity- manufacture of refractories (general method).

Composites –characteristics – constituents of composites – types – polymer matrix composites (PMC), metal matrix composites (MMC), ceramic matrix composites (CMC) – FRP -properties and applications.

UNIT V ALLOYS AND PHASE RULE 7

Introduction- properties of alloys- significance of alloying- ferrous alloys (stainless steel and carbon steels) - non-ferrous alloys (brass and bronze) - heat treatment of steel - special alloys (smart alloys, shape memory alloys).

Phase rule – terminology **–** phase, component, degree of freedom - one component system (water system) – two component system - reduced phase rule- thermal analysis and cooling curves - simple eutectic (lead-silver system).

TOTAL: 45 PERIODS

OUTCOMES:

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

- Describe the potential impact of hardness in boiler feed water and methods of softening.
- Explain the basic concepts of thermodynamics.
- Discuss various types of fuels and their combustion processes.
- Comprehend the properties and uses of engineering materials such as lubricants, refractories and composites.
- Construct and to analyse phase equilibrium diagram of one and two component systems.

TEXT BOOKS:

1. P. C. Jain and Monika Jain, “Engineering Chemistry”, 17th edition, Dhanpat Rai Publishing Company Pvt. Ltd., New Delhi, 2018.
2. Prasanta Rath, “Engineering Chemistry”, 1st edition, Cengage Learning India Pvt. Ltd., Delhi, 2015.

REFERENCES:

1. S. S. Dara and S. S. Umare, “A Textbook of Engineering Chemistry”, 12th edition, S. Chand & Company, New Delhi, 2010.
2. J. C. Kuriacose and J. Rajaram, “Chemistry in Engineering and Technology”, Volume-1 & Volume -2, Tata McGraw-Hill Education Pvt. Ltd., 2010.

20ME205 - ENGINEERING MECHANICS

L	T	P	C
3	2	0	4

OBJECTIVES:

- To develop capacity to predict the effect of force and motion in the course of carrying out the design functions of engineering.

UNIT I STATICS OF PARTICLES 9+6

Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces – Vectorial representation of forces – Vector operations of forces -additions, subtraction, dot product, cross product – Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility .

UNIT II EQUILIBRIUM OF RIGID BODIES 9+6

Free body diagram – Types of supports –Action and reaction forces – stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Single equivalent force -Equilibrium of Rigid bodies in two dimensions.

UNIT III PROPERTIES OF SURFACES AND SOLIDS 9+6

Centroids and Centre of mass – Centroids of lines and areas - Rectangular, circular, triangular areas by integration – T section, I section, - Angle section, Hollow section by using standard formula – Theorems of Pappus - Area moments of inertia of plane areas – Rectangular, circular, triangular areas by integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem – Principal moments of inertia of plane areas – Principal axes of inertia-Mass moment of inertia –mass moment of inertia for prismatic, cylindrical and spherical solids from first principle – Relation to area moments of inertia.

UNIT IV DYNAMICS OF PARTICLES 9+6

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion - Newton's laws of motion – Work Energy Equation– Impulse and Momentum – Impact of elastic bodies.

UNIT V FRICTION AND RIGID BODY DYNAMICS 9+6

Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction – wedge friction-. Rolling resistance -Translation and Rotation of Rigid Bodies – Velocity and acceleration.

TOTAL: 45+30=75 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Illustrate the vectorial and scalar representation of forces and moments
- Analyze the rigid body in equilibrium
- Evaluate the properties of surfaces and solids
- Apply dynamic forces exerted in rigid body
- Solve the friction and the effects by the laws of friction
- Apply the effort of force and moment in the various design functions of rigid body

TEXT BOOKS:

1. Beer, F.P and Johnston Jr. E.R., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 12th Edition, Tata McGraw-Hill Publishing company, New Delhi (2019).
2. Vela Murali, "Engineering Mechanics", Oxford University Press (2019).

REFERENCES:

1. Bhavikatti, S.S and Rajashekarappa, K.G., "Engineering Mechanics", New Age International (P) Limited Publishers, 2019.
2. Hibbeller, R.C and Ashok Gupta, "Engineering Mechanics: Statics and Dynamics", 14th Edition, Pearson Education 2017.
3. Meriam J.L. and Kraige L.G., " Engineering Mechanics- Statics - Volume 1, Dynamics- Volume 2", 8th Edition, John Wiley & Sons,2018.
4. Rajasekaran S and Sankarasubramanian G., "Engineering Mechanics Statics and Dynamics", 3rd Edition, Vikas Publishing House Pvt. Ltd., 2017.

20ME206 - FUNDAMENTALS OF MANUFACTURING PROCESSES

L	T	P	C
3	0	0	3

OBJECTIVE

- To introduce the concepts of basic manufacturing processes and fabrication techniques, such as metal casting, metal joining, metal forming, sheet metal processes and manufacture of plastic components.

UNIT I METAL CASTING PROCESSES 9

Sand Casting : Sand Mould – Types of pattern - Pattern Materials – Pattern allowances – Moulding sand Properties and testing – Cores –Types and applications – Moulding machines– Types and applications; Melting furnaces : Blast and Cupola Furnaces; Principle of special casting processes : Shell - investment – Ceramic mould – Pressure die casting - Centrifugal Casting - CO_2 process – Stir casting; Defects in Sand casting

UNIT II JOINING PROCESSES 9

Operating principle, basic equipment, merits and applications of Fusion welding processes. Gas welding - Types – Flame characteristics; Manual metal arc welding – Gas Tungsten arc welding - Gas metal arc welding – Submerged arc welding – Electro slag welding; Operating principle and applications of: Resistance welding - Plasma arc welding – Thermit welding – Electron beam welding – Friction welding and Friction Stir Welding; Brazing and soldering; Weld defects: types, causes and cure.

UNIT III METAL FORMING PROCESSES 9

Hot working and cold working of metals – Forging processes – Open, impression and closed die forging – forging operations. Rolling of metals– Types of Rolling – 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.

UNIT IV SHEET METAL PROCESSES 9

Sheet metal characteristics – 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.

UNIT V MANUFACTURE OF PLASTIC COMPONENTS 9

Types and characteristics of plastics – Moulding of thermoplastics – working principles and typical applications – injection moulding – Plunger and screw machines – Compression moulding, Transfer Moulding – Typical industrial applications – introduction to blow moulding –Rotational moulding – Film blowing – Extrusion – Thermoforming – Bonding of Thermoplastics. Advanced manufacturing: Additive manufacturing.

TOTAL: 45 PERIODS

OUTCOMES:

On the successful completion of this course, the students will be able to;

- Explain different metal casting processes, associated defects, merits and demerits
- Compare the different metal joining processes.
- Summarize various hot working and cold working methods of metals.
- Demonstrate the various sheet metal making processes.
- Distinguish various methods of manufacturing plastic components and interpret the principles of Additive manufacturing.
- Suggest the suitable chip-less forming processes for an identified product.

TEXT BOOKS:

1. Rajput. R.K., "A Text book of Manufacturing Technology (Manufacturing Processes), 2nd Edition, Laxmi Publications (P) Ltd., 2018.
2. Kalpakjian. S, “Manufacturing Engineering and Technology”, 7th Edition, Pearson Education India, 2018.

REFERENCES:

1. Gowri, S., Hariharan, P., Suresh Babu, A., "Manufacturing Technology Vol. I", Oxford University Press India, 2020.
2. Rao, P.N. "Manufacturing Technology Foundry, Forming and Welding" Vol.1, 5th Edition, Tata McGraw-Hill Education (India) Pvt. Ltd., 2018
3. Roy. A. Lindberg, "Processes and Materials of Manufacture", 3rd Edition, Pearson education, 2015
4. Sharma, P.C., "A Text book of production Technology", 8th Edition, S. Chand and Co. Ltd., 2014.

20PC111 - PHYSICS AND CHEMISTRY LABORATORY

L	T	P	C
0	0	4	2

PHYSICS LABORATORY 30

OBJECTIVES:

- To introduce different experiments to test basic understanding of physics concepts applied in optics, thermal physics, properties of matter, semiconductors and liquids.

LIST OF EXPERIMENTS: (Any five experiments to be conducted)

1. Determination of wavelength and velocity of ultrasonic waves by Ultrasonic Interferometer.
2. Determination of thermal conductivity of a poor conductor by LEE'S Disc method.
3. (i) Determination of wavelength and divergence angle of semiconductor laser source using diffraction grating.

   (ii) Determination of particle size by using diffraction of semiconductor laser beam.

   (iii) Analysis of Numerical aperture and acceptance angle of an optical fibre.
4. Determination of Young's Modulus of a beam by non-uniform bending method.
5. Determination of the moment of inertia of the disc and rigidity modulus of wire by Torsional pendulum.
6. Spectrometer - Determination of wavelength of Mercury Spectrum using diffraction grating.
7. Determination of thickness of wire by air wedge method.
8. Determination of Young's Modulus of a beam by Uniform bending method.
9. Determination of band gap of a semiconductor.

OUTCOMES

Upon completion of the course, based on hands-on experience of the students, they will be able to

- Use the ultrasonic interferometer and to determine the wavelength and velocity of ultrasonic waves of a liquid.
- Examine the thermal conductivity of a bad conductor.
- Determine the wavelength of mercury spectrum and also determine the wavelength of a laser source, particle size, divergence angle of semiconductor laser source using diffraction grating and to analyze the numerical aperture and acceptance angle of an optical fibre.
- Examine the Young's modulus of a beam by uniform and non-uniform bending and to estimate the moment of inertia of the disc and rigidity modulus of wire by torsional pendulum.
- Calculate the thickness of a thin wire by the interference pattern.
- Determine the band gap of a semiconductor.

REFERENCES

1. Physics Laboratory manual, Department of Physics, R.M.K. Engineering College, 2019.
2. Wilson J.D. and Hernandez C.A., - Physics Laboratory Experiments, Houghton Mifflin Company, New York, 2005.

CHEMISTRY LABORATORY 30

OBJECTIVES:

- To make the students acquire practical skills through volumetric and instrumental analysis.

LIST OF EXPERIMENTS:

1. Determination of total, temporary and permanent hardness of water by EDTA method.
2. Conductometric titration of strong acid vs. strong base.
3. Determination of strength of acids in a mixture using a conductivity meter.
4. Determination of strength of given hydrochloric acid using a pH meter.
5. Estimation of the iron content of the given solution using a potentiometer.
6. Estimation of the iron content of the water sample using a spectrophotometer (thiocyanate method).
7. Estimation of sodium present in water using a flame photometer.
8. Determination of the molecular weight of polyvinyl alcohol using Ostwald viscometer.
9. Determination of corrosion rate by weight loss method.
10. Determination of flash and fire point of a lubricating oil (Pensky Martens apparatus).
11. Determination of concentration of a given solution by constructing a galvanic cell.

OUTCOMES:

Based on hands-on experience, students will be able to:

- Analyze the given hard water sample and estimate different types of hardness present.
- Observe and analyse the change in conductivity of an acid(s) when added with base through conductometry.
- Examine the change in pH when an acid is added with a base using pH meter.
- Understand the redox reactions and its impact on emf values through potentiometry.
- Determine the flash and fire point of an oil.
- Assess the corrosion rate of a given metal.
- Construct an electrochemical cell to determine the concentration of the given solution.

TOTAL: 60 PERIODS

REFERENCES:

1. J. Mendham, R. C. Denney, J. D. Barnes, M. J. K. Thomas and B. Sivasankar, "Vogel' Quantitative Chemical Analysis", 6th edition, Pearson Education Pvt. Ltd., 2009.

20CS212 - ADVANCED C PROGRAMMING LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

- To develop programs using Arrays and Strings
- To develop programs using pointers and dynamic memory allocation
- To develop programs using files
- To apply C programming for solving Engineering Problems

LIST OF EXPERIMENTS

1) Array Manipulation
2) String Manipulation
3) Pointers
4) Solving polynomial equations
5) Dynamic Memory Allocation
6) File Manipulation
7) Domain specific problems

INDICATIVE LIST OF EXERCISES:

1. **Arrays:**
   a) Find the prime factors of a number.
   b) Find maximum repeating number.
   c) Find k^{th} smallest element in an unsorted array.
   d) Matrix manipulation – Addition, Subtraction, Multiplication.
   e) Job Sequencing: Given an array of jobs where every job has a deadline and a profit. Profit can be earned only if the job is finished before the deadline. It is also given that every job takes a single unit of time, so the minimum possible deadline for any job is 1. How to maximize total profit if only one job can be scheduled at a time. Print the sequence of job ID order to maximize total profit.

2. **String Manipulation:**
   a) Find the frequency of all the characters in a string.
   b) Given two strings S1 and S2. Remove all the occurrences of S2 in S1 and print the remaining.
   c) Reversing a set of words.
   d) Find the number of patterns of form 1[0]1 where [0] represents any number of zeroes (minimum requirement is one 0) there should not be any other character except 0 in the [0] sequence in a given binary string.

3. **Pointers:**
   a) Manipulating two-dimensional arrays using pointers.
   b) Print the odd positioned characters and then even positioned characters using pointers.
   c) Programs using double pointers in C.
   d) Print all permutations of a given string using pointers.

4. **Numerical Solutions of Polynomials**
   a) Solve a polynomial equation.
   b) Find the value of the derivative of the polynomial equation given by the user who provides the value of the unknown variable x.

5. **Dynamic Memory Allocation:**
   a) Find Largest Number Using Dynamic Memory Allocation.
   b) Print the list of elements in reverse order.

6. **File Manipulation:**
   a) Merge the content of two files.
   b) Merge two lists given.
   c) Print the odd positioned characters from a file content.

7. **Solve domain specific problems in C:**

   Civil
   1) Find the area of the irregular land using Trapeziodal rule.
   2) Find the area of the irregular land using simpson rule.

   EEE & EIE
   1) Find the current through a resistor, for voltage varying from 5V to 20V in steps of 5V, using Ohm's Law.
   2) Find equivalent resistance when resistors are connected in series, equivalent capacitance when capacitors are connected in parallel.

   Mechanical
   1) Compute the volume of solids (prism, pyramids, cylinder and cone) from Engineering Graphics problems.
   2) Draw a projectile from Engineering mechanics problems.

TOTAL: 60 PERIODS

OUTCOMES:

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

- Apply array and string concepts to solve problems.
- Employ pointers to solve various problems.
- Implement dynamic memory allocation.
- Understand file manipulations.
- Design and develop real-world applications utilizing the concepts of arrays, strings, pointers, dynamic memory allocation and files.

20EL211 - ADVANCED READING AND WRITING

L	T	P	C
0	0	2	1

OBJECTIVES:

The Course will enable learners to:

- Strengthen their reading skills.
- Enhance writing skills with specific reference to technical writing.
- Apply their critical thinking skills.
- Demonstrate their project and proposal writing.

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UNIT I **6**

Reading - Strategies for effective reading - Writing - Descriptive essays- Predicting content using photos.

UNIT II **6**

Reading - Use of graphic organizers to review and aid comprehension - Writing - Expository essays.

6

UNIT III

Reading - Speed reading techniques - Writing - Elements of a good essay - Analytical essays.

UNIT IV **6**

Reading - Genre and organization of ideas – Writing - Email writing - Job applications.

UNIT V **6**

Reading - Critical reading and thinking -Writing - Letter of recommendation - Vision statement.

TOTAL: 30 PERIODS

OUTCOMES:

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

- Read and evaluate texts critically.
- Display critical thinking in various professional contexts.
- Apply various texts using speed reading techniques.
- Illustrate and write different types of Essays.
- Write effective emails, winning job applications and persuasive recommendations.

TEXT BOOKS:

1. Daise, Debra., Norloff, Charl., and Carne, Paul. Reading and Writing (Level 4) Oxford: Oxford University Press, 2011.
2. Ward, Colin S., and Margot, Gramer F. Reading and Writing (Level 3) Oxford: Oxford University Press, 2011.

REFERENCES:

1. Elbow, Peter. Writing Without Teachers. London: Oxford University Press, 1973. Print.
2. Goatly, Andrew., and Hiradhar, Preet. Critical Reading and Writing. New York: Routledge, 2016.
3. Liss, Rhonda., and Davis, Jason. Effective Academic Writing (Level 3).Oxford: Oxford University Press, 2006.
4. Petelin, Roslyn., and Durham, Marsha. The Professional Writing Guide: Knowing Well and Knowing Why. Warriewood, NSW: Business & Professional Publishing, 2004.
5. Suresh Kumar, E., Sandhya, B. Savithri, J., and Sreehari, P. Enriching Speaking and Writing Skills. Second Edition. Orient Black swan: Hyderabad, 2012.
6. Withrow, Jeans., Brookes, Gay., and Cummings, Martha Clark. Inspired to Write. Readings and Tasks to develop writing skills. Cambridge: Cambridge University Press, 2004.

SEMESTER – III

20MA301 - TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS

L	T	P	C
3	2	0	4

OBJECTIVES:

The syllabus is designed to:

- illustrate the concepts and techniques of Fourier series.
- discuss the concepts of Fourier transforms and Z-transforms
- describe the solutions of partial differential equations
- formulate and solve the boundary value problems.

UNIT I FOURIER SERIES 15

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range expansions – Complex form of Fourier series – Parseval's identity – Harmonic analysis.

UNIT II FOURIER TRANSFORMS 15

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

UNIT III Z – TRANSFORMS AND DIFFERENCE EQUATIONS 15

Z-transforms – Elementary properties – Inverse Z-transforms (method of partial fraction and residues) – Convolution theorem – Formation of difference equations – Solution of difference equations using Z-transform.

UNIT IV PARTIAL DIFFERENTIAL EQUATIONS 15

Formation of partial differential equations – Solutions of standard types of first order partial differential equations – Lagrange's linear equation — homogenous and non-homogeneous linear partial differential equations of second and higher order with constant coefficients.

UNIT V APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 15

Classification of PDE – Method of separation of variables – Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction (excluding insulated edges).

TOTAL: 75 PERIODS

OUTCOMES:

After the successful completion of the course, the student will be able to:

CO1 Employ the Fourier series concept in Engineering Problems.

CO2 Identify the solution of Fourier transform in continuous time signals.

CO3 Elucidate the difference equation using Z-transform.

CO4 Compute the solutions of the partial differential equation.

CO5 Utilize the Fourier series for heat and wave equations.

TEXT BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India, 2011.
2. B.S. Grewal, "Higher Engineering Mathematics", 44th Edition, Khanna Publishers New Delhi, 2017.

REFERENCES:

1. N.P. Bali, and Manish Goyal, "A Textbook of Engineering Mathematics", 7th Edition, Laxmi Publications Pvt Ltd, 2007.
2. B.V. Ramana, "Higher Engineering Mathematics", 6th Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
3. Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2007.
4. C. Ray Wylie and L.C. Barrett, "Advanced Engineering Mathematics" 6th Edition, Tata McGraw Hill Education Pvt Ltd, New Delhi, 2012.
5. K.B. Datta, "Mathematical Methods of Science and Engineering", 1st Edition, Cengage Learning India Pvt Ltd, Delhi, 2013.

20ME302 - ENGINEERING THERMODYNAMICS

L	T	P	C
3	0	0	3

OBJECTIVE:

Students completing this course are expected to:

- Explain the nature and role of thermodynamic properties and different forms of energy imposed by the first law of thermodynamics on conversion from one form to another.
- Discuss second law of thermodynamics and limitations on the performance of thermodynamic systems.
- Classify the behaviour of power plants based on the Rankine cycle, including the effect of enhancements such as superheat, reheat and regeneration.
- Distinguish the properties of ideal and real gas behaviour with thermodynamic relations.
- Explain psychrometrics, psychrometric processes and gas mixtures

(Use of Standard and approved Steam Table, Mollier Chart, Compressibility Chart and Psychrometric Chart permitted)

UNIT I BASIC CONCEPTS AND FIRST LAW 9

Basic concepts - concept of continuum, comparison of microscopic and macroscopic approach. Path and point functions. Intensive and extensive, total and specific quantities. System and their types. Thermodynamic Equilibrium State, path and process. Quasi-static, reversible and irreversible processes. Heat and work transfer, definition and comparison, sign convention. Displacement work and other modes of work. P-V diagram. Zeroth law of thermodynamics – concept of temperature and thermal equilibrium– relationship between temperature scales –new temperature scales. First law of thermodynamics – application to nonflow or Closed system (Isochoric, Isobaric, Isothermal, Reversible adiabatic and polytropic process) – application to open system- steady flow process.

UNIT II SECOND LAW, ENTROPY AND AVAILABILITY 9

Heat Reservoir, source and sink. Heat Engine, Refrigerator, Heat pump. Statements of second law and its corollaries. Carnot cycle Reversed Carnot cycle, Performance. Clausius inequality. Concept of entropy, T-s diagram, Tds Equations, entropy change for - pure substance, ideal gases - different processes, principle of increase in entropy – applications of entropy principle (Transfer of heat through a finite temperature difference, mixing of two fluids, Maximum work obtainable from two finite bodies at two different temperatures, Maximum work obtainable from a finite body and thermal energy reservoir). Applications of II Law. Basic concept of Exergy and Availability.

UNIT III PROPERTIES OF PURE SUBSTANCE AND STEAM POWER CYCLE 9

Formation of steam and its thermodynamic properties, p-v, p-T, T-v, T-s, h-s diagrams. p-v-T surface. Use of Steam Table and Mollier Chart. Determination of dryness fraction. Application of I and II law for pure substances. Ideal and actual Rankine cycles, Cycle Improvement Methods - Reheat and Regenerative cycles. Comparison between Rankine and Carnot cycle.

UNIT IV IDEAL AND REAL GASES, THERMODYNAMIC RELATIONS 9

Properties of Ideal gas- Ideal and real gas comparison- Equations of state for ideal and real gases- Van Der Waal's equation, Beattie - Bridgeman Equation - Reduced properties. Compressibility factor - Principle of Corresponding states. Generalized Compressibility Chart and its use-. Maxwell relations, Tds Equations, Joule-Thomson Coefficient, Clausius Clapeyron equation, Phase Change Processes. Simple Calculations.

UNIT V GAS MIXTURES AND PSYCHROMETRY 9

Mole and Mass fraction, Dalton’s and Amagat’s Law. Properties of gas mixture – Molar mass, gas constant, density, change in internal energy, enthalpy, entropy and Gibbs function. Psychrometric properties, Psychrometric charts. Property calculations of air vapour mixtures by using chart and expressions. Psychrometric process – adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing. Simple Applications.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Explain the basic concepts and laws of thermodynamics
CO2 Apply second law of thermodynamics to open and closed systems and calculate entropy in thermal systems.
CO3 Calculate the properties of pure substance and explain the working of steam cycles
CO4 Distinguish between the properties of ideal and real gases.
CO5 Solve problems in psychrometric processes and gas mixtures.
CO6 Apply thermodynamic laws for real time applications.

TEXT BOOKS:

1. R.K.Rajput, “A Text Book Of Engineering Thermodynamics “, Fifth Edition, 2017.
2. Yunus A. Cengel & Michael A. Boles, “Thermodynamics”, 8th edition 2016.

REFERENCES:

1. Arora C.P, “Thermodynamics”, Tata McGraw-Hill, New Delhi, sixteenth reprint 2008.
2. Borgnakke & Sonnatag, “Fundamental of Thermodynamics”, 8th Edition, 2016.
3. Chattopadhyay, P, "Engineering Thermodynamics", Oxford University Press, 2016.
4. Michael J. Moran, Howard N. Shapiro, “Fundamentals of Engineering Thermodynamics”, 4th Edition, 2017.
5. Nag. P.K., “Engineering Thermodynamics”, 5th Edition, Tata McGraw-Hill, New Delhi, 2017.
6. Natarajan E., "Engineering Thermodynamics: Fundamentals and Applications", Anuragam Publications, 2014.

20ME303 - FLUID MECHANICS AND MACHINERY

L	T	P	C
3	0	0	3

OBJECTIVES

Students completing this course are expected to:

- Classify various types of fluids with their properties and concept of control volume.
- Apply the law of conservation to flow through pipes
- Discuss the importance of dimensional and model analysis
- Explain the various types of turbines and their performance
- Discuss the various types of pumps and draw their performance curves

UNIT I FLUID PROPERTIES AND FLOW CHARACTERISTICS 9

Units and dimensions – Fluid Statics - Properties of fluids - mass density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapor pressure, surface tension and capillarity. Pressure Measurements - Fluid Dynamics - Flow characteristics- Eulerian and Lagrangian Principle of fluid flow– 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

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

UNIT III DIMENSIONAL ANALYSIS AND MODEL STUDIES 9

Need for dimensional analysis – Fundamental dimensions - Dimensional homogeneity - methods of dimensional analysis – Rayleigh’s method and Buckingham Pi theorem – Dimensionless parameters - Similitude and model studies - Distorted and undistorted models.

UNIT IV TURBINES 9

Impact of jets - Euler’s equation - Theory of roto-dynamic machines – heads and efficiencies – velocity components at entry and exit of the rotor- velocity triangles – Classification of turbines –Pelton wheel, Francis turbine (inward and outward) and Kaplan turbine- Working principles - Work done by water on the runner - Efficiencies – Draft tube - Specific speed - Performance curves for turbines – Governing of turbines.

UNIT V PUMPS 9

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 its variations – work saved by fitting air vessels - Rotary pumps - classification.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1. Calculate the fluid properties and flow characteristics
CO2. Compute the flow of fluid in circular conduits
CO3. Discuss the importance of dimensional and model analysis
CO4. Estimate the performance of hydraulic turbines
CO5. Explain the working principle and draw the performance curves of hydraulic pumps.
CO6. Demonstrate a keen understanding of various fluid properties, involving real time experimentation

TEXT BOOK:

1. Modi P.N. and Seth, S.M. "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi 2019.
2. Bansal, R.K., "Fluid Mechanics and Hydraulic Machines", Laxmi Publications (P) Ltd., 2019

REFERENCES:

1. Graebel. W.P, "Engineering Fluid Mechanics", Taylor & Francis, Indian Reprint, 2018
2. Kumar K. L., "Engineering Fluid Mechanics", Eurasia Publishing House(p) Ltd., New Delhi 2016
3. Robert W.Fox, Alan T. McDonald, Philip J.Pritchard, “Fluid Mechanics and Machinery”, 2017.
4. Streeter, V. L. and Wylie E. B., "Fluid Mechanics", McGraw Hill Publishing Co. 2018
5. Jain A. K. Fluid Mechanics including Hydraulic Machines, Khanna Publishers, New Delhi, 2019.

20ME304 - MACHINE TOOL TECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Apply the concept and mechanics of metal cutting for machining processes.
- Explain the working principles of various operations performed in a lathe machine.
- Distinguish reciprocating and rotary machines.
- Discuss the different types of gear manufacturing and surface finishing processes
- Apply the basic Numerical Control (NC) codes to prepare a machining program

UNIT I FUNDAMENTALS OF MACHINING 9

Introduction: Material removal processes, types of machine tools – Mechanics of metal cutting, chip formation, types of chip, orthogonal cutting, forces in machining, Merchant's circle, thermal aspects – Cutting tools: single point cutting tool, nomenclature, cutting tool materials, tool wear, tool life, surface finish, cutting fluids and Machinability.

UNIT II CENTRE LATHE AND SPECIAL PURPOSE LATHES 9

Centre lathe, constructional features, specification, various operations, taper turning methods, thread cutting methods, special attachments, machining time and power estimation. Capstan and turret lathes: constructional features, turret indexing mechanism, bar feed mechanism, tool layout – Automatic lathes: single spindle - Swiss type, automatic screw type – Multi spindle.

UNIT III RECIPROCATING AND ROTARY MACHINE TOOLS 9

Shaper, planer, slotter – constructional features, types of operations. Broaching machines: broach construction – push, pull, surface and continuous broaching machines. Milling machines: types of milling machines, milling cutters, milling operations, indexing methods. Drilling, reaming, tapping, boring Machines – constructional features.

UNIT IV GEAR MANUFACTURING AND SURFACE FINISHING PROCESSES 9

Gear forming and Gear generation processes - principle - Construction of gear milling, hobbing and gear shaping processes – finishing of gears. Surface finishing processes - Abrasive processes: Types of grinding process – cylindrical grinding, surface grinding, and centerless grinding – grinding wheel specifications and selection – Super finishing processes: Honing, lapping, super finishing, polishing and buffing.

UNIT V CNC MACHINE TOOLS AND PART PROGRAMMING 9

Numerical control (NC) machine tools - CNC: types, constructional details, special features, structural members, slide ways, Linear bearings, ball screws, spindle drives and feed drives - Machining centers - Part programming fundamentals – Manual programming – Basic NC programs (introductory programs only) - Post processors.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Apply the theory of metal cutting for effective machining.
CO2 Summarize the working principles and operations performed in various lathe machines.
CO3 Explain the working of special type machines.
CO4 Discuss various types of gear manufacturing and surface finishing process
CO5 Prepare NC codes for a machining program.
CO6 Apply suitable machine tool in machining of desired product.

TEXT BOOKS:

1. Hajra Choudhury, "Elements of Workshop Technology", Vol.II., Media Promoters 2018
2. Rao. P.N "Manufacturing Technology - Metal Cutting and Machine Tools", 3rd Edition, Tata McGraw-Hill, New Delhi, 2018.

REFERENCES:

1. Richard R. Kibbe, Roland O. Meyer, Jon Stenerson, Kelly Curran "Machine Tool Practices", Pearson, 11th Edition, 2019.
2. Serope Kalpakjian, Steven R. Schmid, "Manufacturing Engineering and Technology" Pearson, 7th Edition, 2018
3. HMT, "Production Technology", McGraw Hill, 2017.
4. Rajput R.K, 'A text book of Manufacturing Technology', Lakshmi Publications, 2018.
5. Mikell P.Groover, 'Fundamentals of Modern Manufacturing, Materials, Processes and Systems', John Wiley and Sons, 7th Edition, 2019.

20CS304 - JAVA PROGRAMMING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand Object Oriented Programming concepts and fundamentals of Java
- To know the principles of packages, inheritance and interfaces
- To define exceptions and multithreading
- To develop a java application with I/O streams and generics classes
- To use the functionalities of Strings and Collections

UNIT I INTRODUCTION TO OOP AND JAVA FUNDAMENTALS 9

An Overview of Java - Data Types, Variables, and Arrays – Operators - Control Statements – Class Fundamentals – Declaring objects – Methods – Constructors – this keyword - Overloading methods - Overloading constructors - Access Control – Static – Final.

UNIT II INHERITANCE, PACKAGE AND INTERFACES 9

Inheritance: Inheritance basics, Using super, Method Overriding, Using Abstract Classes, Using final with Inheritance – Package and Interfaces: Packages, Packages and member access, Importing Packages, Interfaces, Static Methods in an Interface.

UNIT III EXCEPTION HANDLING AND MULTITHREADING 9

Exception Handling: Exception-Handling Fundamentals, Exception Types, Uncaught Exceptions, Using try and catch, Multiple catch Clauses, Nested try Statements, throw, throws, finally, Java'sBuilt-in Exceptions. Multithreaded Programming: Thread Creation.

UNIT IV I/O AND GENERIC PROGRAMMING 9

I/O: I/O Basics, Reading Console Input, Writing Console Output, Reading and Writing Files – Generics: Introduction, Generic class, Bounded Types, Generic Methods, Generic Interfaces, Generic Restrictions.

UNIT V STRING HANDLING AND COLLECTIONS 9

String Handling – Collections: The Collection Interfaces, The Collection Classes – List, Array List, Set, Iterator – Map.

TOTAL: 45 PERIODS

OUTCOMES:
At the end of this course, the students will be able to:

CO1: Understand the Object Oriented Programming concepts and fundamentals of Java
CO2: Develop Java programs with the packages, inheritance and interfaces
CO3: Build applications using Exceptions and Threads.
CO4: Build Java applications with I/O streams and generics classes
CO5: Use Strings and Collections in applications

TEXTBOOKS:

1. Herbert Schildt, "Java - The Complete Reference", 11th Edition, McGraw Hill Education, 2019.

REFERENCES:

1. Cay S. Horstmann, Gary cornell, "Core Java Volume –I Fundamentals", 11th Edition, PrenticeHall, 2019.
2. Paul Deitel, Harvey Deitel, "Java SE 8 for programmers", 3rd Edition, Pearson, 2015.
3. Steven Holzner, "Java 2 Black book", Dreamtech press, 2011.
4. Timothy Budd, "Understanding Object Oriented Programming with Java", 3rd Edition, Pearson Education, 2008.

20GE301 - UNIVERSAL HUMAN VALUES 2: UNDERSTANDING HARMONY

L	T	P	C
2	2	0	3

OBJECTIVE:

The objective of the course is fourfold:

- Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
- Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
- Strengthening of self-reflection.
- Development of commitment and courage to act.

COURSE TOPICS:

The course has 28 lectures (2 lecture hours) and 14 practice sessions (2 Tutorial hour) in 5 Units:

UNIT 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

- Purpose and motivation for the course, recapitulation from Universal HumanValues-I
- Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration
- Continuous Happiness and Prosperity- A look at basic Human Aspirations
- Right understanding, Relationship and Physical Facility- the basic requirements for fulfillment of aspirations of every human being with their correct priority
- Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
- Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking

UNIT 2: Understanding Harmony in the Human Being – Harmony in Myself!

- Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
- Understanding the needs of Self ('I') and 'Body' - happiness and physical facility
- Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)
- Understanding the characteristics and activities of 'I' and harmony in 'I'
- 'Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail
- Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods

available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease

UNIT 3: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship

- Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
- Understanding the meaning of Trust; Difference between intention and competence
- Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
- Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
- Visualizing a universal harmonious order in society- Undivided Society, Universal Order-from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institutes extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

UNIT 4: Understanding Harmony in the Nature and Existence - Whole existence as coexistence

- Understanding the harmony in the Nature
- Interconnectedness and mutual fulfilment among the four orders of nature-recyclability and self-regulation in nature
- Understanding Existence as Co-existence of mutually interacting units in all-pervasive space
- Holistic perception of harmony at all levels of existence.

Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

UNIT 5: Implications of the above Holistic Understanding of Harmony on Professional Ethics

- Natural acceptance of human values
- Definitiveness of Ethical Human Conduct
- Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
- Competence in professional ethics: a. Ability to utilize the professional competence

for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.

- Case studies of typical holistic technologies, management models and production systems.
- Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations
- Sum up.

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. To discuss the conduct as an engineer or scientist etc.

Outcomes:

By the end of the course, students

- would become more aware of themselves, and their surroundings (family, society, nature).
- would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
- would have better critical ability.
- Would become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
- would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

READINGS:

Text Book

1. R R Gaur, R Sangal, G P Bagaria, “Human Values and Professional Ethics”, Excel Books, New Delhi, Second Edition 2019.

Reference Books

1. A Nagaraj, “Jeevan Vidya: Ek Parichaya”, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. E. F Schumacher, "Small is Beautiful", Vintage classics, London, 1993.
3. A.N. Tripathi, “Human Values”, New Age Intl. Publishers, New Delhi, Third Edition 2020.
4. Maulana Abdul Kalam Azad, "India Wins Freedom", Oriental blackswan private limited, Hyderabad, 2020.
5. Mahatma Gandhi, “Hind Swaraj or Indian Home Rule”, Maheswari Publications, Delhi 2020.

6. Romain Rolland, "The life of Vivekananda and the universal gospel", Publication house of Ramakrishna Math, Kolkata, Thirty second edition 2018.
7. Romain Rolland, "Mahatma Gandhi: The man who become one with the universal being “, Srishti Publishers & Distributors, New Delhi, Sixth Edition 2013.
8. Heaton, Dennis P. "The story of stuff." (2010): 553-556.
9. Gandhi, Mohandas Karamchand, “The story of my experiments with truth: An autobiography”, Om Books International, 2018.
10. Andrews, Cecile, “Slow is beautiful: new visions of community, leisure, and joie de vivre”, New society publishers, 2006.
11. Kumarappa, Joseph Cornelius, “The economy of permanence. CP”, All India Village Industries Assn., 1946.

20ME311 - MANUFACTURING PROCESSES LABORATORY AND MINI PROJECT

L	T	P	C
0	0	4	2

OBJECTIVE:

Students completing this course are expected to:

- Demonstrate various operations that can be performed in lathe, shaper, drilling, machines etc.,
- Explain about preparing structural shapes using arc welding.
- Produce different moulds using foundry operations.
- Prepare various shapes using sheet metal
- Apply the basic engineering knowledge to make a working model / mechanical product

LIST OF EXPERIMENTS

Machining and Machining time estimations for:

1. Taper Turning
2. External Thread cutting
3. Internal Thread Cutting
4. Eccentric Turning
5. Knurling
6. Drilling and Boring
7. Square Head Shaping
8. Hexagonal Head Shaping
9. Fabrication of Bolt and Nut assembly
10. Joining of plates and pipes / simple structural shapes using Gas Metal Arc Welding / Arc Welding
11. Preparation of green sand moulds
12. Manufacturing of sheet metal components using metal spinning on a lathe

MINI PROJECT - GUIDELINE FOR REVIEW AND EVALUATION

The students may be grouped into 2 to 3 and work under a project supervisor. The device/ system/component(s) to be fabricated may be decided in consultation with the supervisor and if possible with an industry. A project report and fabricated model is to be submitted by the group.

(80% weightage is given for Laboratory work and remaining 20% weightage is given for Mini project)

TOTAL: 60 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Demonstrate the working of lathe machine
CO2 Compare the various operations performed in Lathe machines.
CO3 Operate the shaper machine to fabricate simple shapes.
CO4 Use the arc welding process for manufacturing basic structural shapes.
CO5 Develop the green sand mould for a simple component
CO6 Apply the concept of manufacturing processes for making mechanical product / working model.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S. NO.	NAME OF THE EQUIPMENT	Qty.
1	Centre Lathes	7 Nos.
2	Horizontal Milling Machine	1 No
3	Vertical Milling Machine	1 No
4	Drilling machine	1 No.
5	Shaper	1 No.
6	Arc welding transformer with cables and holders	2 Nos
7	Oxygen and acetylene gas cylinders, blow pipe and other welding outfit	1 No
8	Moulding table, Moulding Equipments	2 Nos
9	Sheet metal forming tools and Equipments	2 Nos.

20ME312 - COMPUTER AIDED MACHINE DRAWING

L	T	P	C
0	0	4	2

OBJECTIVES

Students completing this course are expected to:

- Apply Indian Standards in drawing practices of machine components.
- Use hand books for selection of the standard components like bolts, nuts, screws, keys etc.
- Show the limits, fits and tolerances in the production drawings of machine components.
- Prepare assembly drawings both manually and using standard CAD packages.
- Add the knowledge on 3D Modelling with the detailing features available in the standard CAD packages for converting 3D models into 2D drawings.

UNIT I DRAWING STANDARDS & FITS AND TOLERANCES 12

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

UNIT II INTRODUCTION TO 2D DRAFTING 16

- Drawing, Editing, Dimensioning, Layering, Hatching, Block, Array, Detailing, Detailed drawing.
- Bearings - Bush bearing, Plummer block
- Valves – Safety and non-return valves.

UNIT III 3D GEOMETRIC MODELING AND ASSEMBLY 32

Sketcher - Datum planes – Protrusion – Holes - Part modeling – Extrusion – Revolve – Sweep – Loft – Blend – Fillet - Pattern – Chamfer - Round - Mirror – Section – Assembly - Detailing for production drawing.

- Couplings – Flange, Universal, Oldham's, Muff, Gear couplings
- Joints – Knuckle, Gib & cotter, strap, sleeve & cotter joints
- Engine parts – Piston, connecting rod, cross-head (vertical and horizontal), stuffing box, multi-plate clutch
- Miscellaneous machine components – Screw jack, machine vice, tail stock, chuck, vane and gear pump

TOTAL: 60 PERIODS

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 / 3D CAD software

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Apply the knowledge on standards in drawing practices to prepare the production drawings.

CO2 Use the hand books for selecting the standard components in the drafting of Machine components.

CO3 Distinguish between the 2D drafting and 3D modeling processes available in the standard CAD packages.

CO4 Draw the 2D orthographic views of standard machine components both manually and using CAD packages.

CO5 Prepare the 3D geometric and assembly models of standard machine components using the CAD packages.

CO6 Produce the production drawings from the 3D Assembly models using the detailing feature available in the CAD packages.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	Description of Equipment	Quantity
1.	Computer nodes or systems with suitable graphics facility	30 No.
2.	Licensed software for Drafting and Modeling	30 Licenses
3.	Laser Printer or Plotter to print / plot drawings	1 No.

TEXT BOOK:

1. Gopalakrishna K.R., “Machine Drawing”, 22nd Edition, Subhas Stores Books Corner, Bangalore, 2017

REFERENCES:

1. N. D. Bhatt and V.M. Panchal, “Machine Drawing”, 48th Edition, Charotar Publishers,2016

2. K.L. Narayana, P. Kannaiam and K. Venkata Reddy,” Machine Drawing”, published by New Age International Publishers,2019.

3. N. Siddeshwar, P. Kanniah, V.V.S. Sastri,” Machine Drawing”, published by Mc GrawHill, 2017

4. Engineering Drawing Practice for Schools and Colleges BIS SP46:2003 (R2008), Published by Bureau of Indian Standards (BIS), 2008.

20CS314 - JAVA PROGRAMMING LABORATORY

L	T	P	C
0	0	4	2

COURSE OBJECTIVES

- To build software development skills using java programming for real-world applications.
- To understand and apply the concepts of classes, packages, interfaces, collections,exception handling and file processing.
- To develop applications using generic programming.

List of Experiments

1. Develop a Java application to generate Electricity bill. Create a class with the following members: Consumer no., consumer name, previous month reading, current month reading, type of EB connection (i.e domestic or commercial). Compute the bill amount using the following tariff

   If the type of the EB connection is domestic, calculate the amount to be paid as follows:First 100 units - Rs. 1 per unit

   101-200 units - Rs. 2.50 per unit

   201 -500 units - Rs. 4 per unit

   > 501 units - Rs. 6 per unit

   If the type of the EB connection is commercial, calculate the amount to be paid asfollows:

   First 100 units - Rs. 2 per unit

   101-200 units - Rs. 4.50 per unit

   201 -500 units - Rs. 6 per unit

   > 501 units - Rs. 7 per unit

2. Arrays Manipulations:
   a. Find k^{th} smallest element in an unsorted array
   b. Find the sub array with given sum
   c. Matrix manipulations – Addition, Subtraction, Multiplication
   d. Remove duplicate elements in an Array

3. Develop a java application to implement currency converter (Dollar to INR, EURO to INR, Yen to INR and vice versa), distance converter (meter to KM, miles to KM and vice versa),time converter (hours to minutes, seconds and vice versa) using packages.

4. Develop a java application with Employee class with Emp_name, Emp_id, Address, Mail_id, Mobile_no as members. Inherit the classes, Programmer, Assistant Professor, Associate Professor and Professor from employee class. Add Basic Pay (BP) as the memberof all the inherited classes with 97% of BP as DA, 10 % of BP as HRA, 12% of BP as PF, 0.1% of BP for staff club fund. Generate pay slips for the employees with their gross and net salary.

5. Design a Java interface for ADT Stack. Implement this interface using array. Provide necessary exception handling in both the implementations.

6. Write a Java Program to create an abstract class named Shape that contains two integers and an empty method named print Area(). Provide three classes named Rectangle, Triangle and Circle such that each one of the classes extends the class Shape. Each one of the classes contains the methods print Area () that prints the area of the given shape and Number of sides () that prints the number of sides of the given shape.

7. Write a Java program to apply built-in and user defined exceptions.

8. String Manipulation:
    a. Reversing a set of words and count the frequency of each letter in the string.
    b. Remove all the occurrences of string S2 in string S1 and print the remaining.
    c. Find the longest repeating sequence in a string
    d. Print the number of unique string values that can be formed by rearranging theletters in the string S.

9. Write a Java program to read and copy the content of one file to other by handlingall file related exceptions.

10. Collections:
    a. Write a program to perform string operations using ArrayList. Write functions forthe following
        i. Append - add at end
        ii. Insert – add at particular index
        iii. Search
        iv. List all string starts with given letter
    b. Find the frequency of words in a given text.

TOTAL: 60 PERIODS

COURSE OUTCOMES

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

CO1: Develop and implement Java programs for simple applications that make use of classes,packages and interfaces.

CO2: Develop and implement Java programs with collections, exception handling and multithreading.

CO3: Design applications using file processing and generic programming.

20CS313 - APTITUDE AND CODING SKILLS – I

L	T	P	C
0	0	2	1

OBJECTIVES:

- To develop vocabulary for effective communication and reading skills.
- To build the logical reasoning and quantitative skills.
- To develop error correction and debugging skills in programming.

List of Exercises:

1. **English – Phase I**
   Vocabulary: Synonyms, Antonyms, Grammar: Subject-Verb Agreement, Tenses and Articles, Prepositions and Conjunctions, Speech and Voices, Comprehension: Inferential and Literal Comprehension, Contextual Vocabulary, Comprehension ordering

2. **Logical Reasoning – Phase I**
   Deductive Reasoning: Coding deductive logic, Directional sense, Blood relations, Objective Reasoning, Selection decision tables, Puzzles, Inductive reasoning: Coding pattern and Number series pattern recognition, Analogy and Classification pattern recognition, Abductive Reasoning: Logical word sequence, Data sufficiency

3. **Quantitative Ability - Phase I**
   Basic Mathematics: Divisibility, HCF and LCM, Numbers, decimal fractions and power, Applied Mathematics: Profit and Loss, Simple and Compound Interest, Time, Speed and Distance, Engineering Mathematics: Logarithms, Permutation and Combinations, Probability

4. **Automata Fix – Phase I**
   Logical, Compilation and Code reuse

TOTAL: 30 PERIODS

OUTCOMES:

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

CO1: Develop vocabulary for effective communication and reading skills.
CO2: Build the logical reasoning and quantitative skills.
CO3: Develop error correction and debugging skills in programming.

SEMESTER – IV

20MA404 - STATISTICS AND NUMERICAL METHODS

L	T	P	C
3	2	0	4

OBJECTIVES:

The syllabus is designed to:

- discuss the concept of testing the hypothesis for small and large samples.
- demonstrate the difference between the types of design to experiments.
- develop the skills of solving algebraic, transcendental and system of equations using various methods.
- determine the interpolation and compute the differentiation and integration.
- illustrate the various techniques of solving ordinary differential equations.

UNIT I TESTING OF HYPOTHESIS 15

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 15

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

UNIT III SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 15

Solution of algebraic and transcendental equations – Fixed point iteration method – Newton Raphson method – Solution of linear system of equations - Gauss elimination method – Pivoting - 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 15

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

UNIT -V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 15

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 Adam's-Bashforth predictor and corrector methods for solving first order equations – Finite difference methods for solving second order – two-point linear boundary value problems.

TOTAL: 75 PERIODS

OUTCOMES:

After the successful completion of the course, the student will be able to:

CO1 Employ the concept of testing the hypothesis in real life problems.
CO2 Implement the analysis of variance for real life problems.
CO3 Compute the solutions of algebraic, transcendental and the system of equations.
CO4 Apply the numerical techniques of interpolation, differentiation and integration for engineering problems.
CO5 Employ the various techniques of solving first and second order ordinary differential equations.

TEXT BOOKS:

1. B.S. Grewal. and J.S. Grewal, “Numerical Methods in Engineering and Science ", 10th Edition, Khanna Publishers, New Delhi, 2015.
2. R.A. Johnson, I. Miller, and J. Freund, “Miller and Freund’s Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.

REFERENCES:

1. R.L. Burden, and J.D. Faires, "Numerical Analysis”, 9th Edition, Cengage Learning, 2016.
2. J.L. Devore, "Probability and Statistics for Engineering and the Sciences”, Cengage Learning, New Delhi, 8th Edition, 2014.
3. C.F. Gerald and P.O. Wheatley "Applied Numerical Analysis” Pearson Education, Asia, New Delhi, 2006.
4. M.R. Spiegel, J. Schiller and R.A. Srinivasan, "Schaum’s Outlines on Probability and Statistics ", Tata McGraw Hill Edition, 2004.
5. R.E. Walpole, R.H. Myers, S.L. Myers and K. Ye, “Probability and Statistics for Engineers and Scientists", 8th Edition, Pearson Education, Asia, 2007.

20ME402 - KINEMATICS OF MACHINERY

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Explain the basic components and layout of linkages in the assembly of a system machine.
- Discuss the principles in analyzing the assembly with respect to the displacement, velocity, and acceleration at any point in a link of a mechanism.
- Examine the motion resulting from a specified set of linkages, design few linkage mechanisms and cam mechanisms for specified output motions.
- Summarize the basic concepts of toothed gearing and kinematics of gear trains and the effects of friction in motion transmission and in machine components.
- Explain the various mechanisms by algebraic and vector methods.

UNIT I BASICS OF MECHANISMS 9

Classification of Mechanisms – Basic Kinematic Concepts and Definitions – Degree of Freedom, Mobility – Kutzbach Criterion, Gruebler's Criterion – Grashof's Law – Kinematic Inversions of Four-Bar Chain and Slider Crank Chains – Limit Positions – Mechanical Advantage – Transmission Angle. Classification of mechanisms - Ratchets and Escapement mechanisms, Indexing mechanisms - Analysis of Hooke's joint – Double Hooke's joint - Pantograph – Straight line motion Mechanisms (Exact and Approximate) - Steering gear mechanisms.

UNIT II KINEMATICS OF LINKAGE MECHANISMS 9

Displacement, Velocity and Acceleration Analysis of Simple Mechanisms – Graphical Method – Velocity and Acceleration Polygons – Velocity Analysis using Instantaneous Centers – Velocities and accelerations by Analytical method – Kinematic Analysis of Simple Mechanisms – Coincident Points – Coriolis Component of Acceleration.

UNIT III KINEMATICS OF CAM MECHANISMS 9

Classification of Cams and Followers – Terminology and Definitions – Displacement Diagrams – Uniform Velocity, Parabolic, Simple Harmonic and Cycloidal Motions – Derivatives of Follower Motions – Layout of Plate Cam Profiles – Specified Contour Cams – Circular Arc and Tangent Cams – Pressure angle and Undercutting – Sizing of Cams.

UNIT IV GEARS AND GEAR TRAINS 9

Law of Toothed Gearing Profiles – Spur Gear Terminology and Definitions – Involutes and Cycloidal Tooth – Gear Tooth Action – Contact Ratio – Interference and Undercutting. Helical, Bevel, Worm, Rack and Pinion gears [Basics only]. Gear Trains – Speed Ratio, Train Value – Parallel Axis Gear Trains – Epicyclic Gear Trains.

UNIT V COMPUTER - AIDED ANALYSIS OF MECHANISMS 9

Displacement, Velocity, Acceleration analysis of four link mechanism – Use of complex algebra – The Vector method – Velocity, Acceleration analysis of slider crank mechanism – Coupler curves

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Explain the principles of kinematic pairs of planar mechanisms.
CO2 Compute velocity and acceleration in planar mechanisms.
CO3 Apply various motion principles to draw cam profiles
CO4 Summarize the role of gear geometry in gear train.
CO5 Explain the mechanisms by algebraic and vector methods.
CO6 Examine the kinematic interactions of various elements in a given machine tool.

TEXT BOOKS:

1. Rattan, S.S, “Theory of Machines”, 5th Edition, McGraw-Hill Education (India) Limited, 2019.
2. Uicker J.J, Pennock G.R and Shigley J.E."Theory of Machines and Mechanisms”, 4th Edition, Oxford University Press, 2014.

REFERENCES:

1. Robert L. Norton, “Kinematics and Dynamics of Machinery”, McGraw-Hill Education (India) Limited, 2010 (2017)
2. Thomas Bevan, "Theory of Machines", 3rd Edition, Pearson Education, 2009 (2018).
3. R S Khurmi and J K Gupta, "Theory of Machines", 14th Edition, S.Chand Publishing, 2005 (2015).
4. V.P.Singh, “Theory of Machines” 6th Edition, Dhanpat Rai & Co (P) Limited, 2017.
5. Sadhu Singh, “Theory of Machines”, 3rd Edition, Pearson Education, 2011 (2016).

20ME403 - ENGINEERING MATERIALS AND METALLURGY

L	T	P	C
3	0	0	3

OBJECTIVE:

Students completing this course are expected to:

- Explain the principles of constitution of alloys, phase diagrams, and Iron carbide Equilibrium Diagram.
- Classify various types of Heat treatment process and its applications.
- Discuss the properties and applications of Ferrous and Nonferrous metals.
- Summarize the properties of Non-metallic materials and applications.
- Select the suitable materials for various Engineering applications.

UNIT I CONSTITUTION OF ALLOYS AND PHASE DIAGRAMS 9

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

UNIT II HEAT TREATMENT 9

Annealing – Full annealing, stress relief, recrystallization and spheroidising – normalizing, hardening and Tempering of steel. Isothermal transformation diagrams for eutectoid steel – cooling curves superimposed on I.T. diagram, CCT diagram – Hardenability, Jominy end quench test - Austempering, martempering – case hardening- carburizing, Nitriding, cyaniding, carbonitriding – Flame and Induction hardening –strain hardening - Vacuum and Plasma hardening.

UNIT III FERROUS AND NON-FERROUS METALS 9

Effect of alloying additions on steel- Properties and applications of Carbon steel, Alloy steel - stainless and tool steels – HSLA, Maraging steels – Copper and copper alloys – Brass, Bronze and Cupronickel – Aluminium and Al-Cu – precipitation strengthening treatment – Bearing alloys, Super Alloys, Titanium and Titanium alloys, Alpha, Beta, Alpha –Beta Ti alloys, Ni and Nickel alloys, Monel and Mg-alloys.

UNIT IV NON-METALLIC MATERIALS 9

Polymers – types of polymer, commodity and engineering polymers – Properties and applications of various thermosetting and thermoplastic polymers (PP, PS, PVC, PMMA, PET,PC, PA, ABS, PI, PAI, PPO, PPS, PEEK, PTFE, Polymers – Urea and Phenol formaldehydes)- Engineering Ceramics – Properties and applications of Al_2O_3, SiC, Si_3N_4, PSZ and SIALON – Composites - Classifications - MMC - FRP – CMC – hybrid composites- Applications of Composites.

UNIT V MATERIAL CHARACTERIZATION 9

Types of fracture – Testing of materials under tension, compression and shear loads – Hardness tests (Brinell, Vickers and Rockwell), Impact test Izod and charpy, fatigue and creep failure mechanisms. Introduction to NDT techniques such as X-ray radiography, Dye penetration test, Magnetic particle test and Ultrasonic test.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Explain various binary alloy systems with respective invariant reaction.
CO2 Classify various heat treatment process and its significance
CO3 Discuss various Ferrous and non-ferrous metals with its application
CO4 Summarize the various non-metallic materials with its applications
CO5 Compute the material properties by various material testing techniques
CO6 Apply the knowledge of material science on material selection for specific requirements

TEXT BOOKS:

1. Avner, S.H., “Introduction to Physical Metallurgy”, McGraw Hill Book Company, 2017.
2. Williams D Callister, “Material Science and Engineering” Wiley India Pvt Ltd, Revised Indian 10th Edition, 2017

REFERENCES:

1. Kenneth G. Budinski and Michael K. Budinski, “Engineering Materials”, Prentice Hall of India Private Limited, 2012.
2. Van Vlack L.H., ‘Elements of Materials Science and Engineering’, 6th Edition, Addison-Wesley, 2011
3. Raghavan.V, “Materials Science and Engineering”, Prentice Hall of India Pvt. Ltd., 2017.
4. U.C.Jindal : Material Science and Metallurgy, "Engineering Materials and Metallurgy", First Edition, Dorling Kindersley, 2012
5. Upadhyay. G.S. and Anish Upadhyay, “Materials Science and Engineering”, Viva Books Pvt. Ltd., New Delhi, 2006.
6. Dieter George E., “Mechanical Metallurgy”, 3rd Edition, McGraw-Hill, New York, 2014
7. J. Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-Hill Education, 2nd edition (2011).

20ME404 - STRENGTH OF MATERIALS

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Explain the concepts of stress, strain and deformation of solids.
- Compute the shearing force and bending moment due to external loads on statically determinate beams and their effect on stresses.
- Calculate the stresses and deformation in circular shafts and helical spring due to torsion.
- Compute slopes and deflections in statically determinate beams by various methods.
- Examine the stresses and deformations induced in thin cylindrical and spherical shells.

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS 9

Rigid bodies and deformable solids – Tensile, Compressive and Shear Stresses – Basics of Elasticity – Hooke's law - Stress-strain diagram - Deformation of simple and compound bars under axial load – Thermal stresses - Elastic constants - Volumetric strains - Strain energy due to axial load.

UNIT II TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAMS 9

Beams – Types - Transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and overhanging beams - Stresses in Beams - Theory of simple bending – Bending stress variation along the length and in the beam section – Effect of shape of beam section on stress induced - Shear stress distribution.

UNIT III TORSION 9

Torsion of circular bars – Torsion Equation - Stresses and deformations in circular and hollow shafts – Stepped shafts – Twist and torsion stiffness – Compound shafts – Deflection in shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs under axial load - carriage springs.

UNIT IV DEFLECTION OF BEAMS 9

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

UNIT V ANALYSIS OF STRESSES IN TWO DIMENSIONS 9

Biaxial state of stresses – Thin cylindrical and spherical shells – Stresses in thin cylindrical shell due to internal pressure - Deformation in thin cylindrical and spherical shells subjected to internal pressure - Biaxial stresses at a point – Stresses on inclined planes – Principal planes and stresses – Mohr's circle for biaxial stresses – Maximum shear stress.

TOTAL: 45 PERIODS

OUTCOMES

After successful completion of the course, the students will be able to

CO1 Estimate the stresses, strains and deformations in solids under axial loading
CO2 Compute the bending and shearing stresses in beams subjected to loadings
CO3 Examine the effect of torsion in shafts and springs
CO4 Calculate the deflection and slopes in beams
CO5 Compute the two dimensional stresses in thin cylinder and spherical shells
CO6 Calculate the stresses and deformation of solids subjected to various loads.

TEXT BOOKS:

1. Bansal, R.K., "A Text Book of Strength of Materials", Laxmi Publications (P) Ltd., New Delhi, 5th Edition, 2018.
2. S.S. Rattan "Strength of Materials" McGraw Hill Education (India) Pvt. Ltd., 3rd Edition, 2017.

REFERENCES:

1. Timoshenko S.P., "Elements of Strength of Materials", 10th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2010.
2. Rajput, R.K., "Strength of Materials", S. Chand Publications, 7th edition, 2018.
3. Ferdinand P. Beer, E. Russell Johnston, John T. Dewolf, David F. Mazurek, Sanjeev Sanghi , "Mechanics of Materials", 8th edition, McGraw-Hill, New York, 2020.
4. Popov E. P., "Mechanics of Solids", 2nd Edition, Pearson, 2015.

20ME405 - THERMAL ENGINEERING - I

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Compute the appropriate energy transfers and system properties to analyze closed system processes and gas power cycles
- Estimate the performance of Positive displacement compressor.
- Examine the properties of fuels and combustion characteristics
- Calculate the performance on internal combustion engines and explain various systems used in IC engines
- Apply the practical amendments employed to improve the basic gas turbine cycle efficiency, for example, intercooling, reheating and regeneration

(Use of standard refrigerant property data book, Steam Tables, Mollier diagram and Psychrometric chart permitted)

UNIT I GAS POWER CYCLES 9

Air Standard Cycles - Otto, Diesel, Dual, – Cycle Analysis, Calculation of mean effective pressure and air standard efficiency, comparison of Otto, diesel, and Dual Cycle.

UNIT II RECIPROCATING AIR COMPRESSOR 9

Classification and comparison, working principle, work of compression - with and without clearance, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency. Multistage air compressor with Intercooling. Working principle and comparison of Rotary compressors with reciprocating air compressors.

UNIT III INTERNAL COMBUSTION ENGINES 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 IV INTERNAL COMBUSTION ENGINE PERFORMANCE AND SYSTEMS 9

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

UNIT V GAS TURBINES 9

Gas turbine – Brayton - Cycle analysis – open and closed cycle. Performance and its improvement - Regenerative, Intercooled, Reheated cycles and their combinations. Materials for Turbines.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Distinguish the performance of different air standard cycles
CO2 Summarize the working of compressor and factors influencing its performance in different stages.
CO3 Explain the functioning and features of IC engines, components and auxiliaries.
CO4 Calculate the performance parameters of IC Engines and its associated systems.
CO5 Discuss the concepts to improve the performance of Gas turbines.
CO6 Examine the performance of compressors, engines and turbines.

TEXT BOOKS:

1. Kothandaraman. C.P., Domkundwar. S, Domkundwar. A.V., “A course in thermal Engineering", Fifth Edition, ”Dhanpat Rai & sons , 2016
2. Rajput. R. K., “Thermal Engineering” S. Chand Publishers, 2017

REFERENCES:

1. Arora. C.P, “Refrigeration and Air Conditioning”, McGraw-Hill Publishers 4th Edition 2020
2. Ganesan. V “Internal Combustion Engines”, Fourth Edition, McGraw-Hill2017
3. Rudramoorthy, R, “Thermal Engineering “, McGraw-Hill, New Delhi,2017
4. Sarkar. B.K, “Thermal Engineering”, McGraw-Hill Publishers, 2017
5. Ballaney. P.L., Thermal Engineering, 25th Edition, Khanna Publishers, New Delhi, 2017.
6. Mahesh M. Rathore, Thermal Engineering, 1st Edition, McGraw Hill Publishing Company, New Delhi, 2010.

20ME406 - ENGINEERING METROLOGY AND MEASUREMENTS

(Laboratory Integrated Course)

L	T	P	C
2	0	2	3

OBJECTIVES:

Students completing this course are expected to:

- Discuss the various Metrological equipments for measurement.
- Explain the various methods for linear and angular measurement.
- Summarize the basic and advanced metrology concepts.
- Classify the methods used for form measurement.
- Operate various instruments to measure the power, flow and temperature.

UNIT I BASICS OF METROLOGY **6**

Introduction to Metrology – Need – Elements – Work piece, Instruments – Persons – Environment – their effect on Precision and Accuracy – Errors – Errors in Measurements – Types – Control – Types of standards.

UNIT II LINEAR AND ANGULAR MEASUREMENTS **6**

Linear Measuring Instruments – Evolution – Types – Classification – Limit gauges – gauge design – terminology – procedure – concepts of interchange ability and selective assembly – Angular measuring instruments – Types – Bevel protractor clinometers angle gauges, spirit levels sine bar – Angle alignment telescope – Autocollimator – Applications.

UNIT III ADVANCES IN METROLOGY **6**

Basic concept of lasers Advantages of lasers – laser Interferometers – types – DC and AC Lasers interferometer – Applications – Straightness – Alignment. Basic concept of CMM – Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Basic concepts of Machine Vision System – Element – Applications.

UNIT IV FORM MEASUREMENT **6**

Principles and Methods of straightness – Flatness measurement – Thread measurement, gear measurement, surface finish measurement, Roundness measurement – Applications.

UNIT V MEASUREMENT OF POWER, FLOW AND TEMPERATURE **6**

Force, torque, power – mechanical, Pneumatic, Hydraulic and Electrical type. Flow measurement: Venturimeter, Orifice meter, rotameter, pitot tube – Temperature: bimetallic strip, thermocouples, electrical resistance thermometer

TOTAL: 30 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Explain the fundamentals of Measuring system and calibration of various measuring devices.
CO2 Discuss the use of Linear and Angular Measuring instruments.
CO3 Demonstrate the advanced Instruments used in Metrology.
CO4 Distinguish the various methods for form measurement.
CO5 Associate suitable measuring instruments to measure power, flow and temperature.
CO6 Apply the different measurement tools and perform measurements in quality Inspection.

TEXT BOOKS:

1. Gupta. I.C., “Engineering Metrology”, Dhanpatrai Publications, 2018.
2. Jain R.K. “Engineering Metrology”, Khanna Publishers, 2018.

REFERENCES:

1. Nakra B.C., Chaudhry K K, “Instrumentation, Measurement and Analysis, McGraw Hill, 3rd Edition, 2017.
2. Gupta S.C, “Engineering Metrology”, Dhanpatrai Publications, 2018.
3. Dominique Placko, “Fundamentals of Instrumentation and Measurement”, Wiley- ISTE, 2017.
4. Ernest O. Doebelin, “Measurements systems, Applications and Design”, McGraw Hill, 7th Edition, 2019.
5. John H. Lienhard V Thomas G. Beckwith, Roy D. Marangoni, Mechanical Measurements, Revised 6th Edition in SI Units, Pearson, 2020

LIST OF EXPERIMENTS

1. Calibration and use of measuring instruments – Vernier caliper, micrometer, Vernier height gauge – using gauge blocks
2. Calibration and use of measuring instruments – depth micrometer, bore gauge, telescopic gauge
3. Measurement of linear dimensions using Comparators
4. Measurement of angles using bevel protractor and sine bar
5. Measurement of screw thread parameters – Screw thread Micrometers and Three wire method (floating carriage micrometer)
6. Measurement of gear parameters – disc micrometers, gear tooth vernier caliper
7. Measurement of features in a prismatic component using Coordinate Measuring Machine (CMM)
8. Programming of CNC Coordinate Measuring Machines for repeated measurements of identical components
9. Non-contact (Optical) measurement using Toolmaker’s microscope / Profile projector
10. Measurement of Surface finish in components manufactured using various processes (turning, milling, grinding, etc.,) using stylus based instruments.
11. Machine tool metrology – Level tests using precision level; Testing of straightness of a machine tool guide way using Autocollimator, spindle tests.
12. Measurement of force, torque and temperature
13. Study of vibration setup.

TOTAL: 30 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1	Micrometer	5
2	Vernier Caliper	5
3	Vernier Height Gauge	2
4	Vernier depth Gauge	2
5	Slip Gauge Set	1
6	Gear Tooth Vernier	1
7	Sine Bar	1
8	Floating Carriage Micrometer	1
9	Profile Projector / Tool Makers Microscope	1
10	Mechanical / Electrical / Pneumatic Comparator	1
11	Autocollimator	1
12	Temperature Measuring Setup	1
13	Force Measuring Setup	1
14	Torque Measuring Setup	1
15	Coordinate measuring machine	1
16	Surface finish measuring equipment	1
17	Bore gauge	1
18	Telescope gauge	1

20ME411 - MACHINE TOOL LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVE:

Students completing this course are expected to:

- Demonstrate the sequence of machining operations required for industry
- Prepare manufacturing components according to given drawings using various machine tools
- Compute the cutting forces in Milling and Turning Process
- Discuss various simple machining operations in special purpose machines and its applications in real life manufacture of components in the industry
- Use CNC part programming for turning operations

LIST OF EXPERIMENTS:

1. Simple machining operations using Capstan and Turret lathe
2. Contour milling using vertical milling machine
3. Spur gear cutting in horizontal milling machine
4. Helical gear cutting in milling machine

5. Gear generation in hobbing
6. Gear Generation in Gear shaping machine
7. Plain Surface grinding
8. Cylindrical grinding
9. Centerless cylindrical grinding
10. Tool angle grinding with tool and cutter grinder
11. Measurement of cutting forces in Milling / Turning Process
12. CNC part programming for turning operations

TOTAL: 60 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Complete the machining operation using Capstan and Turret lathe

CO2 Operate special machines to machine gear tooth and contours.

CO3 Use different machine tools for finishing operations

CO4 Produce cutting edges using tool and cutter grinder

CO5 Prepare a CNC Program for machining special contour cutting operation

CO6 Apply suitable machining sequence to plan the process in producing a component

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1	Turret and Capstan Lathes	1 No each
2	Horizontal Milling Machine	2 No
3	Vertical Milling Machine	1 No
4	Surface Grinding Machine	1 No.
5	Cylinderical Grinding Machine	1 No.
6	Radial Drilling Machine	1 No.
7	Lathe Tool Dynamometer	1 No
8	Milling Tool Dynamometer	1 No
9	Gear Hobbing Machine	1 No
10	Tool Makers Microscope	1 No
11	CNC Lathe Machine	1 No
12	Gear Shaping Machine	1 No
13	Centerless grinding Machine	1 No
14	Tool and cutter grinder	1 No

20ME412 - STRENGTH OF MATERIALS AND FLUID MECHANICS AND MACHINERY LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

Students completing this course are expected to:

- Predict the mechanical properties of materials such as impact strength, tensile strength, compressive strength, hardness, ductility etc.
- Demonstrate the basic principles in the area of mechanics of materials through a series of experiments
- Compute the rate of flow through pipes using various flow measuring devices such as Venturimeter, orifice meter and rotameter
- Discuss the performance characteristics of turbines and pumps
- Demonstrate the basic principles of fluid mechanics and working of hydraulic machines

LIST OF EXPERIMENTS

STRENGTH OF MATERIALS LABORATORY **30**

1. Tension test on a mild steel rod
2. Double shear test on Mild steel and Aluminium rods
3. Compression test on Mild steel specimen
4. Torsion test on mild steel rod
5. Impact test on metal specimen
6. Hardness test on metals - Brinnell and Rockwell Hardness Number
7. Deflection test on beams
8. Compression test on helical springs
9. Effect of hardening- Improvement in hardness and impact resistance of steels.
10. Microscopic Examination of Unhardened and hardened samples

FLUID MECHANICS AND MACHINES LABORATORY **30**

1. Determination of the Coefficient of discharge of given Orifice meter.
2. Determination of the Coefficient of discharge of given Venturi meter.
3. Determination of the rate of flow using Rota meter.
4. Determination of friction factor for a given set of pipes.
5. Conducting experiments and drawing the characteristic curves of Centrifugal pump/ Submergible pump
6. Conducting experiments and drawing the characteristic curves of Reciprocating pump.

7. Conducting experiments and drawing the characteristic curves of Gear pump.
8. Performance characteristics test on Pelton wheel turbine.
9. Performance characteristics test on Francis turbine.
10. Performance characteristics test on Kaplan turbine.

TOTAL: 60 PERIODS

OUTCOMES:
After successful completion of the course, the students will be able to

CO1 Compute the mechanical properties of materials.
CO2 Calculate the deflection of beam by deflection method and springs using tensile and compression tests
CO3 Summarize the influence of heat treatment process in mechanical properties and micro structure
CO4 Apply Bernoulli's principle in various flow meters
CO5 Discuss the characteristics of hydraulic pumps and prime movers.
CO6 Use flow meters and hydraulic machines for specific applications.

LIST OF EQUIPMENT FOR STRENGTH OF MATERIALS LAB FOR A BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1	Universal Tensile Testing machine with double 1 shear attachment 40 Ton Capacity	1
2	Torsion Testing Machine (60 NM Capacity)	1
3	Impact Testing Machine (300 J Capacity)	1
4	Brinell Hardness Testing Machine	1
5	Rockwell Hardness Testing Machine	1
6	Spring Testing Machine for tensile and compressive loads (2500 N)	1
7	Metallurgical Microscopes	3
8	Muffle Furnace (800º C)	1

LIST OF EQUIPMENT FOR FLUID MECHANICS AND MACHINERY LAB FOR A BATCH OF 30 STUDENTS

S. NO.	NAME OF THE EQUIPMENT	Qty.
1	Orifice meter setup	1
2	Venturi meter setup	1
3	Rotameter setup	1
4	Pipe Flow analysis setup	1
5	Centrifugal pump/submergible pump setup	1
6	Reciprocating pump setup	1
7	Gear pump setup	1
8	Pelton wheel setup	1
9	Francis turbine setup	1
10	Kaplan turbine set up	1

20CS415 - APPLICATIONS OF PROGRAMMING IN MECHANICAL ENGINEERING

L	T	P	C
0	0	4	2

OBJECTIVES:

- To implement the various mechanical applications using programming language.
- To create a project for shaft design

Exercises for Programming Lab:

(Suggested to use C Programming / GPU Programming / MS Solver appropriately to solvegiven Exercises)

1. Write the program to find the magnitude and direction of resultant force of concurrentforces acting in different directions.
2. Write the program to find the components of a force acting in a particular direction.
3. Write the program to find the area moment of inertia of rectangular cross section.
4. Write the program to find the polar moment of inertia of circular cross section.
5. Write the program to find the deformation and stresses in an axial bar.
6. Write the program to find the deformation and stresses in beams subjected touniformly distributed load.
7. Write the program to find the coefficient of discharge of a venturi meter
8. Write the program to find the air standard cycle efficiency of Petrol Engines.
9. Write the program to find the tool life of a single point cutting tool.
10. Project - Write the program to design a shaft under twisting and draw its orthographicviews.

TOTAL: 60 PERIODS

OUTCOMES:

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

CO1: Implement the various mechanical applications using programming language.

CO2: Create a project for shaft design.

20CS414 - APTITUDE AND CODING SKILLS – II

L	T	P	C
0	0	2	1

OBJECTIVES:

- To develop advanced vocabulary for effective communication and reading skills.
- To build an enhanced level of logical reasoning and quantitative skills.
- To develop error correction and debugging skills in programming.
- To apply data structures and algorithms in problem solving.

List of Exercises:

1. **English – Phase II**
   Vocabulary: Synonyms, Antonyms, Grammar: Subject-Verb Agreement, Tenses and Articles, Prepositions and Conjunctions, Speech and Voices, Comprehension: Inferential and Literal Comprehension, Contextual Vocabulary, Comprehension ordering

2. **Logical Reasoning – Phase II**
   Deductive Reasoning: Coding deductive logic, Directional sense, Blood relations, Objective Reasoning, Selection decision tables, Puzzles, Inductive reasoning: Coding pattern and Number series pattern recognition, Analogy and Classification pattern recognition, Abductive Reasoning: Logical word sequence, Data sufficiency

3. **Quantitative Ability - Phase II**
   Basic Mathematics: Divisibility, HCF and LCM, Numbers, decimal fractions and power, Applied Mathematics: Profit and Loss, Simple and Compound Interest, Time, Speed and Distance, Engineering Mathematics: Logarithms, Permutation and Combinations,Probability

4. **Automata Fix – Phase II**
   Logical, Compilation and Code reuse

5. **Automata - Phase II**
   Data Structure Concepts: Array and Matrices, Linked list, String processing and manipulation, Stack/Queue, Sorting and Searching

   Advanced Design and Analysis Techniques: Greedy Algorithms, Minimum SpanningTrees, String Matching, Divide and Conquer, Computational Geometry

TOTAL: 30 PERIODS

OUTCOMES:

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

CO1: Develop advanced vocabulary for effective communication and reading skills.
CO2: Build an enhanced level of logical reasoning and quantitative skills.
CO3: Develop error correction and debugging skills in programming.
CO4: Apply data structures and algorithms in problem solving.

SEMESTR – V

20ME501 – THERMAL ENGINEERING – II

L	T	P	C
3	2	0	4

OBJECTIVES:
Students completing this course are expected to:

- Analyse the performance of steam nozzle, calculate critical pressure ratio.
- Compare the different types of boilers and compute their performance parameters
- Evaluate the performance of steam turbines through velocity triangles.
- Understand the concept of utilising residual heat in thermal systems.
- Illustrate the working principles of various refrigeration systems and perform cop calculations.

UNIT I STEAM NOZZLES 9+6

Types and Shapes of nozzles, Flow of steam through nozzles, Critical pressure ratio, Variation of mass flow rate with pressure ratio. Effect of friction, throat and exit area calculations. Metastable flow.

UNIT II BOILERS 9+6

Types (Fire-Tube, Water Tube, High-Pressure and Some Industrial Boilers),Comparison Between Fire Tube and Water Tube Boilers. Mountings and Accessories. Fuels - Solid, Liquid and Gas- Characteristics of Fuels. Performance calculations, Boiler trial, Boiler Draught and Performance.

UNIT III STEAM TURBINES 9+6

Types, Impulse and reaction principles, Velocity diagrams, Work done and efficiency – optimal operating conditions. Multi-staging, compounding and governing, Comparison Between Impulse and Reaction Turbines, Special forms of Turbines -Applications of Turbines.

UNIT IV COGENERATION AND RESIDUAL HEAT RECOVERY 9+6

Cogeneration Principles, Cycle Analysis, Applications, Source and utilisation of residual heat. Heat pipes, Heat pumps, Recuperative and Regenerative heat exchangers. Economic Aspects.

UNIT V REFRIGERATION AND AIRCONDITIONING 9+6

Vapour compression refrigeration cycle, Effect of Superheat and Sub-cooling, Performance calculations, Air Refrigeration Cycle, Working principle of air cycle, vapour absorption system, and Thermoelectric refrigeration. Air conditioning systems, classification of air conditioning systems (comfort, Industrial, winter, summer, year-round, Unitary and Central air conditioning systems) concept of RSHF, GSHF and ESHF, Cooling load calculations. Introduction to HVAC (Descriptive).

TOTAL: 75 PERIODS

OUTCOMES:

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

CO1 Discuss various types of steam nozzles and their flow characteristics.

CO2 Explain the functioning and features of different types of Boilers along with their auxiliaries required to compute performance parameters.

CO3 Calculate the Performance of steam turbines in power generation.

CO4 Summarize the concept of Cogeneration, working features of heat pumps and Heat Exchangers.

CO5 Compute the cooling load for air conditioning and COP of refrigeration systems .

CO6 Apply thermal engineering principles to examine the performance of various thermal systems.

TEXT BOOKS:

1. Kothandaraman, C.P., Domkundwar .S and Domkundwar A.V.,"A course in Thermal Engineering", Dhanpat Rai & Sons, 2016.
2. Mahesh. M. Rathore, "Thermal Engineering", 1st Edition, Tata Mc Graw Hill Publications, 2010.

REFERENCES:

1. Arora .C.P., "Refrigeration and Air Conditioning", Tata Mc Graw Hill, 2017
2. Ballaney. P.L . " Thermal Engineering", Khanna publishers, 25th Edition 2017
3. Donald Q. Kern, "Process Heat Transfer", Tata Mc Graw Hill, 2019.

20ME502 - DESIGN OF MACHINE ELEMENTS

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Explain the various steps involved in the Design Process
- Understand the principles involved in evaluating the shape and dimensions of a component like shaft and couplings to satisfy functional and strength requirements.
- Learn to use catalogues and standard machine components like bearing.
- Discuss the various steps involved in the optimization of energy storing devices.
- Apply the standard practices and standard data

(Use of PSG Design Data Book is permitted)

UNIT I STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS 9

Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers, fits and tolerances – Direct, Bending and torsional stress equations – Impact and shock loading – calculation of principle stresses for various load combinations, eccentric loading – curved beams – crane hook and "C" frame- Factor of safety - theories of failure – Design based on strength and stiffness – stress concentration – Design for variable loading

UNIT II SHAFTS AND COUPLINGS 9

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

UNIT III BEARINGS 9

Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Somerfield Number, Raimondi and Boyd graphs, - Selection of Rolling Contact bearings - Introduction to Seals and Gasket – (Descriptive)

UNIT IV ENERGY STORING ELEMENTS AND ENGINE COMPONENTS 9

Various types of springs, optimization of helical springs - rubber springs - Flywheels considering stresses in rims and arms for engines and punching machines- Connecting Rods.

UNIT V TEMPORARY AND PERMANENT JOINTS 9

Threaded fasteners - Bolted joints including eccentric loading, Knuckle joints, Cotter joints – Welded joints, riveted joints for structures - theory of bonded joints.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Compute the stress acting on various machine elements.
CO2 Discuss the dimensions, stress requirements of shaft and couplings based on various load conditions.
CO3 Predict appropriate bearing, from the standard catalog for varied applications.
CO4 Demonstrate the dimensions of the energy storing devices for specific applications.
CO5 Summarize the temporary and permanent joints based on application requirements.
CO6 Apply the various design concepts on to real time product applications.

TEXT BOOKS:

1. Bhandari V, “Design of Machine Elements”, 5th Edition, Tata McGraw-Hill Book Co,2020.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett “Mechanical Engineering Design”, 10th Edition, Tata McGraw-Hill, 2014.

REFERENCES:

1. Alfred Hall, Halowenko, A and Laughlin, H., “Machine Design”, Tata McGraw-HillBookCo (Schaum’s Outline), 2010
2. Ansel Ugural, “Mechanical Design – An Integral Approach",1st Edition, Tata McGraw-Hill Book Co, 2003.
3. P.C. Gope, “Machine Design – Fundamental and Application”, PHI learning private ltd, New Delhi, 2012.
4. R.B. Patel, “Design of Machine Elements”, MacMillan Publishers India P Ltd., Tech-Max Educational resources, 2011.
5. Robert C.Juvinall and Kurt M. Marshek, “Fundamentals of Machine Design”, 5thEdition, Wiley, 2011.

20ME503 - DYNAMICS OF MACHINES

L	T	P	C
2	2	0	4

OBJECTIVES:

Students completing this course are expected to:

- Apply the force-motion relationship in components subjected to external forces and analysis of standard mechanisms.
- Identify the undesirable effects of unbalances resulting from prescribed motions in mechanism.
- Classify the various types of vibrations a mechanical system can encounter.
- Discuss the effect of Dynamics of undesirable vibrations.
- Explain the principles in mechanisms used for speed control and stability control.

UNIT I FORCE ANALYSIS 12

Dynamics of Rigid Bodies in Plane Motion - Dynamic force analysis – Inertia force and Inertia torque– D Alembert's principle –Dynamic Analysis in reciprocating engines – Gas forces – Inertia effect of connecting rod– Bearing loads – Crank shaft torque – Turning moment diagrams –Fly Wheels – Flywheels of punching presses.

UNIT II BALANCING 12

Static and dynamic balancing – Balancing of rotating masses – Balancing a single cylinder engine – Balancing of Multi-cylinder inline, V-engines – Partial balancing in engines – Balancing of linkages – Balancing machines- Field balancing of discs and rotors.

UNIT III FREE VIBRATION 12

Basic features of vibratory systems – Degrees of freedom – single degree of freedom – Free vibration– Equations of motion – Natural frequency – Types of Damping – Damped vibration– Torsional vibration of shaft – Critical speeds of shafts – Torsional vibration – Two and three rotor torsional systems.

UNIT IV FORCED VIBRATION 12

Response of one degree freedom systems to periodic forcing – Harmonic disturbances – Disturbance caused by unbalance – Support motion –transmissibility – Vibration isolation vibration measurement.

UNIT V MECHANISM FOR CONTROL 12

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

TOTAL: 60 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Calculate the dynamic forces in mechanisms

CO2 Compute the balancing masses and their locations in reciprocating and rotating masses.

CO3 Discuss the importance of the frequencies of free vibration.

CO4 Estimate the frequency of forced vibration and damping coefficient.

CO5 Explain the working principle and calculate the speed and lift of the governor and estimate the gyroscopic effect on automobiles, ships and airplanes.

CO6 Demonstrate a keen understanding of the force analysis of Mechanisms to calculate the unbalanced forces and consequent vibrations to facilitate their design for smooth operations

TEXT BOOKS:

1. Khurmi R.S & Gupta J.K, "Theory of Machines" S. Chand Publications, 2020.
2. Rattan, S.S, “Theory of Machines”, 4th Edition, Tata McGraw-Hill, 2018.

REFERENCES:

1. Uicker, J.J., Pennock G.R and Shigley, J.E., “Theory of Machines and Mechanisms”, 4th Edition, Oxford University Press, 2019.
2. Ghosh. A and Mallick, A.K., “Theory of Mechanisms and Machines", 3r d Edition Affiliated East-West Pvt. Ltd., New Delhi, 2017.
3. Thomas Bevan, "Theory of Machines", CBS Publishers and Distributors, 3rd Edition, 2016.
4. Rao.J.S. and Dukkipati. R.V. "Mechanisms and Machine Theory", Wiley-Eastern Ltd., New Delhi, 2016.
5. Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 2018.
6. V. Ramamurthi, "Mechanics of Machines", Narosa Publishing House, 2016.

20ME504 - FUNDAMENTALS OF NEW PRODUCT DEVELOPMENT AND PRODUCT LIFE CYCLE MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Illustrate the need and importance of New Product Development.
- Understand the concepts of New Product Development
- Summarizes the essentials of Product Lifecycle Management.
- Develop the Design Strategies in Product Lifecycle Management
- Apply the various standards and methods in PLM

UNIT I INTRODUCTION TO NEW PRODUCT DEVELOPMENT 9

Introduction: Types of design, the importance of design, design considerations, product life cycle, technology life cycle, benchmarking and mass customization, stages, objectives, success factors, concurrent approach in NPD Product Development.

Process & Methodologies: Integrated Product development process-Identifying Customer Needs: Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process.

Mass Customization: Phishing – Product Classification, functional and innovation project.

UNIT II CONCEPT, DESIGN AND MANUFACTURING STRATEGIES IN NPD 9

Overview of the different phases of product development: Concept, Design, Manufacturing, Service and End of Life. Concept design, the activities of concept generation, Concept Selection, concept screening, and concept scoring.

Design - Detailed design, Validation and analysis(simulation),Tool Design, Manufacturing: Factors influencing material and process selection, approaches, tools and software used in selection, Manufacture, Build/Assemble, Test (quality check), Service – Sell and Deliver, Use, Maintain and Support, Dispose.

Product Development Approaches Modular design, Model- based systems engineering, Concurrent engineering, partnership with the supplier, collaborative and global design.

UNIT III INTRODUCTIONTO PLMFUNDAMENTALS 9

Introduction: Background, Overview, Need, Benefits, and Concept of Product Life Cycle, Components /Elements of PLM, Emergence of PLM, Significance of PLM, Customer Involvement.

Product life cycle environment: Product Data and Product Work flow, The Link between Product Data and Product Workflow, Key Management Issues around Product Data and Product Workflow.

UNIT IV PLM STRATEGY 9

Company's PLM vision, The PLM Strategy, Principles for PLM strategy, Preparing for the PLM strategy, Developing a PLM strategy, Strategy identification and selection, Change Management for PLM.

Components of PLM: Functional and System Components overview Different phases of product lifecycle and corresponding technologies, product development processes and methodologies.

UNIT V PLM FOUNDATION – STANDARDS AND METHODS 9

Foundation technologies and standards (e.g.visualization, collaboration and enterprise application integration), Information authoring tools (e.g., MCAD, ECAD, and technical publishing), Core functions (e.g., data vaults, document and content management, workflow and program management), Functional applications. (e.g., configuration management), Product organizational structure.

Methods and techniques, Methodologies, Processes, System components in the lifecycle, slicing and dicing the systems, Interfaces, Information, Standards, Vendors of PLM Systems and Components, Examples of PLM in use.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Discuss the role of various entities in NPD

CO2 Explain the importance of concept, design and manufacturing strategies in NPD

CO3 Describe the key components of the PLM tool.

CO4 Distinguish the various PLM processes in an organization structure.

CO5 Use the standards relevant to the PLM

CO6 Demonstrate the role of PLM in NPD

TEXTBOOKS:

1. Kari T. Ulrich and Steven D. Eppinger, “Product Design and Development”, McGraw-Hill International Edns. Reprint 2017.
2. MichaelGrieves,“ProductLifeCycleManagement”,TataMcGrawHill,2006.
3. John Stark, “Global Product: Strategy, Product Life cycle Management and the Billion Customer Question”, Springer Publisher, 2007.

REFERENCEBOOKS:

1. Kemnneth Crow, “Concurrent Engg. / Integrated Product Development”, DRM Associates, 26/3, Via Olivera, Palos Verdes, CA90274 (310)377-569, Workshop Book.
2. StephenRosenthal,“EffectiveProductDesignandDevelopment”,BusinessOneOrwin,Homewood, 1992, ISBN 1-55623-603-4.
3. Staurt Pugh, “Tool Design –Integrated Methods for Successful Product Engineering”, Addison Wesley Publishing, New York, NY.
4. Antti Saaksvuori and AnselmiImmonen, “Product Lifecycle Management”, SpringerPublisher, 2008 (3rdEdition), Reprint 2016.
5. John Stark, “Product Life cycle Management: 21st Century Paradigm for Product Realisation”, Springer Publisher, 2011 (2ndEdition), Reprint 2016.

20ME505 - PRODUCT DATA MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Describe the product data management and functions.
- Understand the Product Data Management and its associated elements to handle enterprise data.
- Illustrate the various components of PDM
- Discuss the basics of configuration management
- Summarize the various components of projects and Change management

UNIT I INTRODUCTION TO PDM 9

Introduction to PDM: Benefits and Terminology, CIM Data, PDM functions, definition and architectures of PDM systems, Engineering data, engineering workflow.

UNIT II PDM ACQUISITION 9

PDM acquisition and implementation, Resolving Data Issues, product data interchange, present market constraints, need for collaboration, Internet and developments in client server computing, portal integration

UNIT III COMPONENTS OF PDM 9

Components of PDM: Components of a typical PDM setup - hardware and document management - creation and viewing of documents - creating parts-version - control of parts and documents

UNIT IV CONFIGURATION MANAGEMENT 9

Configuration Management: Base lines, product structure, configuration management. Generic Products and Variants: Products configuration, comparison between sales configuration and products generic, generic product modeling in configuration modeler, use of order generator for variant creation, registering of variants in product register.

UNIT V PROJECTS AND CHANGE MANAGEMENT 9

Projects and Roles: creation of projects and roles - life cycle of a product- life cycle management - automating information flow - work flows - creation of workflow, Templates-life cycle – workflow integration.

Change Management: Change issue, change request, change investigation, change proposal, change activity.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Explain the various terminologies in PDM
CO2 Discuss the mode of data transfer within an enterprise.
CO3 Associate the supportive components of PDM for efficient data management.
CO4 Summarize the types of configurations needed for an enterprise.
CO5 Explain the process involved in project and change management techniques in an enterprise.
CO6 Apply the concepts of PDM for efficient data handling.

TEXT BOOKS:

1. Michael Grieves, “Product Life Cycle Management”, Tata McGraw Hill, 2006.
2. John Stark, “Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question”, Springer Publisher, 2007.

REFERENCE BOOKS:

1. Antti Saaksvuori and Anselmi Immonen, “Product Lifecycle Management”, Springer Publisher, 2008 (3rd Edition).
2. John Stark, “Product Lifecycle Management: 21st Century Paradigm for Product Realisation”, Springer Publisher, 2011 (2nd Edition).

20ME511 - KINEMATICS AND DYNAMICS LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

Students completing this course are expected to

- Develop skills for designing and analyzing linkages, cams, gears and other mechanisms.
- Determine the technical parameters relevant to gyroscope, various types of governors, bifilar suspension, compound pendulum, turn table apparatus etc.
- Experiment with various shafts, rotors, spring - mass system and compare it with the theoretical values.
- Demonstrate the given rotor system dynamically with the aid of force polygon and couple polygon.
- Construct the miniature projects from the concepts learnt in mechanisms and vibrations.

LISTOFEXPERIMENTS

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 Flywheel and Axle System.
   b) Determination of Mass Moment of Inertia of Axi-symmetric 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 & Couple.

5. Governor –Determination of Range Sensitivity, Effort etc. for Watt, Porter, Proell and Hartnell Governors.

6. Cams– Cam Profile Drawing, Motion Curves& Study of Jump Phenomenon

7. a) Single Degree of Freedom – Spring Mass System– Determination of Natural Frequency& Verification of Laws of springs–Determination of Damping Coefficient.
   b)Multi Degree Freedom - Suspension System–Determination of influence coefficient.

8. a) Determination of Torsional Natural Frequency of Single & Double Rotor Systems - Undamped and Damped Natural frequencies.
   b) Vibration Absorber–Tuned Vibration Absorber.

9. Vibration of Equivalent Spring Mass System – Undamped & Damped Vibration.

10. 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 Beam – with & without Concentrated Masses.
    b) Forced Vibration of Cantilever Beam–Mode Shapes& Natural Frequencies.
    c) Determination of Transmissibility Ratio using Vibrating Table.

TOTAL: 60 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Explain the kinematics of various mechanisms and parameters related to toothed gearing and gear trains.

CO2 Determine mass moment of inertia using turn table apparatus, bifilar suspension, compound pendulum etc.

CO3 Discuss the whirling phenomena of shafts, vibration of beams and spring - mass system, balancing of rotating and reciprocating masses

CO4 Compute the torsional frequency of single and double rotor systems, Transmissibility ratio using vibrating table

CO5 Demonstrate the gyroscopic effect, effort and sensitivity of various types of Governors

CO6 Illustrate the concepts of mechanisms and vibrations through miniature projects

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S. No.	NAME OFTHEEQUIPMENT	Quantity
1	Cam Follower Set - Up	1No.
2	Motorized Gyroscope	1No.
3	Governor Apparatus-Watt, Porter, Proell & Hartnell Governors	1No.
4	Whirlingof Shaft Apparatus	1No.
5	Dynamic Balancing Machine	1No.
6	Two Rotor Vibration Set – Up	1No.
7	Spring Mass Vibration System	1No.
8	Torsional Vibration of Single Rotor System Set - Up	1No.
9	Gear Models	1No.
10	Kinematic Models to study various Mechanisms	1No.
11	Turn - Table Apparatus	1No.
12	Transverse Vibration Set – Up of a Cantilever Beam	1No.

20ME512 – THERMAL ENGINEERING LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

Students completing this course are expected to

- Explain the value timing-V diagram and performance of IC Engines
- Illustrate the characteristics of fuels/Lubricates used in IC Engines
- Demonstrate the Performance of steam generator/ turbine
- Experiment the heat transfer phenomena predict the relevant coefficient using implementation
- Discuss the performance of refrigeration cycle / components

LIST OF EXPERIMENTS

I.C. ENGINE LAB

1. Valve Timing and Port Timing diagrams.
2. Actual p-v diagrams of IC engines.
3. Performance Test on 4 – stroke Diesel Engine.
4. Heat Balance Test on 4 – stroke Diesel Engine.
5. Morse Test on Multi-cylinder Petrol Engine.
6. Retardation Test on a Diesel Engine.
7. Determination of Flash Point and Fire Point of various fuels / lubricants.

STEAM LAB

1. Study on Steam Generators and Turbines.
2. Performance and Energy Balance Test on a Steam Generator.
3. Performance and Energy Balance Test on Steam Turbine.

HEAT TRANSFER LAB:

1. Thermal conductivity measurement using guarded plate apparatus.
2. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
3. Determination of heat transfer coefficient under natural convection from a vertical cylinder.
4. Determination of heat transfer coefficient under forced convection from a tube.
5. Determination of Thermal conductivity of composite wall.
6. Determination of Thermal conductivity of insulating powder.
7. Heat transfer from pin-fin apparatus (natural & forced convection modes)
8. Determination of Stefan – Boltzmann constant.
9. Determination of emissivity of a grey surface.
10. Effectiveness of Parallel / counter flow heat exchanger.

REFRIGERATION AND AIR CONDITIONING LAB

1. Determination of COP of a refrigeration system
2. Study on Psychrometric processes
3. Performance test on a reciprocating air compressor
4. Study on HC Refrigeration System
5. Study on fluidized Bed Cooling Tower

TOTAL: 60 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Explain the performance of different air standard cycles
CO2 Discuss the functioning and features of IC engines, components, and auxiliaries.
CO3 Apply thermal engineering principles to examine the performance of engines steam boilers and turbines.
CO4 Utilize thermal analysis of different heat exchanger to compare the actual and theoretical heat transfer rate.
CO5 Apply thermodynamics principles to find various parameters of compressors, air conditioner and refrigerator.
CO6 Demonstrate the fundamentals of heat transfer and predict the performance of various heat transfer equipment.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1	I.C Engine – 2 stroke and 4 stroke model	1 set
2	Apparatus for Flash and Fire Point	1 No.
3	4-stroke Diesel Engine with mechanical loading.	1 No
4	4-stroke Diesel Engine with hydraulic loading.	1 No.
5	4-stroke Diesel Engine with electrical loading.	1 No.
6	Multi-cylinder Petrol Engine	1 No.
7	Single cylinder Petrol Engine	1 No.
8	Data Acquisition system with any one of the above engines	1 No.
9	Steam Boiler with turbine setup	1 No.

S.No.	NAME OF THE EQUIPMENT	Qty.
1	Guarded plate apparatus	1 No.
2	Lagged pipe apparatus	1 No.
3	Natural convection-vertical cylinder apparatus	1 No.
4	Forced convection inside tube apparatus	1 No.
5	Composite wall apparatus	1 No.
6	Thermal conductivity of insulating powder apparatus	1 No.
7	Pin-fin apparatus	1 No.
8	Stefan-Boltzmann apparatus	1 No.
9	Emissivity measurement apparatus	1 No.
10	Parallel/counter flow heat exchanger apparatus	1 No.
11	Single/two stage reciprocating air compressor	1 No.
12	Refrigeration test rig	1 No.
13	Air-conditioning test rig	1 No.

20ME513 - PRODUCT DATA MANAGEMENT AND PLM LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

Students completing this course are expected to:

- Explain the PLM software and Hardware requirements
- Understand the various functionalities involved in Product development.
- Illustrate the Product structure management
- Discuss the Search management
- Describe the Search management

Content to Demonstration and Practice

- Introduction, Installation & maintenance of following software: Oracle / SQL Server / DB2, PLM Server, CAD Software, MS Office, Rich client, Web client, Application server, Software/ Hardware/ Network issues resolutions
- Product Development – Basic Concept.
- Product Development II – Phases, Product Development and Information System, Product Data Management (PDM), PDM Basic Functions, PDM Function - Product Structure Management, PDM Function - Electronic Vault Management, PDM Function - Workflow Management, PDM Function - Project Management, PDM Function - Search Management,
- Case Study

List of Exercises

1. Study of PDM/PLM software
2. Study of Installation & maintenance PDM/PLM software
3. Idea Generation and Documentation
4. Product development –Design Phase
5. Windchill Interface management
6. Design file integration with Windchill
7. Product structure management
8. Work flow management
9. Search management
10. Case study

TOTAL: 60 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Explain the installation and maintenance procedure of software related to PLM.
CO2 Understand the PLM and PDM functions in executing the task of enterprise.
CO3 Demonstrate workflow, Project and search in PLM environment.
CO4 Describe the case studies in detail
CO5 Discuss the PLM software interface
CO6 Illustrate Design file integration with Windchill

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS		
S.No.	**Description of Equipment**	**Qty**
Hardware		
1	Computer Server	1
2	Computer nodes or systems (High end CPU with at least 2 GB main memory) networked to the server	30
3	High Speed data connectivity	To all nodes
Software		
1	PLM Software Windchill	30 users
2	CAD software	30 users

20CS512 - ADVANCED APTITUDE AND CODING SKILLS - I

L	T	P	C
0	0	2	1

OBJECTIVES:

Students completing this course are expected to:

- To develop vocabulary for effective communication and reading skills.
- To build the logical reasoning and quantitative skills.
- To develop error correction and debugging skills in programming.

LIST OF EXERCISES:

1. English – Phase I Advanced

Vocabulary: Synonyms, Antonyms, Grammar: Subject-Verb Agreement, Tenses and Articles, Prepositions and Conjunctions, Speech and Voices, Comprehension: Inferential and Literal Comprehension, Contextual Vocabulary, Comprehension ordering

2. Logical Reasoning – Phase I Advanced

Deductive Reasoning: Coding deductive logic, Directional sense, Blood relations, Objective Reasoning, Selection decision tables, Puzzles, Inductive reasoning: Coding pattern and Number series pattern recognition, Analogy and Classification pattern recognition, Abductive Reasoning: Logical word sequence, Data sufficiency

3. Quantitative Ability - Phase I Advanced

Basic Mathematics: Divisibility, HCF and LCM, Numbers, decimal fractions and power, Applied Mathematics: Profit and Loss, Simple and Compound Interest, Time, Speed and Distance, Engineering Mathematics: Logarithms, Permutation and Combinations, Probability

4. Automata Fix – Phase I Advanced

Logical, Compilation and Code reuse

TOTAL: 30 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Develop vocabulary for effective communication and reading skills.

CO2 Build the logical reasoning and quantitative skills.

CO3 Develop error correction and debugging skills in programming.

SEMESTER – VI

20ME601 - DESIGN OF TRANSMISSION SYSTEMS

L	T	P	C
2	2	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the principles and procedure for the design of Mechanical power Transmission components.
- Explain the standard procedure available for Design of Transmission of Mechanical elements.
- Discuss the advanced transmission systems
- Use the standard data and catalogs.
- Apply the design procedures in the project work

UNIT I DESIGN OF FLEXIBLE ELEMENTS 9+3

Design of Flat belts and pulleys – Design and Selection of V belts and pulleys – Design and 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 - Lewis and Buckingham method - Design of straight tooth spur Gears & helical gears based on Gear materials & Gear Life considerations – Spur gear contact ratio and Interface - Design of Spur & helical gear 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 AND WORM 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. Design of Bevel gears based on gear life considerations. Worm Gear: Merits and demerits- terminology. Design of worm gear pair- Thermal capacity, materials - forces and stresses, efficiency, estimating the size of the worm gear pair.

UNIT IV GEAR BOXES 9+3

Geometric progression –Preferred numbers- Standard step ratio – speed selection- Ray diagram, kinematics layout – Gear tooth calculation - module- length of shaft – Design of shafts- Design of sliding mesh gear box - Design of multi speed gear box for machine tool applications - Constant mesh gear box, Epicyclic Gear Box - Speed reducer unit. – Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications.

UNIT V CLUTCHES, BRAKES 9+3

Design of plate clutches – axial clutches - cone clutches - internal expanding rim clutches. Band and Block brakes - external shoe brakes – Internal expanding shoe brake.

TOTAL: 60 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Understand the concepts of design to belts, chains and rope drives.
CO2 Explain the concepts of design to spur, helical gears.
CO3 Discuss the concepts of design to worm and bevel gears.
CO4 Summarize and apply the concepts of design to gear boxes.
CO5 Demonstrate the concepts of advanced transmission systems
CO6 Apply the design procedures in their projects

TEXT BOOKS:

1. Bhandari V, "Design of Machine Elements", 5th Edition, Tata McGraw-Hill Book Co, 2020.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 10th Edition, Tata McGraw-Hill, 2017.

REFERENCES:

1. Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, "Design of Machine Elements" 8th Edition, Printice Hall, 2003.
2. Orthwein W, "Machine Component Design", Jaico Publishing Co, 2003.
3. Prabhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai, 2000.
4. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Design", 4th Edition, Wiley, 2005

20ME602 - COMPUTER AIDED DESIGN AND MANUFACTURING

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the advanced aspects of enabling computer aided technologies used in design, manufacturing and rapid product development
- Discuss the use of computers in mechanical component design
- Describe the application of computers in various aspects of Manufacturing viz., Design, Proper planning, Manufacturing cost, Layout & Material Handling system.
- Illustrate the advances in modern techniques of rapid prototyping
- Summarize the various CAD standards in exchange of data, graphics and images

UNIT I INTRODUCTION TO CAD AND CAM 9

Product cycle - Design process- sequential and concurrent engineering- Computer aided design – CAD system architecture- Computer graphics - 2D and 3D transformations-homogeneous coordinates - Line drawing – Clipping. Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control – CAD/CAM concepts – Lean Production and Just-In-Time Production.

UNIT II GEOMETRIC MODELING 9

Wireframe Modeling-Representation of curves - Hermite curve- Bezier curve- B-spline curves-rational curves -Techniques for surface modeling - Solid modeling techniques- CSG and B-rep-Assembly modeling- Top-down Approach- Bottom-Up Approach

UNIT III CAD STANDARDS 9

Standards for computer graphics - Graphical Kernel System (GKS) - standards for exchange images - Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP etc. – communication standards.

UNIT IV CELLULAR MANUFACTURING AND FLEXIBLE MANUFACTURING SYSTEM 9

Group Technology (GT), Part Families – Parts Classification and coding – Computer Aided Process Planning (CAPP) – Production flow Analysis–Cellular Manufacturing – Composite part concept – Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control.

UNIT V ADDITIVE MANUFACTURING 9

Need - Development of RP systems – RP process chain - Impact of Rapid Prototyping on Product Development. - STL file generation. Rapid Prototyping system: Stereolithography (SLA)- Fused deposition Modeling (FDM)- laminated object manufacturing (LOM)- Selective Laser Sintering (SLS) - Working Principles, details of processes, products, materials, advantages, limitations and applications.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Describe the product cycle, 2D and 3D transformations, CAD/CAM concepts
CO2 Interpret the fundamentals of parametric curves, surfaces and Solids
CO3 Use the different types of Standard systems used in CAD
CO4 Summarize the types of techniques used in Cellular Manufacturing and FMS
CO5 Explain the basic types of additive manufacturing process.
CO6 Apply the CAD Packages in Design and manufacturing process

TEXT BOOKS:

1. Ibrahim Zeid “Mastering CAD CAM” Tata McGraw-Hill Publishing Co. 2020
2. Mikell.P. Groover “Automation, Production Systems and Computer Integrated Manufacturing”, Prentice Hall of India, 2020.
3. Mikell.P. Groover , ‘’CAD CAM Theory and Practice’’ Special Indian Edition 2019
4. Rapid prototyping: Principles and applications, second edition, Chua C.K., Leong K.F and Lim C.S., World Scientific Publishers, 2019.

REFERENCES:

1. Anthony Lal, “Oil hydraulics in the service of industry”, Allied publishers, 2016.
2. Chris McMahon and Jimmie Browne “CAD/CAM Principles”, "Practice and Manufacturing management “Fourth Edition, Pearson Education,2019
3. Donald Hearn and M. Pauline Baker “Computer Graphics”’. Prentice Hall Inc, 2020
4. Foley, Wan Dam, Feiner and Hughes - "Computer graphics principles & practice" Pearson Education, 2019
5. William M Neumann and Robert F. Sproul “Principles of Computer Graphics”, McGraw Hill Book Co. Singapore, 2018

20ME603 - HEAT AND MASS TRANSFER

L	T	P	C
2	2	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the mechanisms of heat transfer under steady and transient conditions.
- Apply the fundamental concept and principles in convective heat transfer
- Discuss the theory of phase change heat transfer and design of heat exchangers.
- Explain the fundamental concepts and principles in radiation heat transfer
- Describe the relation between heat and mass transfer and to solve simple mass transfer problems.

(Use of standard HMT data book permitted)

UNIT I CONDUCTION 9+3

General Differential equation of Heat Conduction– 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.

UNIT II CONVECTION 9+3

Free and Forced Convection - Hydrodynamic and Thermal Boundary Layer. 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 PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS 9+3

Nusselt's theory of condensation - Regimes of Pool boiling and Flow boiling. Correlations in boiling and condensation. Heat Exchanger Types - Overall Heat Transfer Coefficient – Fouling Factors - Analysis – LMTD method - NTU method. Applications of Heat Exchangers, Introduction to TEMA Standards

UNIT IV RADIATION 9+3

Radiation laws, Black Body Radiation – Grey body radiation - Shape Factor – Electrical Analogy – Radiation Shields. Radiation through gases.

UNIT V MASS TRANSFER 9+3

Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion – Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations.

TOTAL: 60 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Explain the concept of one dimensional steady and transient heat conduction through various systems

CO2 Discuss the concept of convection with the flow of fluids in different elements.

CO3 Associate the significance of phase change with heat transfer in heat exchangers.

CO4 Discuss the concept of radiation and application in heat transfer systems.

CO5 Understand the concept of mass transfer and its correlations.

CO6 Apply the conduction and convection principles in product application by real time study.

TEXT BOOKS:

1. Holman, J.P., "Heat and Mass Transfer", Tata McGraw Hill, 10th Edition, 2017
2. Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata McGraw Hill, 6th Edition 2020

REFERENCES:

1. Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley & Sons, 7th Edition, 2014.
2. Kothandaraman, C.P., "Fundamentals of Heat and Mass Transfer", New Age International,New Delhi, 2012.
3. Nag, P.K., "Heat Transfer", Tata McGraw Hill, New Delhi, 2011
4. R.C. Sachdeva, “Fundamentals of Engineering Heat & Mass transfer”, New Age International Publishers, 2009.

20ME604 - ADVANCED PLM AND PRODUCT MASTER MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the Product management and architecture.
- Explain the Advanced concepts of PLM
- Illustrate the PLM data management
- Discuss the PLM repair and Maintenance
- Summarize the essentials of PLM Configuration and Integration

UNIT I PRODUCT MASTER MANAGEMENT AND ARCHITECT 9

Product master management (managing the deployment of the finished design into the production environment), product architecture (Functional architecture, Physical architecture etc), understanding business object, CADBOM alignment, security services, PLM localization, Business modeling, classification structure, PLM System Architecture (2tier/3tier/4tier etc).

UNIT II PLM DATA MANAGEMENT 9

Managing Changes and Workflows, Classifying Data, Managing Documents, Reports, Requirements, and Schedules, Sharing Data, Managing Product Structures, Managing Manufacturing Data, Managing Mechatronics Data and Managing CAE Data

UNIT III PLM REPAIR AND MAINTENANCE 9

Visualizing Products, Repeatable Digital Validation, Managing Quality Data, Managing Maintenance, Repair, and Overhaul Data.

UNIT IV PRODUCT DATA REPRESENTATION 9

Product Data - Data objects to represent product data - parts, assemblies, processes, product changes, requirements, and specifications, Simple parts (with JT /with CAD /with CAD & JT/ with CAD & drawing / with CAD, JT, drawing & other documents), Simple assembly, multilevel assembly, Hybrid assembly - concurrency in data transfer (replica transfer/delta transfer/re-export), collision

UNIT V PLM CONFIGURATION AND INTEGRATION 9

Concepts of Product Structure management - Configurations, Multi CAD Integrations, issues involved - data management of heterogeneous CAD system - management of product data interfaces - GD&T, annotations, manufacturing notes - Integration of CAM with PLM.

TOTAL: 45 PERIODS

OUTCOMES:

After success full completion of the course, students will be able to

CO1 Discuss the PLM architecture and data management
CO2 Explain the steps involved in maintenance of PLM Tools
CO3 Describe and Classify the varies ways of data representation
CO4 Demonstrate the PLM configuration and integration with CAM.
CO5 Illustrate the Integration of CAM with PLM
CO6 Distinguish the data interfaces, GD&T, annotations, manufacturing notes, Integration of CAM with PLM

TEXT BOOKS:

1. Michael Grieves, “Product Life Cycle Management”, Tata McGraw Hill, 2006.
2. John Stark, “Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question”, Springer Publisher, 2007.

REFERENCE BOOKS:

1. Antti Saaksvuori and Anselmi Immonen, “Product Lifecycle Management”, Springer Publisher, 2008 (3rd Edition).
2. John Stark, “Product Lifecycle Management: 21st Century Paradigm for Product Realisation”, Springer Publisher, 2011 (2nd Edition).

20ME611 - CAD / CAM LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES

Students completing this course are expected to:

- Show the practical knowledge in handling 2D drafting and 3D modelling software systems.
- Design the 3 - Dimensional geometric model of parts, sub-assemblies, assemblies and exporting it to drawing.
- Explore to the features of CNC Machine Tools.
- Use the various types of to modern control systems (Fanuc)
- Know the application of various CNC machines like CNC lathe, CNC Vertical Machining centre.

LIST OF EXPERIMENTS

I. 3D GEOMETRIC MODELLING **30 PERIODS**

1. Introduction of 3D Modelling software

Creation of 3D assembly model of following machine elements using 3D Modelling software

2. Flange Coupling
3. Plummer Block
4. Screw Jack
5. Universal Joint
6. Machine Vice
7. Stuffing box
8. Connecting rod
9. Piston
10. Crankshaft

II. Manual Part Programming. **30 PERIODS**

(i) Part Programming - CNC Machining Centre
(a) Linear Cutting. (b) Circular cutting (c) Cutter Radius Compensation.
(d) Canned Cycle Operations.

(ii) Part Programming - CNC Turning Centre
(a) Straight, Taper and Radius Turning. (b) Thread Cutting.
(c) Rough and Finish Turning Cycle. (d) Drilling and Tapping Cycle.

III. Study on Computer Aided Part Programming

(a) CL Data and Post process generation using CAM packages.
(b) Application of CAPP in Machining and Turning Centre.

TOTAL: 60 PERIODS

OUTCOMES

After successful completion of the course, the students will be able to

CO1 Explore to the different 3D modelling features available in the CAD System.

CO2 Design the 3 - Dimensional geometric part and assembly models.

CO3 Detail the 3 - Dimensional geometric model of parts, sub-assemblies, assemblies into to production drawings.

CO4 Apply the fundamental working principle of CNC machine tools.

CO5 Program using G & M Codes and simulate the CNC program.

CO6 Generate part programming data through CAM software.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	Description of Equipment	Qty
HARDWARE		
1.	Computer Server	1
2.	Computer nodes or systems (High end CPU with at least 1 GB main memory) networked to the server	30
3.	A3 size plotter	1
4.	Laser Printer	1
5.	CNC Lathe	1
6.	CNC milling machine	1
SOFTWARE		
7.	Any High-end integrated modeling and manufacturing CAD / CAM software	15 licenses
8.	CAM Software for machining centre and turning centre (CNC Programming and tool path simulation for FANUC)	15 licenses
9.	Licensed operating system	Adequate

20ME612 - DESIGN AND FABRICATION PROJECT AND INTERNSHIP

L	T	P	C
0	0	4	2

OBJECTIVES:

Students completing this course are expected to:

- Use the laboratories to fabricate the working model.
- Complete the 'hands-on' working experience in the real world or industry, and to enhance the student's learning experience.
- Develop the ability to conceptualize a product, apply standard/innovative design techniques and realize the product through fabrication with focus on design-manufacturing integration.
- Experiment to arrive at solutions for real world mechanical engineering problems
- Apply the principles of mechanical engineering in real world systems.

DESIGN AND FABRICATION PROJECT

The students may be grouped into 2 to 3 and work under a project supervisor. The device/ system/component(s) to be fabricated may be decided in consultation with the supervisor and if possible with an industry.

INTERNSHIP

Every student should undergo Industrial / Practical Training, Summer Project, Internship. At the end of Industrial/Practical training/internship/Summer Project, the candidate shall submit a certificate from the organization where the candidates have undergone training and a brief report.

(50% weightage is given for **Design and Fabrication Project** and remaining 50% weightage is given for **Internship**)

TOTAL: 60 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Design and fabricate the machine element or the mechanical product.
CO2 Demonstrate the working model of the machine element or the mechanical product
CO3 Interpret the working of mechanical engineering systems.
CO4 Develop the ability to solve a specific problem right from its identification.
CO5 Identify the realization of a product, conceptualized and designed by him.
CO6 Ability to solve real life challenges in the workplace by analyzing work environment and conditions, and selecting appropriate skill sets acquired from the course.

20ME613 – ADVANCED PLM AND PRODUCT MASTER MANAGEMENT LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

Students completing this course are expected to:

- Understand the customization of PLM
- Experience the hands-on training on CAD integration.
- Discuss the Advanced PLM concepts in project execution.
- Demonstrate the CAD client test
- Experiment the Sample Data Migration using PLM tool

PLM Customization Lab: using PLM software - Windchill

- Introduction to customization, need, types; introduction, Basic customization concepts, common customization tasks
- Windchill customization, Architecture and POM
- PDM Functions - Workflow Management, Project Management, Search Management
- Product Lifecycle Management (PLM) Concept and Special Functions - Creating Organization (Users, Roles, Group, Volume etc), Defining rights (Object/Rule-Based), Creating a required hierarchy of folders, Creating item, form, LOVs, dataset types, Defining business model (Naming Rule, Type Display Rule, Action Rule, Deep Copy Rule, GRM rules, Business Modeler Import/Export Rules, Property Rule, Compound Property rule), Customizing different queries and reports out of the box, Creating different workflows, Creating and managing engineering change, Adding a custom attribute to forms / in class, Creating different BOM view (PSE), Resource classification.
- CAD Integration - CAD Manager/ Embedded Client, Seed/Template Creation, Attribute Mappings – PDM Functionalities Mappings
- Sample Data Migration - Removing Broken Links and Duplicates, Associated Files (TIFF, CGM etc), Attribute Mappings, Define Search File, Define Map File, Importing Data
- Testing & QA - Typical Server Tests (Database Testing, Utilities Database and Volume, Backup & Restore), Typical Client Tests (Rich client test, CAD client test, Web client test)

LIST OF EXPERIMENTS

1. Study of PLM software Customization
2. Study of windchill Customization Architecture
3. Workflow Management,
4. Project Management and Search Management
5. Customizing different queries and reports
6. Creating different workflows
7. CAD Integration and Attribute Mappings
8. Sample Data Migration

TOTAL: 60 PERIODS

OUTCOMES:
After successful completion of the course, the students will be able to

- **CO1** Use customization to create a newer design in PLM platform
- **CO2** Describe the PDM functions in managing workflows of an enterprise
- **CO3** Apply the various CAD tool integration for effective data transfer/management
- **CO4** Illustrate the Testing and certify the projects through various test methods.
- **CO5** Demonstrate the CAD integration tool.
- **CO6** Explain the process involved in Data Migration.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS		
S.No.	**Description of Equipment**	**Qty**
	Hardware	
1.	Computer Server	1
2.	Computer nodes or systems (High-end CPU with at least 2GB main memory) networked to the server	30
3	High Speed data connectivity	To all nodes
	Software	
1	PLM Software – Windchill	30 Users
2	Creo	30 Users

20CS614 - ADVANCED APTITUDE AND CODING SKILLS - II

L	T	P	C
0	0	2	1

OBJECTIVES:

Students completing this course are expected to:

- To develop advanced vocabulary for effective communication and reading skills.
- To build an enhanced level of logical reasoning and quantitative skills.
- To develop error correction and debugging skills in programming.
- To apply data structures and algorithms in problem solving.

LIST OF EXERCISES:

1. English – Phase II Advanced

Vocabulary: Synonyms, Antonyms, Grammar: Subject-Verb Agreement, Tenses and Articles, Prepositions and Conjunctions, Speech and Voices, Comprehension: Inferential and Literal Comprehension, Contextual Vocabulary, Comprehension ordering

2. Logical Reasoning – Phase II Advanced

Deductive Reasoning: Coding deductive logic, Directional sense, Blood relations, Objective Reasoning, Selection decision tables, Puzzles, Inductive reasoning: Coding pattern and Number series pattern recognition, Analogy and Classification pattern recognition, Abductive Reasoning: Logical word sequence, Data sufficiency

3. Quantitative Ability - Phase II Advanced

Basic Mathematics: Divisibility, HCF and LCM, Numbers, decimal fractions and power, Applied Mathematics: Profit and Loss, Simple and Compound Interest, Time, Speed and Distance, Engineering Mathematics: Logarithms, Permutation and Combinations, Probability

4. Automata Fix – Phase II Advanced

Logical, Compilation and Code reuse

5. Automata - Phase II Advanced

Data Structure Concepts: Array and Matrices, Linked list, String processing and manipulation, Stack/Queue, Sorting and Searching Advanced Design and Analysis Techniques: Greedy Algorithms, Minimum Spanning Trees, String Matching, Divide and Conquer, Computational Geometry

TOTAL: 30 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Develop advanced vocabulary for effective communication and reading skills.
CO2 Build an enhanced level of logical reasoning and quantitative skills.
CO3 Develop error correction and debugging skills in programming.
CO4 Apply data structures and algorithms in problem solving.

SEMESTER – VII

20ME701 – POWER PLANT ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Explain overview of Steam Power Plant and its operation and maintenance.
- Describe basic working principles of gas turbines and Diesel engine power plant
- List the principal components and types of nuclear reactors
- Applying the principle of various Solar, Wind and Ocean energy generating devices.
- Describe the current energy, economic and environmental issues

UNIT I COAL BASED THERMAL POWER PLANTS 9

Rankine Cycle - improvisations, Layout of Modern Coal Power Plant, Super Critical Boilers, FBC Boilers, Turbines, Condensers, Steam & Heat Rate, Sub - Systems of Thermal Power Plants – Fuel and Ash Handling, Draught System, Feed Water Treatment, Binary Cycles and Cogeneration Systems

UNIT II DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS 9

Otto, Diesel, Dual & Brayton Cycle - Analysis & Optimization. Components of Diesel and Gas Turbine Power Plants. Combined Cycle Power Plants. Integrated Gasifier based Combined Cycle Systems.

UNIT III NUCLEAR AND MHD POWER PLANTS 9

Basics of Nuclear Engineering, Layout and Sub - Systems of Nuclear Power Plants, Working of Nuclear Reactors: Boil*ing Water Reactor* (BWR), P*ressurized Water Reactor* (PWR), CANada Deuterium- Uranium Reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety Measures for Nuclear Power Plants. Magneto Hydro Dynamic (MHD) Power Plants

UNIT IV POWER FROM RENEWABLE ENERGY 9

Hydro Electric Power Plants – Classification, Typical Layout and associated Components including Turbines. Principle, Construction and Working of Wind, Tidal, *Solar* Photo Voltaic (SPV), Solar Thermal, Geo Thermal, Biogas and Fuel Cell Power Systems.

UNIT V ENERGY, ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS 9

Power Tariff Types, Load Distribution Parameters, Load Curve, Comparison of Site Selection Criteria, Relative Merits & Demerits. Capital & Operating Cost of Different Power Plants. Pollution Control Technologies including Waste Disposal Options for Coal and Nuclear Power Plants. Environmental legislations / Government policies

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Analyse various aspects of a Thermal Power Plant and its components

CO2 Interpret the Systems viz. Fuel and Ash Handling, Draught, Feed Water, Cogeneration etc. associated with a Thermal Power Plant

CO3 Exemplify Diesel, Gas Turbine and Combined Cycle Power Plants besides analysis of Air Standard Cycles

CO4 Infer the Working Operation of various Nuclear Reactors and Magneto Hydro Dynamic power generation.

CO5 Discuss environmental aspects and alternate sources of energy to reduce pollution.

CO6 Evaluate various factors of power. Calculate power generation cost

TEXT BOOKS:

1. Nag. P.K., "Power Plant Engineering", Third Edition, Tata McGraw – Hill Publishing Company Ltd., July 2017.
2. A Course in Power Plant Engineering - ARORA, S C; DOMKUNDWAR, S - DHANPAT RAI PUBLICATION, 2016
3. Power Plant Technology - EL-WAKIL. M.M - McGraw-Hill 2012

REFERENCES:

1. El-Wakil. M.M., "Power Plant Technology", Tata McGraw – Hill Publishing Company Ltd., 2010.
2. Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, "Power Plant Engineering", Second Edition, Standard Handbook of McGraw – Hill, 1998.
3. Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University, 2004.
4. Domkundwar, S., Power Plant Engineering, Dhanpat Rai & Sons, 1988. 4. Wakil, M.M., Power Plant Technology, Tata McGraw-Hill, 1985

20ME702 - PROCESS PLANNING AND COST ESTIMATION

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the process planning concepts and its activities
- Distinguish the various methods of cost estimation
- Compare the cost estimation and cost accounting
- Demonstrate the cost estimation for various products after process planning
- Calculate the Machining time of various operation

UNIT I PROCESS PLANNING ACTIVITIES 10

Introduction - methods of process planning - Manual - CAPP- Variant – Generative CAPP - Process planning activities - Drawing Interpretation - Material evaluation – steps in process selection - Production equipment and tooling selection - Types of Production.

UNIT II PROCESS PLANNING TOOLS 10

Process parameters calculation for various production processes - Selection jigs and fixtures election of quality assurance methods – Set of documents for process planning - Economics of process planning- Break Even Analysis - make or buy decision- case studies

UNIT III COSTING ESTIMATION AND EXPENSES 8

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

UNIT IV ESTIMATION OF COSTS IN PRODUCTION SHOP 8

Estimation of Different Types of Jobs – Estimation of Forging Shop, Estimation of Welding Shop, Estimation of Foundry Shop - Estimate of sheet metal shop

UNIT V ESTIMATION MACHINING TIMEs AND COST 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 - Illustrative examples

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Associate the knowledge of engineering fundamentals for process planning and its activities
CO2 Distinguish various process planning tool and its applications
CO3 Discuss the various elements involved in costing.
CO4 Estimate the product cost of various manufacturing methods
CO5 Calculate the Machining time for various operations carried out in different machines
CO6 Apply the concept of Process planning and cost estimation for various production process

TEXT BOOKS:

1. Peter Scalon, “Process planning, Design/Manufacture Interface”, Elsevier science technology Books, Dec 2018.

REFERENCES:

1. Ostwalal P.F. and Munez J., “Manufacturing Processes and systems”, 9th Edition, John Wiley, 2008.
2. Russell R.S and Taylor B.W, “Operations Management”, 7th Edition, John Wiley & Sons, 2008.
3. Chitale A.V. and Gupta R.C., Product Design and Manufacturing, 6th Edition, PHI, 2011.
4. Mikell P. Groover, “Automation, Production, Systems and Computer Integrated Manufacturing”, Pearson Education, 4th Edition, 2016.
5. K.C. Jain & L.N. Aggarwal, “Production Planning Control and Industrial Management”, Khanna Publishers, Eighth Edition, 1999.
6. G.B.S. Narang&V.Kumar, “Production and Costing” Khanna Publishers, 4th Edition, 2014.

20ME703 - INTRODUCTION TO BUSINESS INTELLIGENCE AND ANALYTICS, ADVANCED INTEGRATION TECHNIQUES

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the need of Industry 4.0.
- Illustrate the integration of PLM with advanced digitization techniques.
- Explain the evolution of disruptive technologies
- Discuss the concepts of Digital Twin
- Differentiate the components of Digital Thread

UNIT I INTRODUCTION TO INDUSTRY 4.0 **9**

Industry 4.0: Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories. Introduction to Business Intelligence and Analytics, Advanced Integration techniques, IOT platforms.

UNIT II INTEGRATION OF THE PLM SYSTEM WITH OTHER APPLICATIONS **9**

The role of PLM systems in relation to other systems- Business Process- Product Structure- Transfer File - Enterprise Resource Planning- Enterprise Resource Planning System

UNIT III DIGITAL TWIN BASICS **9**

Introduction, Industrial Revolution Facts, Industry 4.0 Environment, Technologies Transforming Industry 4.0. Basic Concepts of Digital Twin: Evolution of Pairing, Definition and Features of Digital Twins, Digital Twin Timeline.

UNIT IV DIGITAL TWIN **9**

Features and Implementation of Digital Twin: Digital Twin Terminologies & Essentials, Working of Digital Twins. Building Blocks of Digital Twin: Digital Twin Building Blocks, Digital Twin Technology Drivers & Enablers.

Types of Digital Twin: Based on Product, Process, Based on Functionality, Based on Maturity, Characteristics of a Good Digital Twin Platform. Digital Twin: Benefits, Impacts and Challenges: Barriers of Digital Twin Implementation

UNIT V DIGITAL THREAD **9**

Digital Thread Definition, Data Storage in the Digital Thread, Data Sharing and The Digital Thread, Strategic issues in implementing the digital thread, Technologies used in the Design Process, Cyber infrastructure Components of the Digital Thread and Digital Thread on the Shop Floor

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Describe the need for Industry4.0 and the associated technologies
CO2 Explain the process of integrating PLMwithIndustry4.0.
CO3 Understand the basic concepts of Digital Twin
CO4 Illustrate the features and types of Digital Twin.
CO5 Discuss the technologies of Digital Thread
CO6 Explain the importance of advanced tools and techniques for business integration.

TEXT BOOKS:

1. Michael Grieves, “Product Life Cycle Management”, Tata McGraw Hill, 2006.
2. John Stark, “Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question”, Springer Publisher, 2007.

REFERENCES:

1. Antti Saaksvuori and AnselmiImmonen, “Product Lifecycle Management”, Springer Publisher, 2008 (3rd Edition).
2. John Stark, “Product Lifecycle Management: 21st Century Paradigm for Product Realisation”, Springer Publisher, 2011 (2nd Edition).
3. Industry 4.0: The Industrial Internet of Things”, by Alasdair Gilchrist (A press)
4. Industrial Internet of Things: Cyber manufacturing Systems ”by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer)

20ME711 - SIMULATION AND ANALYSIS LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

Students completing this course are expected to:

- Understand the software tools needed to analyse engineering problems.
- Experiment on MATLAB for solving dynamic problems.
- Apply the simulation and analysis tools.
- Experiment the structural and dynamic analysis using the FE tool.
- Illustrate the time-variant analysis using a FE tool.

LIST OF EXPERIMENTS

A. SIMULATION

1. MATLAB basics / C- Basic Dealing with matrices, Graphing-Functions of one variable and two variables
2. Use of MATLAB / C to solve simple problems in vibration
3. Mechanism Simulation using Multibody Dynamics software

B. ANALYSIS

1. Force and Stress analysis using link elements in Trusses, cables etc.
2. Stress and deflection analysis in beams with different support conditions.
3. Stress analysis of flat plates and simple shells.
4. Stress analysis of axisymmetric 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.
9. Harmonic, transient and spectrum analysis of simple systems.

TOTAL: 60 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Apply the fundamentals concepts of the finite element method in problem characterization

CO 2 Compute the deflection and stress in 1D and 2D problem

CO 3 Explain the effect of various load acting on 1D beam in real-time problem

CO 4 Examine the modal analysis for a beam under various boundary conditions

CO 5 Demonstrate the effects due to harmonic loading on structures

CO 6 Examine the thermal effects on 2D structure

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S. NO.	NAME OF THE EQUIPMENT	Qty.
1	Computer Work Station	30
2	Color Desk Jet Printer	01
3	Multibody Dynamic Software Suitable for Mechanism simulation and analysis	30 licenses
4	C / MATLAB	5 licenses

20ME712 - MECHATRONICS LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

Students completing this course are expected to:

- Understand an interdisciplinary research and industry driven innovation in the cutting-edge areas of mechatronics.
- Explain the working principle of transducers
- Demonstrate basic pneumatic circuit, hydraulic and Electro pneumatic circuits.
- Operate the Stepper motor and Servomotor motor
- Explain the assembly language programming of 8085

LIST OF EXPERIMENTS:

1. Assembly language programming of 8085 – Addition – Subtraction – Multiplication – Division – Sorting – Code Conversion.
2. Stepper motor interface.
3. Traffic light interface.
4. Speed control of DC motor.
5. Study of various types of transducers.
6. Study of hydraulic, pneumatic and electro-pneumatic circuits.
7. Modelling and analysis of basic hydraulic, pneumatic and electrical circuits using Software.
8. Study of PLC and its applications.
9. Study of image processing techniques..

TOTAL: 60 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Examine various fluid power circuits.
CO2 Experiment Hydraulic, Pneumatic and electro pneumatic circuits using software tool
CO3 Prepare PLC programs for controlling multiple cylinders using timers
CO4 Demonstrate the speed control of DC motor by microcontroller
CO5 Use programmable peripheral interface for stepper motor and traffic light
CO6 Summarize assembly language programming of 8085 for arithmetic operation

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1	Basic Pneumatic Trainer Kit with manual and electrical controls/ PLC Control - each	1 No.
2	Basic Hydraulic Trainer Kit	1 No.
3	Hydraulics and Pneumatics Systems Simulation Software	10 Nos,
4	8051 - Microcontroller kit with stepper motor and drive circuit sets	1 Nos.
5	Image processing system with hardware & software	1 No.

20ME713 - MINIPROJECT AND COMPREHENSION

L	T	P	C
0	0	2	1

OBJECTIVE:

Students completing this course are expected to:

- Demonstrate various operations that can be performed in conventional and special purpose machines.
- Give an opportunity to the student to get hands on training in the fabrication process.
- Apply the basic engineering knowledge to make a working model / mechanical product
- Summarize the basic principles of core engineering concepts.
- Comprehend the knowledge acquired from the first Semester to Sixth Semester

MINI PROJECT

The students may be grouped into 2 to 3 and work under a project supervisor. The device/ system/component(s) to be fabricated may be decided in consultation with the supervisor and if possible with an industry. A project report and fabricated model is to be submitted by the group.

COMPREHENSION

The students will be assessed 100% internally through weekly test with objective type questions on all the subject related topics

(50% weightage is given for Mini Project and remaining 50% weightage is given for Comprehension)

TOTAL: 30 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Apply the concept of manufacturing processes for making mechanical product / working model.
CO2 Demonstrate the working model of the machine element or the mechanical product
CO3 Discuss various applications of engineering materials.
CO4 Summarize the basics of core engineering concepts.
CO5 Apply the various engineering concepts in day to day life.
CO6 Understand and comprehend any given problem related to mechanical engineering

SEMESTER – VIII

20ME811 – PROJECT WORK

L	T	P	C
0	0	20	10

OBJECTIVES:
Students completing this course are expected to:

- Analyze the real time problems through literatures in engineering perspective.
- Create a methodology to develop solution to the complex systems.
- Synthesize the business opportunities for a new product with novel design.
- Develop comprehensive report on the engineering facts applied to a specific problem.
- Evaluate the effectiveness of the product or a system through the knowledge acquired.

The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor.

TOTAL: 300 PERIODS

OUTCOMES:
After successful completion of the course, the students will be able to

CO 1 Understand and explain the real time problems through literatures.
CO 2 Analyze the methods to develop solution to the systems.
CO 3 Classify, compare and analyze business opportunities for a new product.
CO 4 Summarize and prepare reports for the experimental determinations.
CO 5 Evaluate the performance and effectiveness of the existing systems.
CO 6 Apply the knowledge expanding business through new product design and development.

PROFESSIONAL ELECTIVE – I (SEMESTER V)

20ME901 - AUTOMOBILE ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Explain the vehicle construction, aerodynamics and working principle of various parts of an IC Engine.
- Describe an Electronic Engine Management system.
- Explain the working principle of various parts of Transmission systems.
- Discuss the construction and working principle of steering, brakes and suspension systems.
- Distinguish the construction and working principle of Hybrid vehicle, E-vehicle and Autonomous vehicle.

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), IC engines – components-functions and materials, variable valve timing (VVT).

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 (BS -VI). AUTOTRONICS: An overview of basic electrical components and circuits in an automobile - overview of vehicle electronic systems.

UNIT III TRANSMISSION SYSTEMS 9

Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, Over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.

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), electronic brake force distribution (EBD) and Traction Control.

UNIT V ALTERNATIVE ENERGY SOURCES & ADVANCES IN AUTOMOBILE ENGINEERING 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. Introduction about Connected Vehicles – The Future of Transportation, Future of Autonomous Vehicles - ADAS – Safe and efficient drive, IoT Enhanced Mobility.

TOTAL: 45 PERIODS

OUTCOMES:

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

- **CO1** Recognize the various parts of the automobile and their functions and materials.
- **CO2** Discuss the engine auxiliary systems and engine emission control.
- **CO3** Distinguish the working of different types of transmission systems.
- **CO4** Differentiate the Steering, Brakes and Suspension Systems.
- **CO5** Use the possible alternate sources of energy for IC Engines.
- **CO6** Explain the upcoming technology related to E – Vehicle and Autonomous vehicle.

TEXT BOOKS:

1. Jain K.K. and Asthana .R.B, “Automobile Engineering” Tata McGraw Hill Publishers, New Delhi, 2015.
2. Kirpal Singh, “Automobile Engineering”, Vol 1 & 2, Seventh Edition, Standard Publishers, New Delhi, 14th Edition 2018.
3. Rajput R.K., A Text book of Automobile Engineering, 2nd Edition, Laxmi Publication, New Delhi, 2019.

REFERENCES:

1. Ganesan V. “Internal Combustion Engines”, Third Edition, Tata McGraw-Hill, 2014.
2. Heinz Heisler, “Advanced Engine Technology,” SAE International Publications USA, 1998.
3. Joseph Heitner, “Automotive Mechanics,” Second Edition, East-West Press, 2006.
4. Martin W, Stockel and Martin T Stockle , “Automotive Mechanics Fundamentals,” The Good heart - Will Cox Company Inc, USA ,1978.
5. Newton ,Steeds and Garet, “Motor Vehicles”, Butterworth Publishers,1996.

20ME902 - GAS DYNAMICS AND JET PROPULSION

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the basic concepts of incompressible flow
- Explain the basic difference between incompressible and compressible flow.
- Discuss the phenomenon of shock waves and its effect on flow.
- To gain some basic knowledge about jet propulsion
- Use the phenomenon of Rocket Propulsion.

(Use of Standard Gas Tables permitted)

UNIT I BASIC CONCEPTS AND ISENTROPIC FLOWS 9

Energy and momentum equations of compressible fluid flows - Stagnation states, Mach waves and Mach cone - Effect of Mach number on compressibility - Isentropic flow through variable ducts - Nozzle and Diffusers

UNIT II FLOW THROUGH DUCTS 9

Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow)- variation of flow properties.

UNIT III NORMAL AND OBLIQUE SHOCKS 9

Governing equations - Variation of flow parameters across the normal shocks - Prandtl- Meyer relations - Applications - Introduction to oblique shocks.

UNIT IV JET PROPULSION 9

Theory of jet propulsion - Thrust equation - Thrust power and propulsive efficiency - Operating principle, cycle analysis and use of stagnation state performance of ram jet, turbojet, turbofan and turbo prop engines.

UNIT V SPACE PROPULSION 9

Types of rocket engines - Propellants-feeding systems - Ignition and combustion - Theory of rocket propulsion - Performance study - Staging - Terminal and characteristic velocity - Applications - space flights.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO 1 Explain the significance of Mach number on compressible fluid flow.
CO 2 Compute the flow characteristics using Rayleigh and Fanno flow.
CO 3 Calculate the flow parameters across normal and oblique shock wave.
CO 4 Classify the propulsion performance in various aircraft engines.
CO 5 Compute the performance characteristics of space propulsion system.
CO 6 Apply the gas dynamics principles in the jet and space propulsion.

TEXT BOOKS:

1. Anderson, J.D., "Modern Compressible flow", 4th Edition, McGraw Hill, 2021.
2. Yahya, S.M. "Fundamentals of Compressible Flow", 6th Edition, New Age International (P) Limited, New Delhi, 2018.

REFERENCES:

1. Cohen. H., G.E.C. Rogers and Saravanamutto, "Gas Turbine Theory", 17th Edition, Pearson, 2017.
2. Ganesan. V., "Gas Turbines", 3rd Edition, Tata McGraw Hill Publishing Co., New Delhi, 2017.
3. Shapiro. A.H.," Dynamics and Thermodynamics of Compressible fluid Flow", 1st Edition, John wiley, New York, 1991.
4. George P Sutton., Oscar Biblarz "Rocket Propulsion Elements", 9th Edition, John wiley, New York,2017,.
5. E.Radhakrishnan, “Gas Dynamics” 9th Edition, PHI Learning Pvt. Ltd. 2020.

20ME903 - HYDRAULICS AND PNEUMATICS CONTROL

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Explain the basic principles of fluid power application and construction of various pumps.
- Discuss the constructional features of hydraulics actuators and control components
- Describe the standard hydraulic circuits
- Distinguish the various pneumatic and components and electro-pneumatic components
- Summarize the industrial application of fluid power and its trouble shootings

UNIT I FLUID POWER PRINICIPLES AND HYDRAULIC PUMPS 9

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power: Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps – Problems.

UNIT II HYDRAULIC ACTUATORS AND CONTROL COMPONENTS 9

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components : Direction Control - rotary and linear, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories : Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols – Problems.

UNIT III HYDRAULIC CIRCUITS AND SYSTEMS 9

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double-Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

UNIT IV PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS 9

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits.

UNIT V TROUBLE SHOOTING AND APPLICATIONS 9

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs. Application of PLC in fluid power systems.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Discuss the Fluid power and operation of different types of pumps.
CO2 Explain the features and functions of Hydraulic motors, actuators and Flow control valves.
CO3 Apply the different types of Hydraulic circuits and systems.
CO4 Explain the working of different pneumatic circuits and systems.
CO5 Summarize the various trouble shooting methods and applications of hydraulic and pneumatic systems.
CO6 Discuss the robotic arm using various pneumatic components for loading and unloading applications.

TEXT BOOKS:

1. Anthony Esposito, “Fluid Power with Applications”, Pearson Education 2018.
2. Majumdar S.R., “Oil Hydraulics Systems - Principles and Maintenance”, Tata McGraw-Hill, 2018.

REFERENCES:

1. Anthony Lal, “Oil hydraulics in the service of industry”, Allied publishers, 2016.
2. Dudelyt, A. Pease and John T. Pippenger, “Basic Fluid Power”, Prentice Hall, 2018.
3. Majumdar S.R., “Pneumatic systems – Principles and maintenance”, Tata McGraw Hill, 2020
4. Michael J, Prinches and Ashby J. G, “Power Hydraulics”, Prentice Hall, 2018.
5. Shanmugasundaram.K, “Hydraulic and Pneumatic controls”, Chand & Co, 2018.

20ME904 - TOOL DESIGN

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the basics of machine tool nomenclature and kinematic structures
- Explain the machining processes forces and general design of various types of machine tool structures
- Discuss on analysis of spindles, bearing and power screws
- Distinguish the types of vibration machine tool structures
- Use the appropriate pneumatics and hydraulics to monitor and control the machine tool structures

UNIT I INTRODUCTION TO MACHINE TOOLS 9

Classification of Machine Tools: General purpose, Special purpose, Automatic, Semi-Automatic machine tools, Transfer lines. Kinematics of Machine Tools: Shaping of geometrical and real surfaces, Developing and designing of kinematics schemes of machine tools, Kinematic structures of lathe, drilling, milling, relieving lathe, grinding, gear shaping and gear hobbing machining. Kinematic design and speed and feed boxes. Productivity loss. Stepped and stepless regulation.

UNIT II MACHINE TOOL STRUCTURE 9

Strength and Rigidity of Machine Tool Structures: Basic principles of design for strength. Different types of structures. General design procedures. Effect of materials and shape factors on the rigidity of structure, overall compliance of machine tool. Design of beds, bases columns, tables, cross rails for various machines. Effect of wear of guide ways on the performance. Various types of guide ways, their relative advantages. Materials for machine tool components including plastic guide ways (PTFE).

UNIT III ANALYSIS OF MACHINE TOOLS 9

Analysis of Spindles, Bearing and Power Screws: Design of spindles subjected to combined bending and torsion. Layout of bearings. Pre-loading. Anti-friction slide ways. Rolling contact, hydrodynamic, hydrostatic, aerostatics and magnetic bearings, their relative performance. Power Screws, Recirculating ball screws. Hydrodynamic design of journal bearings.

UNIT IV VIBRATIONS 9

Machine Tool Vibrations: Effect of vibration on machine tool; Forced vibrations. Machine tool chatter. Self-excited vibration and dynamic stability single- and two-degree freedom analysis. Comply coefficient. Elimination of vibration. Vibration analysis of machine tool structures.

UNIT V HYDRAULICS AND PNEUMATICS IN MACHINE TOOLS 9

Hydraulic Systems: General principles, hydraulic fluid power lines. Properties of hydraulic fluid. Various positive displacement pumps, their characteristics and operation. Design of hydraulic tanks and other systems. Various valves used in hydraulic systems. Design and application of various hydraulic circuits. One position and multi-position scheme. Single and multi-pump screws. Electrical analogy. Pneumatic circuits. Hydro copying system. Evaluation of machine tools with regard to accuracies, sound and vibration.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Describe the requirements on machine tool technology to support High Speed Machining

CO2 Understand the causes of machine tool structures

CO3 Explain the machine tool components subjected to combined bending and torsion

CO4 Analyse and evaluate the machine tool vibrations

CO5 Apply the hydraulics and pneumatics in designing of machine tools.

CO6 Discuss the design of machine tool structure.

TEXT BOOKS:

1. P. H. Joshi, 'Jigs and Fixtures Design Manual', McGraw Hill, 2017.
2. Kempster M. H. A.,'An Introduction to Jig and Tool Design', Viva Books Pvt. Ltd., 2004.
3. John G. Nee, 'Fundamentals of Tool Design', Society of Manufacturing, 6th Edition 'Production Techno1ogy Hand Book', HMT, Tata McGraw Hill, 2010.

REFERENCES:

1. E. K. Henriksen, 'Jig and Fixture Design Manual', Industrial Press, New York, 2010.
2. Donaldson, Lecain and Goold, 'Tool Design', McGraw Hill, New York, 2017.
3. Paquin and Crowley, 'Die Design Fundamentals', Industrial Press, New York,1979.

20ME905 – WELDING TECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the basics of welding and to know about the various types of welding processes
- Explain the principles of different gas and arc welding processes.
- Discuss the Resistance welding processes.
- Illustrate the effect of solid-state welding process with various applications.
- Summarize the importance of allied welding processes.

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 non-destructive testing of weldments.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Understand the construction and working principles of gas and arc welding process.
CO2 Describe the construction and working principles of resistance welding process.
CO3 Explain the construction and working principles of various solid-state welding process.
CO4 Differentiate the various special welding processes.
CO5 Discuss the weld joint design, weldability and testing of weldments.
CO6 Summarize the various types of welding processes.

TEXT BOOKS:

1. Richard L. Little., Welding and welding Technology, Tata McGraw Hill Publishing Co., Ltd., New Delhi,2017.
2. Parmer R.S., Welding Engineering and Technology, 2nd Edition, Khanna Publishers, New Delhi, 2013.

REFERENCES:

1. AWS- Welding Hand Book. 8th Edition. Vol- 2. Welding Process
2. Davis A.C., The Science and Practice of Welding, Cambridge University Press, Cambridge, 1993
3. Nadkarni S.V. Modern Arc Welding Technology, Oxford IBH Publishers, 3rd Edition, 2016.
4. Schwartz M.M. Metals Joining Manual. McGraw Hill Books, 1979.
5. Tylecote R.F. The Solid Phase Welding of Metals. Edward Arnold Publishers Ltd. London,2019.

20ME906 - ENGINEERING TRIBOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Discuss the various concepts of surface interactions and friction
- Explain the laws of wear and surface modification process
- Summarize the properties of lubricants and lubrication regime
- Distinguish between hydrodynamic and hydrostatic lubrication
- Explain contact mechanism of lubrication

UNIT I SURFACE INTERACTION AND FRICTION 7

Topography of Surfaces – Surface features - Properties and measurement – Surface interaction – Adhesive Theory of Sliding Friction – Rolling Friction - Friction properties of metallic and non-metallic materials – friction in extreme conditions –Thermal considerations in sliding contact.

UNIT II WEAR AND SURFACE TREATMENT 8

Types of wear – Mechanism of various types of wear – Laws of wear – Theoretical wear models - Wear of Metals and Nonmetals – Surface treatments – Surface modifications – surface coatings methods - Surface Topography measurements – Laser methods – instrumentation – International standards in friction and wear measurements.

UNIT III LUBRICANTS AND LUBRICATION REGIMES 8

Lubricants and their physical properties - Viscosity and other properties of oils –Additives and selection of Lubricants - Lubricants standards ISO, SAE, AGMA, BIS standards – Lubrication Regimes – Solid Lubrication - Dry and marginally lubricated contacts - Boundary Lubrication - Hydrodynamic lubrication – Elasto and plasto hydrodynamic - Magneto hydrodynamic lubrication – Hydro static lubrication – Gas lubrication.

UNIT IV THEORY OF HYDRODYNAMIC AND HYDROSTATIC LUBRICATION 12

Reynolds Equation - Assumptions and limitations - One and two dimensional Reynolds Equation - Reynolds and Sommerfeld boundary conditions - Pressure wave, flow, load capacity and friction calculations in Hydrodynamic bearings -Long and short bearings - Pad bearings and Journal bearings - Squeeze film effects - Thermal considerations - Hydrostatic lubrication of Pad bearing - Pressure, flow, load and friction calculations - Stiffness considerations - Various types of flow restrictors in hydrostatic bearings.

UNIT V HIGH PRESSURE CONTACTS AND ELASTO HYDRODYNAMIC LUBRICATION 10

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.Application of PLC in fluid power systems.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Explain about topography of surfaces, surface interactions and friction.
CO2 Summarize various types of wear and surface treatment process.
CO3 Discuss about lubricant and types of lubrication film.
CO4 Associate the concepts of hydrodynamic and hydrostatic lubrication
CO5 Distinguish the contact mechanism of elastic solid and elasto hydrodynamic lubrication
CO6 Apply the concepts of engineering tribology in real time application to reduce the contact between to interaction surface

TEXT BOOKS:

1. Williams J.A. “Engineering Tribology”, Cambridge Univ. Press, 2012.
2. G.W.Stachowiak & A.W .Batchelor , Engineering Tribology, Butterworth - Heinemann, UK, 4th Edition 2013

REFERENCES:

1. Cameron, A. “Basic Lubrication Theory”, Ellis Herward Ltd., UK, 2002
2. Halling, J. (Editor) – “Principles of Tribology “, Macmillian – 2004.
3. Rabinowicz.E, “Friction and Wear of materials”, John Willey &Sons ,UK,1995
4. S.K.Basu, S.N.Sengupta&B.B.Ahuja ,”Fundamentals of Tribology”, Prentice – Hall of India Pvt Ltd , New Delhi, 2005.

20ME907 - FUNDAMENTALS OF NANOSCIENCE

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the basis of nanomaterial science, preparation method, types and application
- Discuss the various Nanostructure characterization techniques.
- Explain the material's structure and properties that are probed and measured.
- Summarize the fabrication processes for development of MEMS/NEMS devices and systems.
- Discuss the potential applications of NEMS.

UNIT I INTRODUCTION 9

Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering- Classifications of nanostructured materials- nano particles- quantum dots, nanowires-ultra-thinfilms- multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties.

UNIT II GENERAL METHODS OF PREPARATION 9

Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self - assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

UNIT III NANOMATERIALS 9

Nanoforms of Carbon - Buckminster fullerene - graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT) - methods of synthesis(arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications - Nanometal oxides-ZnO, TiO2,MgO, ZrO2, NiO, nanoalumina, CaO, AgTiO2, Ferrites, Nanoclays- functionalization and applications-Quantum wires, Quantum dots-preparation, properties and applications.

UNIT IV CHARACTERIZATION TECHNIQUES 9

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS - Nanoindentation.

UNIT V APPLICATIONS 9

NanoInfoTech: Information storage- nanocomputer, molecular switch, super chip, nanocrystal, Nanobiotechlogy: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bioimaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

- **CO1** Describe the basic material science with special, emphasize on nanomaterials
- **CO2** Identify and understand various top-down and bottom-up approaches for nano material synthesis.
- **CO3** Understand and apply of nanomaterial synthesis
- **CO4** Explain the features of various morphological techniques and selecting appropriate tools for their future research
- **CO5** Discuss the Gain knowledge in other carbon based nanomaterials such as nanocones, nanofibers, nanodiscs and nanodiamonds.
- **CO6** Summarise the mechanisms in MESM/NEMS

TEXT BOOKS:

1. A.S. Edelstein and R.C. Cammearata, eds., “Nanomaterials: Synthesis, Properties and Applications”, Institute of Physics Publishing, Bristol and Philadelphia, 2015.
2. N John Dinardo, “Nanoscale Charecterisation of surfaces & Interfaces”, 2nd edition, Weinheim Cambridge, Wiley-VCH, 2010.
3. Guozhong Cao. Ed Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, World Scientific Series in Nanoscience and Nanotechnology, 2011

REFERENCES:

1. G Timp, “Nanotechnology”, AIP press/Springer, 1999.
2. Akhlesh Lakhtakia,“The Hand Book of Nano Technology, Nanometer Structure, Theory,Modeling and Simulations”. Prentice-Hall of India (P) Ltd, New Delhi, 2007
3. Bharat Bhushan, Handbook of Nanotechnology, Springer, 2005
4. Hari Singh Nalwa, Handbook Of Nanostructured Biomaterials And Their Applications InNanobiotechnology, Journal of Nanoscience and Nanotechnology, 2005.
5. D.M. Hata, Introduction to Vacuum Technology, Prentice Hall New Jersey, 2007.
6. K. Jousten, Handbook of Vacuum Technology, John Wiley and sons, Weinheim, 2008.
7. S. Schmidt et.al., CFx thin films deposited by high power impulse magnetron sputtering:synthesis and characterization Surf.Coat.Technol. 2011, 206, pp. 646-653.
8. J. George, Preparation of Thin Films, Marcel Dekker, Inc., New York. 2005
9. R.W. Cahn, E.M. Lifshitz, Concise Encyclopedia of Materials Characterization: Advancesin Materials Sciences and Engineering,Elsevier, 2016.

20ME908 - INTELLECTUAL PROPERTY RIGHTS

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to

- Understand the various types of Intellectual property
- Describe the relevant criteria for generating and protecting intellectual works
- Explain the relevance and impact of IP Law on academic/scientific works/studies
- Discuss the various digital innovations and its content protection techniques.
- Recognize the intellectual property likely to be produced in the academic and professional environment

UNIT I INTRODUCTION 9

Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO –TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.

UNIT II REGISTRATION OF IPRs 10

Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad

UNIT III AGREEMENTS AND LEGISLATIONS 10

International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.

UNIT IV DIGITAL PRODUCTS AND LAW 9

Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies.

UNIT V ENFORCEMENT OF IPRs 7

Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies.

TOTAL: 45 PERIODS

OUTCOME:

After successful completion of the course, the students will be able to

CO1 Understand the importance and classification of Intellectual property with Examples.

CO2 Illustrate the protection and Registration of IPRs in India and abroad

CO3 Explain the procedural knowledge to Legal System and solving the problem relating to intellectual property rights

CO4 Describe the various digital innovations and IP law, cyber law, unfair competition

CO5 Discuss the Infringement of IPRS and case studies.

CO6 Summarize the recent developments in copyrights, trademarks and patents

TEXT BOOKS

1. S.P. Satarkar, Intellectual Property Rights and Copy Rights, EssEss Publications, New Delhi, 2003.
2. V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India pvt Ltd, 4th Edition, 2014.

REFERENCES

1. Prabuddha Ganguli,"Intellectual Property Rights: Unleashing the Knowledge Economy", McGraw Hill Education, 2017.
2. Deborah E. Bouchoux, "Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets", Cengage Learning, Fourth Edition, 2013.
3. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013.

20ME909 - INDIAN CONSTITUTION

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the various Indian constitutions.
- Discuss about the central and state government functionalities in India.
- Describe the Indian society.
- Explain the various Constitution functions
- Summarize the structure of Indian Society

UNIT I INTRODUCTION 9

Historical Background – Constituent Assembly of India – Philosophical foundations of the Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies for citizens.

UNIT II STRUCTURE AND FUNCTION OF CENTRAL GOVERNMENT 9

Union Government – Structures of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review.

UNIT III STRUCTURE AND FUNCTION OF STATE GOVERNMENT 9

State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts.

UNIT IV CONSTITUTION FUNCTIONS 9

Indian Federal System – Center – State Relations – President's Rule – Constitutional Amendments – Constitutional Functionaries - Assessment of working of the Parliamentary System in India.

UNIT V INDIAN SOCIETY 9

Society : Nature, Meaning and definition; Indian Social Structure; Caste, Religion, Language in India; Constitutional Remedies for citizens – Political Parties and Pressure Groups; Right of Women, Children and Scheduled Castes and Scheduled Tribes and other Weaker Sections.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Discuss the constitution and fundamentals rights of India
CO2 Explain the various structure and functions of central government.
CO3 Illustrate the various structure and functions of State government.
CO4 Describe the various constitution functions in India.
CO5 Understand the various Indian social structures.
CO6 Summarize the important of various right about women and children.

TEXTBOOKS:

1. Durga Das Basu, Introduction to the Constitution of India, Gurgaon; Lexis Nexis, 2021 (25rd edn.)
2. Himanshu Roy and M P. Singh "Indian Political System", Published by Pearson India Education Services Pvt Ltd. 4th Edition 2018.

3. Maciver and Page, " Society: An Introduction Analysis ", Mac Milan India Ltd., New Delhi.
4. K.L.Sharma, (1997) "Social Stratification in India: Issues and Themes", Jawaharlal Nehru University, New Delhi.
5. Suresh Mani Tripathi, "Fundamental Rights and Directive Principles in India", Anchor academic publishing, 2016.

REFERENCES:

1. Sharma, Brij Kishore, "Introduction to the Constitution of India: Prentice Hall of India, New Delhi.
2. U.R.Gahai, "Indian Political System", New Academic Publishing House, Jalaendhar.
3. R.N. Sharma, "Indian Social Problems", Media Promoters and Publishers Pvt. Ltd.
4. M. V. Pylee, India's Constitution, New Delhi; S. Chand Pub., 2017 (16th edn.)

PROFESSIONAL ELECTIVE – II (SEMESTER VI)

20ME910 - FINITE ELEMENT ANALYSIS

L	T	P	C
3	0	0	3

OBJECTIVES

Students completing this course are expected to:

- Identify the concepts of Mathematical Modeling of Engineering Problems.
- Apply FEM to a range of Engineering Problems.
- Classify the formulation of FEM problems into 1D and 2D problems.
- Discuss the FEM for scalar and Vector Variable problems.
- Explain the method of Iso parametric element formulation for FEA.

UNIT I INTRODUCTION 9

Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

UNIT II ONE-DIMENSIONAL PROBLEMS 9

One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices - Solution of problems from solid mechanics and heat transfer. Longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation – Transverse deflections and Natural frequencies of beams.

UNIT III TWO-DIMENSIONAL SCALAR VARIABLE PROBLEMS 9

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation – Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems – Torsion of Non circular shafts –Quadrilateral elements – Higher Order Elements.

UNIT IV TWO-DIMENSIONAL VECTOR VARIABLE PROBLEMS 9

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations - Plate and shell elements.

UNIT V ISOPARAMETRIC FORMULATION 9

Natural co-ordinate systems – Isoperimetric elements – Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems - Matrix solution techniques –– Introduction to Analysis Software and generative design.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

- **CO1** Summarize the basics of finite element formulation using mathematical models of Boundary Value Problems.
- **CO2** Apply finite element formulations to solve one dimensional Problems
- **CO3** Discuss the finite element formulations to solve two dimensional scalar Problems.
- **CO4** Estimate the element matrices and vectors to solve two-dimensional Vector problems.

CO5 Explain the need for Isoperimetric transformation and the use of numerical integration

CO6 Compute the real time primitive structural and thermal problems using finite element techniques.

TEXT BOOKS:

1. Seshu, P, “Text Book of Finite Element Analysis”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2017.
2. Reddy. J.N., “An Introduction to the Finite Element Method”, 3rd Edition, Tata McGraw-Hill, 2015

REFERENCES:

1. Rao, S.S., “The Finite Element Method in Engineering”, 3rd Edition, Butterworth Heinemann, 2020.
2. Chandrupatla & Belagundu, “Introduction to Finite Elements in Engineering”, 3rd Edition, Prentice Hall College Div, 2017.
3. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, “Concepts and Applications of Finite Element Analysis”, 4th Edition, Wiley Student Edition, 2018.
4. David Hutton, “Fundamentals of Finite Element Analysis”, Tata McGraw Hill, 2017.
5. Logan, D.L., “A first course in Finite Element Method”, Thomson Asia Pvt. Ltd., 2018

20ME911 - UNCONVENTIONAL MACNINING PROCESSES

L	T	P	C
3	0	0	3

OBJECTIVE:

Students completing this course are expected to:

- Classify the non-traditional machining processes and describe mechanical energy based non-traditional machining processes.
- Differentiate the chemical and electrochemical energy based processes.
- Describe the thermo-electric energy based processes
- Explain the Nano finishing processes.
- Summarize the hybrid non-traditional machining processes and differentiate hybrid non-traditional machining processes

UNIT I INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES 9

Unconventional Machining Processes **–** Need **–** classification **–** merits, demerits and applications. Abrasive Jet Machining **–** Water Jet Machining **–** Abrasive Water Jet Machining - Ultrasonic Machining (AJM, WJM, AWJM and USM). Working Principles**–** equipment used **–** Process parameters**–**MRR-Applications.

UNIT II CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED PROCESSES 9

Chemical machining - Fundamental principle, types of chemical machining, maskants, etchants - Electro Chemical Machining (ECM –Theory of ECM – Working principle, Mechanism of metal removal, Modelling of ECM, Process characteristics –Advantages, limitations and applications.

UNIT III THERMAL AND ELECTRICAL ENERGY BASED PROCESSES 9

Electric Discharge Machining(EDM) **–** Wirecut EDM **–** Working Principle – equipments – Process Parameters**–** Power and control Circuits **–** Dielectric **–** Flushing **–**Applications. Laser Beam machining (LBM), plasma Arc machining (PAM), Electron Beam Machining (EBM) and Ion beam machining. Principles **–** Equipment –Applications.

UNIT IV NANO FINISHING PROCESSES 9

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

UNIT V HYBRID NON-TRADITIONAL MACHINING PROCESSES 9

Electro Chemical Drilling –Electro stream Drilling – Electro Chemical Jet Drilling – Electro Chemical Deburring – Electro Chemical Grinding (ECG) – Electro Chemical Honing (ECH) – Electrochemical super finishing –Electrical Discharge Grinding (EDG) – Electrical Discharge Diamond Grinding (EDDG) – Electro Chemical Discharge Grinding(ECDG) – Process capabilities and applications.

TOTAL:45 PERIODS

OUTCOMES:

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

CO1 Classify the unconventional machining processes and understand the process principle of mechanical energy based processes.

CO2 Illustrate the chemical and electro chemical energy based processes.

CO3 Discuss the thermo-electric energy based processes.

CO4 Explain the Nano finishing processes.

CO5 Analyze the hybrid non-traditional machining processes.

CO6 Distinguish the various non-traditional machining processes.

TEXTBOOKS:

1. Vijay.K. Jain “Advanced Machining Processes” Allied Publishers Pvt. Ltd., NewDelhi, 2015.
2. PandeyP.C. and ShanH. S.“Modern Machining Processes” Tata McGraw -Hill, NewDelhi, 2017.

REFERENCES:

1. Benedict.G.F.“Non-traditional Manufacturing Processes”, Marcel DekkerInc., NewYork,1987.
2. Anand Pandey, “Modern Machining Processes”, Ane Books Pvt. Ltd., New Delhi, India, 2019.
3. McGeough,“Advanced Methods of Machining”,Chapman and Hall, London,1998.
4. Kapil Gupta, N.K.Jain and R.F.Laubscher, Hybrid Machining Process: Perspectives on machining and finishing, Springer International Publishing, 2016.

20ME912 - RENEWABLE SOURCES OF ENERGY

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Identify the new methodologies / technologies for effective utilization of renewable energy sources.
- Explain the various forms of conventional energy resources
- Learn the present energy scenario and the need for energy conservation
- Understand the technical and commercial aspects of Wind and Alternative Sources of Energy
- Discuss the environmental friendly energy production and consumption

UNIT I INTRODUCTION 9

World Energy Use – Reserves of Energy Resources – Environmental Aspects of Energy Utilisation– Renewable Energy Scenario in Tamilnadu, India and around the World – Potentials - Achievements / Applications – Impact of current energy usage- Economics of renewable energy systems..

UNIT II SOLAR ENERGY 9

Solar Radiation – Measurements of Solar Radiation - Solar energy incident on earth, solar spectrum - Flat Plate and Concentrating Collectors – Solar direct Thermal Applications – Solar thermal Power Generation - Fundamentals of Solar Photo Voltaic Conversion – Solar Cells – Solar PV Power Generation – Solar PV Applications.

UNIT III WIND ENERGY 9

Wind Data and Energy Estimation – Types of Wind Energy Systems - Technology and geographical aspects – Performance – Site Selection– Details of Wind Turbine Generator – Safety and Environmental Aspects.

UNIT IV BIO – ENERGY 9

Biomass direct combustion – Biomass gasifiers – Biogas plants – Digesters – Ethanol production– Bio diesel – Cogeneration - Biomass Applications – Biomass Usage and Issues.

UNIT V OTHER RENEWABLE ENERGY SOURCES 9

Tidal energy – Wave Energy – Open and Closed OTEC Cycles – Small Hydro-Geothermal Energy– Hydrogen and Storage - Fuel Cell Systems - Schematic of typical Fuel Cell systems – Hybrid Systems.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Analyze the importance and Economics of renewable Energy.
CO2 Discuss the method of power generation from Solar Energy.
CO3 Describe the method of power generation from Wind Energy.
CO4 Explain the method of power generation from Bio Energy.
CO5 Differentiate the Tidal energy, Wave Energy, OTEC, Hydro energy and Geothermal Energy.
CO6 Summarize the importance of Fuel cells and Hybrid systems.

TEXT BOOKS:

1. Rai. G.D., "Non Conventional Energy Sources", Khanna Publishers, New Delhi,3rd edition, 2017.
2. Twidell, J.W. & Weir, A., "Renewable Energy Sources", EFN Spon Ltd., UK, 3rd edition, 2015.

REFERENCES:

1. Chetan Singh Solanki, Solar Photovoltaics, "Fundamentals, Technologies and Applications", PHI Learning Private Limited, New Delhi, 2015.
2. David M. Mousdale – "Introduction to Biofuels", CRC Press, Taylor & Francis Group, USA 2017
3. Freris. L.L., "Wind Energy Conversion Systems", Prentice Hall, UK, 1990.
4. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 2012.Johnson Gary, L. "Wind Energy Systems", Prentice Hall, New York, 2012.

20ME913 – REFRIGERATION AND AIR CONDITIONING

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the fundamentals of refrigeration and properties of refrigerants.
- Analyze the underlying principles of operations in Vapour Compression Refrigeration Systems and components.
- Differentiate the various refrigeration systems.
- Illustrate the psychrometric properties and processes.
- Summarize the design aspects of Air conditioning systems

UNIT I INTRODUCTION 9

Introduction to Refrigeration - Unit of Refrigeration and C.O.P.– Ideal cycles- Refrigerants desirable properties – Classification - Nomenclature - ODP & GWP.

UNIT II VAPOUR COMPRESSION REFRIGERATION SYSTEM 9

Vapor compression cycle : p-h and T-s diagrams - deviations from theoretical cycle – subcooling and super heating- effects of condenser and evaporator pressure on COP- multipressure system - low temperature refrigeration - Cascade systems – problems. Equipments: Type of Compressors, Condensers, Expansion devices, Evaporators.

UNIT III OTHER REFRIGERATION SYSTEMS 9

Working principles of Vapour absorption systems and adsorption cooling systems - Lithium Bromide absorption system – Ammonia Hydrogen absorption system - Steam jet refrigeration- Thermoelectric refrigeration- Air refrigeration.

UNIT IV PSYCHROMETRIC PROPERTIES AND PROCESSES 9

Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temperature Thermodynamic wet bulb temperature, Psychrometric chart; Psychrometric of air-conditioning processes, mixing of airstreams.

UNIT V AIR CONDITIONING SYSTEMS AND LOAD ESTIMATION 9

Air conditioning loads: Outside and inside design conditions; Heat transfer through structure, Solar radiation, Electrical appliances, Infiltration and ventilation, internal heat load; Apparatus selection; fresh air load, human comfort & IAQ principles, effective temperature & chart, calculation of summer & winter air conditioning load; Classifications, Layout of plants; Air distribution system; Filters; Air Conditioning Systems with Controls: Temperature, Pressure and Humidity sensors, Actuators & Safety controls.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 Explain the basic concepts of Refrigeration
CO2 Understandthe Vapor compression Refrigeration systems and to solve problems
CO3 Discuss the various types of Refrigeration systems
CO4 Calculate the Psychrometric properties and its use in psychrometric processes

CO5 Explain the concepts of air conditioning
CO6 Compute the problem related to load estimation in air conditioning systems

TEXT BOOK:

1. Arora, C.P., "Refrigeration and Air Conditioning", 4th edition, McGraw Hill, New Delhi, 2020.

REFERENCES:

1. ASHRAE Hand book, Fundamentals,2021
2. Jones W.P., "Air conditioning engineering", 5th edition, Elsevier Butterworth-Heinemann,2020
3. Roy J. Dossat, "Principles of Refrigeration", 4th edition, Pearson Education Asia,2009.
4. Stoecker, W.F. and JonesJ.W., "Refrigeration and Air Conditioning",Mc Graw Hill, New Delhi, 1986.

20ME914 – QUALITY CONTROL AND RELIABILITY ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the quality concepts and process control for variables
- Explain the process control for attributes
- Discuss the acceptance sampling procedure and their application.
- Summarize the concept of life testing.
- Analyze the concept of reliability and improvements in durability.

UNIT I INTRODUCTION TO QUALITY CONCEPTS AND PROCESS CONTROL FOR VARIABLES 9

Introduction, Quality era, Quality concepts in general. Quality control concept, Kano model for customer behavior, Quality dimensions as a whole – Fit form and function (given), Aesthetics, Reliability, Durability, Continuous up gradation with latest technology, serviceability, Availability, Brand image, Customer relationship management - Variation in Normal distribution concept, standard deviation and variance, control charts and concept of quality control and assurance, process causes of variation – Theory of control chart - uses of control chart – X chart, R chart and chart - process capability – process capability studies and simple problems. Six sigma concepts

UNIT II PROCESS CONTROL FOR ATTRIBUTES 9

Control chart for attributes - Defects and defectives – control chart for defects and defectives - p chart and np chart – control chart for nonconformities – C and U charts, State of control and process out of control identification in charts, pattern study.

UNIT III ACCEPTANCE SAMPLING 9

Random sample definition - Lot by lot sampling – types – probability and statistical standards of acceptance in single, double, multiple sampling techniques – O.C. curves – producer's Risk and consumer's Risk. AQL, LTPD, AOQL concepts-standard sampling plans for AQL and LTPD - uses of standard sampling plans.

UNIT IV LIFE TESTING – RELIABILITY 9

Life testing – Objective – Bath tub curve for understanding the reliability - failure data analysis, Weibull distribution - B10 life Mean failure rate, mean time to failure, mean time between failure, hazard rate – Weibull model, system reliability, series, parallel and mixed configuration – simple problems. Maintainability and availability – simple problems. Acceptance sampling based on reliability test – O.C Curves.

UNIT V QUALITY AND RELIABILITY 9

Reliability and Durability improvements – techniques- use of Pareto analysis – design for reliability and durability – redundancy unit and standby redundancy – Optimization in reliability – Product design – Product analysis – Product development–Product life cycles.

Note: Use of approved statistical table permitted in the examination.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 Summarize the concepts of Quality control in general
CO2 Discuss the process control for variables
CO3 Apply the process control for attributes
CO4 Explain the concept of sampling and to solve problems
CO5 Use the concept of Life testing
CO6 Illustrate the concept of Reliability and techniques involved

TEXT BOOKS:

1. Douglas.C. Montgomery, "Introduction to Statistical quality control", 7th edition, John Wiley 2012.
2. Ebeling C. – 'An Introduction to Reliability and Maintainability Engineering' – Tata McGraw Hill Publishing Company Ltd. – 2004

REFERENCES:

1. Eugene G. L. – 'Statistical Quality Control' – McGraw-Hill – 1996
2. Srinath L. S. – 'Concept in Reliability with an Introduction to Maintainability and Availability' – Associated East-West – 1998
3. Lewis E. E. – 'Introduction to reliability Engineering' – John Wiley & Sons – 1987
4. Rao S. S. – 'Reliability Based Design' – McGraw Hill – 1992
5. Barlow R. E., Proselan R. E. and Hunter L. C. – 'Mathematical Theory of Reliability' – John Wiley, New York – 1965
6. Halpern S. – 'The Assurance Services, an Introduction to Reality control and Reliability' – Prentice Hall, New Jersey – 1977
7. O'cconer P. D. T. – 'Practical Reliability Engineering' – John Wiley & Sons Ltd. – 2003

20ME915 - OPERATIONS RESEARCH

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the constraints on the availability of resources and developing a model and render an optimal solution during the given circumstances.
- Apply the challenges in the transportation and production problems and furnishing a rational solution to maximize the benefits.
- Discuss the purchase/ manufacturing policies, managing the spares/ stocks and meeting the customer demands.
- Analyse the queue discipline and exploring the avenues for better customer service.
- Demonstrate the nature of the project/ failure and offering methodical assistance towards decision making.

UNIT I LINEAR PROGRAMMING PROBLEMS 9

OR - Definition - Phases - models, LP problem formulation – Graphical solution, GLPP, Standard and Canonical forms of LPP- simplex methods- Big M, Two phase methods, Alternate optimal solutions, Duality in LP.

UNIT II TRANSPORTATION 9

Transportation problems- Basic feasible solution, Optimal solution By MODI method, Balanced and Unbalanced TP, Degeneracy, Production problems. Assignment problems – Hungarian method Traveling salesman problems - Sequencing models- Johnson algorithm, n job 2 machines, n job 3 machines and n job m machines.

UNIT III INVENTORY CONTROL 9

Types of inventory- Inventory cost - EOQ - Deterministic inventory problems – Purchase and Production models with and without shortages-EOQ with price breaks - Stochastic inventory problems - Multi product problems - Systems of inventory control (P and Q Systems)- Determination of buffer stock and re-order levels -Selective inventory control techniques (ABC,VED, SDE, etc.)

UNIT IV QUEUING THEORY 9

Queuing system - Characteristics - symbols - Poisson process and exponential distribution – Single server queuing models - Multiserver queuing models, Simulation Monte Carlo technique- Inventory& Queuing problems.

UNIT V PROJECT MANAGEMENT AND REPLACEMENT MODELS 9

Project management: Network logic – Ford-Fulkerson's rule - AON diagram - CPM and PERT techniques, Critical path and float calculations Replacement models -types of failures – Gradual failures-replacement of items: Efficiency deteriorates with time, sudden failures-individual and group replacement policies.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

- **CO1** Explain the need and importance of Linear Programming Problems
- **CO2** Discuss the optimal solution of Transportation Problems
- **CO3** Distinguish various types of Inventory control
- **CO4** Describe the various Queuing System and Queuing Problems
- **CO5** Demonstrate the various Project Management Techniques
- **CO6** Summarize the various replacement models and policies

TEXT BOOKS:

1. Hamdy A Taha, “Operations Research: An Introduction”, 10th edition, PHI/Pearson education, 2017.
2. Srinivasan G, “Operations Research: Principles and Applications”, 3rd edition EEE PHI, 2017.

REFERENCES:

1. Sharma J K, “Operations Research: Theory and Applications”, 5th edition, Macmillan India, 2013.
2. Ravindran, Phillips and Solberg, “Operations research principles and practice”, 2nd edition, Wiley India, 2007.

20ME916 - DESIGN OF JIGS, FIXTURES AND PRESS TOOLS

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the principles, functions and design practices of Jigs, Fixtures and dies for press working.
- Demonstrate the principles of jigs and fixtures design, locating principles, locating elements and clamping Devices.
- Classify various fixture operations, inspection and welding of fixtures.
- Discuss the Press working terminology, elements of dies and strip lay out.
- Design and develop the progressive and compound dies.

(Use of approved design data book is permitted)

UNIT I PURPOSE TYPES AND FUNCTIONS OF JIGS AND FIXTURES 8

Tool design objectives - Production devices - Inspection devices - Materials used in Jigs and Fixtures – Types of Jigs - Types of Fixtures - Mechanical actuation-pneumatic and hydraulic actuation - Analysis of clamping force-Tolerance and error analysis.

UNIT II JIGS 9

Drill bushes – different types of jigs - plate latch, channel, box, post, angle plate, angular post, turnover, pot jigs - Automatic drill jigs - Rack and pinion operated. Air operated Jigs components. Design and development of Jigs for given components.

UNIT III FIXTURES 9

General principles of boring, lathe, milling and broaching fixtures- Grinding, planning and shaping fixtures, assembly, Inspection and welding fixtures- Modular fixtures. Design and development of fixtures for given components.

UNIT IV PRESS WORKING TERMINOLOGIES AND ELEMENTS OF DIES AND STRIP LAY OUT 10

Press working terminology - Presses and press accessories-Computation of capacities and tonnage requirements. Elements of progressive combination and compound dies: Die block-die shoe. Bolster plate - punch plate - punch holder - guide pins and bushes – strippers - knockouts – stops – pilots - Selection of standard die sets strip lay out - strip layout calculations

UNIT V DESIGN AND DEVELOPMENT OF DIES 9

Design and development of progressive and compound dies for Blanking and piercing operations. Bending dies – development of bending dies-forming and drawing dies-Development of drawing dies. Design Considerations in forging, extrusion, casting and plastic dies, forming techniques, setup reduction for work holding – Single minute exchange of dies – Poka Yoke.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Summarize the principles, functions and design practices of Jigs, Fixtures and dies for press working.

CO2 Understand the principles of jigs and fixtures design, locating principles, locating elements and clamping Devices.

CO3 Discuss various fixture operations, inspection and welding of fixtures.

CO4 Explain Press working terminology, elements of dies and strip lay out.
CO5 Compute the development of the progressive and compound dies.
CO6 Apply the design procedures in their projects.

TEXT BOOKS:

1. Edward G Hoffman, Jigs & Fixture Design, Thomson – Delmar Learning, Singapore 2004
2. Donaldson C., Lecain G.H. and Goold V.C. “Tool Design” McGraw Hill Education; 4 edition (20 April 2012)

REFERENCES:

1. Metal Cutting Theory and Practice (Manufacturing Engineering and Materials Processing), David A. Stephenson, John S Agapiou, March 2016.
2. Mikell P Groover, “Fundamentals of Modern Manufacturing”, John Wiley and Sons, Singapore, January 2010
3. Joshi, P.H., “Jigs & Fixtures, Second Edition”, Tata McGraw-Hill Publishing Company Limited, New Delhi 2004
4. PSG College of Technology, Coimbatore - Design Data Handbook.

20ME917 - ALTERNATE ENERGY SOURCES FOR AUTOMOBILES

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the need of alternate fuels and the properties of alcohols as fuels.
- Explain the production method of various Biodiesel.
- Analyse the performance, emission and combustion characteristics of engines using Hydrogen fuel.
- Compute the performance, emission and combustion characteristics of Bio gas and LPG in engines.
- Summarise the basics of electric, hybrid and fuel cell vehicles.

UNIT I ALCOHOL 9

Production methods of alcohols. Properties of alcohols as fuels. Methods of using alcohols in CI and SI engines. Dual fuel operation, surface ignition and oxygenated additives. Performance emission and combustion characteristics of alcohol in CI and SI engines.

UNIT II BIODIESEL 9

Vegetable oils and their properties. Methods of using vegetable oils in engines – Agrofuels – Vegetable oil to Biodiesel. Factors impacting biofuel production. Blending, preheating Transesterification and emulsification of Vegetable oils – Developing Biocatalysts used for production of Biofuels - Performance in engines – Performance, Emission and Combustion Characteristics biodiesel in diesel engines.

UNIT III HYDROGEN 9

Production methods of hydrogen. Combustive properties of hydrogen. Biohydrogen Technology from Waste-Pilot Plant. Problems associated with hydrogen as fuel and solutions. Different methods of using hydrogen in SI and CI engines. Performance, emission and combustion analysis in engines. Hydrogen storage – safety aspects of hydrogen.

UNIT IV BIOGAS, NATURAL GAS AND LPG 9

Production methods of Biogas, Municipal solid wastes to Biogas. Anaerobic digestion and its stages. Natural gas and LPG. Properties studies. CO2 and H2S scrubbing in Biogas., Modification required to use in SI and CI Engines- Performance and emission characteristics of Biogas, NG and LPG in SI and CI engines.

UNIT V ELECTRIC HYBRID AND FUEL CELL 9

Layout of Electric vehicle and Hybrid vehicles –Storage for EVs - Electric vehicle Accessories-System components, Electronic control system – Types of Hybrid vehicles. Power split device. High energy and power density batteries – Basics of Fuel cell vehicles - Battery Charging and Swapping.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Analyse the performance emission and combustion characteristics of alcohol-fuelled CI and SI engines.

CO2 Compare different types of biofuels used in diesel engines and compute their performance emission and combustion parameters.

CO3 Evaluate the performance of SI and CI engines using hydrogen as fuel in different methods.

CO4 Demonstrate the performance and emission characteristics of Biogas, NG and LPG in SI and CI engines

CO5 Explain the working principles of Electric vehicles, Hybrid vehicles and Fuel cell vehicles

CO6 Summarize the various alternative energy sources used in automobiles

TEXT BOOKS:

1. AyhanDemirbas, 'Biodiesel A Realistic Fuel Alternative for Diesel Engines', Springer-Verlag London Limited 2018, ISBN-13: 9781846289941
2. S.S. Thipse, "Alternative Fuels", Jaico Publishing House; First edition, 2018.
3. Ganesan. V."Internal Combustion Engines", Tata McGraw-Hill Publishing Co, 4th edition, 2017.
4. Mathur D.S., Sharma. R.P. "A course in internal combustion engines", Dhanpatrai publication, 2018

REFERENCES:

1. Devaradjane. Dr. G., Kumaresan. Dr. M., "Automobile Engineering", AMK Publishers, 2018.
2. Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, The Biodiesel Handbook, AOCS Press Champaign, Illinois 2019.
3. Richard L Bechtold P.E., Alternative Fuels Guide book, Society of Automotive Engineers, 2017 ISBN 0-76-80-0052-1.
4. Simon , Christopher A., Alternate Source of Energy, Rowman and LittleField Publishers Inc.(2017).

20ME918 - ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to

- Understand the concept of Traditional knowledge and its importance
- Explain the need and importance of protecting traditional knowledge.
- Describe the acts of scheduled tribes and biological diversity act.
- Discuss the concepts of Intellectual property to protect the traditional knowledge
- Summarise the traditional knowledge in different sectors.

UNIT I INTRODUCTION TO TRADITIONAL KNOWLEDGE 9

Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, Indigenous Knowledge (IK), characteristics, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge.

UNIT II PROTECTION OF TRADITIONAL KNOWLEDGE 9

The need for protecting traditional knowledge, Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.

UNIT III LEGAL FRAMEWORK AND TK 9

The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act);
The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016.

UNIT IV TRADITIONAL KNOWLEDGE AND INTELLECTUAL PROPERTY 9

Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge.

UNIT V TRADITIONAL KNOWLEDGE IN DIFFERENT SECTORS 9

Traditional knowledge and engineering, Traditional medicine system, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Understand the various kinds of traditional knowledge system and discuss different characteristics of Indigenous knowledge.
CO2 Discuss the significance of traditional knowledge protection.
CO3 Explain the acts related to schedule tribes, traditional forest dwellers,
CO4 Interpret the concepts of Intellectual property to protect the traditional knowledge.
CO5 Illustrate the importance of Traditional knowledge in Agriculture and Medicine.
CO6 Summarize the concepts of traditional knowledge and apply the traditional knowledge in daily life.

TEXT BOOKS:

1. Traditional Knowledge System in India, by Amit Jha, Atlantic publishers, 2021.
2. Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta and Vipin Kumar Singh, Pratibha Prakashan 2012.

REFERENCE BOOKS:

1. "Knowledge Traditions and Practices of India" Kapil Kapoor, Michel Danino 2012.
2. Essence of Indian Traditions, Dr.Omprakash Mishra, Kanna Publishers, 2021.

PROFESSIONAL ELECTIVE – III (SEMESTER VII)

20ME919 - MECHATRONICS

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Explain the various types of sensors and transducers.
- Demonstrate the working of microprocessor and microcontroller
- Discuss the PPI for various applications
- Summarize the need of programmable logic controller
- Select the suitable actuators for the specific applications

UNIT I INTRODUCTION 9

Introduction to Mechatronics – Systems – Concepts of Mechatronics approach – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers**:** Static and dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance sensors – Strain gauges – Eddy current sensor – Hall effect sensor – Temperature sensors – Light sensors

UNIT II MICROPROCESSOR AND MICROCONTROLLER 9

Introduction – Architecture of 8085 – Pin Configuration – Addressing Modes –Instruction set, Timing diagram of 8085 – Concepts of 8051 microcontroller – Block diagram,.

UNIT III PROGRAMMABLE PERIPHERAL INTERFACE 9

Introduction – Architecture of 8255, Keyboard interfacing, LED display –interfacing, ADC and DAC interface, Temperature Control – Stepper Motor Control – Traffic Control interface.

UNIT IV PROGRAMMABLE LOGIC CONTROLLER 9

Introduction – Basic structure – Input and output processing – Programming – Mnemonics – Timers, counters and internal relays – Data handling – Selection of PLC.

UNIT V ACTUATORS AND MECHATRONIC SYSTEM DESIGN 9

Types of Stepper and Servo motors – Construction – Working Principle – Advantages and Disadvantages. Design process-stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Engine Management system – Automatic car park barrier.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 Discuss the interdisciplinary applications of Electronics, Electrical, Mechanical and Computer Systems for the Control of Mechanical, Electronic Systems and Sensor technology.

CO2 Explain the architecture of Microprocessor and Microcontroller, Pin Diagram, Addressing Modes of Microprocessor and Microcontroller.

CO3 Demonstrate the Programmable Peripheral Interface, Architecture of 8255 PPI, and various device interfacing

CO4 Explain the architecture, programming and application of programmable logic controllers to problems and challenges in the areas of Mechatronic engineering.

CO5 Summarize the various Actuators and Mechatronics system using the knowledge and skills acquired through the course and also from the given case studies

CO6 Design and develop the mechatronics system for the suitable applications

TEXT BOOKS:

1. Bolton, “Mechatronics”, Prentice Hall, 2015.
2. Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, 5th Edition, Prentice Hall, 2016.

REFERENCES:

1. Bradley D.A, Dawson D, Buru N.C and Loader A.J, “Mechatronics”, Chapman and Hall, 2014.
2. Clarence W, de Silva, "Mechatronics" CRC Press, First Indian Re-print, 2013
3. Devadas Shetty and Richard A. Kolk, “Mechatronics Systems Design”, PWS publishing company, 2016.
4. Krishna Kant, “Microprocessors & Microcontrollers”, Prentice Hall of India, 2012.
5. Michael B.Histand and Davis G.Alciatore, “Introduction to Mechatronics and Measurement systems”, McGraw Hill International edition, 2014.

20ME920 - ROBOTICS

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the functions of the basic components of a Robot.
- Study the use of various types of End of Effectors and Sensors
- Explain the working principle of various sensors and machine vision.
- Describe the Robot Kinematics and Programming
- Summarize the Robot safety issues and economics.

UNIT I FUNDAMENTALS OF ROBOT 9

Robot - Definition - Robot Anatomy - Coordinate Systems, Work Envelope Types and Classification- Specifications-Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load-Robot Parts and their Functions-Need for Robots-Different Applications.

UNIT II ROBOT DRIVE SYSTEMS AND END EFFECTORS 9

Pneumatic Drives-Hydraulic Drives-Mechanical Drives-Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison of all these Drives, End Effectors-Grippers-Mechanical Grippers, Pneumatic and Hydraulic-Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

UNIT III SENSORS AND MACHINE VISION 9

Requirements of a sensor, Principles and Applications of the following types of sensors-Position sensors - Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, pneumatic Position Sensors, Range Sensors Triangulations Principles, Structured, Lighting Approach, Time of Flight, Range Finders, Laser Range Meters, Touch Sensors ,binary Sensors., Analog Sensors, Wrist Sensors, Compliance Sensors, Slip Sensors, Camera, Frame Grabber, Sensing and Digitizing Image Data-Signal Conversion, Image Storage, Lighting Techniques, Image Processing and Analysis-Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms, Applications-Inspection, Identification, Visual Serving and Navigation.

UNIT IV ROBOT KINEMATICS AND ROBOT PROGRAMMING 9

Forward Kinematics, Inverse Kinematics and Difference; Forward Kinematics and Reverse Kinematics of manipulators with Two, Three Degrees of Freedom (in 2 Dimension), Four Degrees of freedom (in 3 Dimension) Jacobians, Velocity and Forces-Manipulator Dynamics,

Trajectory Generator, Manipulator Mechanism Design - Derivations and problems. Lead through Programming, Robot programming Languages-VAL Programming-Motion Commands, Sensor Commands, End Effector commands and simple Programs.

UNIT V IMPLEMENTATION AND ROBOT ECONOMICS 9

RGV, AGV; Implementation of Robots in Industries - Various Steps; Safety Considerations for Robot Operations - Economic Analysis of Robots.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Explain the concepts of industrial robots, with its classification and specifications.

CO2 Summarize the different types of robot drive systems as well as robot end effectors.

CO3 Apply the different sensors and image processing techniques in robotics.

CO4 Develop robotic programs for different tasks and familiarize with the kinematics motions of robot.

CO5 Examine the implementation of robots in various industrial sectors and interpolate the economic analysis of robots.

CO6 Design and develop the suitable robot for the particular applications

TEXT BOOKS:

1. Groover M.P., “Industrial Robotics -Technology Programming and Applications”, McGraw Hill, 2021.
2. Klafter R.D., Chmielewski T.A and Negin M., “Robotic Engineering - An Integrated Approach”,Prentice Hall, 2016.

REFERENCES:

1. Craig J.J., “Introduction to Robotics Mechanics and Control”, Pearson Education, 2015.
2. Deb S.R., “Robotics Technology and Flexible Automation” Tata McGraw Hill Book Co., 2013.
3. Janakiraman P.A., “Robotics and Image Processing”, Tata McGraw Hill, 2015.
4. Koren Y., “Robotics for Engineers", Mc Graw Hill Book Co., 2014.
5. Subir Kumar Saha, “Introduction to Robotics”, McGraw Hill Education (India) Private Limited, 2014.
6. Richard M. Murray, “A Mathematical Introduction to Robotic Manipulation”, CRC Press, 2017

20CE917 - PROFESSIONAL ETHICS IN ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:
Students completing this course are expected to:

- To familiarize with Engineering Ethics and Human Values.
- To impart knowledge on codes of ethics, safety, responsibilities and rights of engineers.
- To create awareness on global issues related to environmental ethics, computer ethics, weapons development and corporate social responsibility.

UNIT I HUMAN VALUES 9

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self-confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

UNIT II ENGINEERING ETHICS 9

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION 8

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law - The Challenger Case Study.

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS 10

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Case Studies: Chernobyl and Bhopal Disasters - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

UNIT V GLOBAL ISSUES 9

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.

TOTAL: 45 PERIOD

OUTCOMES:
At the end of this course, the students will be able to:

CO1 Summarize the importance of human values in work place.
CO2 Discuss the senses of engineering ethics, moral dilemmas, moral autonomy and uses of ethical theories.
CO3 Describe the role of engineers as responsible experimenters and necessity of codes of ethics in engineering.
CO4 Explain safety, risk, responsibilities and rights in the society.
CO5 Analyze the global issues related to environmental ethics, computer ethics, weapons development and the role of engineers as expert witnesses and advisors.
CO6 Apply ethics in society and discuss the ethical issues related to engineering.

TEXTBOOKS:

1. Mike W. Martin and Roland Schinzinger, “Ethics in Engineering”, Tata McGraw Hill, New Delhi, 2014.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, Prentice Hall of India, New Delhi, 2013.

REFERENCES:

1. Charles B. Fleddermann, “Engineering Ethics”, Pearson Prentice Hall, New Jersey, 2012.
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, “Engineering Ethics – Concepts and Cases”, Cengage Learning, 2018.
3. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2012.
4. Edmund G Seebauer and Robert L Barry, “Fundamentals of Ethics for Scientists and Engineers”, Oxford University Press, Oxford, 2001.

20ME922 - COMPUTATIONAL FLUID DYNAMICS

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Discuss the Governing Equations of viscous fluid flows
- Distinguish the techniques in the numerical solutions of heat transfer
- Describe the numerical modeling and its role in the field of fluid flow and heat transfer
- Explain the students to understand the various discretization methods, solution procedures and turbulence modeling.
- Illustrate the complex problems in the field of fluid flow and heat transfer by using high speed computers.

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UNIT I GOVERNING EQUATIONS AND BOUNDARY CONDITIONS 9

Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – initial and boundary conditions –Time-averaged equations for Turbulent Flow (RANS) – Turbulent – Kinetic Energy Equations –Mathematical behaviour of PDEs on CFD – Elliptic, Parabolic and Hyperbolic equations.

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 multidimensional diffusion problems –Parabolic equations – Explicit and Implicit schemes – Example problems on elliptic and parabolic equations – Use of Finite Difference and Finite Volume methods.

UNIT III FINITE VOLUME METHOD FOR CONVECTION DIFFUSION 9

Steady one-dimensional convection and diffusion – Central, upwind differencing schemes properties of discretization schemes – Conservativeness, Boundedness, Transportiveness, Hybrid, Power-law, QUICK Schemes.

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.

UNIT V TURBULENCE MODELS AND MESH GENERATION 9

Introduction to different turbulent models such as mixing length model, one equation, two equation models – High and low Reynolds number models, Mesh Generation and refinement Techniques-software tools etc.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Understand the basic principles of Fluid Mechanics and will be able to analyze fluid mechanical systems.

CO2 Create numerical modeling and its role in the field of fluid flow and heat transfer

CO3 Apply the various discretization methods, solution procedures and turbulence modeling to solve flow and heat transfer problems.

CO4 Understand the principles to solve real life problems

CO5 Discuss CFD problems directly related to industries and societal applications
CO6 Develop skills in the actual implementation of the CFD methods (boundary conditions, numerical schemes etc.)

TEXT BOOKS:

1. Versteeg, H.K., and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The finite volume Method", Pearson Education Ltd. Second Edition, 2007.
2. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw Hill Publishing Company Ltd., 1998.
3. Anderson J.D. (1995) Computational Fluid Dynamics: The Basics with Applications, McGraw-Hill, Inc.

REFERENCES:

1. Patankar, S.V. "Numerical Heat Transfer and Fluid Flow", Hemisphere Publishing Corporation, 2004.
2. Chung, T.J. "Computational Fluid Dynamics", Cambridge University, Press, 2002.
3. Ghoshdastidar P.S., "Heat Transfer", Oxford University Press, 2005
4. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 1995.
5. Prodip Niyogi, Chakrabarty, S.K., Laha, M.K. "Introduction to Computational Fluid Dynamics", Pearson Education, 2005.
6. Anil W. Date "Introduction to Computational Fluid Dynamics" Cambridge University Press, 2005.

20ME923 - COMPOSITE MATERIALS AND MECHANICS

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the fundamentals of composite material strength and its mechanical behaviour
- Explain the analysis of fiber reinforced Laminate design for different combinations of plies with different orientations of the fiber.
- Discuss the mechanical behavior and study of residual stresses in Laminates during processing.
- Describe the thermal behaviour of composite laminates.
- Apply the Classical Laminate Theory (CLT) to study the residual stresses in an isotropic layered structure such as electronic chips.

UNIT I INTRODUCTION, LAMINA CONSTITUTIVE EQUATIONS & MANUFACTURING 9

Definition –Need – General Characteristics, Applications. Fibers – Glass, Carbon, Ceramic and Aramid fibers. Matrices – Polymer, Graphite, Ceramic and Metal Matrices – Characteristics of fibers and matrices. Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Typical Commercial material properties, Rule of Mixtures.

Generally, Orthotropic Lamina –Transformation Matrix, Transformed Stiffness. Manufacturing: Bag Moulding Compression Moulding – Pultrusion – Filament Winding.

UNIT II FLAT PLATE LAMINATE CONSTITUTE EQUATIONS 9

Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Lainates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.

UNIT III LAMINA STRENGTH ANALYSIS 9

Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill's Criterion for Anisotropic materials. Tsai-Hill's Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure

UNIT IV THERMAL ANALYSIS 9

Assumption of Constant C.T.E's. Modification of Hooke's Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T.E's. C.T.E's for special Laminate Configurations – Unidirectional, Off-axis, Symmetric Balanced Laminates, Zero C.T.E laminates, Thermally Quasi-Isotropic Laminates

UNIT V ANALYSIS OF LAMINATED FLAT PLATES 9

Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations – Natural Frequencies

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

- **CO1** Summarize the various types of Fibers, Equations and manufacturing methods for Composite materials
- **CO2** Discuss Flat plate Laminate equations
- **CO3** Understand the structural analysis of Composite Lamina
- **CO4** Analyse the thermal behaviour of Composite laminates
- **CO5** Calculate the bending properties of composite laminates.
- **CO6** Summarize the response of Composite laminates for specific load conditions.

TEXTBOOKS:

1. Gibson, R.F., "Principles of Composite Material Mechanics", Fourth Edition, McGraw-Hill, CRC press in progress, 2016, -.
2. Hyer, M.W., “Stress Analysis of Fiber – Reinforced Composite Materials”, McGraw Hill, 2009

REFERENCES:

1. Agarwal, B.D., and Broutman L.J., “Analysis and Performance of Fiber Composites”, John Wiley and Sons, New York, 2017.
2. Halpin, J.C., “Primer on Composite Materials, Analysis”, Technomic Publishing Co., 1984.
3. Issac M. Daniel and OriIshai, “Engineering Mechanics of Composite Materials”, Oxford University Press-2006, First Indian Edition - 2007
4. Mallick, P.K., Fiber, ”Reinforced Composites: Materials, Manufacturing and Design”, Maneel Dekker Inc, 1993.
5. Mallick, P.K. and Newman, S., (edition), “Composite Materials Technology: Processes and Properties”, Hansen Publisher, Munish, 1990.
6. Handbook of Composites, Springer US, 2013.
7. Robert M. Jones., “Mechanics Of Composite Materials” CRC Press, 2018

20ME924 - CRYOGENIC ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the basics of cryogenics.
- Apply the Principles of cryogenic Refrigeration systems.
- Associate various parameters in performance in system optimization
- Explain various methods of gas separation and Purifications.
- Demonstrate the knowledge of cryogenic instrumentation

UNIT I INTRODUCTION TO CRYOGENICS 9

Cryogenic engineering, properties of cryogenic fluids like Oxygen, Nitrogen, Argon, Neon, Florin, Helium, Hydrogen, Properties of material at cryogenic temperature- mechanical, thermal, and electrical-Super conductivity, application of cryogenic systems in space, medical, industries, biological etc.

UNIT II CRYOGENIC REFRIGERATION 9

Principle and Methods of production of low temperature and their analysis: Joule Thomson Expansion, Cascade processes, Ortho and para hydrogen conversion, cold gas refrigerators, Linde - Hampson cycles, Claude and cascaded systems, magnetic cooling, Stirling Cycle Cryocoolers, Philips refrigerators, Gifford single volume refrigerator, Pulse tube refrigerators

UNIT III CRYOGENIC REQUIREMENTS 9

Cryogenics Heat Exchangers, Compressors, Expanders, Effect of various parameters in performance and system optimization. Various insulations (expanded foams, gas filled, fibrous, vacuum, multi-layer etc.) and Storage equipment for cryogenic fluids, industrial storage and transfer of cryogenic fluids.

UNIT IV GAS SEPARATION AND PURIFICATION 9

Ideal gas, mixture characteristics composition diagrams, gas separation, principle of rectification, plate calculation, flash calculation rectification column analysis, separation of air, hydrogen and helium, gas purification methods.

UNIT V CRYOGENIC INSTRUMENTATION AND SAFETY 9

Properties and characteristics of instrumentation, strain displacement, pressure, flow, liquid level, density and temperature measurement in cryogenic range. Safety in cryogenic fluid handling, storage and use. Safety against cryogen hazards like burns, frostbite, asphyxiation, hypothermia etc.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Explain the Properties of Cryogenic Fluids and Applications of Cryogenics.
CO2 Describe the Principles of Cryogenic Refrigeration.
CO3 Discuss the various parameters in performance and system optimization.
CO4 Summarize the concept of Gas Separation and Purification.
CO5 Understand the instrumentation in Cryogenics and safety in handling cryogenic Fluids.
CO6 Apply the Concept of Cryogenics in various fields.

TEXT BOOKS:

1. Randal F. Barron, Cryogenic Systems, Oxford University Press, New York, 1999
2. T.M Flynn, Cryogenic Engineering, Maxwell Dekker,2nd edition 2009.
3. Scoot, Cryogenic Engineering, Van Nostrand Co. Inc. 1985.

REFERENCES:

1. Dr.Zuyu Zhao and Dr.Chao Wang, Cryogenic Engineering and Technologies, Taylor and Francis, 2020.
2. Klaus D. Timmerhaus, Richard Palmer Reed, Cryogenic Engineering: 50 years of progress, Springer, 2007.

20CB404 - INTRODUCTION TO INNOVATION, IP MANAGEMENT & ENTREPRENEURSHIP

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Develop mindsets to pursue entrepreneurship.
- Understand the basics of Innovation and Entrepreneurship
- Create, protect, assetize and commercialize intellectual property?
- Identify and discover market needs
- Manage an innovation program
- Understand opportunities and challenges for entrepreneurs through Startup Models

UNIT I INNOVATION 9

Innovation Types of Innovation Incremental, disruptive, Lifecycle of Innovation (idea, literature survey, PoT, PoC, etc.), Challenges in Innovation (time, cost, data, infrastructure, etc.)

UNIT II IPR 9

Types of IPR (patents, copyrights, trademarks, GI, etc.) Lifecycle of IP (creation, protection, assetization, commercialization), Balancing IP Risks and Rewards (Right Access and Right Use of Open Source and 3rd party products, technology transfer and licensing)

UNIT III ENTREPRENEURSHIP 9

Opportunity Identification in Technology Entrepreneurship (customer pain points, competitive context) Market Research, Segmentation and Sizing Product Positioning, Pricing, and Go-To-Market Strategy IP Valuation (methods, examples, limitations)

UNIT IV TYPES OF STARTUP BUSINESS MODEL 9

Startup Business Models (fund raising, market segments, channels, etc.) Co-innovation and Open Innovation (academia, startups, corporates) Technology Innovation: Two Case Studies

UNIT V PROCESSES IN STARTUP BUSINESS MODEL 9

Innovation, Incubation and Entrepreneurship in Corporate Context Technology-driven Social Innovation and Entrepreneurship Manage Innovation, IP and Entrepreneurship Programs – Processes, Governance and Tools.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1: Understand the basics of Innovation and Entrepreneurship
CO2: Manage an innovation program
CO3: Create, protect, assetize and commercialize intellectual property
CO4: Understand opportunities and challenges for entrepreneurs
CO5: Developing mind sets to pursue entrepreneurship.
CO6: Identify and discover market needs

TEXT BOOKS:

1. Jugaad Innovation: Think Frugal, Be Flexible, Generate Breakthrough Growth Navi Radjou, Jaideep Prabhu, Simone Ahuja , John Wiley & Sons, 2012.

REFERENCES:

1. Identifying Entrepreneurial Opportunities: Cognition and Categorization in Nascent Entrepreneurs, Matthew J. Karlesky, University of Michigan, 2015.
2. http://www.businessdictionary.com/definition/entrepreneurship.
3. https://www.infoentrepreneurs.org/en/guides/use-innovation-to-grow-your- business/
4. http://sourcesofinsight.com/innovation-life-cycle/
5. https://www.investottawa.ca/
6. https://www.Lead-innovation.com

20ME926 – PRINCIPLES OF MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the roles of Management and the principles of an organization.
- Discuss the functions and responsibilities of managers.
- Demonstrate the tools and techniques to be used in the performance of the managerial job.
- Analyze and understand the environment of the organization.
- Develop the cognizance of the importance of management principles.

UNIT I INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS 9

Definition of Management – Science or Art– Manager Vs Entrepreneur - types of managers-managerial roles and skills– Evolution of Management – Scientific, human relations , system and contingency approaches – Types of Business organization-Sole proprietorship, partnership, company-public and private sector enterprises-Organization culture and Environment– Current trends and issues in Management. Fundamentals of Entrepreneurship, Circular flow of income.

UNITII PLANNING 9

Nature and purpose of planning – planning process – types of planning – objectives – setting objectives – policies –Planning premises – Strategic Management –Planning Tools and Techniques–Decision making steps and process - strategic technology planning

UNITIII ORGANISING 9

Nature and purpose – Formal and informal organization – organization chart – organization structure – types – Line and staff authority–departmentalization–delegation of authority–centralizationanddecentralization–JobDesign-HumanResource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management ,Career planning and management. Managing personnel records

UNITIV DIRECTING 9

Foundations of individual and group behaviour – motivation – motivation theories – motivational techniques – job satisfaction–job enrichment–leadership–types and theories of leadership–communication–process of communication–barrier in communication– effective communication– communication and IT. Organizational behaviour

UNIT V CONTROLLING 9

System and process of controlling – budgetary and non-budgetary control techniques – use of computers and IT in Management control – Productivity problems and management – control and performance – direct and preventive control – reporting .SQC techniques

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Understand the management thoughts and various challenges of managerial activities in a global business environment.

CO2 Demonstrate the various strategies in Decision making at various levels management in the Organizations.

CO3 Discuss the various types of Organization structure.

CO4 Describe the steps in Staffing process and stages in Career development.

CO5 Explain the elements in Direction.

CO6 Summarise the various Controlling techniques to maintain standards in Organizations.

TEXTBOOKS:

1. Koontz, H, & Weihrich, H (2016). Essentials of Management: An International Perspective (8th ed.), Tata McGraw Hills, New Delhi..
2. Ghuman, K & Aswathapa, K, (2017). Management concepts and cases (10th ed.), Tata McGraw Hills, New Delhi.
3. Telsan, M.T. (2016). Industrial and Business Management, (4th ed.), S. Chand, New Delhi.

REFERENCES:

1. Robbins, S. (2017). Management, (13th ed.), Pearson Education, New Delhi.
2. Saxena, P.K., Principles of Management: A Modern Approach, Global India publicaions.(2016)

20ME927 - TOTAL QUALITY MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the techniques for the implementation of quality management in manufacturing and services processes.
- Explain the Quality Management principles and process.
- Discuss the importance of Quality in an organization.
- Understand the ISO Quality systems.
- Summarise the quality concepts adopted in industry scenario.

UNIT I INTRODUCTION 9

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, and Customer retention

UNIT II TQM PRINCIPLES 9

Leadership – Quality Statements, Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S and case study, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.

UNIT III TQM TOOLS & TECHNIQUES I 9

The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process – FMEA and Applications in the Industry - Stages, Types.

UNIT IV TQM TOOLS & TECHNIQUES II 9

Quality Circles, Cost of Quality, Quality Function Development (QFD) and case study- Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

UNIT V QUALITY SYSTEMS 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: 45 PERIODS

OUTCOMES:
After successful completion of the course, the students will be able to

CO1 Understand the quality philosophies and customer focused managerial system
CO2 Summarize the quality management principles
CO3 Apply the six sigma concepts in manufacturing and service sector
CO4 Determine the tools and techniques for quality improvement.
CO5 Discuss the standards and auditing system on implementation of TQM.
CO6 Analyze standards for the operation of EMS

TEXT BOOKS:

1. Dale H.Besterfiled, Carol B.Michna, Glen H. Besterfield, Mary B.Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe, —Total Quality Management, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2020.

REFERENCES:

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2019.
2. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2018.
3. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2020.
4. ISO 9001-2015 standards

PROFESSIONAL ELECTIVE – IV (SEMESTER VII)

20ME928 - ENTERPRENEURSHIP DEVELOPMENT

L	T	P	C
3	0	0	3

OBJECTIVES:
Students completing this course are expected to:

- Explain the role of an entrepreneur in the economic world.
- Discuss the motivating factors & theories behind a successful entrepreneur.
- Describe the business opportunities and strategies.
- Distinguish among the structure of various financial sources and taxation.
- Summarize the potential opportunities for an entrepreneur for start-up and expansion in future.

UNIT I INTRODUCTION TO ENTREPRENEURSHIP 9

Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth.

UNIT II ENTREPRENEURIAL MOTIVATION 9

Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Self Rating, Business Games, Thematic Apperception Test – Stress Management, Entrepreneurship Development Programs – Need, Objectives.

UNIT III BUSINESS 9

Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies.

UNIT IV FINANCING AND ACCOUNTING 9

Need – Sources of Finance, Term Loans, Capital Structure, Financial Institution, Management of working Capital, Costing, Break Even Analysis, Taxation – Income Tax slabs, Excise Duty – Sales Tax.

UNIT V SUPPORT TO ENTREPRENEURS 9

Sickness in small Business – Concept, Magnitude, Causes and Consequences, Corrective Measures - Business Incubators – Government Policy for Small Scale Enterprises – Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger and Sub Contracting.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
After successful completion of the course, the students will be able to:

CO 1 Understand the role of entrepreneur in economic growth of the nation.
CO 2 Explain the major motivation factors for becoming an entrepreneur.
CO 3 Classify, compare and analyze for setting up of a good business opportunity.
CO 4 Summarize the various sources of finance and method of accounting.
CO 5 Establish business opportunity with the knowledge on Government taxation norms.
CO 6: Apply the knowledge for expanding business.

TEXT BOOKS:

1. Khanka. S.S., “Entrepreneurial Development” S.Chand & Co. Ltd., Ram Nagar, New Delhi, 2013.
2. Donald F Kuratko, “Entreprenuership – Theory, Process and Practice”, 9th Edition, Cengage Learning, 2014.

REFERENCES:

1. Hisrich R D, Peters M P, “Entrepreneurship” 8th Edition, Tata McGraw-Hill, 2013.
2. Mathew J Manimala, "Enterprenuership theory at cross roads: paradigms and praxis” 2nd Edition Dream tech, 2005.
3. Rajeev Roy, "Entrepreneurship" 2nd Edition, Oxford University Press, 2011.
4. EDII “Faulty and External Experts – A Hand Book for New Entrepreneurs Publishers: Entrepreneurship Development”, Institute of India, Ahmadabad, 1986.

20ME929 - PRODUCTION PLANNING AND CONTROL

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the benefits and types of planning.
- Describe the various aspects of product development and design.
- Analyze the method study, motion study and time study.
- Distinguish the various components and functions such as product planning, process planning, production scheduling, inventory control
- Summarise the recent trends like Manufacturing Requirement Planning (MRP II) and Enterprise Resource Planning (ERP)

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. Case Studies.

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. Case Studies.

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. Case Studies.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 Illustrate production planning functions and manage manufacturing functions in a better way
CO2 Develop competency in scheduling and sequencing of manufacturing operations
CO3 Discuss the demand of the product and prepare an aggregate plan
CO4 Develop the skills of Inventory Management and cost effectiveness
CO5 Apply the logical approach to Line Balancing in various production systems
CO6 Illustrate the techniques of manufacturing planning and control

TEXT BOOKS:

1. James B.Dilworth, "Operations Management - Design, Planning and Control for Manufacturing and Services" McGraw Hill International Edition, 1992.
2. Martand Teslang, "Industrial Engineering and Production Management", Third Revised Edition, S. Chand and Company, 2018.
3. William Bolton "Production Planning and Control" Longman Scientific & Technical, 1994.
4. M.Mahajan "Industrial Engineering and Production Management" Dhanpat Rai Publisher, 2015.

REFERENCES:

1. Samson Eilon, "Elements of production planning and control", Universal Book Corpn.1984
2. Elwood S.Buffa and Rakesh K.Sarin, "Modern Production / Operations Management", 8th Edition. John Wiley and Sons, 2000.
3. Kanishka Bedi, " Production and Operations management", Oxford university press, 2nd Edition 2007.
4. Melynk, Denzler, " Operations management – A value driven approach" Irwin Mc grawhill.
5. Norman Gaither, G. Frazier, "Operations management" Thomson learning 9th edition IE, 2007
6. K.C.Jain & L.N. Aggarwal, "Production Planning Control and Industrial Management", Khanna Publishers, 1990.
7. S.N.Chary, "Theory and Problems in Production & Operations Management", Tata McGraw Hill, 1995.
8. Upendra Kachru, "Production and operations management – Text and cases" Excel books 1st edition 2007.

20ME930 – COMPUTER INTEGRATED MANUFACTURING SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVES:

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

- Explain the fundamentals of CAD.
- Illustrate the role of computers are integrated at various levels of planning and manufacturing understand computer-aided planning
- Describe the concepts of computer control and computer monitoring and how to manage manufacturing in the industry.
- Discuss the various concepts of shop floor control.
- Summarize the latest manufacturing methods.

UNIT I INTRODUCTION TO CIM AND AUTOMATED SYSTEMS 9

Introduction to CIM concepts – Computerized elements of CIM system –Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance– Simple problems – Manufacturing Control – Simple Problems – Basic Elements of an Automated system – Levels of Automation – Lean Production

UNIT II PRODUCTION PLANNING AND CONTROL AND COMPUTERISED PROCESS PLANNING 9

Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer-Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control-Inventory Control – Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP) - Simple Problems.

UNIT III CELLULAR MANUFACTURING 9

Group Technology(GT), Part Families – Parts Classification and coding – Simple Problems in Opitz Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method - Arranging Machines in a GT cell – Hollier Method – Simple Problems

UNIT IV FLEXIBLE MANUFACTURING SYSTEM (FMS) AND AUTOMATED GUIDED VEHICLE SYSTEM (AGVS) 9

Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control – Quantitative analysis in FMS – Simple Problems. Automated Guided Vehicle System (AGVS) – AGVS Application – Vehicle Guidance technology – Vehicle Management & Safety.

UNIT V INDUSTRIAL ROBOTICS 9

Robot Anatomy and Related Attributes – Classification of Robots- Robot Control systems – End Effectors – Sensors in Robotics – Robot Accuracy and Repeatability - Industrial Robot Applications – Robot Part Programming – Robot Accuracy and Repeatability – Simple Problems.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Understand the CIM concepts and basic elements of an automated system.
CO2 Explain the concept of Computer aided process planning and material requirement planning
CO3 Discuss the concept of cellular manufacturing using Rank order clustering and Hollier method
CO4 Describe the FMS planning and applications of Automated guided vehicle systems.
CO5 Distinguish the concepts of robot control system and part programming
CO6 Summarize the applications of computer in planning, manufacturing and controlling

TEXTBOOKS:

1. Mikell.P.Groover "Automation, Production Systems and Computer Integrated Manufacturing", Pearson publications 2016.
2. Radhakrishnan P, Subramanyan S.and Raju V., "CAD/CAM/CIM", 4th Edition, New Age International (P) Ltd, New Delhi, 2018

REFERENCES:

1. Rao. P, N Tewari &T.K. Kundra, "Computer Aided Manufacturing", Tata McGraw Hill Publishing Company, 2016
2. R.Panner Selvam, "Computer-Integrated Manufacturing" (English, Paperback) Cencage publishers, 2018.

20ME931 - VIBRATION AND NOISE CONTROL

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the fundamental nature of various types of vibrations
- Illustrate the various basic parameters of noise
- Demonstrate the sources of various noise components in engine allied systems
- Summarize various vibration inhibition and control techniques
- Apply the various noise reduction and control techniques

UNIT I BASICS OF VIBRATION 9

Introduction, classification of vibration: free and forced vibration, undamped and damped vibration, linear and nonlinear vibration, response of damped and undamped systems under harmonic force, analysis of single degree and two degree of freedom systems, torsional vibration, determination of natural frequencies.

UNIT II BASICS OF NOISE 9

Introduction, amplitude, frequency, wavelength and sound pressure level, addition, subtraction and averaging decibel levels, noise dose level, legislation, measurement and analysis of noise, measurement environment, equipment, frequency analysis, tracking analysis, sound quality analysis.

UNIT III AUTOMOTIVE NOISE SOURCES 9

Noise Characteristics of engines, engine overall noise levels, assessment of combustion noise, assessment of mechanical noise, engine radiated noise, intake and exhaust noise, engine necessary contributed noise, transmission noise, aerodynamic noise, tire noise, brake noise.

UNIT IV CONTROL TECHNIQUES 9

Vibration isolation, tuned absorbers, un-tuned viscous dampers, damping treatments, application dynamic forces generated by IC engines, engine isolation, crank shaft damping, modal analysis of the mass elastic model shock absorbers.

UNIT V SOURCE OF NOISE AND CONTROL 9

Methods for control of engine noise, combustion noise, mechanical noise, predictive analysis, palliative treatments and enclosures, automotive noise control principles, sound in enclosures, sound energy absorption, sound transmission through barriers

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Summarize the Basics of Vibration
CO2 Explain the Basics of Noise
CO3 Discuss the Sources of Automotive Noise
CO4 Use the Control techniques for vibration
CO5 Demonstrate the significance of Modal analysis
CO6 Describe the sources and control of Noise

TEXT BOOKS:

1. Singiresu S.Rao, “Mechanical Vibrations”, 6th Edition, Pearson Education, 2016.

REFERENCES:

1. Balakumar Balachandran and Edward B. Magrab, “Fundamentals of Vibrations”, 1st Editon, Cengage Learning, 2009
2. Benson H. Tongue, “Principles of Vibrations”, 2nd Edition, Oxford University, 2007
3. Bernard Challen and Rodica Baranescu - “Diesel Engine Reference Book”, Second Edition,
4. SAE International, 1999.
5. David Bies and Colin Hansen, “Engineering Noise Control – Theory and Practice”,4th Edition, E and FN Spon, Taylore & Francise e-Library, 2009
6. Grover. G.T., “Mechanical Vibrations”, Nem Chand and Bros., 2009

20ME932 - MICRO ELECTRO MECHANICAL SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVES:
Students completing this course are expected to:

- Understand the semiconductors and solid mechanics to fabricate MEMS devices.
- Discuss the various materials used for MEMS.
- Explain the various sensors and actuators.
- Describe the rudiments of Micro fabrication techniques.
- Apply the elements of Micro-fluidic systems, and select the suitable MEMS devices for Industrial applications.

UNITI INTRODUCTION 9

Intrinsic Characteristics of MEMS – Energy Domains - Scaling Laws in Miniaturization. Introduction to Micro fabrication - Silicon based MEMS processes – Materials for MEMS and Microsystems. – Review of Electrical and Mechanical concepts in MEMS– Semiconductor devices–Stress and strain analysis–Flexural beam bending-Torsional deflection.

UNITII ELECTROSTATIC AND THERMAL BASED MEMS 9

Introduction to Electrostatic Sensors and Actuators, Parallel-Plate Capacitor, Application of Parallel-Plate Capacitors, Interdigitated Finger Capacitors, Applications of Comb-Drive Devices, Introduction to Thermal Sensors and Actuators, Sensors and Actuators Based on Thermal Expansion, Thermocouples, Thermal Resistors, Shape Memory Alloy, Applications of Thermal Sensors and Actuators.

UNITIII PIEZO-RESISTIVE/ELECTRIC AND MAGNETIC BASED MEMS 9

Introduction to Piezoresistive & Piezoelectric effects, Piezoresistive & Piezoelectric materials, Stress Analysis of Mechanical Elements, Applications of Piezo resistive & Piezoelectric Sensors and Actuators, Essential Concepts and Principles of Magnetic Sensors and Actuators, Fabrication of Micro Magnetic Components, Applications of Magnetic Sensors and Actuators.

UNITIV MICROMACHINING 9

Silicon Anisotropic Etching–Anisotrophic Wet Etching–Dry Etching of Silicon–Plasma Etching – Deep Reaction Ion Etching(DRIE)–Isotropic Wet Etching–Gas Phase Etchants– Case studies - Basic surface micro machining processes – Structural and Sacrificial Materials – Acceleration of sacrificial Etch – Striction and Antistriction methods – LIGA Process - Assembly of 3D MEMS – Foundry process.

UNIT V MICROFLUIDICS AND APPLICATIONS OF MEMS 9

Microfluidics - Fluid Mechanics Concepts, Design and Fabrication of Channels, Valves, Pumps, Case Studies - Accelerometer, Gyros, RFMEMS and MOEMS.

TOTAL: 45 PERIODS

OUTCOMES:

- **CO1** Explain the scaling laws involved in miniaturization and materials for MEMS.
- **CO2** Distinguish the working principle of electrostatic and thermal based MEMS sensors and actuators
- **CO3** Discuss the working principle of piezo-resistive, piezo-electric and magnetic effect in the design of MEMS devices.
- **CO4** Understand the various micro-manufacturing processes.
- **CO5** Design the elements of Micro-fluidic systems
- **CO6** Construct the suitable MEMS devices for Industrial applications.

TEXTBOOKS:

1. ChangLiu,"Foundationsof MEMS", PearsonEducation,2011.
2. TaiRanHsu,“MEMS& MicrosystemsDesignandManufacture”TataMcGrawHill,NewDelhi,2017.

REFERENCES:

1. Marc J. Madou, “Fundamentals of Micro fabrication and Nanotechnology”, CRC Press, 2011.
2. Mohamed Gad-el-Hak, “The MEMS handbook: MEMS Applications”, CRC press, 2006.
3. Nitaigour Premchand Mahalik, “MEMS”, McGraw Hill Education, 2007.
4. Stephen D Senturia, “Microsystem Design”, Kluwer Academic Publishers, 2001.
5. Thomas M. Adams and Richard A. Layton, “Introductory MEMS: Fabrication and Applications”, Springer, 2010.

20ME933 - LEAN SIX SIGMA AND AGILE MANUFACTURING

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the principles of Lean Manufacturing and Six Sigma
- Discuss the various approaches of lean Six Sigma
- Explain the organizational structures and planning of six sigma activities
- Describe the resource and project selection in the lean six sigma activities
- Design and develop the various roles of the six sigma as a team player

UNIT I INTRODUCTION TO LEAN MANUFACTURING AND SIX SIGMA 9

Introduction to Lean- Definition, Purpose, features of Lean; top seven wastes, Need for Lean, Elements of Lean Manufacturing, Lean principles, the lean metric, Hidden time traps. Introduction to quality, Definition of six sigma, origin of six sigma, Six sigma concept, Critical success factors for six sigma.

UNIT II LEAN SIX SIGMA APPROACH 9

Evolution of lean six sigma, the synergy of Lean and six sigma, Definition of lean six sigma, the principles of lean six sigma, Scope for lean six sigma, Features of lean six sigma, The laws of lean six sigma, Benefits of lean six sigma, Introduction to DMAIC tools.

UNIT III INITIATION FOR LEAN SIX SIGMA 9

Top management commitment – Infrastructure and deployment planning, Process focus, organizational structures, Measures – Rewards and recognition, Infrastructure tools, structure of transforming event, Launch preparation.

UNIT IV PROJECT SELECTION FOR LEAN SIX SIGMA 9

Resource and project selection, Selection of Black belts, Selecting projects – Benefit/Effort graph, Process mapping, value stream mapping, Balanced score card for project identification, project suitable for lean six sigma.

UNIT V THE DMAIC PROCESS AND INSTITUTIONALIZING 9

Predicting and improving team performance, Nine team roles, Team leadership, DMAIC process, Institutionalizing lean six sigma, Design for lean six sigma, Case study presentations.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Summarize the principles of Lean Manufacturing and Six Sigma
CO2 Apply the various approaches involved in the Lean Six Sigma.
CO3 Discuss various organizational structures and planning of six sigma activities.
CO4 Explain the resource and project selection in the lean six sigma activities.
CO5 Compute design and develop the various roles of the six sigma as a team player.
CO6 Understand the concepts of Institutionalizing lean six sigma.

TEXT BOOKS

1. Michael L. George, Lean Six Sigma, McGraw-Hill, 2018.
2. James P. Womack, Daniel T. Jones, Lean Thinking, Free press business, 2013.
3. Forrest W. Breyfogle III, Implementing Six Sigma: Smarter solutions Using Statistical Methods,2000.

REFERENCES

1. Ronald G.Askin and Jeffrey B.Goldberg, Design and Analysis of Lean Production Systems, John Wiley & Sons, 2003.
2. Rother M. and hook J., Learning to See: Value Stream Mapping to add value and Eliminate Muda, Lean Enterprise Institute, Brookline, MA.

20ME934 - FUNDAMENTALS OF ADDITIVE MANUFACTURING

L	T	P	C
3	0	0	3

OBJECTIVES:
Students completing this course are expected to:

- Understand the need for rapid prototyping.
- Demonstrate the design tools for additive manufacturing
- Discuss the principle and operation of Photo polymerization and Powder Bed Fusion.
- Explain the working of extrusion and sheet lamination processes.
- Summarize the influence of concentrated beam on additive manufacturing

UNIT I INTRODUCTION 9
Overview - Need - Development of Additive Manufacturing Technology -Principle **–** AM Process Chain- Classification **–** Rapid Prototyping- Rapid Tooling **–** Rapid Manufacturing **–** Applications - Benefits **–** Case studies.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING 9
Design tools: Data processing - CAD model preparation **–** Part orientation and support structure generation **–** Model slicing **–** Tool path generation- Design for Additive Manufacturing: Concepts and objectives - AM unique capabilities **–** DFAM for part quality improvement.

UNIT III PHOTOPOLYMERIZATION AND POWDER BED FUSION PROCESSES 9
Photopolymerization: SLA-Photo curable materials **–** Process - Advantages and Applications. Powder Bed Fusion: SLS-Process description **–** powder fusion mechanism **–** Process Parameters **–** Typical Materials and Application. Electron Beam Melting.

UNIT IV EXTRUSION-BASED AND SHEET LAMINATION PROCESSES 9
Extrusion Based System: FDM-Introduction **–** Basic Principle **–** Materials **–** Applications and Limitations **–** Bioextrusion. Sheet Lamination Process:LOM - Gluing or Adhesive bonding **–** Thermal bonding-.

UNIT V PRINTING PROCESSES AND BEAM DEPOSITION PROCESSES 9
Droplet formation technologies **–** Continuous mode **–** Drop on Demand mode **–**Three Dimensional Printing **–** Advantages **–** Bio-plotter - Beam Deposition Process: LENS- Process description **–** Material delivery **–** Process parameters **–** Materials **–** Benefits **–** Applications.

TOTAL: 45 PERIODS

OUTCOMES:
Upon the completion of this course, the students will be able to
CO1 Summarize the need for Additive manufacturing.
CO2 Explain the working of design tools in AM product making
CO3 Distinguish photo polymerization and PBF processes
CO4 Compare working benefits of extrusion and sheet lamination processes
CO5 Discuss the effect of drop/beam deposition in AM.
CO6 Identify the suitable AM process for product development.

TEXT BOOKS:

1 Chua C.K., Leong K.F., and Lim C.S., **"**Rapid prototyping: Principles and applications**"**, Third edition, World Scientific Publishers, 2010.
2 Ian Gibson, David W.Rosen, Brent Stucker **"**Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing**"** Springer, 2010.

REFERENCES:

1 Andreas Gebhardt **"**Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing**"** Hanser Gardner Publication 2011.
2 Kamrani A.K. and Nasr E.A., **"**Rapid Prototyping: Theory and practice**"**, Springer, 2006.
3 Liou L.W. and Liou F.W., **"**Rapid Prototyping and Engineering applications :A tool box for prototype development**"**, CRC Press, 2007.
4 Tom Page **"**Design for Additive Manufacturing**"** LAP Lambert Academic Publishing, 2012.

20ME935 - NON DESTRUCTIVE TESTING AND EVALUATION

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the fundamental concepts of non-destructive testing techniques
- Discuss about the process of Surface Testing Methods (LPT & MPT)
- Describe the process of Thermography and Eddy Current Testing
- Explain the process of Ultrasonic testing and Acoustic Emission Testing
- Summarise the concept of Radiography

UNIT I OVERVIEW OF NDT 9

NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterization. Relative merits and limitations, various physical characteristics of materials and their applications in NDT. Visual inspection – Unaided and aided.

UNIT II SURFACE NDE METHODS 9

Liquid Penetrant Testing - Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetization methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

UNIT III THERMOGRAPHY AND EDDY CURRENT TESTING (ET) 9

Thermography- Principles, Contact and non-contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation - infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.

UNIT IV ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE) 9

Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique – Principle, AE parameters, Applications

UNIT V RADIOGRAPHY (RT)) 9

Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films - graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Explain the fundamental concepts of NDT
CO2 Discuss different Surface NDE methods
CO3 Understand the concepts of Thermography and Eddy current Testing
CO4 Describe the concept of Ultrasonic Testing and Acoustic Emission
CO5 Explain the concept of Radiography
CO6 Summaries the various NDE techniques which enables to carry out various inspection in accordance with the established procedures

TEXT BOOKS:

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2014.
2. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010

REFERENCES:

1. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
2. ASNT, American Society for Non-Destructive Testing, Columbus, Ohio, NDT Handbook,Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing
3. Charles, J. Hellier," Handbook of Nondestructive evaluation", McGraw Hill, New York 2001.
4. Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2 Jersey, 2005nd Edition New Jersey 2005.

20ME936 - ENGINEERING MANAGEMENT AND FINANCIAL ACCOUNTING

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Discuss about principle of management and personnel management
- Explain the basics of financial accounting
- Apply knowledge gained to perform profit value analysis
- Discuss the activities involved in working capital management
- Explain the significance and process of capital budgeting

UNIT I PRINCIPLES OF MANAGEMENT AND PERSONNEL MANAGEMENT 9

General principles of management – management functions – organization – types – comparison – functions of personnel management – recruitment training leadership/motivation –communication – conflict – Industrial relations – trade union.

UNIT II FINANCIAL ACCOUNTING 9

Accounting principles – basic records depreciation – depreciation methods – preparation and interpretation of profit and loss statement – balance sheet – fixed assets – current assets.

UNIT III PROFIT VALUE ANALYSIS 9

Cost volume profit analysis – relevant costs in decision making profit management analysis – break even analysis – margin of safety, Angle of incidence & multi product break even analysis.

UNIT IV WORKING CAPITAL MANAGEMENT 9

Current assets and liability decisions – estimation of working capital requirements – Management of accounts receivable – Inventory – cash – inventory valuation methods.

UNIT V CAPITAL BUDGETING 9

Significance of capital budgeting – payback period – present value method – Accounting rate of return method, Internal Rate of Return.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Explain the principles of management and personnel management.
CO2 Discuss to prepare and interpret financial statements.
CO3 Apply the knowledge gained to perform Profit analysis.
CO4 Explain the process to manage the working capital.
CO5 Describe the logic behind the capital budgeting.
CO6 Summarize the various management techniques and financial accounting.

TEXTBOOKS:

1. R. Kesavan, C. Elanchezhian and T. Sundar Selwyn – Engineering Management – EswarPress, 2005
2. R. Kesavan, C. Elanchezhian and T. Sundar Selwyn, "Engineering Economics and Financial Accounting", Laxmi Publications 2011
3. Maheswaran. S.N., "Management Accounting and Financial Control", Sultan Chand, 2011

REFERENCES:

1. Koontz and Odonnel-Essentials of Management, McGraw Hill 1992
2. James. C., Vanhorn, "Fundamentals of Financial Management" PHI, 2012
3. Charles T.Homgren, "Cost Accounting", PHI, 2012

20ME937 - INDUSTRIAL SAFETY ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Explain the basics Concepts of Industrial Safety.
- Understand the Principles of Accident Investigation and Prevention.
- Summarize various methods of safety Practices and creating awareness.
- Describe various Industrial Hazards and Protecting methods.
- Demonstrate the Human behaviour-based safety concepts.

UNIT I CONCEPTS 9

Evolution of modern safety concept- Safety policy - Safety Organization - line and staff functions for safety- Safety Committee- budgeting for safety. Techniques: Incident Recall Technique (IRT), disaster control, Job Safety Analysis (JSA), safety survey, safety inspection, safety sampling, Safety Audit.

UNIT II ACCIDENT INVESTIGATION AND REPORTING 9

Concept of an accident, reportable and non-reportable accidents, unsafe act and condition – principles of accident prevention, Supervisory role- Role of safety committee - Accident causation models - Cost of accident. Overall accident investigation process - Response to accidents, India reporting requirement, planning document, Planning matrix, Investigators Kit, functions of investigator, four types of evidences, Records of accidents, accident reports- Class exercise with case study.

UNIT III SAFETY EDUCATION, TRAINING AND PERFORMANCE MONITORING 9

Importance of training-identification of training needs-training methods – programme, seminars, conferences, competitions – method of promoting safe practice - motivation – communication - role of government agencies and private consulting agencies in safety training – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign – Domestic Safety and Training. permanent total disabilities, permanent partial disabilities, temporary total disabilities - Calculation of accident indices, frequency rate, severity rate, frequency severity incidence, incident rate, accident rate, safety “t” score, safety activity rate – problems.

UNIT IV PERSONAL PROTECTIVE EQUIPMENT 9

Need for personal protection equipment - Non-respiratory personal protective devices: Head protection, Ear protection. Face and Eye protection. Hand protection, Foot protection, body protection. Respiratory personal protective devices : Classification of hazards. Classification of respiratory personal protective devices. Selection of respiratory personal protective devices. Instructions and training in the use, maintenance and care of self-containing breathing apparatus. Testing Procedures and Standards.

UNIT V BEHAVIOUR BASED SAFETY 9

Human behavior : Individual differences, behavior as function of self and situation, perception of danger and acceptance of risk, knowledge, and responsibility vis-avis safety performance, theories of motivation and their application to safety, role of, supervisors and safety departments in motivation. Conflict & Frustration : Identification of situations leading to conflict and frustration and techniques of management. BBS Program.

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course, the students will be able to

CO1 Describe the basics Concepts of Industrial Safety.
CO2 Explain the Principles of Accident Investigation and Prevention.
CO3 Discuss various methods of safety Practices and creating awareness.
CO4 Summarize various Industrial Hazards and Protecting methods.
CO5 Demonstrate the Human behaviour-based safety concepts.
CO6 Apply the Concepts of Industrial Safety in Engineering and other fields.

TEXT BOOKS:

1. Accident Prevention Manual for Industrial Operations, N.S.C. Chicago, 2010
2. Heinrich H.W., Industrial Accident Prevention, McGraw-Hill Company, New York, 2000.
3. John V.Grimaldi and Rollin H.Simonds, Safety Management, All India Travellers Bookseller, New Delhi, 1994.

REFERENCES:

1. R W Yance and WM Duke, Applied Cryogenic Engineering, John Willey.
2. Klaus D. Timmerhaus, Richard Palmer Reed, Cryogenic Engineering: 50 years of progress, Springer, 2007.