R.M.K. COLLEGE OF ENGINEERING AND TECHNOLOGY

(An Autonomous Institution)

R.S.M. Nagar, Puduvoyal, Gummidipoondi Taluk,

Thiruvallur District, Tamil Nadu- 601206

Affiliated to Anna University, Chennai / Approved by AICTE, New Delhi

Accredited by NAAC with A Grade / All the Eligible UG Programs are Accredited by NBA, New Delhi

B.E. Degree in

MECHANICAL ENGINEERING

CURRICULUM AND SYLLABI

REGULATIONS – 2021

CHOICE-BASED CREDIT SYSTEM

(For the students admitted from the academic year 2021 – 2022 onwards)

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BoS Coordinator	**BoS Chairman**	**Principal**

B.E. MECHANICAL ENGINEERING

REGULATIONS – 2021

CHOICE-BASED CREDIT SYSTEM

CURRICULUM AND SYLLABI

SEMESTER I

S. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
		Induction Program	MC	3 Weeks				
THEORY COURSES								
1.	21EL101	Communicative English and Life Skills	HS	2	2	0	0	2
2.	21MA101	Engineering Mathematics - I	BS	5	3	2	0	4
3.	21ME101	Computer Aided Engineering Graphics	ES	6	2	0	4	4
4.	21CH102	Environmental Science and Engineering	HS	3	3	0	0	3
5.	21CS101	Problem Solving and C Programming	ES	3	3	0	0	3
6.	21GE102	Basic Electrical, Electronics and Instrumentation Engineering	ES	3	3	0	0	3
PRACTICALS								
7.	21EM111	Engineering Practices Laboratory	ES	4	0	0	4	2
8.	21CS111	C Programming Laboratory	ES	4	0	0	4	2
9.	21EL111	Interpersonal Skills - Listening and Speaking Laboratory	HS	2	0	0	2	1
TOTAL				**32**	**16**	**2**	**14**	**24**

SEMESTER II

S. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSES								
1.	21EL201	Technical English	HS	2	2	0	0	2
2.	21MA201	Engineering Mathematics - II	BS	5	3	2	0	4
3.	21PH201	Physics for Mechanical Engineering	BS	3	3	0	0	3
4.	21CH201	Chemistry for Mechanical Engineering	BS	3	3	0	0	3
5.	21ME201	Engineering Mechanics	ES	5	3	2	0	4
6.	21ME202	Fundamentals of Manufacturing Processes	PC	3	3	0	0	3
PRACTICALS								
7.	21PC111	Physics and Chemistry Laboratory	BS	4	0	0	4	2
8.	21CS212	Advanced C Programming Laboratory	ES	4	0	0	4	2
9.	21EL211	Advanced Reading and Writing Laboratory	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 COURSES								
1.	21MA303	Transforms and Partial Differential Equations	BS	5	3	2	0	4
2.	21ME301	Engineering Thermodynamics	PC	3	3	0	0	3
3.	21ME302	Fluid Mechanics and Machinery	ES	3	3	0	0	3
4.	21ME303	Machine Tool Technology	PC	3	3	0	0	3
5.	21CS305	JAVA Programming	ES	3	3	0	0	3
6.	21EL301	Universal Human Values – 2: Understanding Harmony	HS	4	2	2	0	3
PRACTICALS								
7.	21ME311	Manufacturing Processes Laboratory and Mini Project	PC	4	0	0	4	2
8.	21ME312	Computer Aided Machine Drawing	PC	4	0	0	4	2
9.	21CS314	Aptitude and Coding Skills – I	EEC	2	0	0	2	1
10.	21CS315	JAVA Programming Laboratory	ES	4	0	0	4	2
TOTAL				**35**	**17**	**04**	**14**	**26**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSES								
1.	21MA403	Statistics and Numerical Methods	BS	5	3	2	0	4
2.	21ME401	Kinematics of Machinery	PC	3	3	0	0	3
3.	21ME402	Engineering Materials and Metallurgy	ES	3	3	0	0	3
4.	21ME403	Strength of Materials	ES	3	3	0	0	3
5.	21ME404	Thermal Engineering- I	PC	3	3	0	0	3
THEORY COURSE WITH LABORATORY COMPONENT								
6.	21ME405	Engineering Metrology and Measurement	PC	4	2	0	2	3
PRACTICALS								
6.	21ME411	Machine Tool Laboratory	PC	4	0	0	4	2
7.	21ME412	Strength of Materials and Fluid Mechanics and Machinery Laboratory	ES	4	0	0	4	2
9.	21CS414	Aptitude and Coding Skills - II	EEC	2	0	0	2	1
10.	21CS415	Applications of Programming in Mechanical Engineering	ES	4	0	0	4	2
TOTAL				**35**	**17**	**02**	**16**	**26**

SEMESTER V

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSE WITH LABORATORY COMPONENT								
1.	21ME501	Thermal Engineering- II	PC	5	3	0	2	4
THEORY COURSES								
2.	21ME502	Design of Machine Elements	PC	3	3	0	0	3
3.	21ME503	Dynamics of Machines	PC	4	2	2	0	3
4.	21ME504	Basics of Product life cycle Management	PC	3	3	0	0	3
5.		Professional Elective – I	PE	3	3	0	0	3
PRACTICALS								
6.	21ME511	Kinematics and Dynamics Laboratory	PC	4	0	0	4	2
7.	21ME512	Product Lifecycle Management Laboratory	PC	4	0	0	4	2
8.	21CS512	Advanced Aptitude and Coding Skills – I	EEC	2	0	0	2	1
			TOTAL	**28**	**14**	**02**	**12**	**21**

SEMESTER VI

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSE WITH LABORATORY COMPONENT								
1.	21ME602	Computer Aided Design and Manufacturing	PC	4	2	0	2	3
THEORY COURSES								
2.	21ME601	Design of Transmission Systems	PC	4	2	2	0	3
3.	21ME603	Advanced Product Lifecycle Management	PC	3	3	0	0	3
4.		Open Elective – I	OE	3	3	0	0	3
5.		Professional Elective – II	PE	3	3	0	0	3
PRACTICALS								
6.	21ME611	Design and Fabrication Project and Internship	EEC	4	0	0	4	2
7.	21ME612	Advanced Product Lifecycle Management Laboratory	PC	4	0	0	4	2
8.	21CS613	Advanced Aptitude and Coding Skills - II	EEC	2	0	0	2	1
TOTAL				**27**	**13**	**02**	**12**	**20**

SEMESTER VII

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSES								
1.	21ME701	Introduction to Business Intelligence and Analytics, Advanced Integration techniques	PC	3	3	0	0	3
2.		Open Elective – II	OE	3	3	0	0	3
3.		Professional Elective – III	PE	3	3	0	0	3
4.		Professional Elective – IV	PE	3	3	0	0	3
PRACTICALS								
5.	21ME711	Simulation and Analysis Laboratory	PC	4	0	0	4	2
6.	21ME712	Mechatronics Laboratory	PC	4	0	0	4	2
7.	21ME713	Mini project and Comprehension	EEC	2	0	0	2	1
			TOTAL	**22**	**12**	**0**	**10**	**17**

SEMESTER VIII

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICAL								
1.	21ME811	Project Work	EEC	16	0	0	16	8
			TOTAL	**16**	**0**	**0**	**16**	**8**

TOTAL NUMBER OF CREDITS = 166

HUMANITIES AND SOCIAL SCIENCES (HS)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21EL101	Communicative English and Life Skills	HS	2	2	0	0	2
2.	21CH102	Environmental Science and Engineering	HS	3	3	0	0	3
3.	21EL111	Interpersonal Skills – Listening and Speaking Laboratory	HS	2	0	0	2	1
4.	21EL201	Technical English	HS	2	2	0	0	2
5.	21EL211	Advanced Reading and Writing Laboratory	HS	2	0	0	2	1
6.	21EL301	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.	21MA101	Engineering Mathematics - I	BS	5	3	2	0	4
2.	21MA201	Engineering Mathematics - II	BS	5	3	2	0	4
3.	21PH201	Physics for Mechanical Engineering	BS	3	3	0	0	3
4.	21CH201	Chemistry for Mechanical Engineering	BS	3	3	0	0	3
5.	21PC111	Physics and Chemistry Laboratory	BS	4	0	0	4	2
6.	21MA303	Transforms and Partial Differential Equations	BS	5	3	2	0	4
7.	21MA403	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.	21ME101	Computer Aided Engineering Graphics	ES	6	2	0	4	4
2.	21CS101	Problem Solving and C Programming	ES	3	3	0	0	3
3.	21GE102	Basic Electrical, Electronics and Instrumentation Engineering	ES	3	3	0	0	3
4.	21EM111	Engineering Practices Laboratory	ES	4	0	0	4	2
5.	21CS111	C Programming Laboratory	ES	4	0	0	4	2
6.	21ME201	Engineering Mechanics	ES	5	3	2	0	4
7.	21CS212	Advanced C Programming Laboratory	ES	4	0	0	4	2
8.	21ME302	Fluid Mechanics and Machinery	ES	3	3	0	0	3
9.	21CS305	JAVA Programming	ES	3	3	0	0	3
10.	21CS315	JAVA Programming Laboratory	ES	4	0	0	4	2
11.	21ME402	Engineering Materials and Metallurgy	ES	3	3	0	0	3
12.	21ME403	Strength of Materials	ES	3	3	0	0	3
13.	21ME412	Strength of Materials and Fluid Mechanics and Machinery Laboratory	ES	4	0	0	4	2
14.	21CS415	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.	21ME202	Fundamentals of Manufacturing Processes	PC	3	3	0	0	3
2.	21ME301	Engineering Thermodynamics	PC	3	3	0	0	3
3.	21ME303	Machine Tool Technology	PC	3	3	0	0	3
4.	21ME311	Manufacturing Processes Laboratory and Mini Project	PC	4	0	0	4	2
5.	21ME312	Computer Aided Machine Drawing	PC	4	0	0	4	2
6.	21ME401	Kinematics of Machinery	PC	3	3	0	0	3
7.	21ME404	Thermal Engineering- I	PC	3	3	0	0	3
8.	21ME405	Engineering Metrology and Measurement (Theory Course with Laboratory Component)	PC	4	2	0	2	3
9.	21ME411	Machine Tool Laboratory	PC	4	0	0	4	2
10.	21ME501	Thermal Engineering- II (Theory Course with Laboratory Component)	PC	5	3	0	2	4
11.	21ME502	Design of Machine Elements	PC	3	3	0	0	3
12.	21ME503	Dynamics of Machines	PC	4	2	2	0	3
13.	21ME504	Basics of Product life cycle Management	PC	3	3	0	0	3
14.	21ME511	Kinematics and Dynamics Laboratory	PC	4	0	0	4	2
15.	21ME512	Product Lifecycle Management Laboratory	PC	4	0	0	4	2
16.	21ME601	Design of Transmission Systems	PC	4	2	2	0	3
17.	21ME602	Computer Aided Design and Manufacturing (Theory Course with Laboratory Component)	PC	4	2	0	2	3

18.	21ME603	Advanced Product Lifecycle Management	PC	3	3	0	0	3
19.	21ME612	Advanced Product Lifecycle Management Laboratory	PC	4	0	0	4	2
20.	21ME701	Introduction to Business Intelligence and Analytics, Advanced Integration techniques	PC	3	3	0	0	3
21.	21ME711	Simulation and Analysis Laboratory	PC	4	0	0	4	2
22.	21ME712	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.	21CS314	Aptitude and Coding Skills – I	EEC	2	0	0	2	1
2.	21CS414	Aptitude and Coding Skills - II	EEC	2	0	0	2	1
3.	21CS512	Advanced Aptitude and Coding Skills – I	EEC	2	0	0	2	1
4.	21ME611	Design and Fabrication Project and Internship	EEC	4	0	0	4	2
5.	21CS613	Advanced Aptitude and Coding Skills - II	EEC	2	0	0	2	1
6.	21ME713	Mini project and Comprehension	EEC	2	0	0	2	1
7.	21ME811	Project Work	EEC	16	0	0	16	8

PROFESSIONAL ELECTIVES

SEMESTER V, ELECTIVE I

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21ME901	Automobile Engineering	PE	3	3	0	0	3
2.	21ME902	Gas Dynamics and Jet Propulsion	PE	3	3	0	0	3
3.	21ME903	Hydraulics and Pneumatics Control	PE	3	3	0	0	3
4.	21ME904	Tool Design	PE	3	3	0	0	3
5.	21ME905	Welding Technology	PE	3	3	0	0	3
6.	21ME906	Engineering Tribology	PE	3	3	0	0	3
7.	21ME907	Basics of Nano Science	PE	3	3	0	0	3
8.	21ME908	Intellectual Property Rights	PE	3	3	0	0	3
9.	21ME909	Indian Constitution (Common to all branches)	PE	3	3	0	0	3

SEMESTER VI, ELECTIVE II

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21ME910	Finite Element Analysis	PE	3	3	0	0	3
2.	21ME911	Unconventional Machining Processes	PE	3	3	0	0	3
3.	21ME912	Renewable Sources of Energy	PE	3	3	0	0	3
4.	21ME913	Refrigeration and Air Conditioning	PE	3	3	0	0	3
5.	21ME914	Quality Control and Reliability Engineering	PE	3	3	0	0	3
6.	21ME915	Operations Research	PE	3	3	0	0	3
7.	21ME916	Design of Jigs, Fixtures and Press Tools	PE	3	3	0	0	3
8.	21ME917	Alternate Energy sources for Automobiles	PE	3	3	0	0	3
9.	21ME918	Essence of Indian Traditional Knowledge (Common to all branches)	PE	3	3	0	0	3
10.	21ME938	Heat and Mass Transfer	PE	4	2	2	0	3

SEMESTER VII, ELECTIVE III

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21ME919	Mechatronics	PE	3	3	0	0	3
2.	21ME920	Robotics	PE	3	3	0	0	3
3.	21CS938	Professional Ethics in Engineering (Common to all branches)	PE	3	3	0	0	3
4.	21ME921	Introduction to Hybrid and Electric Vehicles	PE	3	3	0	0	3
5.	21ME922	Computational Fluid Dynamics	PE	3	3	0	0	3
6.	21ME923	Composite Materials and Mechanics	PE	3	3	0	0	3
7.	21ME924	Cryogenic Engineering	PE	3	3	0	0	3
8.	21ME925	Introduction to Innovation, IP Management and Entrepreneurship (Common to Mech & ECE)	PE	3	3	0	0	3
9.	21ME926	Principles of Management (Common to Mech, ADS & CSE)	PE	3	3	0	0	3
10.	21ME927	Total Quality Management (Common to Mech & ECE)	PE	3	3	0	0	3
11.	21ME939	Power Plant Engineering	PE	3	3	0	0	3

SEMESTER VII, ELECTIVE IV

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21ME928	Entrepreneurship Development	PE	3	3	0	0	3
2.	21ME929	Production Planning and Control	PE	3	3	0	0	3
3.	21ME930	Computer Integrated Manufacturing Systems	PE	3	3	0	0	3
4.	21ME931	Vibration and Noise Control	PE	3	3	0	0	3
5.	21ME932	Micro Electro Mechanical Systems	PE	3	3	0	0	3
6.	21ME933	Lean Sigma and Agile Manufacturing	PE	3	3	0	0	3
7.	21ME934	Basics of Additive Manufacturing	PE	3	3	0	0	3
8.	21ME935	Non-Destructive Testing and Evaluation	PE	3	3	0	0	3
9.	21ME936	Engineering Management and Financial Accounting	PE	3	3	0	0	3
10.	21ME937	Industrial Safety Engineering	PE	3	3	0	0	3
11.	21ME940	Process Planning and Cost Estimation	PE	3	3	0	0	3

LIST OF OPEN ELECTIVES

(ARTIFICIAL INTELLIGENCE AND DATA SCIENCE)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21AI001	Data Analytics	OE	3	3	0	0	3
2.	21AI002	Machine Learning	OE	3	3	0	0	3
3.	21AI003	Business Analytics	OE	3	3	0	0	3
4.	21AI004	Deep Learning Techniques	OE	3	3	0	0	3
5.	21AI005	Natural Language Processing	OE	3	3	0	0	3

LIST OF OPEN ELECTIVES

(COMPUTER SCIENCE AND ENGINEERING)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21CS001	Python Programming	OE	3	3	0	0	3
2.	21CS303	Software Engineering	OE	3	3	0	0	3
3.	21CS002	Mobile Application Development	OE	3	3	0	0	3
4.	21CS304	Database Management System	OE	3	3	0	0	3
5.	21CS914	Internet of Things	OE	3	3	0	0	3
6.	21CS701	Cloud Computing	OE	3	3	0	0	3
7.	21CS003	Block Chain Technologies	OE	3	3	0	0	3
8.	21CS901	Cyber Physical Systems	OE	3	3	0	0	3
9.	21CS902	Web Security	OE	3	3	0	0	3
10.	21CS904	Image Processing	OE	3	3	0	0	3
11.	21CS905	Computer Vision	OE	3	3	0	0	3
12.	21CS907	Human Computer Interaction	OE	3	3	0	0	3

LIST OF OPEN ELECTIVES

(ELECTRONICS AND COMMUNICATION ENGINEERING)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21OE001	PCB Design	OE	3	3	0	0	3
2.	21OE002	Embedded Systems	OE	3	3	0	0	3
3.	21OE003	Principles Of Analog And Digital Communication	OE	3	3	0	0	3
4.	21OE004	Sensors and and Instrumentation	OE	3	3	0	0	3
5.	21OE005	Automotive Electronics	OE	3	3	0	0	3
6.	21OE006	Robotic Systems	OE	3	3	0	0	3
7.	21OE007	Consumer Electronics	OE	3	3	0	0	3
8.	21OE008	Healthcare Electronics	OE	3	3	0	0	3
9.	21OE009	Semiconductor Physics	OE	3	3	0	0	3
10.	21OE010	Biomedical Instrumentation	OE	3	3	0	0	3
11.	21OE011	MATLAB Programming	OE	3	3	0	0	3
12.	21OE012	Industrial IoT Applications	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	7.23
2.	BS	4	12	4	4	-	-	-	-	24	14.46
3.	ES	14	6	8	10	-	-	-	-	38	22.89
4.	PC	-	3	10	11	17	11	7	-	59	35.54
5.	PE	-	-	-	-	3	3	6	-	12	7.23
6.	OE	-	-	-	-	-	3	3	-	06	3.61
7.	EEC	-	-	1	1	1	3	1	8	15	9.04
8.	MC	NON-CREDIT COURSE									
	Total	**24**	**24**	**26**	**26**	**21**	**20**	**17**	**8**	**166**	**100**

SEMESTER I

21EL101-COMMUNICATIVE ENGLISH AND LIFE SKILLS

(Common to all branches)

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 a 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 one-self- 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 this course, the students will be able to:

- Read articles in magazines and newspapers efficiently and acquire different life skills.

- Comprehend conversations and short talks delivered in English and develop an awareness of the self and apply well-defined techniques to cope with emotions and stress.
- Participate actively in informal conversations and develop negotiation skills.
- Write effective personal letters and emails and deal with personal and societal issues.
- Exhibit proficiency in writing analytical essays and developing leadership skills.

TEXT BOOKS:

1. Kumar, Suresh E., and Sreehari, P. Communicative English. Hyderabad: Orient Blackswan, 2019.
2. Richards, C. Jack. Interchange. Students' Book-2. New Delhi: CUP, 2017.

REFERENCES:

1. Bailey, Stephen. Academic Writing: A Practical Guide for Students. New York: Rutledge, 2017.
2. Dhanavel, S P. English and Soft Skills, Volume Two, Hyderabad: Orient Blackswan, 2019.
3. Elbow, Peter. Writing Without Teachers. London: Oxford University Press, 1998.
4. James, Larry. The First Book of Life Skills; First Edition, Embassy Books, 2016.
5. Larsen, Kristine, Stephen Hawking: A Biography. Westport: Greenwood Publishing Group, 2012.
6. Redston, Chris., and Cunningham, Gillie. Face2Face (Pre-intermediate Student 's Book & Workbook). New Delhi: Cambridge University Press, 2020.

21MA101-ENGINEERING MATHEMATICS – I

(Common to all branches)

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 of 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 an envelope of normal).

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 PERIODS: 75

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 the function of several variables.
- Apply Gamma and Beta integrals to evaluate improper integrals.
- Evaluate the area and volume by using multiple integrals.

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, 44th Edition, 2018.
3. T. Veerarajan, "Engineering Mathematics", Tata McGraw Hill, 2nd Edition, New

Delhi, 2011.

REFERENCES:

1. M. K. Venkataraman, “Engineering Mathematics”, Volume I, Fourth 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.

21ME101-COMPUTER AIDED ENGINEERING GRAPHICS

(Common to I semester ECE, ME & II semester CSE, AI&DS)

L	T	P	C
2	0	4	4

OBJECTIVES:

Students completing this course are expected to:

- Explain the graphic skills for communication of concepts, ideas and design of engineering products.
- Summarize the procedure to draw the various types of curves
- Reproduce the concept to project orthographic projections of points, lines and plane surfaces.
- Apply the concept of projections in the projection of solids and sections of solids.
- Use visualization skills in the development of surfaces of solids and isometric projections.

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 SURFACE 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 the above solids in the simple vertical position when the cutting plane is inclined to one of the principal planes and perpendicular to the other – obtaining the 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:

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

- Discuss the procedure to draw the orthographic views using CAD software.
- Explain the methods to construct the various types of plane curves.
- Draw the projection of points, lines and planes.
- Use the concepts in the drawing of projections and sections of solids.
- Demonstrate the isometric projection and development of surfaces of a solid.
- Apply the concepts of engineering drawing in practical applications.

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.

21CH102-ENVIRONMENTAL SCIENCE AND ENGINEERING

(Common to I semester ME & II semester CSE, AI&DS and ECE)

L	T	P	C
3	0	0	3

OBJECTIVES:

The course is designed to:

- Appreciate the natural resources of the 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 the environment.
- Understand the integrated themes of biodiversity.
- Appreciate the importance of the 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:

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

- Associate the effects of the exploitation of Natural resources on the environment.
- Discuss the sources, effects, and control measures of different types of pollution and solid waste management
- Summarize the values, threats, conservation of biodiversity and ecosystems
- Summarize the water conservation methods and various environmental acts for environmental sustainability
- Explain the effect of the Human population and the role of IT in the environment and human health.

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, “Textbook of Environmental Studies”, Universities Press Pvt. Ltd., Hyderabad, 2nd edition, 2015.
4. Muhammad Adnan Shereen, Suliman Khan, Abeer Kazmi, Nadia Bashir, Rabeea Siddique, COVID-19 infection: Origin, transmission, and characteristics of human coronaviruses, Journal of Advanced Research 24, 91–98, 2020.
5. Siam, M. H. B., Nishat, N. H., Ahmed, A., & Hossain, M. S., Stopping the COVID-19 Pandemic: A Review on the Advances of Diagnosis, Treatment, and Control Measures. Journal of Pathogens, 1–12, 2020.
6. Ben Hu, Hua Guo, Peng Zhou & Zheng-Li Shi, Characteristics of SARS-CoV-2 and COVID-19, Nature Reviews, Microbiology volume 19, 141–154, 2021.

21CS101-PROBLEM SOLVING AND C PROGRAMMING

(Common to all branches) **L T P C**

3 0 0 3

OBJECTIVES

- To make the students understand the fundamentals of problem-solving using Algorithms and Flowcharts
- 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 FORMATTED 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.

REFERENCE BOOKS:

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.

21GE102-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

COURSE OUTCOMES:

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

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

TEXT BOOKS:

1. S.K. Bhattacharya, "Basic Electrical & Electronics Engineering", Pearson Education India, 2011.

2. E. Fitzgerald, David E Higginbotham and Arvin Grabel, "Basic Electrical Engineering", McGraw Hill Education (India) Private Limited, 2009.
3. D P Kothari and I J Nagarath," Electrical Machines "Basic Electrical and Electronics Engineering", McGraw Hill Education (India) Private Limited, Third Reprint, 2016.

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. N K De, Dipu Sarkar, "Basic Electrical Engineering", Universities Press (India) Private Limited 2016.

21EM111-ENGINEERING PRACTICES LABORATORY

(Common to I semester ME & II semester CSE, ECE, AI&DS)

L	T	P	C
0	0	4	2

OBJECTIVES:

Students completing this course are expected to:

- Use suitable tools for making carpentry components and pipe connections for plumbing works.
- Apply the welding techniques to join the structures
- Demonstrate the basic machining operations, working of centrifugal pump, Air conditioner, and operations of the smithy, foundry
- Measure various electrical quantities
- Explain the working of electronic components and their utilization.

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 sewage works.

(d) Hands-on-exercise: Basic pipe connections – Mixed pipe material connection – Pipe connections 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 metal arc 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 cone pulley.

(c) Fitting: Exercises – Preparation of square fitting and V – fitting models.

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:

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

- Classify the Tools and Techniques used for Carpentry work and Sheet Metal Fabrication.
- Use welding equipment to join the structures.
- Demonstrate the pipe fittings for plumbing works.
- Carry out simple wiring as per the layout given
- Measures various electrical parameters like Voltage, Current, Power factor, Energy, Earth resistance 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

21CS111-C PROGRAMMING LABORATORY

(Common to all branches)

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

- Algorithm and Flowchart
- Control Flow Structures
- Arrays
- Functions
- Searching
- Sorting
- Structures
- Pointers
- Files and File Operations

INDICATIVE LIST OF EXERCISES:

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 >, <3 6, 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./fg|| 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 Employeewith the following members:

EID, Ename, 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 atelephone 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", DorlingKindersley (India) Pvt. Ltd., Pearson Education in South Asia, 2011.

Reference Books:

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 SubjectsYou Keep Avoiding (like C)", (Zed Shaw's Hard Way Series), 1st Edition, Addison- Wesley Professional, 2015.

21EL111-INTERPERSONAL SKILLS -LISTENING AND SPEAKING LABORATORY

(Common to all branches)

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.
- Demonstrate presentation skills competently.
- Improve general and academic listening skills.
- Develop intent listening and negotiating skills pertaining to placement

UNIT I **06**

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 **06**

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 **06**

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 **06**

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

UNIT V **06**

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 this course, the students will be able to:

- Listen and respond appropriately.
- Exhibit linguistic competency.
- Greet and respond effectively.
- Participate in group discussions.
- Make effective presentations.

TEXT BOOKS:

1. Brooks, Margaret. Skills for Success. Listening and Speaking. Level 4. Oxford: Oxford University Press, 2015.
2. Dhanavel, S. P. English and Soft Skills, Volume One, Hyderabad: Orient Blackswan, 2016.

REFERENCES:

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

SEMESTER II

21EL201-TECHNICAL ENGLISH

(Common to all branches)

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 this course, the students will be able to:

- Listen to short talks effectively and read technical texts effortlessly.
- Manage to interpret the given phrase or the graphical rendering and review the contents.
- Develop flair for writing technical documents with grammatical accuracy.
- Write context specific reports and record minutes of the meeting.
- Speak effectively in varied formal and informal contexts and prepare winning job applications.

TEXT BOOKS:

1. Fried-Booth, Diana L. Project Work. Oxford: Oxford University Press, 2014.
2. Sudharshana. N. P., and Saveetha C. English for Technical Communication. New Delhi: Cambridge University Press, 2018.

REFERENCES:

1. Grussendorf, Marion. English for Presentations. Oxford: Oxford University Press, 2010.
2. Herbert, A. J. The Structure of Technical English. London: Longman.1976.
3. Kumar, Suresh. E. Engineering English. Orient BlackSwan: Hyderabad, 2015.
4. Means, Thomas L., and Langlois, Elaine. English & Communication for Colleges. Cengage Learning, USA: 2017.
5. Raman, Meenakshi., and Sharma, Sangeetha, Technical Communication Principles and Practice. New Delhi: Oxford University Press, 2017.

21MA201-ENGINEERING MATHEMATICS – II

(Common to all branches)

L	T	P	C
3	2	0	4

OBJECTIVES:

The syllabus is designed to:

- Explain various techniques for solving ordinary differential equations.
- Make the students understand the concepts of vector differentiation and integration.
- Introduce the concepts of Laplace transforms and their applications.
- Develop an understanding of 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:

At the end of this course, the students 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, 44th Edition, 2018.
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.

21PH201-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

COURSE OUTCOMES:

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

- Describe the characteristics of laser light, principle behind the propagation of light through an optical fibre and its application in sensors.
- Discuss the elastic and thermal properties of materials and its determination through experimental methods.
- Describe the unit cell characteristics and the role of imperfection in the crystal.
- Summarize the properties of magnetic materials and their applications in super conducting and Squid devices.
- Eloborate the Preparation and properties of nano and novel Engineering materials and their applications.

TEXT BOOKS:

1. M.N. Avadhanulu and P.G. Kshirsagar, "A text book of Engineering Physics", S. Chand and Company, New Delhi, 2014.
2. R.K. Gaur and S.L.Gupta, "Engineering Physics", Dhanpat Rai Publications (P) Ltd., Eighth Edition, New Delhi, 2001.
3. V. Rajendran, "Materials Science", Tata McGraw-Hill, 2011.
4. A. Marikani, "Engineering Physics", PHI Learning Private Limited, Second Edition, 2013.
5. T. Pradeep, "A Textbook of Nanoscience and Nanotechnology", McGraw Hill Education, 2017

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. B.B. Laud "Lasers and Non-Linear Optics" New Age International Publishers, 3rd Edition, 2011.
5. R.A. Serway and J.W. Jewett, "Physics for Scientists and Engineers", Ninth Edition, Cengage Learning, 2014.
6. Richard Wolfson, "Essential University Physics", Vols. 1 and 2. Pearson Education, Singapore, 2011.
7. B.K. Pandey, S. Chaturvedi, Engineering Physics, Cengage Learning, 2012.
8. Charles Kittel, Introduction to Solid State Physics, 8th Edition, John Wiley & Sons, NJ, USA, 2005.

21CH201-CHEMISTRY FOR MECHANICAL ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

The syllabus is designed to:

- Be conversant with the hardness of water, its implications in boilers and water treatment techniques.
- Acquaint the basic concepts of thermodynamics and their functions in different processes.
- Impart knowledge of fuels and their properties for various applications.
- Develop an understanding of the basics of different types of engineering.
- 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.
- Summarize the properties and uses of engineering materials such as lubricants, refractories and composites.
- Correlate phase rule in alloying process and the behavior of one component and two component systems using phase diagram.

TEXT BOOKS:

1. P. C. Jain and Monika Jain, "Engineering Chemistry", 17th Edition, Dhanpat Rai Publishing Company Pvt. Ltd., New Delhi, 2019.
2. Prasanta Rath, "Engineering Chemistry", 1st Edition, Cengage Learning India Pvt. Ltd., Delhi, 2015.
3. Samuel Glasstone, "Text-book of physical chemistry", Pranava Books (Reprint), 2020.
4. PK Nag, "Engineering Thermodynamics", Sixth Edition, McGraw Hill Education, 2017.

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.
3. K.M. Gupta, Engineering Materials Research, Applications and Advances, CRC Press, Taylors & Francis Group, 2015.
4. V. Raghavan, "Materials Science and Engineering: A First Course", 6th Edition Prentice Hall India Learning Private Limited, 2015.

21ME201-ENGINEERING MECHANICS

L	T	P	C
3	2	0	4

OBJECTIVES:

Students completing this course are expected to

- Discuss the vectorial and scalar representation of forces and moments.
- Estimate the unknown reactions holding a rigid body in equilibrium by solving the equations of static equilibrium.
- Compute properties of areas, volumes, and masses needed in the solution of mechanics problems.
- Discuss and use basic terms for the description of the motion of particles and the fundamental laws of Newtonian mechanics.
- Explain common occurrences of friction, including those in which friction can be used to advantage in everyday life.

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 ISOMETRIC AND PERSPECTIVE PROJECTIONS 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:

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

- Compute the forces acting on a particle in planar and spatial systems.
- Estimate the force and moment on rigid bodies for planar and spatial systems.
- Calculate the properties of surfaces and solids.
- Examine the motion parameters like displacement, velocity, and acceleration.
- Estimate the frictional force and the motion parameters of the rigid body.
- Apply the concepts of mechanics in work and force analysis

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: Staticsand 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.

21ME202-FUNDAMENTALS OF MANUFACTURING PROCESSES

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to

- Explain the concepts of metal casting, and inspection methods for testing of casting.
- Discuss the basic concepts of the welding process, special welding processes, adhesive bonding and its application.
- Explain the concepts of metal working processes.
- Summarize various sheet metal working processes, formability tests and special forming processes.
- Discuss the concepts of the plastic molding process, bonding of thermoplastics and its applications

UNIT-I METAL CASTING PROCESSES 9

Sand Casting: Sand Mould – Type of patterns - 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:

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

- Distinguish the various casting methods for product manufacturing.
- Explain the various material joining processes and associated defects.
- Discuss various metal forming processes and their applications.
- Summarize various processes involved in sheet metal forming and its applications.
- Distinguish various methods of manufacturing plastic components and Additive manufacturing techniques.
- Apply the suitable process for manufacturing products.

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.

21PC111-PHYSICS AND CHEMISTRY LABORATORY

(Common to I semester CSE, AI&DS, ECE and II semester ME)

L	T	P	C
0	0	4	2

PHYSICS LABORATORY

OBJECTIVES:

The syllabus is designed 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 fiber.
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.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

- Determine the Modulus of elasticity of materials
- Determine the Thermal Conductivity of bad conductor using Lee's disc method.
- Calculate the Compressibility of liquids and velocity of ultrasonic waves in liquids
- Measure the wavelength of prominent spectral lines of Mercury Spectrum and particle size of powder using diffraction phenomenon and thickness of thin materials using interference phenomenon,
- Determine the band gap energy of a semiconductor.

REFERENCES:

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

CHEMISTRY LABORATORY

OBJECTIVES:

The syllabus is designed to:

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

LIST OF EXPERIMENTS

(Any five experiments to be conducted)

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.

TOTAL: 30 PERIODS

OUTCOMES:

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

- Estimate the amount of different types of hardness in the given water sample and also determine the iron and sodium content present in it.
- Determine the change in conductivity of acids on the addition of base through conductometric titration.
- Examine the change in pH when an acid is added with a base using pH meter and to determine the corrosion rate of a given metal.
- Examine the redox reaction using a galvanic cell, its impact on emf values through potentiometer and to determine the flash and fire point of Oil by Pensky Martens apparatus.
- Estimate the amount of a strong acid using a strong base and to determine the molecular weight of the polymer through Ostwald viscometric method.

REFERENCES:

1. J. Mendham, R. C. Denney, J. D. Barnes, M. J. K. Thomas and B. Sivasankar, "Vogel's Quantitative Chemical Analysis", 6th Edition, Pearson Education Pvt. Ltd., 2009.
2. Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, Fundamentals of analytical chemistry Tenth Edition, Cengage Learning 2021.
3. Chemistry Laboratory Manual, Department of Chemistry, RMK College of Engineering and Technology, 2019.

21CS212-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) Arrays
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 kth 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 jobID 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**: (for Mechanical Engineering)

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.

21EL211-ADVANCED READING AND WRITING LABORATORY

(Common to all branches)

	L	T	P	C
	0	0	2	1

OBJECTIVES:

The Course will enable learners to:

- Acquire a wide range of reading and writing techniques.
- Strengthen the reading skills.
- Enhance technical writing skills.
- Develop critical thinking skills.

UNIT I **06**

Reading - Strategies for effective reading - **Writing** -Write a descriptive paragraph - Predicting content using photos and titles.

UNIT II **06**

Reading - Use of graphic organizers to review and aid comprehension. **Writing** - Write an opinion paragraph

UNIT III **06**

Reading - speed reading techniques - **Writing** - Elements of a good essay- Analytical Essay.

UNIT IV **06**

Reading - Genre and Organization of Ideas – **Writing** - Email writing - Job application

UNIT V **06**

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:

- Comprehend and interpret pictures and titles.
- Review texts using transcoding.
- Read various texts using speed reading techniques.
- Write effective emails, job applications, and persuasive recommendations.
- Display critical thinking in various professional contexts.

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. Liss, Rhonda., and Davis, Jason. Effective Academic Writing (Level 3). Oxford: Oxford University Press, 2014.
2. Elbow, Peter. Writing Without Teachers. London: Oxford University Press, 1998. Print.
3. Suresh Kumar, E., Sandhya, B. Savithri, J., and Sreehari, P. Enriching Speaking and Writing Skills. Second Edition. Orient Black swan: Hyderabad, 2014.
4. Goatly, Andrew. Critical Reading and Writing. New York: Routledge, 2000.

5. Petelin, Roslyn., and Durham, Marsha. The Professional Writing Guide: Knowing Well and Knowing Why. Warriewood, NSW: Business & Professional Publishing, 2004.
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

21MA303 - 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.

21ME301 - 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", 5^{th} Edition, Tata McGraw-Hill, New Delhi, 2017.
6. Natarajan E., "Engineering Thermodynamics: Fundamentals and Applications", Anuragam Publications, 2014.

21ME302 - 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.

21ME303 - 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.

21CS305 - 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 MULTI THREADING 9

Exception Handling: Exception-Handling Fundamentals, Exception Types, Uncaught Exceptions, Using try and catch, Multiple catch Clauses, Nested try Statements, throw, throws, finally, Java's Built-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.

21EL301 - 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.

21ME311 - 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 the fabricated model is to be submitted by the group.

(80% weightage is given for Lab 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 Operate 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.

21ME312 - 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.

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
4. GrawHill, 2017
5. Engineering Drawing Practice for Schools and Colleges BIS SP46:2003 (R2008), Published by Bureau of Indian Standards (BIS), 2008.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

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

21CS315 - 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 as follows:

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 member of 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, Triangleand 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 the letters in the string S.

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

10. Collections:

a. Write a program to perform string operations using Array List. Write functions for the following

i. Append - add at end
ii. Insert – add at particular index
iii. Search
iv. List all string starts with given letter

a. 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.

21CS314 - 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

21MA403 - 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.

21ME401 - 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).

21ME402 - 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 polymers, 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 lzod 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).

21ME403 - 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.

21ME404 - 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.

21ME405 - ENGINEERING METROLOGY AND MEASUREMENTS

(Theory course with laboratory component)

L	T	P	C
2	0	2	3

OBJECTIVES:

Students completing this course are expected to:

- Discuss the various Metrological equipment 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

21ME411 - 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

21ME412 - 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

21CS415 - 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 to uniformly 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.

21CS414 - 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 Spanning Trees, 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.

SEMESTER – V

21ME501 – THERMAL ENGINEERING – II

(Theory Course with Laboratory Component)

L	T	P	C
3	0	2	4

OBJECTIVES:

Students completing this course are expected to:

- Analyze 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 utilizing 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.

List of Exercise/Experiments

1. Study of steam nozzle

2. Study of Energy balance test

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.

List of Exercise/Experiments

1. Determination of Flash Point and Fire Point of various fuels / lubricants.
2. Study on Steam Generators and Turbines.
3. Performance and Energy Balance Test on a Steam Generator.

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.

List of Exercise/Experiments

1. Performance and Energy Balance Test on Steam Turbine.

UNIT IV COGENERATION AND RESIDUAL HEAT RECOVERY 9+6

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

List of Exercise/Experiments

1. Performance test on a reciprocating air compressor
2. Study on fluidized Bed Cooling Tower

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 Thermo electric 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).

List of Exercise/Experiments

1. Determination of COP of a refrigeration system
2. Study on Psychrometric processes
3. Study on HC Refrigeration System

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.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S. No.	NAME OF THE EQUIPMENT	Qty.
1	Apparatus for Flash and Fire Point	1 No.
2	4-stroke Diesel Engine with hydraulic loading.	1 No.
3	4-stroke Diesel Engine with electrical loading.	1 No.
4	Data Acquisition system with any one of the above engines	1 No.
5	Steam Boiler with turbine setup	1 No.
6	Guarded plate apparatus	1 No.
7	Lagged pipe apparatus	1 No.
8	Natural convection-vertical cylinder apparatus	1 No.
9	Forced convection inside tube apparatus	1 No.
10	Composite wall apparatus	1 No.
11	Thermal conductivity of insulating powder apparatus	1 No.
12	Pin-fin apparatus	1 No.
13	Stefan-Boltzmann apparatus	1 No.
14	Emissivity measurement apparatus	1 No.
15	Parallel/counter flow heat exchanger apparatus	1 No.
16	Single/two stage reciprocating air compressor	1 No.
17	Refrigeration test rig	1 No.
18	Air-conditioning test rig	1 No.

21ME502 -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:

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

21ME503 - DYNAMICS OF MACHINES

L	T	P	C
2	2	0	3

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.Rand 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.

21ME504 - BASICS OF PRODUCT LIFECYCLE MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Use the concepts of New Product Development in Product Lifecycle Management
- Identify the Concept Product Lifecycle Management
- Classify the components of Product Lifecycle Management
- Explain the role of Product Data Management in PLM.
- Discuss the basics of PLM Customization.

UNIT I NEW PRODUCT DEVELOPMENT 9

Types of design, importance of design, design considerations, Product Classification, product life cycle, Technology life cycle, Overview of the different phases of product development: Processes of Identifying Customer Needs; Conceptual design - concept generation, Concept Selection, concept screening, and concept scoring; Embodiment Design, Detailed design, Validation and analysis (simulation), Manufacturing - Planning, Engineering and Testing (quality check); Service and End of Life. Product Development Approaches – Sequential Engineering and Concurrent engineering.

UNIT II PLM FUNDAMENTALS 9

PLM - Introduction, Need, Benefits, Emergence of PLM, Components /Elements of PLM, Significance of PLM, Product life cycle environment: Product Data and Product Workflow, The Link between Product Data and Product Workflow, Key Management Issues around Product Data and Product Workflow, Company's PLM vision, The PLM Strategy, Principles for PLM strategy, preparing for the PLM strategy, developing a PLM strategy.

UNITIII COMPONENTS OF PLM 9

Functional and System Components overview, Different phases of product lifecycle and corresponding technologies, product development processes and methodologies. 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), Product organizational structure, Methodologies, Processes, System components in lifecycle, slicing and dicing the systems, Interfaces, Information, Standards, Vendors of PLM Systems and Components, Examples of PLM in use.

UNIT IV PRODUCT DATA MANAGEMENT 9

Introduction - PDM functions, definition and architectures of PDM systems, Engineering data, engineering workflow, Components of PDM, Configuration Management: Base lines, product structure, configuration management, Generic Products And Variants: Products configuration, comparison between sales configuration and products generic, Projects And Roles: creation of projects and roles - life cycle of a product- life cycle management.

UNIT V BASICS ON CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE 9

PLM Customization, use of EAI technology (Middleware), Integration with legacy data base – CAD, Work group manager, SLM, MES and ERP.

TOTAL:45 PERIODS

OUTCOMES:

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

CO1: Illustrate the need and importance of New Product Development

CO2: Summarize the essentials of Product Lifecycle Management

CO3: Recognize the components of Product Lifecycle Management

CO4: Infer the role of PDM in Product Lifecycle Management

CO5: Extend the knowledge on PLM to Enterprise integration and Customization

CO6: Use PLM technology to develop new products

TEXT BOOKS:

1. Kari T. U lrich and Steven D. Eppinger, "Product Design and Development", McGraw-Hill International Edns. Reprint 2017.
2. Michael Grieves,"Product Life Cycle Management", Tata McGraw Hill,2006.
3. JohnStark, "Global Product: Strategy, Product Life cycle Management and the Billion Customer Question", Springer Publisher, 2007.

REFERENCE BOOKS:

1. Kemnneth Crow, "Concurrent Engg./ Integrated Product Development", DRM Associates, 26/3,Via Olivera, Palos Verdes, CA90274 (310)377- 569, Workshop Book.
2. Stephen Rosenthal, "Effective Product Design and Development", Business One Orwin, 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", Springer Publisher, 2008 (3rdEdition), Reprint 2016.
5. John Stark, "Product Life cycle Management: 21st Century Paradigm for Product Realisation", Springer Publisher, 2011 (2ndEdition), Reprint 2016.

21ME511- 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.

LIST OF EXPERIMENTS

1. a) Study of Gear Parameters

   b) Experimental Study of Velocity Ratios of Simple, Compound, Epicyclic and Differential Gear Trains.

2. a) Kinematics of Four Bar, Slider Crank, Crank Rocker, Double crank, Double rocker, Oscillating Cylinder Mechanisms.

   b) Kinematics of Single and Double Universal Joints.

3. a) Determination of Mass moment of Inertia of 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 ABATCH 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	Whirling of 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.

21ME512 – PRODUCT LIFECYCLE MANAGEMENT LABORATORY

OBJECTIVES:

L	T	P	C
0	0	4	2

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.

C03 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

21CS512 - 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

21ME601 - 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

21ME602 - COMPUTER AIDED DESIGN AND MANUFACTURING

(Theory Course with Laboratory Component)

L	T	P	C
2	0	2	3

OBJECTIVES:

The Course will enable learners 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
- Design the 3D Model of parts, assemblies and explore the features of CNC Machine tools.
- 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 (6+6)

UNIT II GEOMETRIC MODELING (6+6)

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.

List of Exercise/Experiments

1. Creation of 3D Assembly model of Machine Elements

2. Detailing of the Assembly model of Machine Elements

UNIT III CAD STANDARDS (6+6)

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

List of Exercise/Experiments

1. Export the Assembly model in IGES format.

2. Import the model in STEP & DXF format.

UNIT IV CELLULAR MANUFACTURING AND FLEXIBLE MANUFACTURING SYSTEM (6+6)

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.

List of Exercise/Experiments

1. Study the Application of CAPP in machining and Turning centre

2. Post Process generation using CAM Package

UNIT V ADDITIVE MANUFACTURING (6+6)

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.

List of Exercise/Experiments

1. Develop a mechanical product using the 3D Printer

2. Obtain the model of the Machine Element using 3D Scanner

TOTAL: 60 PERIODS

OUTCOMES:

Upon 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. Chris McMahon and Jimmie Browne “CAD/CAM Principles”, "Practice and Manufacturing management “Fourth Edition, Pearson Education,2019
2. Donald Hearn and M. Pauline Baker “Computer Graphics”. Prentice Hall Inc, 2020
3. Foley, Wan Dam, Feiner and Hughes - "Computer graphics principles & practice" Pearson Education, 2019
4. William M Neumann and Robert F. Sproul “Principles of Computer Graphics”, McGraw Hill Book Co. Singapore, 2018

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
7.	3D Printer	1
8.	3D Scanner	1
SOFTWARE		

9.	Any High-end integrated modeling and manufacturing CAD / CAM software	15 licenses
10.	CAM Software for machining centre and turning centre (CNC Programming and tool path simulation for FANUC)	15 licenses
11.	Licensed operating system	Adequate

21ME603 - ADVANCED PRODUCT LIFECYCLE 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 STRUCTURE 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.

UNIT II 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 III PLM DATA MANAGEMENT 9

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

Manufacturing Data and Managing CAE Data.

UNIT IV PLM REPAIR AND MAINTENANCE 9

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

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).

21ME611 - 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.

21ME612 - ADVANCED PRODUCT LIFECYCLE MANAGEMENT

LABORATORY

OBJECTIVES:

L	T	P	C
0	0	4	2

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-Wind-chill

- Introduction to customization, need, types; introduction, Basic customization concepts, common customization tasks
- Wind-chill customization, Architecture and POM
- PDM Functions –Workflow Management, Project 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 BOMview(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

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		
Sl. 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– Wind chill	30 Users
2	Creo	30 Users

21CS613 - 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.

21ME701 - 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)

21ME711 - 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

21ME712 - 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.

21ME713 - 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

21ME811 – PROJECT WORK

L	T	P	C
0	0	16	8

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: 240 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)

21ME901 - AUTOMOBILE ENGINEERING

OBJECTIVES:

L	T	P	C
3	0	0	3

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.

21ME902 - 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.

21ME903 - 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.

21ME904 - 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 – 2010 – 6th Edition 'Production Techno1ogy Hand Book' – HMT – Tata McGraw Hill.

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.

21ME905 – 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.

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.

21ME906 - 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 Non metals – 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.

21ME907 – BASICS 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-thin films- 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

Nano Info Tech: Information storage- nano computer, molecular switch, super chip, nanocrystal, Nano biotechlogy: 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

Nano cones, nano fibers, nano discs 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 Characterization 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: Advances in Materials Sciences and Engineering,Elsevier, 2016.

21ME908 - 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”, McGrawHill 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.

21ME909 - INDIAN CONSTITUTION

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the various Indian constitution.
- 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; LexisNexis, 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)

21ME910 - 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 McGrawHill, 2017.
5. Logan, D.L., “A first course in Finite Element Method”, Thomson Asia Pvt. Ltd., 2018

21ME911 - UNCONVENTIONAL MACHINING 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) **–**Wire cut 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, Magnetor heological finishing, Magnetorheological abrasive flow finishing.

UNITV 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., New Delhi,2015.
2. PandeyP.C. and ShanH.S. "Modern Machining Processes" Tata McGraw-Hill, NewDelhi,2017.

REFERENCES:

1. Benedict.G.F. "Nontraditional Manufacturing Processes ",Marcel Dekker Inc., 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.

21ME912 - RENEWABLE SOURCES OF ENERGY

OBJECTIVES:

L	T	P	C
3	0	0	3

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 environmentally 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.

21ME913 – 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 Understand the Vapour 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", 4^{th} edition, McGraw Hill, New Delhi, 2020.

REFERENCES:

1. ASHRAE Hand book, Fundamentals,2021
2. Jones W.P., "Air conditioning engineering", 5^{th} edition, Elsevier Butterworth-Heinemann,2020
3. Roy J. Dossat, "Principles of Refrigeration", 4^{th} edition, Pearson Education Asia,2009.
4. Stoecker, W.F. and Jones J.W., "Refrigeration and Air Conditioning" , McGraw Hill, New Delhi, 1986.

21ME914 – 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 CONTROLFORATTRIBUTES 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.

UNITV 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

21ME915 - 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.

21ME916 - 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.

21ME917 - 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. Ayhan Demirbas, '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 Little Field Publishers Inc. (2017).

21ME918 - 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 andapply 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.

21ME938 - 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", JohnWiley & 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.

PROFESSIONAL ELECTIVE – III

(SEMESTER VII)

21ME919 - 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.

21ME920 - 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

21CS938 - 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.

21ME921 - INTRODUCTION TO HYBRID AND ELECTRIC VEHICLES

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to

- Discuss the History of Hybrids and Electric Vehicle.
- Explain the Dynamics and Architecture of Electric and Hybrid vehicles
- Discuss and use basic terms for the description of the Storage for EVs
- Discuss the Fundamentals of EV Battery Pack design, Motors and Controllers
- Explain Battery Charging and Swapping, Analytics

UNIT I Hybrids and Electric Vehicle 9

History of Hybrids and Electric Vehicle - Electric Vehicle Introduction - The drive Torque, Power, Speed and Energy - Energy Source - Vehicle Auxiliary, Petrol pumps and Charging stations - Introduction to EV's in India - Batteries, Charging and Swapping Infrastructure - Lithium for batteries and EV Subsystems - Economic and Environmental Impact of Electric Hybrid Vehicle

UNIT II Dynamics and Architecture of Electric and Hybrid vehicles 9

Forces acting when a vehicle move - Aerodynamic drag, Rolling Resistance and Uphill Resistance -Power and Torque to accelerate - Concept of Drive Cycle - Drive Cycles and Energy - EV Power-train - Motion and dynamic equations for vehicles - Vehicle

Power Plant and Transmission Characteristics - Basic Architecture of Hybrid Drive Trains and Analysis of Series Drive Train - Power Flow in HEVs - Torque Coupling and Analysis of Parallel Drive Train - Basic Architecture of Electric Drive Trains

UNIT III Storage for EVs 9

Introduction to Battery Parameters – need of Lithium Ion Battery - Batteries in Future - Li-Ion Battery Cells - Storage for EVs - SoH and SoC estimation and Self Discharge - Battery Pack Development - Computation of Effective cost of battery - Charging Batteries

UNIT IV Fundamentals of EV Battery Pack design, Motors and Controllers 9

Fundamentals and Design - Electrical Design of Battery Pack - Mechanical Design of Battery Pack - Thermal Design of Battery Pack - BMS Design of Electric Vehicle - BMS Design and Embedded System - Cell Testing and Characterization - Torque Production - Power and Efficiency - Speed and Back EMF - The d-q Equivalent circuit - Field-oriented Control - Thermal Design - Engineering Considerations - Future Frontiers

UNIT V Battery Charging and Swapping, Analytics 9

EV Charger Introduction - Charger Parameters and Types - Slow/Fast chargers and Swapping – Swapping - Standardization and on-board chargers - Public chargers - Public charger economics in Indian Context - Bulk Chargers, Swapping stations and data analytics

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 Discuss the History of Hybrids and Electric Vehicle.

CO2 Explain the Dynamics and Architecture of Electric and Hybrid vehicles

CO3 Discuss and use basic terms for the description of the Storage for EVs

CO4 Discuss the Fundamentals of EV Battery Pack design, Motors and Controllers

CO5 Explain Battery Charging and Swapping, Analytics

CO6 Examine the interactions of various elements in a given Hybrids and Electric Vehicle

TEXT BOOKS:

1. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory and Design, Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay & Ali Emadi, CRC Press, 2004.
2. Electric and Hybrid Electric Vehicles, James D. Halderman, Pearson Publishers, 1st edition, 2022
3. Introduction to Hybrid Vehicle System Modeling and Control, Wei Liu, Wiley, Second Edition, 2017

REFERENCES:

1. Chris Mi, M. Abul Masrur, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", Wiley, 2nd Edition 2017.
2. "Hybrid & Electric Vehicles", A CRC Press
3. Denton T, "Electric and Hybrid vehicles" 2nd Edition, CBS Publishers & Distributors Pvt. Ltd. 2020
4. Wei Liu, "Introduction to Hybrid Vehicle System Modeling and Control", Wiley, 2nd Edition, 2015.
5. https://archive.nptel.ac.in/courses/108/103/108103009/

21ME922 - 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. ProdipNiyogi, 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.

21ME923 - 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 Laminates, 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

21ME924 - 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 andFrancis, 2020.

2. Klaus D. Timmerhaus, Richard Palmer Reed, Cryogenic Engineering: 50 years of progress, Springer, 2007.

21ME925 - INTRODUCTION TO INNOVATION, IP MANAGEMENT AND 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

UNITV 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 mindsets to pursue entrepreneurship.

CO6 Identify and discover market needs

TEXTBOOKS:

1. Jugaad Innovation: Think Frugal, Be Flexible, Generate Breakthrough Growth Navi Radjou,Jaideep Prabhu, Simone Ahuja , John Wiley & Sons , 2017

REFERENCE BOOKS:

1. Identifying Entrepreneurial Opportunities: Cognition and Categorization in Nascent Entrepreneurs, Matthew J. Karlesky

2. http://www.businessdictionary.com/definition/entrepreneur ship.

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

21ME926 –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 proprietor ship, partnership, company- public and private sector enterprises- Organization culture and Environment– Current trends and issues in Management. Fundamentals of Entrepreneurship, Circular flow of income.

UNIT II 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

UNIT III ORGANISING 9

Nature and purpose – Formal and informal organization – organization chart – organization structure – types – Line and staff authority–departmentalization–delegation of authority–centralization and decentralization–Job Design-HumanResource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management. Managing personnel records

UNIT IV DIRECTING 9

Foundations of individual and group behaviour – motivation – motivation theories – motivational techniques – job satisfaction– job enrichment – leadership–types and the ories 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 Indiapublicaions.(2016)

21ME927 - 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

21ME939 – 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

UNITI 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

UNITII 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.

UNITIII NUCLEAR AND MHD POWER PLANTS 9

Basics of Nuclear Engineering, Layout and Sub – Systems of Nuclear Power Plants, Working of Nuclear Reactors: Boi*ling 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 Chenand Robert C.Swanekamp, "Power Plant Engineering", Second Edition, Standard Hand book of McGraw–Hill,1998.

3. Godfrey Boyle,"Renewable energy", Open University, Oxford University Pressin association with the Open University,2004.
4. Domkundwar, S., Power Plant Engineering, Dhanpat Rai & Sons, 1988.
5. Wakil, M.M., Power Plant Technology, Tata McGraw-Hill, 1985

PROFESSIONAL ELECTIVE – IV

(SEMESTER VII)

21ME928 - ENTREPRENEURSHIP 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.

21ME929 - 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 Mcgrawhill.

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.

21ME930 – 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 II 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.

21ME931 - 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. SingiresuS.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 RodicaBaranescu - "Diesel Engine Reference Book", Second Edition, SAE International, 1999.
4. David Bies and Colin Hansen, "Engineering Noise Control – Theory and Practice",4th Edition, E and FN Spon, Taylore&Francise e-Library, 2009
5. Grover. G.T., "Mechanical Vibrations", Nem Chand and Bros., 2009

21ME932 - 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.

UNIT I 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 ofElectricalandMechanicalconceptsinMEMS–Semiconductordevices–Stressandstrain analysis– Flexural beam bending-Torsional deflection.

UNIT II ELECTROSTATICANDTHERMAL 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.

UNIT III 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 & Piezo electric Sensors and Actuators, Essential Concepts and Principles of Magnetic Sensors and Actuators, Fabrication of Micro Magnetic Components, Applications of Magnetic Sensors and Actuators.

UNIT IV MICROMACHINING 9

SiliconAnisotropicEtching–AnisotrophicWetEtching–DryEtchingofSilicon–PlasmaEtching–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, RF MEMS and MOEMS.

TOTAL: 45 PERIODS

OUTCOMES:

CO1 Explain the scaling laws involved in miniaturization and materials for MEMS.

CO2 Distinguish the working principle of electro static 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& Microsystems Design and Manufacture" Tata McGrawHill, NewDelhi, 2017.

REFERENCES:

1. Marc J. Madou, "Fundamentals of Microfabrication and Nanotechnology", CRC Press, 2011.

2. Mohamed Gad-el-Hak, "The MEMS handbook: MEMS Applications", CRC press, 2006.

3. Nitaigour PremchandMahalik, "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.

21ME933 - 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.

21ME934 - BASICS 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 Photopolymerization 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 photopolymerization 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.

21ME935 - 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.

21ME936 - 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 – Eswar Press, 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

21ME937 - 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.

21ME940- 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 IIICOSTING 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 OF 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.

1. K.C. Jain & L.N. Aggarwal, "Production Planning Control and Industrial Management", Khanna Publishers, Eighth Edition, 1999.
2. G.B.S. Narang&V.Kumar, "Production and Costing" Khanna Publishers, 4th Edition, 2014.

R.M.K. COLLEGE OF ENGINEERING AND TECHNOLOGY

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Affiliated to Anna University, Chennai / Approved by AICTE, New Delhi

Accredited by NAAC with A Grade / All the Eligible UG Programs are Accredited by NBA, New Delhi

B.E. Degree in

MECHANICAL ENGINEERING

CURRICULUM AND SYLLABI

REGULATIONS – 2021

CHOICE BASED CREDIT SYSTEM

(For the students admitted from the academic year 2021 – 2022 onwards)

(Syllabus of Honours Degree Courses)

HONOURS DEGREE

IN

PRODUCT LIFECYCLE MANAGEMENT

S. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSES WITH LABORATORY COMPONENT								
1.	21ME942	Product Data Management	PC	4	2	0	2	3
THEORY COURSES								
2.	21ME941	New Product Development	PC	3	3	0	0	3
3.	21ME943	AI Based Product Design and Development	PC	3	3	0	0	3
4.	21ME944	Cyber Physical Systems	PC	3	3	0	0	3
PRACTICALS								
5.	21ME945	Project Work	EEC	12	0	0	12	6
			TOTAL	**25**	**11**	**0**	**14**	**18**

B.E. - HONOURS DEGREE IN PRODUCT LIFECYCLE MANAGEMENT

21ME941	NEW PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- Identify the need for New Product Development
- Use the methods to develop conceptual Design
- Classify the Product Architecture
- Explain the importance of Industrial Design in NPD.
- Discuss the basics of Design for Manufacture

UNIT I	INTRODUCTION	9

Need for NPD – Strategic importance of Product development – integration of customer, designer, material supplier and process planner, Competitor and customer – Behaviour analysis. Understanding customer – prompting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan and establish product specifications.

UNIT II	CONCEPT GENERATION AND SELECTION	9

Task – Structured approaches – clarification – search – externally and internally – explore systematically – reflect on the solutions and processes – concept selection – methodology – benefits.

UNIT III	PRODUCT ARCHITECTURE	9

Implications – Product change – variety – component standardization – product performance – manufacturability – product development management – establishing the architecture – creation – clustering – geometric layout development – fundamental and incidental interactions – related system level design issues – secondary systems – architecture of the chunks – creating detailed interface specifications.

UNIT IV	INDUSTRIAL DESIGN	9
Integrate process design – Managing costs – Robust design – Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing processes electronically – Need for industrial design – impact – design process – investigation of for industrial design – impact – design process – investigation of customer needs – conceptualization – refinement – management of the industrial design process – technology driven products – user – driven products – assessing the quality of industrial design.		
UNIT V	**DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT**	**9**
Definition – Estimation of Manufacturing cost – reducing the component costs and assembly costs – Minimize system complexity – Prototype basics – principles of prototyping – planning for prototypes – Economic Analysis – Understanding and representing tasks – baseline project planning – accelerating the project – project execution.		
		TOTAL: 45 PERIODS

OUTCOMES:

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

CO1: Illustrate the need for New Product Development.

CO2: Summarize the essentials of conceptual design.

CO3: Recognize the types of Product Architecture

CO4: Infer the role Industrial Design in NPD

CO5: Extend the knowledge on Design for Manufacture in NPD

CO6: Use NPD to develop innovative new products

TEXT BOOKS:

1. Kari T.Ulrich and Steven D.Eppinger, ”Product Design and Development”,

McGraw-Hill International Edns. 2020
REFERENCES:
1. Geoge E.Dieter, Linda C.Schmidt, Engineering Design, McGraw-Hill International Edns. 2013
2. Kemnneth Crow, "Concurrent Engg./Integrated Product Development", DRM Associates, 26/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569, Workshop Book.
3. Stephen Rosenthal, "Effective Product Design and Development", Business One Orwin, Homewood, 1992, ISBN 1-55623-603-4.
4. Staurt Pugh, "Tool Design –Integrated Methods for Successful Product Engineering", Addison Wesley Publishing, New york, NY.

21ME942	PRODUCT DATA MANAGEMENT (Theory Course with Laboratory Component)	L	T	P	C
		2	0	2	3

OBJECTIVES:

The Course will enable learners 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	(6+6)

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

List of Exercise/Experiments

1. Study of PDM/PLM software

2. Study of Installation & maintenance PDM/PLM software

UNIT II	PDM ACQUISITION	(6+6)

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.

List of Exercise/Experiments

1. Idea Generation and Documentation

2. Product development –Design Phase

UNIT III	**COMPONENTS OF PDM**	**(6+6)**

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.

List of Exercise/Experiments

1. Windchill Interface management
2. Design file integration with Windchill

UNIT IV	**CONFIGURATION MANAGEMENT**	**(6+6)**

Configuration Management: Baselines, 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.

List of Exercise/Experiments

1. Product structure management
2. Work flow management

UNIT V	**PROJECTS AND CHANGE MANAGEMENT**	**(6+6)**

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-lifecycle – workflow integration.

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

List of Exercise/Experiments

1. Search management
2. Case study

TOTAL: 60 PERIODS

OUTCOMES:

Upon the completion of this 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. JohnStark,"GlobalProduct:Strategy,ProductLifecycleManagementandtheBillionCustomerQuestion", Springer Publisher, 2007.

REFERENCES:

1. Antti Saaksvuori and Anselmi Immonen,"Product Life cycle Management",

Springer Publisher,2008 (3rdEdition).
2. John Stark, "Product Life cycle Management:21st Century Paradigm for Product Realisation", Springer Publisher, 2011 (2ndEdition).

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

21ME943	AI BASED PRODUCT DESIGN AND DEVELOPMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- Understand the structure behind intelligence mathematically.
- Explain the logical implications in computational intelligence.
- Discuss the automated learning techniques.
- Demonstrate the techniques of knowledge representation.
- Explore the adaption of artificial intelligence techniques in real-time scenarios.

UNIT I	INTELLIGENT AGENTS AND SEARCH TECHNIQUES	9

Agents and Environments – Good Behavior: The Concepts of Rationality – The Nature of Environments – The Structure of Agents – Problem Solving by Search – Uninformed Search – Searching with Costs – Informed State Space Search – Heuristic Search: Greedy – A* Search – Problem Reduction Search – Game Search – Constraint Satisfaction Problems.

UNIT II	REASONING WITH LOWER ORDER LOGIC	9

Logical Agent – Proposition Logic – Syntax and Semantics – Theorem Proving – Model Checking – Inference in First Order Logic: Forward Chaining – Backward Chaining – Resolution.

UNIT III	KNOWLEDGE REPRESENTATION	9

Knowledge Representation Issues – Approaches for Knowledge Representation: Simple Relational Knowledge – Inherited Knowledge – Semantic Nets – Frames – Semantic Web –

Ontology.

UNIT IV	AI PLANNING AND NATURAL LANGUAGE PROCESSING	9

Classical Planning – Types – Partial Order Planning – Graph Plan and SAT Plan – Natural

Language Processing Basics: Syntax – Semantics – Introduction to Statistical NLP.

UNIT V	LEARNING AND APPLICATIONS	9

Logical Formulation of Learning – Knowledge in Learning – Explanation-based Learning –

Learning using Relevance Information – Application with NLP: Developing a Simple Chatbot

– Types of Chatbot.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1: Understand the search techniques.

CO2: Illustrate the search techniques to real-time problems.

CO3: Discuss the reasoning techniques to real world problems.

CO4: Understand the representation of knowledge.

CO5: Explain the learning techniques.

CO6: Apply AI techniques in developing real world applications.

TEXT BOOKS:

1. Stuart J. Russell, Peter Norvig, "Artificial Intelligence - A Modern Approach", Third Edition, Pearson Publishers, 2015.

2. Elaine Rich, Kevin Knight, Shivashankar B. Nair, "Artificial Intelligence", Third Edition, Tata McGraw-Hill Education, 2008.

REFERENCES:

1. Dheepak Khemani, "A first course in Artificial Intelligence", McGraw Hill Education Pvt Ltd., NewDelhi, 2013.

2. Steven Bird, Ewan Klein and Edward Loper, "Natural Language Processing with Python", O'Reilly, 2009, https://www.nltk.org/book/.
3. Nils J. Nilsson, "Artificial Intelligence: A New Synthesis", Morgan Kaufmaan Publishers Inc; Second Edition, 2003.

<table>
<tr><td rowspan="2">21ME944</td><td rowspan="2">CYBER PHYSICAL SYSTEMS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">OBJECTIVES:

The Course will enable learners to:

• Understand the basic concepts, requirements, principles, and techniques in emerging cyber-physical systems.
• Explain the need of prototyping in a cyber-physical system
• Discuss the real-world problems through Cyber Physical Systems
• Develop an exposition of the challenges in implementing a cyber-physical system from a computational perspective
• Differentiate the disciplinary background with necessary
• Understand the fundamentals of cyber physical systems</td></tr>
<tr><td>UNIT I</td><td colspan="4">CYBER PHYSICAL SYSTEMS AND SYSTEM REQUIREMENTS</td><td>9</td></tr>
<tr><td colspan="6">Cyber Physical Systems (CPS) in Real world, Basic Principle of Cyber Physical Systems, Industry 4.0, IIoT. Cyber Physical Systems Design Recommendations, CPS system requirements, Cyber Physical System Application, Case study of Cyber Physical Systems.</td></tr>
<tr><td>UNIT II</td><td colspan="4">COMPONENTS OF CPS</td><td>9</td></tr>
<tr><td colspan="6">Physical Space - Sensors and Actuators - Embedded Processors, Input and Output Interfaces - ADC and DAC. Control Systems - Feedback Control systems open and closed loop. Human in the loop predictive model based control systems - Concurrency and Synchronization of components in distributed CPS.</td></tr>
<tr><td>UNIT III</td><td colspan="4">INTEGRATING PHYSICAL AND CYBER SPACE</td><td>9</td></tr>
<tr><td colspan="6">Highly dynamic networked systems. Designing Communication stack in node operating system for CPS. Comparison with Industry 4.0, the Industrial Internet, Machine-to-Machine (M2M) technologies. Issues integrating the heterogeneous physical systems with existing cyberspace. Building IoT Applications with Accessors - CapeCode - Terra Swarms- Swarm Sensors, Swarm OS and Swarmlets Design.</td></tr>
<tr><td>UNIT IV</td><td colspan="4">CPS PLATFORMS MODELS AND DYNAMIC BEHAVIORS</td><td>9</td></tr>
</table>

Hardware platforms for Cyber Physical Systems (Sensors/Actuators, Microprocessor/Microcontrollers), Wireless Technologies for Cyber Physical Systems. Continuous Dynamics, Discrete dynamics, Hybrid Systems.		
UNIT V	**SECURITY AND PRIVACY IN CYBER PHYSICAL SYSTEMS**	**9**
Security and Privacy Issues in CPSs, Local Network Security for CPSs, Internet-Wide Secure Communication, Security and Privacy for Cloud-Interconnected CPSs, Case Study: Cybersecurity in Digital Manufacturing/Industry 4.0.		
TOTAL: 45 PERIODS		

OUTCOMES:

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

CO1: Understand the need and purpose of the different components of

Cyber Physical System

CO2: Develop the ability to interact with Cyber Physical System.

CO3: Explain the abstraction and various system architectures

CO4: Discuss the semantics of a CPS model

CO5: Ability to interact with cyber-physical systems protocols

CO6: Analyse common methods used to secure cyber-physical systems

TEXT BOOKS:

1. Principles of Cyber Physical Systems, Rajeev Alur, MIT Press, 2015

2. E. A. Lee, Sanjit Seshia , "Introduction to Embedded Systems – A Cyber–Physical Systems Approach", Second Edition, MIT Press, 2017, ISBN: 978-0-262-53381-2

REFERENCES:

1. Guido Dartmann, Houbing song, Anke schmeink, “Big data analytics for Cyber Physical System”, Elsevier, 2019.

2. Houbing song, Danda B Rawat, Sabina Jeschke, Christian Brecher, "Cyber Physical Systems Foundations, Principles and Applications", Elsevier, 2017.
3. Chong Li, Meikang Qiu, "Reinforcement Learning for Cyber Physical Systems with Cyber Securities Case Studies", CRC press, 2019.
4. Houbing Song, Glenn A.Fink, Sabina Jesche, "Security and Privacy in Cyber-Physical Systems: Foundations, Principles and Solutions", IEEE Press.

21ME945	PROJECT WORK	L	T	P	C
		0	0	12	6

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: 180 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.

R.M.K. COLLEGE OF ENGINEERING AND TECHNOLOGY

(An Autonomous Institution)

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B.E. Degree in

MECHANICAL ENGINEERING

OPEN ELECTIVES

REGULATIONS – 2021

CHOICE-BASED CREDIT SYSTEM

(Electives offered to Other Department)

(For the students admitted from the academic year 2021 – 2022 onwards)

DEPARTMENT OF MECHANICAL ENGINEERING

OPEN ELECTIVES

(Electives offered to Other Department)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21ME001	Introduction to Nanotechnology	OE	3	3	0	0	3
2.	21ME002	Design Thinking	OE	3	3	0	0	3
3.	21ME003	Industrial Engineering and Operation Management	OE	3	3	0	0	3
4.	21ME004	Composite Materials	OE	3	3	0	0	3
5.	21ME005	Vehicle Styling and Design	OE	3	3	0	0	3
6.	21ME006	Testing of Materials	OE	3	3	0	0	3
7.	21ME007	Lean six sigma and Supply Chain Management	OE	3	3	0	0	3
8.	21ME008	Product Design and Development	OE	3	3	0	0	3

21ME001 - INTRODUCTION TO NANOTECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand about the nanomaterials, synthesis and its characterization.
- Discuss the development and synthesizing of nano systems and measuring systems to nano scale.
- Explain the fabrication of nanostructures for advanced devices.
- Describe the nanomaterial synthesis and thin film deposition techniques.
- Summaries the application of nanomaterial

UNIT I BASICS AND SCALE OF NANOTECHNOLOGY 9

Introduction–Scientific revolutions–Time and length scale in structures –Definition of a nanosystem –Dimensionality and size-dependent phenomena –Surface to volume ratio -Fraction of surface atoms – Surface energy and surface stress – surface defects –Properties at nanoscale (optical, mechanical, electronic and magnetic).

UNIT II DIFFERENT CLASSES OF NANOMATERIALS 9

Classification based on dimensionality - Quantum Dots, Wells and Wires – Carbon – based nano materials (bucky balls, nanotubes, graphene) – Metal based nano materials (nanogold, nano silver and metal oxides) – Nano composites – Nano polymers – Nano glasses –Nano ceramics – Biological nanomaterials.

UNIT III SYNTHESIS OF NANOMATERIALS 9

Classification of synthesis: Top-down and bottom-up nanofabrication. Chemical Methods: Metal Nanocrystals by Reduction - Solvothermal Synthesis- Photochemical Synthesis – Sono chemical Routes - Chemical Vapor Deposition (CVD) – Metal Oxide – Chemical Vapor Deposition (MOCVD). Physical Methods: Ball Milling –Electrode position - Spray Pyrolysis - Flame Pyrolysis -DC/RF Magnetron Sputtering-Molecular Beam Epitaxy (MBE)

UNIT IV FABRICATION AND CHARACTERIZATION OF NANOSTRUCTURES 9

Nanofabrication: Photolithography and its limitation – Electron beam lithography (EBL) -Nanoimprint – Soft lithography patterning. Characterization: Field Emission Scanning Electron Microscopy (FESEM) – Environmental Scanning Electron Microscopy (ESEM) High-Resolution Transmission Electron Microscope (HRTEM) – Scanning Tunneling Microscope (STM) - Surface-enhanced Raman spectroscopy (SERS) - X-ray Photoelectron Spectroscopy (XPS) - Auger electron spectroscopy (AES) – Rutherford backscattering spectroscopy (RBS).

UNIT V APPLICATIONS 9

Solar energy conversion and catalysis – Molecular electronics and printed electronics -Nano electronics - Polymers with a special architecture - Liquid crystalline systems - Linear and nonlinear optical and electro-optical properties, Applications in displays and other devices - Nanomaterials for data storage - Photonics, Plasmonics - Chemical and biosensors –Nanomedicine and Nanobiotechnology – Nanotoxicology challenges. Nano finishing in textiles (UV resistant, antibacterial, hydrophilic, self-cleaning, flame-retardant finishes) – Modern textiles

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 Understand the background and the nature of the Nanoscience and technology.

CO2 Evaluate Nanosystems, to the various fabrication techniques.

CO3 Explain the crystal system and unit cell, reciprocal lattice and X-ray diffraction methods.

CO4 Differentiate the type of nanostructures and analyze the top-down andbottom up approach for nano-scale device preparation.

CO5 Discuss the nanomaterials and various nano measurements techniques.

CO6 Summarise the various properties of nanocomposites and study mechanical properties.

TEXTBOOKS

1. Bhusan, Bharat(Ed), "Springer Handbook of Nanotechnology", 2nd Edition, 2007.
2. Hari Singh Nalwa, "Nanostructured Materials and Nanotechnology", Academic Press, 2002.
3. Pradeep T., "A Textbook of Nano science and Nano technology", Tata Mc Graw Hill Education Pvt. Ltd., 2012.

REFERENCES

1. Charles P Poole, Frank J Owens, Introduction to Nanotechnology, John Wiley and Sons, 2003
2. Fahrner W.R., Nanotechnology and Nanoelectronics, Springer (India) Private Ltd., 2011.
3. Julian W. Hardner Micro Sensors, Principles and Applications, CRC Press 1993.
4. Mark Madou, Fundamentals of Microfabrication, CRC Press, New York, 1997.
5. Mohamed Gad-el-Hak, MEMS Handbook, CRC Press, 2006, ISBN: 8493-9138-5
6. Norio Taniguchi, Nano Technology, Oxford University Press, New York, 2003
7. Sami Franssila, Introduction to Microfabrication, John Wiley & Sons Ltd, 2004. ISBN:470-85106-6
8. Tai – Ran Hsu, MEMS and Microsystems Design and Manufacture, Tata-McGraw Hill, New Delhi, 2002.
9. Waqar Ahmed and Mark J. Jackson, Emerging Nanotechnologies for Manufacturing, Elsevier Inc.,2013, ISBN: 978-93-82291-39-8

21ME002 - DESIGN THINKING

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the design thinking concepts and principles
- Use design thinking methods in every stage of the problem
- Apply various methods in design thinking to different problems
- Discuss the importance of thinking and creativity for new product development
- Summarize the skills needed for enhancing creative thinking and encouraging innovation.

UNIT I INTRODUCTION 9

Need for design creativity – creative thinking for quality – essential theory about directed creativity

UNIT II MECHANISM OF THINKING AND VISUALIZATION 9

Definitions and theory of mechanisms of mind heuristics and models: attitudes, Approaches and Actions that support creative thinking - Advanced study of visual elements and principles- line, plane, shape, form, pattern, texture gradation, colour symmetry. Spatial relationships and compositions in 2- and 3-dimensional space - procedure for genuine graphical computer animation – Animation aerodynamics – virtual environments in scientific Visualization – Unifying principle of data management for scientific visualization – Unifying principle of data management for scientific visualization - Visualization benchmarking

UNIT III CREATIVITY 9

Methods and tools for Directed Creativity – Basic Principles – Tools of Directed Creativity – Tools that prepare the mind for creative thought – stimulation of new ideas – Development and Actions, Processes in creativity ICEDIP – Inspiration, Clarification, Distillation, Perspiration, Evaluation and Incubation – Creativity and Motivation. The Bridge between man creativity and the Rewards of Innovativeness – Applying Directed Creativity to the Challenge of quality management.

UNIT IV DESIGN 9

Process Design, Emotional Design – Three levels of Design – Viceral, Behavioral and Reflective-Recycling and availability-Creativity and customer needs analysis – Innovative product and service designs, future directions in this application of creativity thinking in quality management.

UNIT V INNOVATION 9

Achieving Creativity – Introduction to TRIZ methodology of Inventive Problem Solving - the essential factors – Innovator's solution – creating and sustaining successful growth – Disruptive Innovation model – Segmentive Models – New market disruption - Commoditization and De-commoditization – Managing the Strategy Development Process – The Role of Senior Executive in Leading New Growth – Passing the Baton

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 Describe the various techniques adopted for stimulating creativity.

CO2 Discuss the thinking and visualization concepts.

CO3 Describe the various tools used for creativity.

CO4 Apply the techniques to the design and development of new products.

CO5 Explain the innovative products as required by the customers.

CO6 Summarize the Design thinking and innovation concepts.

TEXTBOOKS:

1. Christian Mueller-Roterberg, Handbook of Design Thinking - Tips & Tools for How to design thinking. 2018
2. Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation by Tim Brown. 2019

REFERENCES:

1. Clayton M. Christensen Michael E. Raynor,” The Innovator’s Solution”, Harvard Business School Press Boston, USA, 2019
2. Donald A. Norman,” Emotional Design”, Perseus Books Group New York, 2018

3. Geoffrey Petty," How to be better at Creativity", The Industrial Society 2018
4. Rousing Creativity: Think New Now Floyd Hurr, Crisp Publications, 2019
5. Semyon D. Savransky," Engineering of Creativity – TRIZ", CRC Press, USA, 2019

21ME003 - INDUSTRIAL ENGINEERING AND OPERATION MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the industrial engineering roles, concepts and activities
- Explain the concept and significance of work-study and ergonomics.
- Discuss network analysis and inventory control
- Describe the concepts, strategies, tools and techniques for managing the transformation process that can lead to competitive advantage.
- Summarise the various methods and techniques for forecasting

UNIT I INTRODUCTION TO INDUSTRIAL ENGINEERING 9

Concept of Industrial Engineering – Role & application – Production management – Tools of management Science – Production and productivity – Plant Location, Layout and line balancing. Measurement of productivity, factors affecting productivity, productivity improvement programmes, wages and incentives

UNIT II WORK STUDY AND ERGONOMICS 9

Definition - Objective and Scope of Work Study - Method study – Definition – Objectives-Motion economy- Principles – Tools and Techniques - Applications – Work measurements- purpose – use – procedure – tools and techniques - Standard time – Ergonomics – principles – applications.

UNIT III NETWORK ANALYSIS &INVENTORY CONTROL 9

Introduction – Network Techniques – Terms related to network planning methods – PERT – Critical path method (CPM) – Smoothing – Applications of Network Techniques - Inventory – Inventory control – Classification – Management objectives – Functions of Inventories (EOQ) – Inventory models – ABC Analysis.

UNIT IV INTRODUCTION OPERATION MANAGEMENT 9

Overview of Production System - Objectives of Operation Management - Scope of Operations Management - Operations Management Framework - Relationship of operations with others - Functional areas -Manufacturing Vs Service sector - Operations Decision making - Production Design Process and Process choices.

UNIT V FORECASTING 9

Need, Determinants of Demand - Demand Patterns - Measures of forecast error - Qualitative Forecasting Methods- Delphi Techniques - Market Research - Nominal Group Technique – Quantitative Forecasting Methods – Moving Average Methods - Exponential Smoothing Methods - Regression Methods.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 Describe the scope, objectives, application, methods and tools of Industrial Engineering systems

CO2 Discuss the various methods of Work study and establish an efficient work system using ergonomics principles to Improve Productivity

CO3 Examine various network techniques and inventory models.

CO4 Understand the strategic and operational decisions in managing manufacturing and service organizations.

CO5 Determine demand forecast, qualitative and quantitative forecasting technique

CO6 Apply the concept of industrial engineering and operation management for the success of the organization.

TEXTBOOKS:

1. ILO, Introduction to work study, Oxford & IBH Publishing Co Pvt. Ltd., 3rd edition, 2015.

2. Seetharama L. Narasimhan, Dennis W. Mc Leavey, Peter J.Billington, “Production Planning and Inventory Control”, 2nd Edition, PHI, 2002.

REFERENCES:

1. Human Factors in Engineering Design - S Sanders and E J McCormick, 7th Edition,1993Mc Graw Hill, New York.

2. Work Study and Ergonomics - S Dalela and Sourabh, – Standard Publishers Distributor, 3rd edition, 2017.

3. Lee J.Krajewski, Larry P.Ritzman, “Operations Management Strategy and Analysis”, 6th edition, PHI, 2003.

4. Norman Gaither, Greg Frazier, "Operations Management", 9th Edition, Thomson Learning, 2002

21ME004 - COMPOSITE MATERIALS

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the benefits of composite materials.
- Explain the different processing methods, properties and testing methods of Polymer matrix composite materials.
- Discuss the different processing methods, properties and testing methods of metal matrix composite materials.
- Describe the different processing methods, properties and testing methods of ceramic matrix composite materials.
- Summarize the applications of composite materials in various fields.

UNIT I INTRODUCTION TO COMPOSITES 8

Fundamentals of composites - need for composites – enhancement of properties - classification of composites – Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Reinforcement – particle reinforced composites, Fibre reinforced composites. Applications of various types of composites. Fiber production techniques for glass, carbon and ceramic fibers

UNIT II POLYMER MATRIX COMPOSITES 12

Polymer resins – thermosetting resins, thermoplastic resins – reinforcement fibres – rovings –woven fabrics – non-woven random mats – various types of fibres. PMC processes - hand lay-up processes – spray-up processes – compression moulding – reinforced reaction injection moulding- resin transfer moulding – Pultrusion – Filament winding – Injection moulding. Fibre-reinforced plastics (FRP), Glass Fibre Reinforced Plastics (GFRP). Laminates- Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates.-applications of PMC in aerospace, automotive industries

UNIT III METAL MATRIX COMPOSITES
9

Characteristics of MMC, various types of metal matrix composites alloy vs. MMC, advantages of MMC, limitations of MMC, Reinforcements – particles – fibres. Effect of reinforcement – volume fraction – rule of mixtures. Processing of MMC – powder metallurgy process - diffusion bonding – stir casting – squeeze casting, a spray process, Liquid infiltration In-situ reactions-Interface measurement of interface properties- applications of MMC in aerospace, automotive industries

UNIT IV CERAMIC MATRIX COMPOSITES AND SPECIAL COMPOSITES 9

Engineering ceramic materials – properties – advantages – limitations – monolithic ceramics -need for CMC – ceramic matrix - various types of ceramic matrix composites- oxide ceramics – non-oxide ceramics – aluminium oxide – silicon nitride – reinforcements – particles- fibres- whiskers. Sintering - Hot pressing – Cold isostatic pressing (CIPing) – Hot isostatic pressing (HIPing). applications of CMC in aerospace, and automotive industries- Carbon /carbon composites – advantages of carbon matrix – limitations of carbon matrix carbon fibre – chemical vapour deposition of carbon-on-carbon fibre perform. Sol-gel technique- Processing of Ceramic Matrix composites.

UNIT V MECHANICS OF COMPOSITES 7

Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated Anisotropic Plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli.Evaluation of Lamina Properties from Laminate Tests.QuasiIsotropic

Laminates. Determination of Lamina stresses within Laminates. Analysis of Thermal stresses on laminates.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 Understand the basic concepts and classification of composite

CO2 Classify the different processing methods of polymer matrix composites.

CO3 Use of different techniques to study the characterisation, properties and strength of metal matrix composites

CO4 Discuss the various types of ceramic matrix composites based on their properties.

CO5 Summarize the various types of Fibers, Equations and manufacturing methods for Composite materials

CO6 Analyse the thermal behaviour of Composite laminates

TEXTBOOKS:

1. Mathews F. L. and Rawlings R. D., "Composite Materials: Engineering and Science", 1st Edition, Chapman and Hall, London, England, 2003.

2. Chawla K. K., "Composite materials", Third Edition, Springer – Verlag, 2012.

REFERENCES:

1. Clyne, T. W. and Withers, P. J., "Introduction to Metal Matrix Composites", Cambridge University Press, 1995.

2. Bhagwan D. Agarwal, Lawrence J. Broutman, K. Chandrashekhara., "Analysis and Performance of Fiber Composites", Wiley Publications, 2017.

3. Strong, A.B., "Fundamentals of Composite Manufacturing", SME, 1989.

4. B.TomasAstrom., "Manufacturing of Polymer Composites", CRC Press, 2018.

5. Sharma, S.C., "Composite materials", Narosa Publications, 2000.
6. Handbook of Composites, Springer US, 2013.

7. Robert M. Jones., "Mechanics Of Composite Materials" CRC Press, 2018

21ME005 - VEHICLE STYLING AND DESIGN

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Explain the basics of Automobile design and aerodynamics.
- Discuss the vehicle styling and control components.
- Describe the vehicle body design and Computational Fluid Dynamics.
- Distinguish the various noise and vibration
- Summarize the vehicle impacts, injury analysis and Ergonomics methods

UNIT I INTRODUCTION 9

Assumptions to be made in designing a vehicle, Aerodynamic-Rolling resistance-Transmission efficiency, Range of values for Gross Vehicle Weight, Frontal Area, maximum speed, maximum acceleration, gradability in different gears, and Basics of Automobile Design.

UNIT II VEHICLE STYLE & DESIGN 9

Timeline developments in design - Mass production – Streamlining for style and low drag - Commercial vehicles - Engine developments - Transmission system development – Steering – Suspension – Brakes - Interior refinement - Safety design.

UNIT III VEHICLE BODY DESIGN 9

The styling process - Working environment and structure - Product planning - Concept sketching and package-related sketching - Full-sized tape drawing - Clay modelling. Aerodynamics - Aerodynamic forces – Drag & Drag reduction - Stability during cross-winds – Wind Noise - Under-hood ventilation - Cabin ventilation - Introduction to Computational fluid dynamics - Wind tunnel testing of scale models.

UNIT IV NOISE AND VIBRATION 9

Vibration – fundamentals & control – Acoustics – fundamentals - Human response to sound - Sound measurement - Automotive noise criteria - Drive-by noise tests, Noise from stationary vehicles, Interior noise in vehicles, Automotive noise sources and control techniques - Engine noise, Transmission noise, Intake & exhaust noise, Aerodynamic noise, Tyre noise, Brake noise

UNIT V CRASHWORTHINESS AND ERGONOMIC APPROACH 9

Accident and injury analysis - Vehicle impacts: general dynamics & crush characteristics - Structural collapse and its influence upon safety - Occupant accommodation – Ergonomics in the automotive industry - Ergonomics methods and tools - Case studies of Fiat Punto

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 Discuss the assumptions made in designing a vehicle and aerodynamics.

CO2 Explain the features and functions of Commercial vehicles and Engine developments

CO3 Describe the different types of vehicle body design and ventilation.

CO4 Explain the Automotive noise sources, vibration and control techniques.

CO5 Summarize the various vehicle impacts, general dynamics and crush characteristics.

CO6 Discuss the various Ergonomics methods and tools.

TEXTBOOK:

1. An Introduction to Modern Vehicle Design, Julian Happian-Smith, Butterworth-Heinemann Ltd (2002)

REFERENCES:

1. Aerodynamics of Road Vehicles: From Fluid Mechanics to Vehicle Engineering, Wolf-Heinrich Hucho (Eds.), Butterworth-Heinemann Ltd (1998)

2. Sensors and Transducers, Ian R Sinclair, Butterworth - Heinemann Ltd (2001)

3. The Motor Vehicle - T.K. Garrett, K. Newton & W. Steeds, Butterworth- Heinemann Ltd (2001)

21ME006 - TESTING OF MATERIALS

L	T	P	C
3	0	0	3

OBJECTIVE:

Students completing this course are expected to:

- Distinguish the various material testing standards and functions of testing organization.
- Explain the basic methods of Destructive testing of materials and their industrial applications.
- Summarize the concepts of Non-destructive testing methods of materials and their industrial applications
- Discuss the important materials characterization testing methods.
- Demonstrate the procedures for thermal and chemical testing of materials

UNIT I INTRODUCTION TO MATERIALS TESTING 9

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

UNIT II MECHANICAL TESTING 9

Introduction to mechanical testing, Hardness test (Vickers, Brinell, Rockwell), Tensile test, Impact test (Izod, Charpy) - Principles, Techniques, Methods, Advantages and Limitations, Applications. Bend test, Shear test, Creep and Fatigue test - Principles, Techniques, Methods, Advantages and Limitations, Applications.

UNIT III NON-DESTRUCTIVE TESTING 9

Visual inspection, Liquid penetrant test, Magnetic particle test, Thermography test — Principles, Techniques, Advantages and Limitations, Applications. Radiographic test, Eddy current test, Ultrasonic test, Acoustic emission- Principles, Techniques, Methods, Advantages and Limitations, Applications.

UNIT IV MATERIAL CHARACTERIZATION TESTING 9

Macroscopic and Microscopic observations, Optical and Electron microscopy (SEM and TEM) - Principles, Types, Advantages and Limitations, Applications. Diffraction Techniques, Spectroscopic Techniques, Electrical and Magnetic Techniques- Principles, Types, Advantages and Limitations, Applications.

UNIT V THERMAL AND CHEMICAL TESTING 9

Thermal Testing: Differential scanning calorimetry, Differential thermal analysis. Thermo-mechanical and Dynamic mechanical analysis: Principles, Advantages, Applications. Chemical Testing: X-Ray Fluorescence, Elemental Analysis by Inductively Coupled Plasma-Optical Emission Spectroscopy and Plasma-Mass Spectrometry.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 Explain the role of testing organization and select the appropriate testing standards for materials.

CO2 Identify the suitable destructive testing method to inspect industrial components.

CO3 Select the appropriate Non-Destructive testing method to assess the quality of industrial components.

CO4 Illustrate the Material characterization testing methods and able to analyse the tested results.

CO5 Demonstrate the various thermal and chemical testing methods of materials.

CO6 Select and justify the suitable testing methods to ensure the quality of industrial components through case studies.

TEXT BOOKS:

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2018.
2. Cullity, B. D., "Elements of X-ray diffraction", 3rd Edition, Creative Media Partners, LLC , 2017.
3. P. Field Foster, "The Mechanical Testing of Metals and Alloys" 7th Edition, Cousens Press, 2017.

REFERENCES:

1. Metals Handbook: Mechanical testing, (Volume 8) ASM Handbook Committee, 9th Edition, American Society for Metals, 1985.
2. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA.
3. Brandon D.G., "Modern Techniques in Metallography", Von Nostrand Inc. NJ, USA, 2014.

21ME007 - LEAN SIX SIGMA AND SUPPLY CHAIN MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Understand the basics of Lean Six Sigma & SCM.
- Use of various tools & techniques.
- Illustrate the methods of increasing productivity.
- Explain the framework and scope of SCM.
- Summarise the functions of SCM in current and future trends.

UNIT I LEAN & SIX SIGMA BACKGROUND AND FUNDAMENTALS 9

Historical Overview – Definition of quality – What is six sigma -TQM and Six Sigma - lean manufacturing and six sigma- six sigma and process tolerance – Six Sigma and cultural changes – six sigma capability – six sigma need assessments - implications of quality levels, Cost of Poor Quality (COPQ), Cost of Doing Nothing – assessment questions

UNIT II OVERVIEW OF TOOLS AND TECHNIQUES 9

Tools for definition – Tools for measurement – Tools for improvement – Tools for Control – Design for Six Sigma (DFSS), Design for Six Sigma Method - Failure Mode Effect Analysis (FMEA), Six Sigma and Leadership, Tools for implementation.

UNIT III EVALUATION AND CONTINUOUS IMPROVEMENT METHODS 9

Evaluation strategy – the economics of six sigma quality, Return on Six Sigma (ROSS), ROI, poor project estimates – continuous improvement – lean manufacturing – value, customer focus, Perfection, focus on waste, overproduction – waiting, inventory in the process (IIP), processing waste, transportation, motion, making defective products, underutilizing people – Kaizen – 5S

UNIT IV INTRODUCTION TO SCM 9

Role of Logistics and Supply Chain Management: Scope and Importance- Evolution of Supply Chain-Decision Phases in Supply Chain - Competitive and Supply Chain Strategies – Drivers of SupplyChain Performance and Obstacles.Factors influencing Distribution network design, Role of Network Design.

UNIT V LOGISTICS & SOURCING IN SCM 9

Role of transportation in the supply chain – factors affecting transportation decision – Routing and scheduling in transportation.Role of sourcing supply chain supplier selection assessment and contracts- Design collaboration -sourcing planning, analysis& coordination - The role IT in the supply chain- The supply chain IT framework Customer RelationshipManagement – future of IT in the supply chain.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 Discuss the Six Sigma Fundamentals

CO2 Explain the cost of poor quality and its effect.

CO3 Describe and Classify the various tools & techniques of six sigma.

CO4 Distinguish the strategies of continuous improvement methods

CO5 Use the supply chain phase and strategies.

CO6 Summarise the sourcing techniques and future scopes of SCM.

TEXTBOOKS:

1. Michael L.George, David Rownalds, Bill Kastle, What is Lean Six Sigma, McGraw – Hill 2003
2. Thomas Pyzdek, The Six Sigma Handbook, McGraw-Hill,2000
3. Sunil Chopra, Peter Meindl and Kalra, "Supply Chain Management, Strategy, Planning, and Operation", Pearson Education, 2010

REFERENCES:

1. Fred Soleimannejed , Six Sigma, Basic Steps and Implementation, AuthorHouse, 2004
2. Forrest W. Breyfogle, III, James M. Cupello, Becki Meadows, Managing Six Sigma: A Practical Guide to Understanding, Assessing, and Implementing the Strategy That Yields Bottom-Line Success, John Wiley & Sons, 2000
3. James P. Womack, Daniel T.Jones, Lean Thinking, Free Press Business, 2003
4. David J.Bloomberg , Stephen Lemay and Joe B.Hanna, "Logistics", PHI 2002.

5. James B.Ayers, **"**Handbook of Supply chain management**"**, St.Lucle press, 2000.
6. Jeremy F.Shapiro, **"**Modeling the supply chain**"**, Thomson Duxbury, 2002.
7. Srinivasan G.S, **"**Quantitative models in Operations and Supply Chain Management**"**, PHI, 2010

21ME008 - PRODUCT DESIGN AND DEVELOPMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

Students completing this course are expected to:

- Explain the common features of a product concept.
- Discuss the basic concepts of engineering design and product development with a focus on the front-end processes.
- Describe the overview of all the product development processes.
- Distinguish the concept generation and selection tools.
- Use the various product architecture with various clustering tools
- Demonstrate the error on the parts using DFMA concepts

UNIT I INTRODUCTION 9

Need for IPPD – New Product design (NPD) – NPD Process- Product Life Cycle (PLC) – Product design: Concepts and steps- Product Analysis-Generic Product Development process- Identifying the Customer needs Process - Plan and establishing product specifications – structured approach.

UNIT II CONCEPT GENERATION, CONCEPT SELECTION AND TESTING 9

Task – Structured approaches – clarification – search – externally and internally – explore systematically – reflect on the solutions and processes – concept selection – methodology – benefits – Concept Testing - Process

UNIT III PRODUCT ARCHITECTURE 9

Implications – Product change – variety – component standardization – product performance – manufacturability – product development management – establishing the architecture – creation – clustering – geometric layout development – fundamental and incidental interactions – related system-level design issues – secondary systems – architecture of the chunks – creating detailed interface specifications.

UNIT IV INDUSTRIAL DESIGN 9

Integrate process design –Robust design – Integrating CAE, CAD, CAM tools – Ergonomics in Product design- Need for industrial design – impact – design process – investigation of for industrial design – impact – design process – investigation of customer needs – conceptualization – refinement – management of the industrial design process – technology-driven products –user–driven products – assessing the quality of industrial design.

UNIT V DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT 9

Design for Manufacturing: Definition – Estimation of Manufacturing cost – reducing the component costs and assembly costs – Minimizing system complexity. – Design for Assembly - Guidelines – DFMA Guidelines Design guidelines for the different processes: Casting, machining, Injection moulding, welding Prototype basics – principles of prototyping – planning for prototypes

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 Associate all the stakeholders for effective NPD in an organization

CO2 Predict the feasible concept for product development

CO3 Explain the various process involved in product architecture

CO4 Defend the significance of the Industrial Design process in product development.

CO5 Discuss the cost involved in project execution and product making.

CO6 Apply the concepts involved in NPD and validated them through a case study.

TEXT BOOK:

1. Karl T.Ulrich and Steven D.Eppinger, "Product Design and Development", McGraw-Hill International – 7th Edition - 2020.

REFERENCES:

1. Kemnneth Crow, "Concurrent Engg./Integrated Product Development", DRM Associates, 26/3, Via Olivera, Palos Verdes, CA 90274(310) 377-569, Workshop Book.
2. Stephen Rosenthal, "Effective Product Design and Development", Business One Orwin, Homewood, 1992, ISBN 1-55623-603-4.
3. Staurt Pugh, "Tool Design –Integrated Methods for Successful Product Engineering", Addison Wesley Publishing, New york, NY.