Annexure – G

S.A. ENGINEERING COLLEGE

(An Autonomous Institution, Affiliated to Anna University, Chennai)

Veeraraghavapuram, Thiruverkadu post, Chennai-600077

Curriculum and Syllabi

Bachelor of Engineering
Mechanical Engineering

Regulation – 2020A

Choice Based Credit System (CBCS)

Contents

S.A. ENGINEERING COLLEGE

(An Autonomous Institution)

B.E. MECHANICAL ENGINEERING

CURRICULUM

(Batch-2020A)

SEMESTER I

S.NO	SUB CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1.	HS1101A	Technical English	HS	3	0	0	3
2.	MA1101A	Calculus And Its Applications	BS	3	1	0	4
3.	PH1101A	Applied Physics	BS	3	0	0	3
4.	CY1101A	Engineering Chemistry	BS	3	0	0	3
5.	CS1101A	Problem Solving and Python Programming	ES	3	0	0	3
6.	ME1101A	Engineering Graphics	ES	2	0	2	3
PRACTICALS							
1.	BS1101A	Physics and Chemistry Laboratory	ES	0	0	4	2
2.	CS1102A	Problem Solving and Python Programming Laboratory	BS	0	0	4	2
1.	CI1101A	Indian Constitution	MC	2	0	0	0
			TOTAL	**21**	**1**	**10**	**23**

SEMESTER II

S.NO	SUB CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1.	TA1201A	Heritage of Tamils	TA	1	0	0	1
2.	HS1201A	English for Communication	HS	3	0	0	3
3.	MA1201A	Complex Variables and Transforms	BS	3	1	0	4
4.	PH1201A	Materials Science	BS	3	0	0	3
5.	EE1201A	Basics Electrical & Electronics Engineering	ES	3	0	0	3
6.	CE1201A	Engineering Mechanics	ES	3	1	0	3
PRACTICALS							
1.	GE1201A	Engineering Practices Laboratory	ES	0	0	4	2
2.	EE1204A	Basic Electrical and Electronics Laboratory	ES	0	0	4	2
1.	CY1201A	Environmental Science and Engineering	MC	2	0	0	0
			TOTAL	**17**	**2**	**8**	**21**

SEMESTER III

S.NO	SUB CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
	TA1101A	Tamils and Technology	TA	1	0	0	1
1.	MA1302A	Transforms and Partial Differential Equations	BS	4	0	0	4
2.	ME1301A	Engineering Thermodynamics	PC	3	0	0	3
3.	ME1302A	Fluid Mechanics and Machinery	ES	3	0	0	3
4.	EE1308A	Electrical Drives and Controls	ES	3	0	0	3
5.	ME1303A	Production Technology	PC	3	0	0	3
6.	ME1304A	Engineering Metallurgy	PC	3	0	0	3
PRACTICALS							
1.	EE1309A	Electrical Engineering Laboratory	ES	0	0	4	2
2.	ME1305A	Production Technology Laboratory	PC	0	0	4	2
			TOTAL	**20**	**0**	**8**	**24**

SEMESTER IV

S.NO	SUB CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1.	MA1404A	Statistics and Numerical Methods	BS	4	0	0	4
2.	ME1401A	Manufacturing Processes	PC	3	0	0	3
3.	ME1402A	Strength of Materials	ES	3	0	0	3
4.	ME1403A	Thermal Engineering	PC	3	0	0	3
5.	ME1404A	Mechanics of Machines-I	PC	3	0	0	3
6.	HV1401A	Universal Human Values	HS	2	1	0	3
PRACTICALS							
1.	ME1405A	Strength of Materials and Fluid Mechanics Laboratory	ES	0	0	4	2
2.	ME1406A	CAD & CNC Laboratory	PC	0	0	4	2
			TOTAL	**18**	**1**	**08**	**23**

SEMESTER V

S.NO	SUB CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1.	ME1501A	Mechanics of Machines – II	PC	3	0	0	3
2.	ME1502A	Metrology & Computer Aided Inspection	PC	3	0	0	3
3.	ME1503A	Design of Machine Elements	PC	3	0	0	3
4.	ME1504A	Heat and Mass Transfer	PC	3	0	0	3
5.	EC1514A	Microprocessor and Microcontroller for Mechanical Engineers	ES	3	0	0	3
6.		Open Elective-I	OE	3	0	0	3
PRACTICALS							
1.	ME1505A	Metrology & Inspection Laboratory	PC	0	0	4	2
2.	ME1506A	Kinematics and Dynamics Laboratory	PC	0	0	4	2
			TOTAL	**18**	**0**	**8**	**22**

SEMESTER VI

S.NO	SUB CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1.	ME1601A	Design of Mechanical Transmission Systems	PC	3	0	0	3
2.	ME1602A	Finite Element Analysis	PC	3	0	0	3
3	ME1603A	Hydraulics & Pneumatics	PC	3	0	0	3
4.	ME1604A	Computer Aided Design and Manufacturing	PC	3	0	0	3
5.		Professional Elective-I	PE	3	0	0	3
PRACTICALS							
1.	ME1613A	Thermal Engineering Laboratory	PC	0	0	4	2
2.	ME1614A	Innovative Project	EEC	0	0	4	2
3.	HS1601A	Professional Communication	EEC	0	0	2	1
			TOTAL	**15**	**0**	**10**	**20**

SEMESTER VII

S.NO	SUB CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1.	ME1701A	Statistical Quality Control	PC	3	0	0	3
2.	ME1702A	Power Plant Engineering	PC	3	0	0	3
3.	ME1703A	Mechatronics	PC	3	0	0	3
4.		Professional Elective-II	PE	3	0	0	3
5.		Professional Elective-III	PE	3	0	0	3
6.		Professional Elective-IV	PE	3	0	0	3
PRACTICALS							
1.	ME1724A	Computer Aided Analysis Laboratory	PC	0	0	4	2
2.	ME1725A	Mechatronics and Automation Laboratory	PC	0	0	4	2
3.		Internship	EEC	0	0	0	1
			TOTAL	**18**	**0**	**08**	**23**

SEMESTER VIII

S.NO	SUB CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1.	ME1801A	Engineering Economics and Cost Analysis	PC	3	0	0	3
2.		Professional Elective-V	PE	3	0	0	3
PRACTICALS							
1.	ME1808A	Project Work	EEC	0	0	16	8
			TOTAL	**6**	**0**	**16**	**14**

TOAL NUMBER OF CREDITS TO BE EARNED FOR AWARD OF THE DEGREE=170

OPEN ELECTIVES

S.No	SUB CODE	COURSE TITLE	L	T	P	C
1.	OME501A	Internal Combustion Engines	3	0	0	3
2.	OME502A	Robotics	3	0	0	3
3.	OME701A	Introduction to Nano Technology	3	0	0	3
4.	OME702A	Product Design and Development	3	0	0	3
5.	OME703A	Energy Conversion Techniques	3	0	0	3
6.	OME704A	Energy Efficient Buildings Design	3	0	0	3

PROFESSIONAL ELECTIVES

S.No	SUB CODE	COURSE TITLE	L	T	P	C
Elective-I						
1.	ME1605A	Design of Jigs and Fixtures and Press Tools	3	0	0	3
2.	ME1606A	Design for Manufacture and Assembly	3	0	0	3
3.	ME1607A	Material Characterization	3	0	0	3
4.	ME1608A	Renewable Energy sources	3	0	0	3
5.	ME1609A	Gas Dynamics & Jet Propulsion	3	0	0	3
6.	ME1610A	Operations Research	3	0	0	3
7.	ME1611A	Total Quality Management	3	0	0	3
8.	ME1612A	Entrepreneurship and Development of Industries	3	0	0	3
Elective-II						
1.	ME1704A	Vibration and Noise Engineering	3	0	0	3
2.	ME1705A	Concurrent and Reverse Engineering	3	0	0	3
3.	ME1706A	Micro Machining and Nano composites	3	0	0	3
4.	ME1707A	Computational Fluid Dynamics	3	0	0	3
5.	ME1708A	Cryogenics Engineering	3	0	0	3
6.	ME1709A	Product Life Cycle Management	3	0	0	3
7.	MG1701A	Principles of Management	3	0	0	3
Elective-III						
1.	ME1710A	Tribology in Design	3	0	0	3
2.	ME1711A	Optimization Techniques for Engineering Systems	3	0	0	3
3.	ME1712A	Failure Analysis and Design	3	0	0	3
4.	ME1713A	Flexible Manufacturing Systems	3	0	0	3
5.	ME1714A	Logistics and Supply Chain Management	3	0	0	3
6.	ME1715A	Industrial Robotics	3	0	0	3
7.	ME1716A	Refrigeration and Air Conditioning	3	0	0	3
Elective-IV						
1.	ME1717A	Advanced Finite Element Analysis	3	0	0	3
2.	ME1718A	Advanced Welding and Joining Technologies	3	0	0	3
4.	ME1719A	Nano Science & Materials	3	0	0	3
3.	ME1720A	Additive Manufacturing	3	0	0	3
5.	ME1721A	Design of Experiments	3	0	0	3
6.	ME1722A	Heat Transfer in Nano fluids	3	0	0	3
7.	ME1723A	Industrial Management & Safety Engineering	3	0	0	3
Elective-V						
1.	ME1802A	Green Manufacturing	3	0	0	3
2.	ME1803A	Plant Layout and Material Handling	3	0	0	3
3.	ME1804A	Inventory Management	3	0	0	3
4.	ME1805A	Energy Auditing	3	0	0	3

5.	ME1806A	Bio Materials	3	0	0	3
6.	ME1807A	Process Planning and Cost Estimation	3	0	0	3

HS1101A **TECHNICAL ENGLISH** **L-T-P-C**

3-0-0-3

Prerequisites: Basic Language Proficiency.

Objective:

- Develop strategies and skills to enhance their ability to read and comprehend engineering and technology texts.
- Nurture their ability in technical writing like to prepare professional job applications and effective reports.
- Develop their speaking skills by participating in various speaking activities.
- Strengthen their listening skill to comprehend lectures and talks in their areas of specialization.
- Improve their ability to explicit their excellence in all modes of technical communication.

Course Outcomes:

The Students will be able to

- **CO1**: Read technical texts and write area- specific texts effortlessly.
- **CO2**: Listen and comprehend lectures and talks in their area of specialization successfully.
- **CO3**: Speak appropriately and effectively in varied formal and informal contexts.
- **CO4**: Write correctly, clearly and concisely with coherence and cohesion.
- **CO5**: Prepare job applications and resume in an inspiring manner.

UNIT – 1 **9 Periods**

Reading- Reading short texts **Listening**- Listening to different formal / informal conversations **Writing**- Instructions, Jumbled sentences **Speaking**- Self introduction **Language development**- Parts of speech, Prepositions **Vocabulary development**- Word formation- root words from foreign language and their use in English.

UNIT – 2 **9 Periods**

Reading-Skimming and Scanning to find specific information **Listening**- Listening to INK talks **Writing**- Job Application – cover letter, resume writing **Speaking**- Asking and Giving directions **Language development**- Conjunctions, Types of Nouns **Vocabulary development**- Prefixes and Suffixes.

UNIT – 3 **9 Periods**

Reading- Reading for predicting the content **Listening**- Listening to situational short talks **Writing**- Types of paragraphs- Descriptive/Analytical/ compare and contrast **Speaking**- Mini presentations, Expressing greeting and thanks **Language development**- Adjectives, Numerical Adjectives, Conditional Clauses **Vocabulary development**- Homophones, Homonyms.

UNIT – 4 **9 Periods**

Reading- Practice in speed reading **Listening**- Listening to short texts and fill the data **Writing**- Interpretation of Graphics / Information, Note making **Speaking**-Contributing for Group Discussion **Language development**- Active, Passive, Impersonal passive voice **Vocabulary development**- Definitions, Nominal Compounds.

UNIT – 5 **9 Periods**

Reading- Reading short stories **Listening**- Listening for note taking **Writing**- Report writing, E-mail Writing **Speaking**- Picture descriptions, Speaking in familiar situations **Language development**- Tenses **Vocabulary development**- British and American Vocabulary.

TOTAL PERIODS : 45

Text Books

- Richards, C. Jack. Interchange Students' Book-2 New Delhi: CUP, 2015.
- Board of editors. Fluency in English A Course book for Engineering and Technology.Orient Blackswan, Hyderabad: 2016.

Extensive Reading

- Khera, Shiv. You can Win, Macmillan, 2000.

Reference

- Bailey, Stephen. Academic Writing: A practical guide for students. New York:Rutledge,2011.
- Comfort, Jeremy, et al. Speaking Effectively : Developing Speaking Skills for Business English. Cambridge University Press, Cambridge: Reprint 2011
- Darlene Smith-Worthington, Sue Jefferson, Technical writing for Success, South-Western Cengage Learning,USA-2011
- Means, L. Thomas and Elaine Langlois, English & Communication For Colleges. Cengage Learning, USA: 2007
- Raman, Meenakshi and Sharma, Sangeetha- Technical Communication Principles and Practice.Oxford University Press: New Delhi, 2014
- Swan Michael, Practical English Usage. Oxford University Press, Eighth impression 2002.

Recommended Websites

bbc.co.uk/1learning english
oxfordonlineenglish.com/
cambridgeenglish.org
inktalks.com/talks/
manageyourwriting.com

MA1101A CALCULUS AND ITS APPLICATIONS L T P C

3 1 0 4

OBJECTIVES:

- To understand the concepts of limits, continuity, differentiation and use it to find maxima and minima of functions of one variable.
- To make the student acquire sound knowledge of techniques in solving ordinary differential equations of first and second order that model in various engineering problems.
- To familiarize the student with functions of several variables that is needed in many branches of engineering.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their usage.

UNIT I- DIFFERENTIAL CALCULUS 9+3

Representation of functions – Limit of a function – Continuity – Derivatives – Differentiation rules – Maxima and Minima of functions of one variable.

UNIT II -ORDINARY DIFFERENTIAL EQUATIONS OF FIRST ORDER WITH APPLICATIONS: 9+3

Basic concepts- Separable differential equations - Exact differential equations - Integrating factors - Linear differential equations - Bernoulli's equation - Geometric Applications- Orthogonal trajectories - Physical Applications - Simple electronic circuits-Newton law of cooling-Heat flow-Rate of decay of radioactive materials-Chemical reaction and solutions.

UNIT III - DIFFERENTIAL EQUATIONS 9+3

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

UNIT IV- FUNCTIONS OF SEVERAL VARIABLES 9+3

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.

UNIT V- MULTIPLE INTEGRALS 9+3

Double integrals – Change of order of integration – Double integrals in polar co-ordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals.

TOTAL PERIODS:60

COURSE OUTCOMES:

After completing this course, students should demonstrate competency in the following skills:

- Use both the limit definition and rules of differentiation to differentiate functions. apply differentiation to solve maxima and minima problems.
- The subject helps the students to develop the fundamentals and basic concepts in ODE
- Apply integration to compute multiple integrals, area, volume, integrals in polar coordinates, in addition to change of order and change of variables.

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TEXTBOOKS:

1. Grewal, B.S., Higher Engineering Mathematics, 43rd Edition, Khanna Publishers, 2016.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, Inc., 2016.

REFERENCE BOOKS:

1. Bali,N.P.,Goyal,M.,Watkins,C.,Advanced Engineering Mathematics,Laxmi Publications Pvt. Limited, 2007.
2. Boyce,W.E.,and DiPrima,R.C.,Elementary Differential Equationsand Boundary Value Problems, Wiley India, 2012.
3. O'Neil. P. V., "Advanced Engineering Mathematics", 7th Edition, Cengage Learning India Pvt., Ltd, New Delhi, 2011.
4. T.Veerarajan , Engineering Mathematics , Mc Grawhill Publications , New Delhi 2017.

PH1101A	APPLIED PHYSICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

To enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology.

UNIT-1 PROPERTIES OF MATTER 9

Elasticity- plasticity – Different Types of Stress and Strain- concept of stress-strain diagram and its application - three types of modulus of elasticity- Poisson's Ratio – Bending of beams- Expression for bending moment –- young's modulus uniform and Non uniform bending : Theory and Experiment – I Shape girders – **Torsional oscillation Theory and Experiment**- Application of Elastic Materials.

UNIT-2 APPLIED OPTICS 9

Laser : characteristics of laser - Principle of spontaneous emission and stimulated emission – Laser action – Einstein A & B coefficients - Population inversion - Pumping – Basic requirement of laser – Types of laser : Nd-YAG and CO_2 – Applications : Welding , Drilling & Cutting – Medical field

Fiber optics: **Introduction**- Principle and propagation of light – Numerical aperture and acceptance angle – classification of optical fibers – **Losses in optical fibers(Qualitative) –** Fiber optics communication system (Block Diagram) – Advantages with fiber optic communication system.

UNIT-3 THERMAL PHYSICS 9

Modes of heat transfer- thermal conduction, convection and radiation – Specific heat capacity- thermal conductivity- Newton's law of cooling - **Searle's** and Lee's disc methods: theory and experiment - conduction through compound media (series and parallel) – **thermal expansion of solids, liquids and gases** - Applications: heat exchangers, refrigerators and solar water heaters.

UNIT-4 WAVE AND PARTICLE PHYSICS 9

Inadequacy of Classical Mechanics - Development of quantum theory- **Planck's Black body radiation and Distribution Laws(Qualitative) – Compton Effect (Derivation)** - De Broglie wavelength – properties of matter waves – Experimental Verification (G.P Thomson experiment) – Heisenberg's uncertainty principle - Schrodinger's wave equation – time dependent – time independent wave equations – physical significance of Wave function – applications: particle in a one dimensional potential box.

UNIT-5 CRYSTALOGRAPHY 9

Single crystalline, polycrystalline and amorphous materials Lattice - unit cell- Crystal systems-Bravais lattices- Lattice planes- Miller indices- Interplanar- d- Spacing in cubic Lattice- calculation of number of atoms per unit cell – atomic radius – packing factor for SC, BCC, FCC and HCP structures- **Crystal Defects – types.**

Total Periods : 45

OUTCOMES:

At the end of this course,

1. The students will gain knowledge on the basics of properties of matter and its applications
2. Use the concepts of waves and optical devices and their applications in Laser and fiber optics
3. The students will understand the properties of thermal materials and its applications
4. The students will get knowledge on advanced physics concepts of quantum theory and its application in one dimensional box.
5. The students will understand the different types of crystals structures and different crystal growth techniques.

TEXT BOOKS :

1. Gupta S.L. and Sanjeev Gupta, Modern Engineering Physics , Dhanpat Rai Publishers, 2015.
2. R. K. Gaur and S.C. Gupta, Engineering Physics, Dhanpat Rai Publication (P) Ltd, New Delhi, 2014.
3. Bhattacharya, D.K. and Poonam, T. Engineering Physics, Oxford University Press, 2015.

REFERENCES :

1. C. Kittel ,Introduction to Solid State Physics 8th Edition , Wiley Eastern Ltd,2004.
2. Halliday, D., Resnick, R. and Walker, J. Principles of Physics. Wiley, 2015.
3. Tipler, P.A. and Mosca, G. Physics for Scientists and Engineers with Modern Physics, W.H.Freeman, 2007.
4. Einstein coefficient calculation,https://youtu.be/TvfiZHXUtXg (Video lecture)
5. Lattice structures, https://youtu.be/Rm-i1c7zr6Q (Video lecture)

CY1101A ENGINEERING CHEMISTRY L T P C

3 0 0 3

COURSE OBJECTIVES:

- To make the students conversant with boiler feed water requirements, related problems and water treatment techniques.
- To develop an understanding of the basic concepts of phase rule and its applications to single and two component systems and appreciate the purpose and significance of alloys.
- It enables the students to gain information about Principles and generation of energy in batteries, nuclear reactors, solar cells, wind mills and fuel cells
- It deals with the information about the types of fuels, calorific value calculations and manufacture of solid, liquid and gaseous fuels.
- To impart knowledge about the nanomaterials synthesis, properties and applications

UNIT I WATER TREATMENT AND TECHNOLOGY (9)

Introduction – characteristics, Water quality parameters -hardness– types, Determination-EDTA method, Alkalinity ,boiler feed water requirements-boiler troubles – scale & sludge - Caustic Embrittlement , boiler explosion -softening of hard water - external treatment process - demineralization and zeolite, internal treatment - boiler compounds (phosphate, calgon, carbonate and colloidal conditioning methods) – desalination of brackish water –reverse osmosis.

UNIT II PHASE RULE AND ALLOYS (9)

Phase rule: Introduction, definition of terms with examples, One Component System- water system,Sulphur,CO_2 system, Thermal Analysis and cooling curves, Reduced phase rule - Two Component Systems- classification – lead-silver system-problems. Alloys: Introduction- Definition- Properties of alloys- Significance of alloying,Functions and effect of alloying elements- Ferrous alloys- Nichrome and Stainless steel – heat treatment of steel.

UNIT III ENERGY SOURCES AND STORAGE DEVICES (9)

Energy – Types – Non-renewable energy - Nuclear energy -renewable energy - solar energy conversion - solar cells. Introduction to Electrochemistry, Nernst Equation-Electrochemical cells – reversible and irreversible cells –Cell construction and representation - Batteries -types of batteries – characteristics – construction and working of primary battery (dry cell) - secondary battery (lithium-ion-battery) - fuel cells (H_2-O_2).

UNIT IV FUELS AND COMBUSTION (9)

Fuel: Introduction- classification of fuels- calorific value- higher and lower calorific values- coal- analysis of coal (proximate and ultimate)- carbonization- manufacture of metallurgical coke (Otto Hoffmann method) – petroleum- manufacture of synthetic petrol (Bergius process)- knocking- octane number – diesel oil- cetane number – natural gas- compressed natural gas(CNG)- liquefied petroleum gases(LPG)- producer gas- water gas. Power alcohol and bio diesel. Combustion of fuels: introduction- theoretical calculation of calorific value- ignition temperature- explosive range – flue gas analysis (ORSAT Method).

UNIT V NANOCHEMISTRY (9)

Basics - distinction between nanoparticles and bulk materials; size-dependent properties., nano cluster, nano rod, nanotube(CNT)-Types of CNT and nanowire. Synthesis: precipitation, thermolysis, chemical vapour deposition, Properties, Characterisation and applications.

TOTAL PERIODS: 45

COURSE OUTCOMES:

- The knowledge gained on water treatment techniques will facilitate better understanding of engineering processes and applications for further learning.
- With the help of phase rule, they could understand the various phase diagrams and able to predict the low melting alloys.
- Students can get knowledge about various fuels and its applications based on its calorific value.
- It provides the students to understand about conventional and non-conventional energy sources and its applications
- Students gain an insight about the recent trends in nano materials.

TEXT BOOKS

Jain P.C. and Monica Jain, “Engineering Chemistry”, Dhanpat Rai Publishing Company (P) Ltd., New Delhi, 2010

REFERENCES

1. Dara S.S, Umare S.S, “Engineering Chemistry”, S. Chand & Company Ltd., New Delhi 2010
2. Sivasankar B., “Engineering Chemistry”, Tata McGraw-Hill Publishing Company, Ltd., New Delhi, 2008.
3. Ozin G. A. and Arsenault A. C., “Nanochemistry: A Chemical Approach to Nanomaterials”, RSC Publishing, 2005.

CS1101A PROBLEM SOLVING AND PYTHON PROGRAMMING L T P C
3 0 0 3

OBJECTIVES:

- To know the basics of algorithmic problem solving
- To read and write simple Python programs.
- To develop Python programs with conditionals and loops.
- To define Python functions and call them.
- To use Python data structures –- lists, tuples, dictionaries.
- To do input/output with files in Python.

UNIT I ALGORITHMIC PROBLEM SOLVING 9

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

UNIT II DATA, EXPRESSIONS, STATEMENTS 9

Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, circulate the values of n variables,distance between two points.

UNIT III CONTROL FLOW, FUNCTIONS 9

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

UNIT IV LISTS, TUPLES, DICTIONARIES 9

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, mergesort, histogram.

UNIT V FILES, MODULES, PACKAGES & TURTLE 9

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file- **Case study: Simple Graphics using Turtle**: Draw a Random Pattern of Circle, Square and Rectangle; Draw a Pattern of Straight Lines, **Plotting Graphs in Python**: Menu Driven Program to Create Mathematical 3D Objects.

TOTAL PERIODS: 45

OUTCOMES:

Upon completion of the course, students will be able to

- Develop algorithmic solutions to simple computational problems
- Read, write, execute by hand simple Python programs.
- Structure simple Python programs for solving problems.
- Decompose a Python program into functions.
- Represent compound data using Python lists, tuples, dictionaries.
- Read and write data from/to files in Python Programs.

TEXT BOOKS:

1. Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist'', 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/thinkpython/)
2. Reema Thareja, Problem Solving and Programming with python, 2nd edition, Oxford University press, 2019.
3. Guido van Rossum and Fred L. Drake Jr, "An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.

REFERENCES:

1. Charles Dierbach, "Introduction to Computer Science using Python: A Computational Problem- Solving Focus, Wiley India Edition, 2013.
2. John V Guttag, "Introduction to Computation and Programming Using Python'', Revised and expanded Edition, MIT Press , 2013.
3. Kenneth A. Lambert, "Fundamentals of Python: First Programs", CENGAGE Learning, 2012.
4. Paul Gries, Jennifer Campbell and Jason Montojo, "Practical Programming: An Introduction to Computer Science using Python 3", Second edition, Pragmatic Programmers,LLC,2013.
5. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.
6. Timothy A. Budd, "Exploring Python", Mc-Graw Hill Education (India) Private Ltd.,, 2015.

ME1101A ENGINEERING GRAPHICS L T P C

2 0 2 3

OBJECTIVES:

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

CONCEPTS AND CONVENTIONS (Not for Examination) 1

Importance of graphics in engineering applications –Use of drafting instruments – BIS conventions and specifications – Size and layout of drawing sheets – Lettering and dimensioning.

UNITI PLANE CURVES AND ORTHOGRAPHIC PROJECTIONS 6+6

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. Visualization principles – Layout of views- Orthographic projection of multiple views(Free Hand Sketching) from pictorial views of objects-Principal planes-Projection of points-Demo using CAD software for above topics.

UNIT II PROJECTION OF POINTS STRAIGHT LINES AND PLANE SURFACES 6+6

Orthographic projections-principles-Principal planes-First angle projection-Projection of points-Projection of straight lines (only First angle projections) inclined to one of the principal planes - Determination of true lengths and true inclinations - Projection of planes (polygonal and circular surfaces) inclined to one of the principal planes - Demo using CAD software for above topics.

UNIT III PROJECTION OF SOLIDS 6+6

Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one of the principal planes by rotating object method-Demo using CAD software for above topics.

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENTOF SURFACES 6+6

Sectioning of above solids in simple vertical position - the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids, cylinders and cones-Demo using CAD software for above topics.

UNITV ISOMETRIC AND PERSPECTIVE PROJECTIONS 6+6

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 –Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method-Demo using CAD software for above topics.

TOTAL: 61 PERIODS

OUTCOMES:

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

- familiarize with the fundamentals and standards of Engineering graphics
- perform freehand sketching of basic geometrical constructions and multiple views of objects.
- project orthographic projections of lines and plane surfaces.
- draw projections of solids and development of surfaces.
- visualize and to project isometric and perspective sections of simple solids.

TEXT BOOK:

1. NatrajanK.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai,2009.
2. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2008.

REFERENCES:

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition,2010.
2. Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
3. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore,2007.
4. Luzzader, Warren.J. and Duff,John M., "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi,2005.
5. N S Parthasarathy and Vela Murali, "Engineering Graphics", Oxford University, Press, New Delhi, 2015.
6. Shah M.B., and Rana B.C., "Engineering Drawing", Pearson, 2nd Edition,2009.

Publication of Bureau of Indian Standards:

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation –Lettering.
3. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
4. IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

Special points applicable to University Examinations on Engineering Graphics:

1. There will be five questions, each of either-or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3size.
4. The examination will be conducted in appropriate sessions on the same day

BS1101A PHYSICS AND CHEMISTRY LABORATORY

L	T	P	C
0	0	4	2

PHYSICS LABORATORY

OBJECTIVES:

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

LIST OF EXPERIMENTS: PHYSICS LABORATORY (Any 5 Experiments)

1. Determination of rigidity modulus – Torsion pendulum
2. Determination of Young's modulus by non-uniform bending method
3. (a) Determination of wavelength, and particle size using Laser
   (b) Determination of acceptance angle in an optical fiber.
4. Determination of thermal conductivity of a bad conductor – Lee's Disc method.
5. Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer
6. Determination of wavelength of mercury spectrum – spectrometer grating
7. Determination of band gap of a semiconductor
8. Determination of thickness of a thin wire – Air wedge method

TOTAL: 30 PERIODS

OUTCOMES:

- Upon completion of the course, the students will be able to apply principles of elasticity, optics and thermal properties for engineering applications.

CHEMISTRY LABORATORY

OBJECTIVES:

To make the student to acquire practical skills in the determination of water quality parameters through volumetric and instrumental analysis

LIST OF EXPERIMENTS (**Any seven experiments to be conducted)**

1. Estimation of HCl using Na_2CO_3 as primary standard and Determination of alkalinity in water sample.
2. Determination of total, temporary & permanent hardness of water by EDTA method.
3. Determination of DO content of water sample by Winkler‘s method.
4. Determination of TDS of water sample.
5. Determination of strength of acids in a mixture of acids using conductivity meter.
6. Estimation of iron content of the given solution using potentiometer.
7. Estimation of iron content of the water sample using spectrophotometer (1, 10-Phenanthroline / thiocyanate method).
8. Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer.
9. Conductometric titration of strong acid vs strong base.

TOTAL PERIODS: 30

OUTCOMES:

The students will be outfitted with hands-on knowledge in the quantitative chemical analysis of water quality related parameters.

CS1102A PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY

L T P C
0 0 4 2

Objectives:

- To study python programs with conditionals and loops
- To use functions for python structured programs.
- Use strings for structuring Python programs.
- Represent compound data using Python lists, tuples, dictionaries.
- To read and write data from and to files in python.

LIST OF EXPERIMENTS:

1. Write a program to display the largest number among three numbers.
2. Write a program to display the Fibonacci series by using looping constructs.
3. Write a function to compute the GCD of two numbers.
4. Explore String Functions
5. With the help of strings, array or list, display a simple calendar in python program without using the calendar module.
6. With the help of list perform Linear search and Binary search.
7. Write a program to perform Selection sort, Insertion sort, Merge sort
8. Create a text file using python file I/O. Read the content of the file and change them from lower to upper case characters.
9. Programs that take command line arguments (word count)
10. Find the most frequent words in a text read from a file
11. Simulate bouncing ball using Pygame

TOTAL PERIODS: 60

Course Outcomes:

- Design simple programs using conditionals and loops.
- Write functions to solve mathematical problems
- Use strings for structuring Python programs.
- Represent compound data using Python lists, tuples, dictionaries.
- Identify to read and write data from and to files in python.

CI1101A **INDIAN CONSTITUTION** **L-T-P-C**
2-0-0-0

Prerequisites: Basic law.

The Constitution of India is the supreme law of India. Parliament of India cannot make any law which violates the Fundamental Rights enumerated under the Part III of the Constitution. The Parliament of India has been empowered to amend the Constitution under Article 368, however, it cannot use this power to change the "basic structure" of the constitution, which has been ruled and explained by the Supreme Court of India in its historical judgments. The Constitution of India reflects the idea of "Constitutionalism" – a modern and progressive concept historically developed by the thinkers of "liberalism" – an ideology which has been recognized as one of the most popular political ideology and result of historical struggles against arbitrary use of sovereign power by state. The historic revolutions in France, England, America and particularly European Renaissance and Reformation movement have resulted into progressive legal reforms in the form of "constitutionalism" in many countries. The Constitution of India was made by borrowing models and principles from many countries including United Kingdom and America.

The Constitution of India is not only a legal document but it also reflects social, political and economic perspectives of the Indian Society. It reflects India's legacy of "diversity". It has been said that Indian constitution reflects ideals of its freedom movement; however, few critics have argued that it does not truly incorporate our own ancient legal heritage and cultural values. No law can be "static" and therefore the Constitution of India has also been amended more than one hundred times. These amendments reflect political, social and economic developments since the year 1950. The Indian judiciary and particularly the Supreme Court of India has played an historic role as the guardian of people. It has been protecting not only basic ideals of the Constitution but also strengthened the same through progressive interpretations of the text of the Constitution. The judicial activism of the Supreme Court of India and its historic contributions has been recognized throughout the world and it gradually made it "as one of the strongest court in the world".

Course content

1. Meaning of the constitution law and constitutionalism
2. Historical perspective of the Constitution of India
3. Salient features and characteristics of the Constitution of India
4. Scheme of the fundamental rights
5. The scheme of the Fundamental Duties and its legal status
6. The Directive Principles of State Policy – Its importance and implementation
7. Federal structure and distribution of legislative and financial powers between the Union and the States
8. Parliamentary Form of Government in India – The constitution powers and status of the President of India
9. Amendment of the Constitutional Powers and Procedure

10. The historical perspectives of the constitutional amendments in India
11. Emergency Provisions: National Emergency, President Rule, Financial Emergency
12. Local Self Government – Constitutional Scheme in India
13. Scheme of the Fundamental Right to Equality
14. Scheme of the Fundamental Right to certain Freedom under Article 19
15. Scope of the Right to Life and Personal Liberty under Article 21

HS1201A **ENGLISH FOR COMMUNICATION** **L T P C**
3 0 0 3

OBJECTIVES:

The Course enables the second semester Engineering and Technology students to:

- Improve their language ability to improve the four basic skills of communication (LSRW).
- Enhance the skills and methods to enrich their reading and comprehending ability.
- Strengthen their skills to listen to the lectures and talks related to their fields of studies.
- Foster their ability to write effectively in all contexts.
- Cultivate their oral presentation skills through technical presentations and contribution in group discussions.

Course Outcomes:

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

CO1: Read for comprehending and responding in general and professional settings.
CO2: Demonstrate the communication skills (LSRW) in academic, professional and social Environment.
CO3: Participate effectively in formal and informal conversations and express findings and opinions with proper language ability.
CO4: Comprehend conversations and short talks delivered in English.
CO5: Use the language effectively to write with clarity and accuracy in general and technical contexts.

UNIT – 1 **9 Periods**

Reading- Reading for detailed comparison **Listening**- Listening to interviews **Writing**- Developing hints, summarizing **Speaking**- Talk about future plans, arrangements intensions **Language development**- Sentence structures **Vocabulary development-** Synonyms, Antonyms, Adverbs

UNIT – 2 **9 Periods**

Reading-Extended reading **Listening**- Listening to telephonic conversations **Writing**- Formal Letter Writing - Letters for bona fide certificate - to the principal for permission for in plant training, industrial visit, paper presentations, inter college events, Letter to the Editor, Recommendations **Speaking**- Formal conversation **Language development**-Use of Punctuation, Modal verbs **Vocabulary development-** One word substitutes, Common Phrasal verbs

UNIT – 3 **9 Periods**

Reading- Identify topic sentences by reading a short story **Listening**- Listening to TED talks **Writing**- Process/product description **Speaking**- Formal Conversations **Language development**- Relative Clauses, Concord, Error correction **Vocabulary development**- Idioms & Phrases, Minimal pairs

UNIT – 4 **9 Periods**

Reading- Reading newspaper articles **Listening**- Listening to inspirational speeches **Writing**- Essays, Checklist **Speaking**- Technical Presentations **Language development**- Degrees of Comparison **Vocabulary development**- Articles, Cause and Effect Expressions

UNIT – 5 **9 Periods**

Reading- Close reading **Listening**- Listening for summarizing **Writing**- Dialogue conversations **Speaking**- Movie/ Book Review **Language development**- Wh Questions, Yes/ no Questions **Vocabulary development**- Foreign Expressions and its applications, Reference words

TOTAL PERIODS: 45

Extensive Reading:

- Kalam, Abdul Dr.A.P.J. - The Wings of Fire, Universities press: 1999

Reference:

- Booth-L. Diana, Project Work, Oxford University Press, Oxford: 2014
- Grussendorf, Marion, English for Presentations, Oxford University Press, Oxford: 2007
- Kumar, Suresh. E. Engineering English. Orient Blackswan: Hyderabad,2015
- Dutt P. Kiranmai and RajeevanGeeta. Basic Communication Skills, Foundation Books: 2013
- Means,L. Thomas and Elaine Langlois. English & Communication For Colleges.CengageLearning ,USA: 2007.

Recommended websites:

- TED.com
- learningenglish.voanews.com
- islcollective.com
- examenglish.com
- englishclass101.com

MA1201A COMPLEX VARIABLES AND TRANSFORMS L T P C
3 1 0 4

OBJECTIVES

- Understand the concept of Divergence and curl and use it in evaluating Line, Surface and
  Volume integrals.
- Understand C-R equations and use it in the construction of Analytic Functions.
- Understand the methods of Complex Integration using Cauchy's Integral Formula and Cauchy Residue theorem, finding Taylor's and Laurent's Series expansions.
- Find the Laplace Transforms of standard Functions and to find the Inverse Laplace Transform of a function and use it in solving Differential Equations.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems

UNIT I VECTOR CALCULUS 9+3

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

UNIT II ANALYTIC FUNCTIONS 9+3

Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates – Properties – Harmonic conjugates – Construction of analytic function – Conformal mapping – Mapping by functions ($w = 1/z, w = z^2, w = e^z, w = \sinh z, w = \cosh z$) – Bilinear transformation.

UNIT III COMPLEX INTEGRATION 9+3

Line integral – Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semicircular contour.

UNIT IV LAPLACE TRANSFORMS 9+3

Existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems -Transforms of derivatives and integrals – Initial and final value theorems – Inverse transforms – Convolution theorem – Transform of periodic functions – Application to solution of linear second order ordinary differential equations with constant coefficients.

UNIT V Z - TRANSFORMS AND DIFFERENCE EQUATIONS 9+3

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

TOTAL PERIODS:60

OUTCOMES

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

- Solve problems using divergence and curl and evaluate line, Surface and Volume integrals.
- Solve problems in Analytic functions and construction of analytic functions using C-R Equations.
- Evaluate problems using Cauchy's integral formula and Cauchy residue theorem and find Taylor's and Laurent's series expansion of a given function.
- Obtain the Laplace Transforms of standard functions.
- Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.

TEXTBOOKS

1. Grewal, B.S., Higher Engineering Mathematics, 43rd Edition, Khanna Publishers, 2016.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, Inc., 2016.

REFERENCE BOOKS

1. Bali,N.P.,Goyal,M.,Watkins,C.,Advanced Engineering Mathematics,Laxmi Publications Pvt. Limited, 2007.
2. Boyce,W.E.,andDiPrima,R.C.,ElementaryDifferentialEquationsandBoundary Value Problems, Wiley India, 2012.
3. O'Neil. P. V. "Advanced Engineering Mathematics", 7th Edition, Cengage Learning India Pvt., Ltd, New Delhi, 2011.
4 T. Veerarajan, Engineering Mathematics, Tata Mcgraw Hill publications co. ltd, New Delhi.2017.

PH1201A	**MATERIAL SCIENCE**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

To enrich the understanding of various types of materials and their applications in engineering and technology.

UNIT I CONDUCTING MATERIALS 9

Conductors – classical free electron theory of metals – Electrical and thermal conductivity – Wiedemann – Franz law – Lorentz number – Draw backs of classical theory – Quantum theory –Fermi distribution function – Effect of temperature on Fermi Function – Density of energy states –carrier concentration in metals.

UNIT II SEMICONDUCTING MATERIALS 9

Intrinsic semiconductor – carrier concentration derivation – Fermi level – Variation of Fermi level with temperature – electrical conductivity – band gap determination –Elemental and Compound Semiconductors – **N-type and P-type semiconductor (Qualitative)** – Hall effect –Determination of Hall coefficient – Applications.

UNIT III MAGNETIC AND SUPERCONDUCTING MATERIALS 9

Origin of magnetic moment – Bohr magneton – comparison of Dia, Para and Ferro magnetism –Domain theory – Hysteresis – soft and hard magnetic materials – antiferromagnetic materials –Ferrites and its applications. **Electro static Discharge (ESD)-**Superconductivity: properties – Type I and Type II superconductors–BCS theory of superconductivity (Qualitative) - High Tc superconductors – Electrical, medical, magnetic and computer application of superconductors.

UNIT IV DIELECTRIC MATERIALS 9

Electrical susceptibility – dielectric constant – electronic, ionic, orientation and space charge polarization – frequency and temperature dependence of polarisation – **Clausius mosotti relation -** dielectric loss – dielectric breakdown – uses of dielectric materials (capacitor and transformer).

UNIT V ADVANCED ENGINEERING MATERIALS 9

Metallic glasses - melt spinning process, applications - shape memory alloys: Ni-Ti alloy, applications – nanomaterials: preparation (bottom up and top down approaches), properties and applications- Bio materials – introduction- properties of bio materials-examples- medical applications- Ophthalmology- bio sensors- characteristics.

Total Periods: 45

OUTCOMES:

At the end of this course,

- The students will gain knowledge of conducting materials and variation of its properties with temperature.
- Acquire knowledge on basics of semiconductor physics and its applications in various devices.
- Get knowledge on magnetic and superconducting materials properties and their various applications.
- The students will understand the basics of dielectric materials, properties and applications of dielectric materials.
- The students will get knowledge about new engineering materials and its applications in social applications.

TEXT BOOKS:

1. S.Mohan, Principles of Materials Science, MJP Publishers, 2018.
2. Jasprit Singh, Semiconductor Devices, Basic Principles, Wiley 2012.
3. Umesh K Mishra and Jasprit Singh, Semiconductor Device Physics and Design‖, Springer, 2008.

REFERENCES:

1. Wahab, M.A. Solid State Physics: Structure and Properties of Materials‖, Narosa Publishing House, 2009.

2. William D.Callister Jr, David G. Rethwisch, Materials Science and Engineering, An Introduction, Wiley India (P) Ltd., 8th Edition, 2009.

3. Pillai S.O., Solid State Physics, New Age International (P) Ltd., Publishers, 2009.

4. Semiconductor Introduction, https://youtu.be/k6ZxP9Yr02E (Video lecture)

5. Superconductivity, https://youtu.be/D-9M3GWOBrw (Video lecture)

EE 1201A BASIC ELECTRICAL AND ELECTRONICS ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To explain the basic Quantities and different componentsused in Electrical circuits
- To explain the operations of electrical machines.
- To explain the working principles of measuring instruments, transducers and calibrationfor instruments.
- To explain the fundamentals of Electronics
- To impart knowledge of communication.

UNIT I FUNDAMENTALS OF ELECTRICALCIRCUITS 9

Basic Electrical Quantities , Circuit components ,Fundamental laws of electric circuits– Steady State Solution of DC Circuits- Nodal analysis and Mesh analysis-Introduction of AC Circuits-Sinusoidal Steady State Analysis, Power and Power Factor-Current and Voltage equations for Three Phase Balanced Circuits.

UNIT II ELECTRICAL MACHINES 9

Construction, Principle of Operation and Basic Equations of DC Generator, DCMotor, Single Phase Transformer and Single phase induction Motor.

UNIT III MEASURING INSTRUMENTS AND TRANSDUCERS 9

Introduction to Measuring instruments –Operating principles of PMMC, Voltmeter,Ammeter,and Dynamometer type Wattmeter & Energy Meter, Introduction to transducers –Stain Gauge, LVDT and RTD-Principles of Calibration.

UNIT IV ELECTRONICS 9

Introductionto Analog electronics–Characteristics of PN Junction Diode and Zener Diode - Half Wave &Full Wave Rectifiers.Bipolar Junction Transistor and its Characteristics. Introduction to Digital electronics:Number systems -Boolean algebra theorems–Logic Gates-Adder-Multiplexer and Demultiplexer Basics of sequentialCircuits– Flip-Flops – Shift Registers-4 bit Ripple Counter – R-2R ladder type D/A and Successive approximation type A/D Conversion.

UNIT V FUNDAMENTALS OF COMMUNICATION SYSTEMS 9

Introduction – Elements of Communication Systems–Principles of Amplitude and Frequency Modulations. Basic of digital Communication –ASK,PSK and FSK- Communication Systems: Radio, Antenna, TV, ISDN, Microwave, Satellite and Optical Fibre (Block Diagram Approach only) and Comparison of 2G,3G and 4G in mobile communications.

TOTAL PERIODS: 45

OUTCOMES:

Ability to

- Understand electric circuits and fundamental analysis of circuits.
- Understand working principles of electrical machines
- Choose appropriate instruments for electrical measurement and transducers for a specific application.
- Understand the concepts of Analog electronics and Digital electronics.
- Understand and Gain knowledge of types communication systems

TEXT BOOKS:

1. D.P.Kothari and I.J. Nagarath –"Basic Electrical & Electronics Engineering", c.Grawhill publications, 1st Edition, 2014. (All Units)
2. Mehta V K, "Principles of Electronics", S.Chand& Company Ltd, 1994.
3. Gary S. Rogers, " An Introduction to Wireless Technology", Pearson Education, 2008

REFERENCE BOOKS:

1. Vincent Del Toro, Electrical Engineering Fundamentals, Prentice Hall, 2006.
2. Del Toro, "Electrical Engineering Fundamentals", Pearson Education, New Delhi, 2007
3. V.K.Mehta&Rohit Mehta, Principles of Electrical Engineering, S.Chand publications, 2nd Edition, 2003.
4. Simon Haykin, ―Communication Systems‖, 4th Edition, Wiley, 2014.

CE 1201A ENGINEERING MECHANICS L T P C

3 1 0 3

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

UNIT-I STATICS OF PARTICLES 9+6

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

UNIT-II EQUILIBRIUM OF RIGID BODIES 9+6

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

UNIT-III ROPERTIES 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 solids from first principle – Relation to area moments of inertia.

UNIT-IV DYNAMICS OF PARTICLES 9+6

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

UNIT-V FRICTION AND RIGID BODY DYNAMICS 9+6

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

TOTAL : 45+30 = 75 PERIODS

OUTCOMES:

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

- illustrate the vectorial and scalar representation of forces and moments

- analyse the rigid body in equilibrium
- evaluate the properties of surfaces and solids
- calculate dynamic forces exerted in rigid body
- determine the friction and the effects by the laws of friction

TEXT BOOKS:

1. Beer, F.P and Johnston Jr. E.R., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 8th Edition, Tata McGraw-Hill Publishing company, New Delhi (2004).
2. Rajasekaran S and Sankarasubramanian G., "Engineering Mechanics Statics and Dynamics", 3rd Edition, Vikas Publishing House Pvt. Ltd., 2005.

REFERENCES:

1. Bhavikatti, S.S and Rajashekarappa, K.G., "Engineering Mechanics", New Age International (P) Limited Publishers, 1998.
2. Hibbeller, R.C and Ashok Gupta, "Engineering Mechanics: Statics and Dynamics", 11th Edition, Pearson Education2010.
3. Irving H. Shames and Krishna Mohana Rao. G., "Engineering Mechanics – Statics and Dynamics", 4th Edition, Pearson Education2006.
4. Meriam J.L. and Kraige L.G., " Engineering Mechanics- Statics - Volume 1, Dynamics- Volume 2", Third Edition, John Wiley &Sons,1993.

GE 1201A ENGINEERING PRACTICES LABORATORY L T P C
0 0 4 2

OBJECTIVES:

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

GROUP A (CIVIL & MECHANICAL)

I CIVIL ENGINEERING PRACTICE 13

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: Wood work, joints by sawing, planing and cutting.

II MECHANICAL ENGINEERING PRACTICE 18

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 **13**

1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.

2. Fluorescent lamp wiring.

3. Stair case wiring

4. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.

5. Measurement of energy using single phase energy meter.

6. Measurement of resistance to earth of electrical equipment.

IV ELECTRONICS ENGINEERING PRACTICE **16**

1. Study of Electronic components and equipments – Resistor, colour coding measurement of AC Signal parameter (peak-peak, rms period, frequency) using CR.

2. Study of logic gates AND, OR, EX-OR and NOT.

3. Generation of Clock Signal.

4. Soldering practice – Components Devices and Circuits – Using general purpose PCB.

5. Measurement of ripple factor of HWR and FWR.

TOTAL PERIODS : 60

OUTCOMES:

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

1. Fabricate carpentry components and pipe connections including plumbing works.
2. Use welding equipments to join the structures.
3. Carry out the basic machining operations
4. Make the models using sheet metal works
5. Illustrate on centrifugal pump, Air conditioner, operations of smithy, foundry and fittings
6. Carry out basic home electrical works and appliances
7. Measure the electrical quantities
8. Elaborate on the components, gates, soldering practices.

EE1204A BASIC ELECTRICAL AND ELECTRONICS LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- To train the students in performing various tests on electrical drivesand sensors
- To enability the students to understand the behavior of semiconductor device based on experimentation.
- To learn the characterizing of circuit behavior with digital ICs.

LIST OF EXPERIMENTS:

1. Verification of KVL and KCL Laws
2. Measurement of three phase power
3. Load test on separately excited DC generator
4. Load test on Single phase Transformer
5. Load test on Induction motor
6. Load test on DC shunt motor.
7. Characteristics of LVDT
8. Calibration of Ammeter and Voltmeter
9. RTD and Thermistor
10. Characteristics of PN Diode and Zener Diode
11. CE Characteristics of NPN Transistor
12. Application of Diode-Half Wave Rectifier and Full Wave Rectifier
13. Verification of Half Adder and Flip-Flops,

Minimum of 10 Experiments to be carried out :-

TOTAL PERIODS : 60

CY1201A ENVIRONMENTAL SCIENCE AND ENGINEERING L T P C
2 0 0 0

COURSE OBJECTIVES

- To understand nature and the facts about the environment.
- To find and implement scientific, technological, economic and political solutions to environmental problems.
- To study the interrelationship between living organism and environment.
- To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- To study the dynamic processes and understand the features of the earth's interior and surface.
- To study the integrated themes and biodiversity, natural resources, pollution control and waste management

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 14

Definition, scope and importance of environment – need for public awareness – concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of major ecosystem – Introduction to biodiversity definition: genetic, species and ecosystem diversity – value of biodiversity – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

UNIT II ENVIRONMENTAL POLLUTION 8

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – solid waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides.

UNIT III NATURAL RESOURCES 10

Forest resources: Use and over-exploitation, deforestation, case studies- dams and their effects on forests and tribal people – Water resources: Use and over- utilization of surface and ground water – Mineral resources: environmental effects of extracting and using mineral resources, case studies – Food resources: changes caused by agriculture and overgrazing, effects of modern agriculture, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification

– 12 Principles of Green chemistry, role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 7

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies – environment protection act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act –- central and state pollution control boards.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare – role of information technology in environment and human health.

TOTAL PERIODS: 45

OUTCOMES

- Students will be able to understand the functions of ecosystems and appreciate the bio diversity.
- Students will be able to know the measures to control environmental pollution.
- Students will be able to understand the usage as well as the effects of over exploitation of natural resources.
- Students will have knowledge about finding technological, economic and political solutions to environmental problems with various Environmental Protection Act in mind.
- Students will be able to understand the interrelationship between population explosion and the environment and also role of IT in environment and human health.
- Students will be able to understand that Environmental problems can only be solved by Public participation in all aspects and cannot be solved by mere laws.

TEXT BOOKS

Environmental Science and Engineering by Anubha Kaushik and C.P.Kaushik-New Age International Publishers. New Delhi, 2017.

REFERENCES

1.Benny Joseph , Environmental Studies, Tata mcgraw-Hill Publishing Company, Ltd., New Delhi, 2006.
2. Dr.B.S.Chauhan,. Environmental Studies , University Science Press, New Delhi, 2011.

MA1302A	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS	L	T	P	C
		4	0	0	4

OBJECTIVES :

- To introduce the basic concepts of PDE for solving standard partial differential equations.
- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier series techniques in solving one dimensional wave and heat flow problems used in various situations.
- To acquaint the student with Fourier series techniques in solving two dimensional heat flow problems used in various situations.
- To acquaint the student with Fourier transform techniques used in wide variety of situations.

UNIT I	PARTIAL DIFFERENTIAL EQUATIONS-I	12

Formation of partial differential equations – Singular integrals - Solutions of standard types of first order partial differential equations - Lagrange's linear equation –Integral surface passing through a curve-surface orthogonal to a system of surface-Non linear partial differential equation –Charpit's method-special methods of solution applicable to certain standard forms- Jacobi's Method

UNIT II	PARTIAL DIFFERENTIAL EQUATIONS-II	12

Homogenous Linear partial differential equations of second and higher order with constant coefficients – Non homogeneous Linear partial differential equations of second and higher order with constant coefficients- Partial differential equation reducible to equation with constant coefficients-partial differential equation of order two with variable coefficients

UNIT III	FOURIER SERIES	12

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

UNIT IV	APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS	12

Classification of PDE – Method of separation of variables - Fourier Series Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction.

UNIT V	FOURIER TRANSFORMS	12

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

TOTAL :	60	PERIODS

OUTCOMES :

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

- Understand how to solve the given standard partial differential equations.
- Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.
- Appreciate the physical significance of Fourier series techniques in solving one dimensional heat flow problems and one dimensional wave equations.
- Appreciate the physical significance of Fourier series techniques in solving two dimensional heat flow problems in Mechanical Engineering.
- Understand the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.

TEXT BOOKS :

1. Grewal B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, New Delhi, 2014.
2. Narayanan S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.

REFERENCES :

1. Andrews, L.C and Shivamoggi, B, "Integral Transforms for Engineers" SPIE Press, 1999.
2. Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 9th Edition, Laxmi Publications Pvt. Ltd, 2014.
3. Erwin Kreyszig, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, India, 2016.
4. James, G., "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2007.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
6. Wylie, R.C. and Barrett, L.C., "Advanced Engineering Mathematics "Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.

ME1301A	ENGINEERING THERMODYNAMICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the fundamentals of thermodynamics
- To study about the second law of thermodynamics and entropy principles.
- To understand the concept of steam power cycle.
- To study about the thermodynamic relations.
- To learn gas mixture concept and psychrometric processes .

(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. System, Property, specific quantities, Temperature and Temperature scales. Quasi-static, reversible and irreversible processes. Displacement work and other modes of work. Zeroth law of thermodynamics, Thermodynamic

states, equilibrium, process cycle, work, heat and other energy – First law of thermodynamics –application to closed and open systems – steady and unsteady flow processes. General Energy equation.

UNIT II	SECOND LAW AND ENTROPY PRINCIPLES	9

Kelvin-Planck and Clausius statements-heat engines and heat pump, reversibility, Carnot cycle, Carnot theorem and performance. Clausius theorem, Concept of entropy, T-s diagram, Tds Equations, entropy change for - pure substance, ideal gases - different processes.

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. Determination of dryness fraction. Application of I and II law for pure substances. Ideal and actual Rankine 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- Reduced properties. Compressibility factor - Principle of Corresponding states. - Generalized Compressibility Chart and its use. Maxwell relations, Energy equation, Joule-Thomson Coefficient and Clausius Clapeyron equation.

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. Psychrometric processes – adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing. Simple Applications

	TOTAL:	45	PERIODS

OUTCOMES:

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

- Apply the first law of thermodynamics for simple open and closed systems.
- Apply second law of thermodynamics to open and closed systems and calculate entropy .
- Apply the concepts of Rankine cycle to steam power plant.
- Derive simple thermodynamic relations of ideal and real gases.
- Calculate the properties of gas mixtures and moist air and its use in psychometric processes.

TEXTBOOKS:

1. R.K.Rajput, "A Text Book Of Engineering Thermodynamics ",Fifth Edition,2017.
2. Nag.P.K., "Engineering Thermodynamics", 5th Edition, Tata McGraw-Hill, New Delhi, 2013..

REFERENCES:

1. Arora C.P, "Thermodynamics", Tata McGraw-Hill, New Delhi, 2019.
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", 8th

Edition.

ME1302A	FLUID MECHANICS AND MACHINERY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basic properties of fluid and solve problems on fluid statics.
- To understand fluid kinematics, fluid dynamics and to analyze and appreciate the complexities involved in solving the fluid flow problems.
- To understand the importance of dimensional analysis.
- To study the conservation laws in flow through pipes are studies.
- To understand the importance of various types of flow in pump and turbine.

UNIT I	FLUID PROPERTIES AND FLUID STATICS	8

Units and dimensions -Properties of Fluids - density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapour pressure, capillarity and surface tension. Fluid statics: concept of fluid static pressure - Atmospheric pressure, Gauge Pressure and Absolute pressure - Pressure measurements by manometers. Hydrostatic Forces on surface – buoyancy and floatation.

UNIT II	FLUID KINEMATICS AND DYNAMICS	9

Fluid Kinematics – Classification and types of flow – Continuity equation for 3D flow in cartesian Co-ordinates - continuity equation for 1D flow. Fluid Dynamics - Forces acting on fluid in motion - Navier Strokes equation - Euler's Equation - Bernoulli's Equation. Application of Bernoulli's Equation - Venturi meter- Orifice meter-Pitot tube- Momentum Equation and its application to pipe bend.

UNIT III	DIMENSIONAL ANALYSIS AND MODEL STUDIES	8

Need for dimensional analysis - Fundamental dimensions - dimensional homogeneity - Rayleigh's method and Buckingham Pi- theorem - Dimensionless Numbers – Model Analysis – Similitude – Model Law - Dimensionless parameters - application of dimensionless parameters – Model analysis.

UNIT IV	FLOW THROUGH PIPES	10

Flow of viscous fluid through circular pipe - Reynold's experiment – Types of flow. Boundary Layer Theory. Energy and head losses through pipes – Major loss – Minor loss – Hydraulic Grade Line and Total Energy Line – Pipes in Series - Pipes in Parallel – Power Transmission by Pipe Line - Moody's diagram.

UNIT V	PUMPS AND TURBINES	10

Impact of jets- Euler's equation- Theory of roto dynamic machines- Centrifugal pumps– working principle- work done by the impeller - performance curves - Reciprocating pump- working principle. Classification of turbines – heads and efficiencies – velocity triangles. Axial, radial and mixed flow turbines. Pelton wheel, Francis turbine and Kaplan turbines- working Principles of operation of turbine calculation of main dimensions, regulation and performance - governing of turbines.

	TOTAL:	**45**	**PERIODS**

OUTCOMES:

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

- Gain basic knowledge on fluid properties, solve problems on static.
- Solve problems on fluid kinematic and dynamic.
- Mathematically predict the nature of physical quantities.
- Analyze and calculate major and minor losses associated with pipe flow in piping networks.
- Analyze the performance of pumps and turbines.

TEXTBOOKS:

1. Bansal.R.K., "Fluid Mechanics and Hydraulic Machines", Laxmi Publications Pvt. Ltd., New Delhi, 2015.
2. Jain.A.K.., "Fluid Mechanics" (Including Hydraulic Machines), Khanna Publishers, Twelth Edition, 2016.

REFERENCES:

1. Graebel. W.P, "Engineering Fluid Mechanics", Taylor & Francis, Indian Reprint, 2011
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", 2011.
4. Streeter, V. L. and Wylie E. B., "Fluid Mechanics", McGraw Hill Publishing Co. 2010

EE1308A	**ELECTRICAL DRIVES AND CONTROL**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- **To understand the basic concepts of different types of electrical machines and their performance.**
- **To understand the concepts of Battery Technologies.**
- **To study the different methods of starting D.C motors and induction motors.**
- **To understand the starting methods of DC & AC motors.**
- **To study the conventional and solid-state drives DC & AC drives**

UNIT I	**INTRODUCTION**	**9**

Basic Elements – Types of Electric Drives – factors influencing the choice of electrical drives – heating and cooling curves – Loading conditions and classes of duty – Selection of power rating for drive motors with regard to thermal overloading. Types of Batteries, Characteristics of Batteries.

UNIT II	**DRIVE MOTOR CHARACTERISTICS**	**9**

Mechanical characteristics – Speed-Torque characteristics of various types of load and drive motors – Braking of Electrical motors – DC motors: Shunt, series and compound – single phase and three phase induction motors. Construction and Mechanical characteristics of BLDC motor.

UNIT III	**STARTING METHODS**	**9**
Types of D.C Motor starters – Typical control circuits for shunt and series motors – Three phase squirrel cage and slip ring induction motors.		
UNIT IV	**CONVENTIONAL AND SOLID STATE SPEED CONTROL OF D.C. DRIVES**	**9**
Speed control of DC series and shunt motors – Armature and field control, Ward-Leonard control system – Introduction to controlled rectifiers & choppers-converter and chopper fed DC drives.		
UNIT V	**CONVENTIONAL AND SOLID STATE SPEED CONTROL OF A.C. DRIVES**	**9**
Speed control of three phase induction motor – Voltage control, voltage / frequency control, slip power recovery scheme – Using inverters and AC voltage regulators – applications.		

	TOTAL	**45**	**PERIODS**

OUTCOMES:

Upon Completion of this subject, the students can able to explain

- Different types of electrical machines and their performance and battery techniques
- Dc and Ac motor performances
- Starting methods of Ac and Dc motors
- Solid state speed control of Dc drives
- Solid state speed control of Ac drives

TEXTBOOKS

1. Nagrath .I.J. & Kothari .D.P, "Electrical Machines", Tata McGraw-Hill, 2006
2. Vedam Subrahmaniam, "Electric Drives (Concepts and Applications)", Tata McGraw-Hill, 2010

REFERENCES:

1. Partab. H., "Art and Science and Utilisation of Electrical Energy", Dhanpat Rai and Sons, 2017
2. Pillai.S.K "A First Course on Electric Drives", Wiley Eastern Limited, 2012
3. Singh. M.D., K.B.Khanchandani, "Power Electronics", Tata McGraw-Hill, 2006.
4. David Linden and Thomas B. Reddy, "Handbook of Batteries" McGraw-Hill Professional,2001

ME1303A	**PRODUCTION TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To study the basic casting processes, various metal joining processes and gain relevant skills.
- To learn about the theory behind metal cutting and principle of working of basic machines
- To learn about the various plastic moulding and forming processes and to make simple plastic part.
- To provide the knowledge on various bulk deformation processes and various abrasive machining processes.

- To expose knowledge on sheet metal forming processes and special forming processes and to make small sheet metal parts.

UNIT I	**CASTING PROCESSES AND METAL JOINING PROCESSES**	**9**

Introduction to production processes and its classifications - Pattern Types and Allowances. Moulding sand – Types & Properties. Moulding machines and its types. Melting furnaces. Sand casting defects. Special casting processes – Centrifugal casting and Investment casting. Introduction to welding processes - Principle of Gas welding and arc welding. Principle of Resistance welding, Gas metal arc welding, Submerged arc welding, Tungsten Inert Gas welding, Thermit welding and Electron beam welding

UNIT II	**THEORY OF METAL CUTTING AND BASIC MACHINES**	**9**

Mechanics of metal cutting, orthogonal and oblique cutting, Mechanism of chip formation, Types of chips, Merchant's Circle Diagram, Cutting Force Measurements, Tool life & Cutting Tool Materials.
Centre lathe, constructional features, specification, operations – taper turning methods, thread cutting methods, Capstan and turret lathes- tool layout, Shaper - Basic operations. Milling operations - types of milling cutter.

UNIT III	**MOULDING AND FORMING OF PLASTICS**	**9**

Introduction to plastics - Moulding of Thermoplastics - Principle and applications of Injection moulding and its types, Blow moulding, Rotational moulding, Thermoforming and Extrusion. Moulding of Thermosets - Principle and applications of Compression moulding and Transfer moulding - Bonding of Thermoplastics - Fusion and solvent methods.

UNIT IV	**BULK DEFORMATION PROCESSES AND ABRASIVE MACHINING**	**9**

Introduction - Hot and cold working of metals - Forging processes - Open and close die forging, Forging equipments. Rolling -Types of Rolling mills, Tube piercing and Defects. Principle of Extrusion and its types.
Abrasive processes: grinding wheel – specifications and selection, types of grinding process – cylindrical grinding, surface grinding, centreless grinding and internal grinding.

UNIT V	**SHEET METAL AND SPECIAL FORMING 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

TOTAL:	**45**	**PERIODS**	

OUTCOMES:

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

- Explain different metal casting processes, compare different metal joining processes merits and demerits
- Describe the mechanism of material removal processes and operational features of centre lathe, shaper

and milling machines

- Distinguish various methods of manufacturing plastic components
- Summarize various hot working and cold working methods of metals, grinding and other super finishing processes
- Explain various sheet metal making special forming processes

TEXTBOOKS:

1. Hajra Chouldhary S.K and Hajra Choudhury. AK., "Elements of workshop Technology", Volume I and II, Media promoters and Publishers Private Limited, Mumbai, 2008
2. Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson Education India Edition, 2013

REFERENCES:

1. Rao, P.N. "Manufacturing Technology Foundry, Forming and Welding", 4th Edition, TMH-2013
2. Sharma, P.C., "A Text book of production Technology", S.Chand and Co. Ltd., 2014.
3. HMT, "Production Technology", Tata McGraw Hill, 1998.
4. Geofrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools", McGraw Hill, 1984
5. Roy. A.Lindberg, "Process and Materials of Manufacture," Fourth Edition, PHI/Pearson Education 2006

ME1304A	ENGINEERING METALLURGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study alloys formation, phase diagrams, invariant reactions and iron-carbon diagram
- To introduce concept of heat treatment processes, Explain isothermal transformation, continuous cooling diagrams and different surface heat treatment methods.
- To study the effect of alloying elements on ferrous and non-ferrous metals and properties, applications of various alloys.
- To explain the properties and applications of non-metallic materials and smart materials.
- To impart knowledge on the testing of mechanical properties of materials and principles of plastic deformation mechanisms.

Review (Not for Exam):

- Crystal structure – BCC, FCC and HCP structure – unit cell – crystallographic planes and directions, miller indices – crystal imperfections, point, line, planar and volume defects – Grain size, ASTM grain size number- Atomic Diffusion

UNIT I	ALLOYS AND PHASE DIAGRAMS	9

Constitution of alloys – Solid solutions, substitutional and interstitial – phase diagrams, Isomorphous, eutectic, eutectoid, peritectic and peritectoid reactions, Iron – carbon equilibrium diagram. Classification of steel, properties and applications.

UNIT II	HEAT TREATMENT OF METALS	9

Purpose of Heat treatment– Full annealing, stress relief, recrystallization and spheroidising – normalizing,

hardening and Tempering of steel. Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram,CCR – Hardenability, Jominy end quench test – Austempering, martempering – case hardening, carburizing, Nitriding, cyaniding, carbonitriding – Flame and Induction hardening – Vacuum and Plasma hardening.

UNIT III	FERROUS AND NON-FERROUS METALS	9

Effect of alloying additions on steel- α and β stabilizers– stainless and tool steels – HSLA, Maraging steels – Cast Iron – Grey, white, malleable, spheroidal – alloy cast irons, Copper and copper alloys – Brass, Bronze and Cupronickel – Aluminium alloys and Al-Cu – precipitation strengthening treatment – Mg-alloys, Bearing alloys, , Ni-based super alloys and Titanium alloys.

UNIT IV	NON METALS & SMART MATERIALS	9

Polymers– types, commodity and engineering polymers – Properties and applications of common thermosetting and thermoplastic polymers - Engineering Ceramics – Properties and applications-Composites- Classifications-FRP,MMC,CMC-Applications of Composites, Fiber Optic materials, Piezo Electrics – Shape Memory Alloys

UNIT V	MECHANICAL PROPERTIES AND DEFORMATION MECHANISMS	9

Mechanisms of plastic deformation, slip and twinning – Types of fracture – Testing of materials under tension, compression and shear loads – Hardness tests (Brinell, Vickers and Rockwell) hardness tests, Impact test- lzod and charpy, fatigue and creep failure mechanisms-testing.

TOTAL:	45	PERIODS

OUTCOMES:

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

- Explain alloys and phase diagram, Iron-Iron carbon diagram and steel classification.
- Explain isothermal transformation, continuous cooling diagrams and different heat treatment processes.
- Clarify the effect of alloying elements on ferrous and non-ferrous metals
- Summarize the properties and applications of non metallic materials.
- Explain the testing of mechanical properties. .

TEXTBOOKS:

1. Williams D Callister, “Material Science and Engineering” Wiley India Pvt Ltd, Revised Indian Edition 2014
2. O.P. Khanna, A text book of Materials Science and Metallurgy, Khanna Publishers, 2003

REFERENCES:

1. Kenneth G.Budinski and Michael K. Budinski, “Engineering Materials”, Prentice Hall of India Private Limited, 2010.
2. Raghavan.V, “Materials Science and Engineering”, Prentice Hall of India Pvt. Ltd., 2015.
3. U.C.Jindal : Material Science and Metallurgy, “Engineering Materials and Metallurgy”, First Edition, Dorling Kindersley, 2012

4. Upadhyay. G.S. and Anish Upadhyay, "Materials Science and Engineering", Viva Books Pvt. Ltd., New Delhi, 2006.
5. Avner, S.H., "Introduction to Physical Metallurgy", McGraw Hill Book Company, 1997.

EE1309A	ELECTRICAL ENGINEERING LABORATORY	L	T	P	C
		0	0	4	2

Objectives:

- To validate the principles studied in theory by performing experiments in the laboratory

LIST OF EXPERIMENTS:

1. Load test on DC Shunt & DC Series motor
2. O.C.C & Load characteristics of DC Shunt and DC Series generator
3. Speed control of DC shunt motor (Armature, Field control)
4. Load test on single phase transformer
5. O.C & S.C Test on a single phase transformer
6. Regulation of an alternator by EMF & MMF methods.
7. V curves and inverted V curves of synchronous Motor
8. Load test on three phase squirrel cage Induction motor
9. Speed control of three phase slip ring Induction Motor
10. Study of DC & AC Starters

TOTAL PERIODS: 60

Course Outcomes:

- Ability to perform speed characteristic of different electrical machine

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1	DC Shunt motor	2
2	DC Series motor	1
3	DC shunt motor-DC Shunt Generator set	1
4	DC Shunt motor-DC Series Generator set	1
5	Single phase transformer	2
6	Three phase alternator	2
7	Three phase synchronous motor	1
8	Three phase Squirrel cage Induction motor	1
9	Three phase Slip ring Induction motor	1

ME1305A	PRODUCTION TECHNOLOGY LABORATORY	L	T	P	C
		0	0	4	2

Objectives:

- To Study and practice the various operations that can be performed in lathe, shaper, drilling, milling machines etc. and to equip with the practical knowledge required in the core industries.

LIST OF EXPERIMENTS:

Machining and Machining time estimations for:

1. External Thread cutting
2. Internal Thread Cutting
3. Eccentric Turning
4. Knurling
5. Hexagonal Head Shaping
6. Contour milling using vertical milling machine
7. gear cutting in milling machine
8. Gear generation in hobbing machine
9. Gear generation in gear shaping machine
10. Tool angle grinding with tool and Cutter Grinder
11. Measurement of cutting forces in Milling / Turning Process

TOTAL PERIODS: 60

Course Outcomes:

Upon completion of this course students will be

- Able to use different machine tools to manufacturing components.
- Able to use different machine tools for finishing operations

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

1	Centre Lathes	7 Nos.
2	Shaper	1 No.
3	Horizontal Milling Machine	1 No
4	Vertical Milling Machine	1 No
5	Turret and Capstan Lathes	1 No each

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	Gear Shaping machine	1 No
12	Centerless grinding machine	1 No
13	Tool and cutter grinder	1 No

MA1404A	STATISTICS AND NUMERICAL METHODS	L	T	P	C
		4	0	0	4

OBJECTIVES :

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

UNIT I	TESTING OF HYPOTHESIS	12

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 AND STATISTICAL QUALITY CONTROL	12

One way and two way classifications - Completely randomized design - Randomized block design - Latin square design - 2^2 factorial design-Control charts for measurements (X and R charts) – Control charts for attributes (p and c charts).

UNIT III	SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS	12

Solution of algebraic and transcendental equations - Fixed point iteration method -Bisection- Regula -Falsi Method-Newton Raphson method - Solution of linear system of equations - Gauss elimination method - Pivoting - Gauss Jordan method -Secant method- Iterative methods of Gauss Jacobi and Gauss Seidel - Eigenvalues of a matrix by Power method and Jacobi‟s method for symmetric matrices.

UNIT IV	INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION	12

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 and 3/8 rules-Romberg‟s Method - Two point and three point Gaussian quadrature formulae.

UNIT V	NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS	12

Single step methods : Taylor‟s series method - Euler‟s method - Modified Euler‟s method - Fourth order

Runge-Kutta method for solving first order equations - Multi step methods : Milne‟s and Adams - Bash forth predictor corrector methods for solving first order equations-Finite difference methods for solving second order equations - Finite difference solution of one dimensional heat equation by explicit and implicit methods.

	TOTAL :	**60**	**PERIODS**

OUTCOMES :

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

- Apply the concept of testing of hypothesis for small and large samples in real life problems.
- Apply the basic concepts of classifications of design of experiments in the field of in the field of statistical quality control.
- Appreciate the numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.
- Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.
- Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications

TEXT BOOKS :

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

REFERENCES :

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

ME1401A	**MANUFACTURING PROCESSES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To attain exposure on computerized numerical machine tools and micromachining processes
- To learn about the various non-traditional machining processes, their working principles and material removal mechanisms
- To understand about the high speed machining techniques
- To earn knowledge on various types of rapid prototyping techniques
- To learn about the role of computer aided engineering, Industry 4.0 and IOT in manufacturing,

UNIT I	**CNC MACHINING**	**9**
Numerical Control (NC) machine tools – CNC types, constructional details, special features, part programming fundamentals CNC – manual part programming – micromachining – wafer machining.		
UNIT II	**NON TRADITIONAL MACHINING PROCESSES**	**9**
Introduction to unconventional machining processes – Working Principle – Material removal mechanism - Parametric analysis and applications of processes such as ultrasonic machining, Abrasive jet machining, Electrochemical machining, Electro discharge machining, Electron beam machining, Laser beam machining processes - process parameters, tool wear, tool life and Machinability.		
UNIT III	**HIGH-SPEED MACHINING**	**9**
High-Speed machining centers, high-speed spindles, spindle sped, feed rate, cutting velocity, surface finish, selection of process parameters, ultra-high-speed machining centers, hard machining.		
UNIT IV	**RAPID PROTOTYPING**	**9**
Introduction to rapid Prototyping (RP), Need of RP -Rapid Manufacturing Process Optimization: factors influencing accuracy. Classification of different RP techniques based on raw materials, layering technique (2D or 3D) and energy sources-Laminated object manufacturing, Solid ground curing, Repetitive masking and deposition, Selective laser melting and Selective laser sintering		
UNIT V	**CAE & SMART MANUFACTURING**	**9**
Need for CAE in manufacturing, simulation of molten metal flow, inspections of casting, analysis of forging & welding processes using CAE Techniques, Introduction to Industry 4.0 and IOT in Manufacturing Industry.		
	TOTAL: **45**	**PERIODS**

OUTCOMES:

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

- Describe about the various types of CNC machines and part programming techniques
- Explain the working principle and material removal mechanism of various types of non traditional machining processes
- Summarize the process of high speed machining
- Distinguish between various types of rapid prototyping techniques
- Explain the application of computer aided engineering, Industry 4.0 and IOT in manufacturing

TEXTBOOKS:

1. Vijay.K. Jain “Advanced Machining Processes” Allied Publishers Pvt. Ltd., New Delhi, 2007.
2. Paul DeGarmo E, Black J T and Ronald A Kohjer, “Materials and Processes in Manufacturing, John Wiley India, 2011.

REFERENCES:

1. Mikell P Grover "Principles of Modern Manufacturing (SI Version)" John Wiley & Sons, 2014.
2. Kaushish J P, "Manufacturing Processes", Prentice Hall India, 2013.
3. Kapil Gupta, J.Paulo Davim, "High Speed Machining", Academic Press,2020.
4. Richerd R Kibbe, John E. Neely, Roland O. Merges and Warren J.White "Machine Tool Practices", Prentice Hall of India, 1998.
5. Rapid Prototyping and Engineering Applications, Frank W. Liou, CRC Press
6. Geofrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools", Mc Graw Hill, 1984
7. Philip F Ostwald and Jairo Munoz, "Manufacturing Processes and Systems" John Wiley India, New Delhi, 2013.
8. Benny Raphael and Ian Alan Smith, Fundamentals of Computer Aided Engineering", Wiley-Blackwell, 2003.
9. Apurba Kumar Roy, Divya Zindani, and J. Paulo Davim, Industry 4.0: Developments Towards the Fourth Industrial Revolution, Springer, 2019.

ME1402A	STRENGTH OF MATERIALS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the concepts of stress, strain, principal stresses and principal planes.
- To study the concept of shearing force and bending moment due to external loads in determinate beams and their effect on stresses.
- To determine stresses and deformation in circular shafts and helical spring due to torsion.
- To compute slopes and deflections in determinate beams by various methods.
- To study the stresses and deformations induced in thin and thick shells.

UNIT I	STRESS, STRAIN AND DEFORMATION OF SOLIDS	9

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants – Volumetric strains –Stresses on inclined planes – principal stresses and principal planes.

UNIT II	TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM	9

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

UNIT III	TORSION	9

Torsion formulation stresses and deformation in circular and hollows shafts– Deflection in shafts fixed at the both ends – Stresses in helical springs – Deflection of helical 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 and strain energy – Maxwell‟s reciprocal theorems.		
UNIT V	**THIN CYLINDERS, SPHERES AND THICK CYLINDERS**	**9**
Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin and thick cylinders – spherical shells subjected to internal pressure –Deformation in spherical shells – Lame‟s theorem.		

	TOTAL:	45	PERIODS

OUTCOMES:

Students will be able to

- Understand the Concepts of stress and strain in simple and compound bars, the importance of principal stresses and principal planes.
- Understand the Distribution of load on beams and stress distribution due to shearing force and bending moment.
- Apply basic equation of simple torsion in designing of shafts and helical spring
- Calculate the slope and deflection in beams using different methods.
- Analyze and design thin and thick shells for the applied internal and external pressures.

TEXTBOOKS:

1. Egor. P.Popov “Engineering Mechanics of Solids” Prentice Hall of India, New Delhi, 2002
2. Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2016

REFERENCES:

1. Ferdinand P. Been, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials", Tata McGraw Hill Publishing „co. Ltd., New Delhi, 2005.
2. Hibbeler, R.C., "Mechanics of Materials", Pearson Education, Low Price Edition, 2013
3. Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series, 2010.
4. Jindal U.C., "Strength of Materials", Asian Books Pvt. Ltd., New Delhi, 2009

ME1403A	THERMAL ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To integrate the concepts, laws and methodologies from the first course in thermodynamics into analysis of cyclic processes
- To learn the working and performance of Internal combustion engines.
- To apply the thermodynamic concepts in Steam nozzles and Steam Turbines
- To understand the working principle and performance of air Compressors

- To study the concepts of Refrigeration and Air conditioning systems
  (Use of standard refrigerant property data book, Steam Tables, Mollier diagram and Psychrometric chart permitted)

UNIT I	**GAS POWER CYCLES**	**9**

Air standard efficiency and mean effective pressure calculation for Otto, Diesel, Dual and Brayton cycles, Comparison of air standard cycles.

UNIT II	**INTERNAL COMBUSTION ENGINES**	**9**

Classification – Components and their function. Valve timing diagram and port timing diagram – actual p-V diagram of four stroke and two stroke engines. Carburettor. MPFI, Diesel pump and injector system. Battery and Magneto Ignition System – Principles of Combustion and knocking in SI and CI Engines. Lubrication and Cooling systems.

UNIT III	**STEAM NOZZLES AND TURBINES**	**9**

Impulse and Reaction principles, Flow of steam through nozzles, effect of friction, critical pressure ratio, supersaturated flow, compounding, velocity diagram for simple and multi-stage turbines, speed regulations – Governors.

UNIT IV	**AIR COMPRESSOR**	**9**

Classification and working principle of various types of compressors, work of compression with and without clearance, Volumetric efficiency derivation, Multistage air compressor and inter cooling –work of multistage air compressor, working of rotary compressor.

UNIT V	**REFRIGERATION AND AIR CONDITIONING**	**9**

Refrigerants and its properties - Vapour compression refrigeration cycle- super heat, sub cooling –
Performance calculations - working principle of vapour absorption system, Ammonia –Water, Lithium bromide – water systems (Description only) and Thermoelectric refrigeration . Air conditioning systems, concept of RSHF, GSHF and ESHF, Cooling load calculations.

TOTAL:	**45**	**PERIODS**	

OUTCOMES:

Upon completion of this course, the students will be able

- to apply the thermodynamic concepts in different gas power cycles
- to explain the functioning, components, auxiliaries and performance parameters of I.C.Engines
- to explain the flow and solve problems in steam nozzles and steam turbines
- to solve problems in single stage and multistage air compressors
- to solve problems using refrigerant table / charts and psychrometric charts

TEXTBOOKS:

1. Rajput. R. K., "Thermal Engineering" Laxmi Publication ,10th edition.
2. Kothandaraman.C.P., Domkundwar. S,Domkundwar. A.V., "A course in thermal Engineering", "Dhanpat Rai & sons , 2019

REFERENCES:

1. Sarkar, B.K,"Thermal Engineering" Tata McGraw-Hill Publishers, 2007
2. Arora.C.P, "Refrigeration and Air Conditioning ," Tata McGraw-Hill Publishers 2008
3. Ganesan V.." Internal Combustion Engines" , Third Edition, Tata Mcgraw-Hill 2007
4. Rudramoorthy, R, "Thermal Engineering ",Tata McGraw-Hill, New Delhi,2006
5. Ramalingam. K.K., "Thermal Engineering", SCITECH Publications (India) Pvt. Ltd., 2009.

ME1404A	Mechanics of Machine-I	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basic components and layout of linkages in the assembly of a system /machine.
- To understand the principles in analyzing the assembly with respect to the displacement, velocity, and acceleration at any point in a link of a mechanism.
- To understand the cam mechanisms for specified output motions.
- To understand the basic concepts of toothed gearing and kinematics of gear trains in motion transmission and in machine components.
- To understand the friction concepts in machine elements.

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 – Description of some common mechanisms – Quick return mechanisms, Straight line generators, Universal Joint – rocker mechanisms.

UNIT II	KINEMATIC ANALYSIS OF LINKAGE MECHANISMS	9

Displacement, velocity and acceleration analysis of simple mechanisms – Graphical method– Velocity and acceleration polygons – Velocity analysis using instantaneous centres – kinematic analysis of simple mechanisms – Coincident points – Coriolis component of Acceleration – Introduction to linkage synthesis problem.

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 – Involutes and cycloidal tooth profiles –Spur Gear terminology and definitions –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	**FRICTION IN MACHINE ELEMENTS**	**9**

Friction drives – Friction during upward motion and downward motion – Friction in screw threads – Bearings – classification and application – lubrication – types – Friction clutches.

TOTAL:	**45**	**PERIODS**	

OUTCOMES:

Upon completion of this course, the students can able to

- Discuss the basics of mechanism
- Calculate velocity and acceleration of simple mechanisms
- Develop cam profiles
- Solve problems on gears and gear trains
- Examine friction in machine elements.

TEXTBOOKS:

1. Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", 3rd Edition, Oxford University Press, 2009.
2. Rattan, S.S, "Theory of Machines", 3rd Edition, Tata McGraw-Hill, 2009.

REFERENCES:

1. Thomas Bevan, "Theory of Machines", 3rd Edition, CBS Publishers and Distributors, 2005.
2. Cleghorn. W. L, "Mechanisms of Machines", Oxford University Press, 2005
3. Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 2009.
4. Allen S. Hall Jr., "Kinematics and Linkage Design", Prentice Hall, 1961
5. Ghosh. A and Mallick, A.K., "Theory of Mechanisms and Machines", Affiliated East-West Pvt. Ltd., New Delhi, 1988.
6. Rao.J.S. and Dukkipati.R.V. "Mechanisms and Machine Theory", Wiley-Eastern Ltd., New Delhi, 1992.
7. John Hannah and Stephens R.C., "Mechanics of Machines", Viva Low-Prices Student Edition, 1999.
8. Ramamurthi. V, "Mechanics of Machines", Narosa Publishing House, 2002.
9. Khurmi, R.S., "Theory of Machines",14th Edition, S Chand Publications, 2005
10. Sadhu Sigh : Theory of Machines, "Kinematics of Machine", Third Edition, Pearson Education, 2012.

ME1405A	**STRENGTH OF MATERIALS AND FLUID MECHANICS AND MACHINERY LABORATORY**	L	T	P	C
		0	0	4	2

Objectives:

- To study the mechanical properties of materials when subjected to different types of loading.
- To verify the principles studied in Fluid Mechanics theory by performing experiments in lab.

STRENGTH OF MATERIALS LABORATORY LIST OF EXPERIMENTS	**30**

1. Tension test on a mild steel rod
2. Double shear test on Mild steel and Aluminium rods
3. Torsion test on mild steel rod
4. Impact test on metal specimen
5. Hardness test on metals - Brinnell and Rockwell Hardness Number
6. Deflection test on beams
7. Compression test on helical springs
8. Strain Measurement using Rosette strain gauge
9. Effect of hardening- Improvement in hardness and impact resistance of steels.
10. Tempering- Improvement Mechanical properties Comparison
    (i) Unhardened specimen
    (ii) Quenched Specimen and
    (iii) Quenched and tempered specimen.
11. Microscopic Examination of
    (i) Hardened samples and
    (ii) Hardened and tempered 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. Calculation 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. Conducting experiments and drawing the characteristic curves of Pelton wheel.
9. Conducting experiments and drawing the characteristics curves of Francis turbine.
10. Conducting experiments and drawing the characteristic curves of Kaplan turbine.

TOTAL: 60 PERIODS

Course Outcomes:

- Ability to perform Tension, Torsion, Hardness, Compression, and Deformation test on Solid materials.

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

- Perform Tension, Torsion, Hardness, Compression, and Deformation test on Solid materials.
- Use the measurement equipments for flow measurement.
- Perform test on different fluid machinery.

LIST OF EQUIPMENT FOR 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 (800 C)	1

LIST OF EQUIPMENT 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 setup	1

ME1406A	CAD & CNC LABORATORY	L	T	P	C
		0	0	4	2

Objectives:

- To gain practical experience in handling 2D drafting and 3D modelling software systems.
- To study the features of CNC Machine Tool.
- To expose students to modern control systems (Fanuc, Siemens etc.,)
- To know the application of various CNC machines like CNC lathe, CNC vertical Machining centre, CNC EDM and CNC wire-cut and studying of Rapid prototyping.

1.3D GEOMETRIC MODELLING	30

LIST OF EXPERIMENTS:

1. Introduction of 3D Modelling software

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

a. Plummer Block
b. Screw Jack
c. Lathe Tailstock
d. Universal Joint
e. Machine Vice
f. Stuffing box
g. Crosshead
h. Safety Valves
i. Non-return valves
j. Connecting rod
k. Piston
l. Crankshaft

* Students may also be trained in manual drawing of some of the above components

2. MANUAL PART PROGRAMMING	**30**

(i) Part Programming -CNC Machining Centre

a) Linear Cutting.
b) Circular cutting.
c) Cutter Radius
d) Compensation. d) Canned Cycle Operations.

(ii) Part Programming - CNC Turning Centre

a) Straight, Taper and Radius Turning.
b) Thread Cutting.
c) Rough and Finish Turning cycle.
d) Drilling and Tapping Cycle.

3. COMPUTER AIDED PART PROGRAMMING

e) CL Data and Post process generation using CAM packages.

Application of CAPP in Machining and Turning Centre.

	TOTAL PERIODS: 60

Course Outcomes:

- Draw 3D and Assembly drawing using CAD software
- Demonstrate manual part programming with G and M codes using CAM

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 atleast 1 GB main memory) networked to the server	30
3.	A3 size plotter	1
4.	Laser Printer	1
5.	CNC Lathe	1
6.	CNC milling machine	1
	SOFTWARE	
7.	Any High end integrated modeling and manufacturing CAD / CAM software	15 licenses
8.	CAM Software for machining centre and turning centre (CNC Programming and tool path simulation for FANUC / Sinumeric and Heidenhain controller)	15 licenses
9.	Licensed operating system	Adequate
10.	Support for CAPP	Adequate

HV1401A	HV1401A UNIVERSAL HUMAN VALUES	L	T	P	C
		2	1	0	3

OBJECTIVES:

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

UNIT I **Course Introduction - Need, Basic Guidelines, Content and Process for Value Education** **6+3**

1. Purpose and motivation for the course, recapitulation from Universal Human Values-I
2. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential validation-as the process for self-exploration
3. Continuous Happiness and Prosperity- A look at basic Human Aspirations
4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority
5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
6. 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 II **Understanding Harmony in the Human Being - Harmony in Myself!** **6+3**

1. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
2. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility
3. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)
4. Understanding the characteristics and activities of 'I' and harmony in 'I'
5. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of physical needs, meaning of Prosperity in detail
6. 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 dealingwith disease.

UNIT III **Understanding Harmony in the Family and Society- Harmony in Human Human Relationship** **6+3**

1. 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
2. Understanding the meaning of Trust; Difference between intention and competence
3. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
4. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
5. 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 institute as 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 IV	Understanding Harmony in the Nature and Existence - Whole existence as Coexistence	6+3

1. Understanding the harmony in the Nature
2. Interconnectedness and mutual fulfilment among the four orders of nature recyclability and self-regulation in nature
3. Understanding Existence as Co-existence of mutually interacting units in all pervasive space
4. 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 V	Implications of the above Holistic Understanding of Harmony on Professional Ethics	6+3

1. Natural acceptance of human values
2. Definitiveness of Ethical Human Conduct
3. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
4. 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.
5. Case studies of typical holistic technologies, management models and production systems
6. 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
7. 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.

	TOTAL:	**30(L)+15(T)=45 PERIODS**

REFERENCES:

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak,1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj - PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)

ME1501A	MECHANICS OF MACHINES – II	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the force-motion relationship in components subjected to external forces and analysis of standard mechanisms.
- To understand the undesirable effects of unbalances resulting from prescribed motions in mechanism.
- To understand the effect of Dynamics of undesirable vibrations.
- To understand the principles in mechanisms used for speed control and stability control

UNIT I	FORCE ANALYSIS	9

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	9

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 machines-Field balancing of discs and rotors

UNIT III	FREE VIBRATION	9

Basic features of vibratory systems – Degrees of freedom – single degree of freedom – Free vibration– Equations of motion – Natural frequency – Types of Damping – Damped vibration– Torsional vibration of shaft – Critical speeds of shafts-Torsional vibration of two rotor system

UNIT IV	FORCED VIBRATION	9

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

UNIT V	MECHANISM FOR CONTROL	9

Governors – Porter, Proell and Hartnell Governor – Characteristics – Effect of friction – Controlling force curves. Gyroscopes –Gyroscopic forces and torques – Gyroscopic stabilization – Gyroscopic effects in Automobiles, ships and airplanes.

TOTAL:	45	PERIODS

OUTCOMES:

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

- Calculate static and dynamic forces of mechanisms.
- Calculate the balancing masses and their locations of reciprocating and rotating masses.
- Compute the frequency of free vibration.
- Compute the frequency of forced vibration and damping coefficient.
- Calculate the speed and lift of the governor
- Estimate the gyroscopic effect on automobiles, ships and airplanes.

TEXTBOOKS:

1. Rattan, S.S, “Theory of Machines”, 4 th Edition, Tata McGraw-Hill, 2014.
2. Uicker, J.J., Pennock G.R and Shigley, J.E., “Theory of Machines and Mechanisms”, 4 th Edition, Oxford University Press, 2014.

REFERENCES:

1. Cleghorn. W. L, “Mechanisms of Machines”, Oxford University Press, 2014
2. Ghosh. A and Mallick, A.K., “Theory of Mechanisms and Machines", 3 rd Edition Affiliated East-West Pvt. Ltd., New Delhi, 2006.
3. Rao.J.S. and Dukkipati.R.V. "Mechanisms and Machine Theory", Wiley-Eastern Ltd., New Delhi, 1992.
4. Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 2009.
5. V.Ramamurthi, "Mechanics of Machines", Narosa Publishing House, 2002.
6. Sadhu Singh “Theory of Machines” Pearson Education, 2002.
7. Thomas Bevan, "Theory of Machines", CBS Publishers and Distributors, 1984.
8. Khurmi, R.S.,”Theory of Machines”, 14th Edition, S Chand Publications, 2005.

ME1502A	METROLOGY AND COMPUTER AIDED INSPECTION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide knowledge on various Metrological equipment available to measure the dimension of the components.
- To provide knowledge on the correct procedure to be adopted to measure the dimension of the components

UNIT I	BASICS OF METROLOGY	5

Introduction to Metrology – Need for measurement – Dimensional and Form tolerances – Elements – Work piece, Instruments – Persons – Environment –their effect on Precision and Accuracy – Errors in Measurements – Causes & Types – Control – Types of standards & Practice

UNIT II	LINEAR AND ANGULAR MEASUREMENTS	10

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, Angle gauges, Sine bar – Angle alignment telescope – Autocollimator – Applications.

UNIT III	FORM AND LASER MEASUREMENT	10

Principles and Methods of straightness – Flatness measurement – Thread measurement, gear measurement, surface finish measurement, Roundness measurement – Applications. Use of Lasers – Principle – Laser Interferometer– Application in Linear and Angular measurements – Testing of machine tools using Laser Interferometer.

UNIT IV	CO-ORDINATE MEASURING MACHINE AND MACHINE VISION	10

Co-ordinate measuring machine (CMM) – Contact type CMM – Configurations, parts and its features, types of probes, probe compensation. Non-Contact type CMM – Features, probes, Specifications. Errors in CMM measurement, Machine vision system – Methods for sensing objects, image processing, segmentation, pattern recognition – Image histogram and processing

UNIT V	MEASUREMENT OF FLOW, PRESSURE AND TEMPERATURE	10

Measurement of Flow: Differential Pressure Meters, Rotameters, Turbine Meters, Electromagnetic Flow meters, Ultrasonic Flow meters. Measurement of Pressure: Dead-Weight Tester, Bourdon-tube pressure gauges, Diaphragm and Bellows. Measurement of Temperature: Bimetallic strip, Resistance Temperature Detectors, Thermistor, Thermocouples, Pyrometers.

TOTAL:	45	PERIODS

OUTCOMES:

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

- Describe the concepts of measurements to apply in various metrological instruments
- Outline the principles of linear and angular measurement tools used for industrial applications
- Explain the procedure for conducting computer aided inspection
- Demonstrate the techniques of form measurement used for industrial components
- Discuss various measuring techniques of mechanical properties in industrial applications
- Explain the procedure for conducting Advance Measuring instruments

TEXTBOOKS:

1. Jain R.K. "Engineering Metrology", Khanna Publishers, 19th Edition, 2005.
2. Gupta. I.C., "Engineering Metrology", Dhanpatrai Publications, 2005.

REFERENCES:

1. Charles Reginald Shotbolt, "Metrology for Engineers", 5th edition, Cengage Learning EMEA, 1990.
2. Beckwith, Marangoni, Lienhard, "Mechanical Measurements", Pearson Education , 2006.
3. Galyer J.F.W. and Shotbolt C.R., "Metrology for Engineers", O.R.Cassel, London,1993.
4. Thomas, "Engineering Metrology", Butthinson & Co., 1984.
5. Bewoor A.K. and Kulkarni V.A., "Metrology and Measurements", Tata McGraw-Hill, 2009.
6. Whitehouse D.J., The Handbook of Surface and Nanometrology, CRC Press, 2011

ME1503A	DESIGN OF MACHINE ELEMENTS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To familiarize the various steps involved in the Design Process
- To understand the principles involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements.
- To learn to use standard practices and standard data
- To learn to use catalogues and standard machine components
- (Use of P S G Design Data Book is permitted)

UNIT I	**STATIC 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 – 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	**TEMPORARY AND PERMANENT JOINTS**	**9**

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

UNIT IV	**ENERGY STORING ELEMENTS**	**9**

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

UNIT V	**BEARINGS**	**9**

Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfeld Number, Raimondi and Boyd graphs, -- Selection of Rolling Contact bearings.

TOTAL:	**45**	**PERIODS**	

OUTCOMES:

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

- Explain the influence of steady and variable stresses in machine component design.
- Apply the concepts of design to shafts, keys and couplings.
- Apply the concepts of design to temporary and permanent joints.
- Apply the concepts of design to energy absorbing members.
- Apply the concepts of design to bearings.
- Design machine components for various industrial applications

TEXTBOOKS:

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

REFERENCES:

1. Alfred Hall, Halowenko, A and Laughlin, H., "Machine Design", Tata McGraw-Hill BookCo.(Schaum's Outline), 2010

2. Ansel Ugural, “Mechanical Design – An Integral Approach", 1st Edition, Tata McGraw-Hill Book Co, 2003.
3. P.C. Gope, “Machine Design – Fundamental and Application”, PHI learning private ltd, New Delhi, 2012.
4. R.B. Patel, “Design of Machine Elements”, MacMillan Publishers India P Ltd., Tech-Max Educational resources, 2011.
5. Robert C. Juvinall and Kurt M. Marshek, “Fundamentals of Machine Design”, 4th Edition, Wiley, 2005
6. Sundararajamoorthy T. V. Shanmugam .N, “Machine Design”, Anuradha Publications, Chennai, 2015.
7.Robert L.Norton, “Machine Design An Integrated Approach”, fifth edition Pearson Education India, 2013.

ME1504A	HEAT AND MASS TRANSFER	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the mechanisms of heat transfer under steady and transient conditions.
- To understand the concepts of heat transfer through extended surfaces.
- To learn the thermal analysis and sizing of heat exchangers and to understand the basic concepts of mass transfer.
- (Use of standard HMT data book permitted)

UNIT I	CONDUCTION	9

General Differential equation of Heat Conduction– Cartesian and Polar 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

Free and Forced Convection – Hydrodynamic and Thermal Boundary Layer. Free and Forced Convection during external flow over Plates and Cylinders and Internal flow through tubes.

UNIT III	PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS	9

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.

UNIT IV	RADIATION	9

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

UNIT V	MASS TRANSFER	9

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:	**45**	**PERIODS**

OUTCOMES:

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

- Apply heat conduction equations to different surface configurations under steady state and transient conditions and solve problems
- Apply free and forced convective heat transfer correlations to internal and external flows through/over various surface configurations and solve problems
- Explain the phenomena of boiling and condensation, apply LMTD and NTU methods of thermal analysis to different types of heat exchanger configurations and solve problems
- Explain basic laws for radiation and apply these principles to radiative heat transfer between different types of surfaces to solve problems
- Apply diffusive and convective mass transfer equations and correlations to solve problems for different applications
- Apply heat transfer and mass transfer concepts in industrial applications.

TEXTBOOKS:

1. R.C. Sachdeva, “Fundamentals of Engineering Heat & Mass transfer”, New Age International Publishers, 2009.
2. Yunus A. Cengel, “Heat Transfer A Practical Approach”, Tata McGraw Hill, 5th Edition 2015

REFERENCES:

1. Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley & Sons, 1998.
2. Kothandaraman, C.P., "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, 1998.
3. Nag, P.K., "Heat Transfer", Tata McGraw Hill, New Delhi, 2002
4. Ozisik, M.N., "Heat Transfer", McGraw Hill Book Co., 1994.
5. Holman, J.P., “Heat and Mass Transfer”, Tata McGraw Hill, 2000

ME1505A	**METROLOGY & INSPECTION LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

OBJECTIVES:

- To become familiar with different measurement equipment and use this for Quality inspection.

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 – bore gauge, telescopic gauge
3. Measurement of angles using bevel protractor and sine bar
4. Inspect, whether the dimensions of the given specimens are within the tolerance limit or not, using Comparators

5.Measurement of screw thread parameters using Floating carriage micrometer

6. Measurement of gear tooth thickness using gear tooth vernier caliper

7.Measurement of features in a prismatic component using Coordinate Measuring Machine (CMM)

8.Measurement of thread parameters by Tool Maker ‘s Microscope

9.Measurement of Surface Roughness using portable surface roughness tester

10.Straightness /Flatness Testing using Autocollimator

11.Measurement of force, torque and temperature

	TOTAL:	**60**	**PERIODS**

OUTCOMES:

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

- Select a suitable measuring instrument for measurement of linear and angular dimensions and use the same for carrying out measurements.
- Calibrate simple linear measuring instruments like Vernier caliper, micrometer, Vernier height gauge, etc. using gauge blocks.
- Use advanced measuring equipment like coordinate measuring machines, Toolmakers microscope, and surface finish measuring equipment to carryout measurements.
- Measure the gear tooth dimensions, straightness. Flatness and thread parameters.
- Measure temperature, force, displacement, torque.
- Handle Measuring Equipment with latest technologies.

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

ME1506A	KINEMATICS AND DYNAMICS LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

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

LIST OF EXPERIMENTS

1. a) Study of gear parameters.
   b) Experimental study of velocity ratios of simple, compound, Epicyclic and differential gear trains.

2. a) Kinematics of Four Bar, Slider Crank, Crank Rocker, Double crank, Double rocker, Oscillating cylinder Mechanisms.
   b) Kinematics of single and double universal joints.

3. a) Determination of Mass moment of inertia of Fly wheel and Axle system.
   b) Determination of Mass Moment of Inertia of axisymmetric bodies using Turn Table apparatus.
   c) Determination of Mass Moment of Inertia using bifilar suspension and compound pendulum.

4. Motorized gyroscope – Study of gyroscopic effect and couple.
5. Governor - Determination of range sensitivity, effort etc., for Watts, Porter, Proell, and Hartnell Governors.
6. Cams – Cam profile drawing, Motion curves and study of jump phenomenon
7. a) Single degree of freedom Spring Mass System – Determination of natural Frequency and verification of Laws of springs –Damping coefficient determination
   b) Multi degree freedom suspension system – Determination of influence coefficient.

8. a) Determination of torsional natural frequency of single and Double Rotor systems. - Undamped and Damped Natural frequencies.
   b) Vibration Absorber – Tuned vibration absorber.

9. Vibration of Equivalent Spring mass system – undamped and 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-Free beam – with and without concentrated masses.
    b) Forced Vibration of Cantilever beam – Mode shapes and natural frequencies.
    c) Determination of transmissibility ratio using vibrating table.

TOTAL:	**60**	**PERIODS**

OUTCOMES:

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

- Explain gear parameters, kinematics of mechanisms, gyroscopic effect and working of lab equipments.
- Determine mass moment of inertia of mechanical element, governor effort and range sensitivity, natural frequency and damping coefficient, torsional frequency, critical speeds of shafts, balancing mass of rotating and reciprocating masses, and transmissibility ratio.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1	Cam follower setup.	1 No.
2	Motorised gyroscope.	1 No.
3	Governor apparatus - Watt, Porter, Proell and Hartnell governors.	1 No.
4	Whirling of shaft apparatus.	1 No.
5	Dynamic balancing machine.	1 No.
6	Two rotor vibration setup.	1 No.
7	Spring mass vibration system.	1 No.
8	Torsional Vibration of single rotor system setup.	1 No.
9	Gear Models	1 No.
10	Kinematic Models to study various mechanisms.	1 No.
11	Turn table apparatus.	1 No.
12	Transverse vibration setup of a) cantilever	1 No.

ME1601A	DESIGN OF MECHANICAL TRANSMISSION SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To gain knowledge on the principles and procedure for the design of Mechanical power Transmission components.
- To understand the standard procedure available for Design of Transmission of Mechanical elements
- To learn to use standard data and catalogues
- (Use of P S G Design Data Book permitted)

UNIT I DESIGN OF BELT, ROPES AND CHAIN **9**

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

UNIT II DESIGN OF SPUR AND HELICAL GEARS **9**

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

UNIT III DESIGN OF BEVEL AND WORM GEARS **9**

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits-terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair. Cross helical: Terminology-helix angles-Estimating the size of the pair of cross helical gears.

UNIT IV	DESIGN OF GEAR BOXES	9

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

UNIT V	DESIGN OF CLUTCHES AND BRAKES	9

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

	TOTAL:	45	PERIODS

OUTCOMES:

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

- Apply the concepts of design to belts, chains and rope drives.
- Apply the concepts of design to spur, helical gears.
- Apply the concepts of design to worm and bevel gears.
- Apply the concepts of design to gear boxes.
- Apply the concepts of design to brakes and clutches.
- Design the power transmission elements for industrial applications.

TEXTBOOKS:

1. Bhandari V, “Design of Machine Elements”,4th Edition, Tata McGraw-Hill Book Co, 2016.
2. Richard Budynas and Keith Nisbett “ Shigley’s Mechanical Engineering Design”, 10th Edition, Tata McGraw-Hill, 2014.

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

ME1602A	FINITE ELEMENT ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the concepts of Mathematical Modeling of Engineering Problems.
- To appreciate the use of FEM to a range of Engineering Problems

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 ANALYSIS**	**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. Fourth Order Beam Equation- Problems on it.

UNIT III	**APPLICATION OF ONE-DIMENSIONAL ELEMENT TO HEAT TRANSFER AND VIBRATION**	**9**

Derivation of matrices and vector for heat transfer. Problems on Heat transfer. Natural frequencies of longitudinal vibration and mode shapes. Transverse Natural frequencies of beams.

UNIT IV	**TWO-DIMENSIONAL ANALYSIS**	**9**

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation – Finite Element formulation – Triangular elements and Quadrilateral elements- Shape functions and element matrices and vectors. Application to Field Problems. Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Constitutive matrices and Strain displacement matrices – Stiffness matrix – Stress calculations.

UNIT V	**ISOPARAMETRIC FORMULATION AND NUMERICAL INTEGRATION**	**9**

Natural co-ordinate systems – Isoparametric elements – Shape functions for isoparametric elements – One and two dimensions – Serendipity elements – Numerical integration - Introduction to non-linearity.

TOTAL:	**45**	**PERIODS**	

OUTCOMES:

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

- Develop mathematical models for Boundary Value Problems and their numerical solution
- Apply the concepts of Finite Element Analysis to solve one dimensional problem in structural analysis
- Apply the concepts of Finite Element Analysis to solve one dimensional problem in Heat transfer and Dynamics

- Apply the concepts of Finite Element Analysis to solve two dimensional problems in structural analysis
- Apply the Isoparametric transformation and the use of numerical integration for various analysis
- Apply FEA concepts in all Engineering Applications.

TEXTBOOKS:

1. Rao S. S, "The Finite Element Method in Engineering", 6th Edition, ButterworthHeinemann,2018.
2. Tirupathi R. Chandrupatla and Ashok D. Belegundu, "Introduction to Finite Elements in Engineering", International Edition, Pearson Education Limited, 2014.

REFERENCES:

1. David Hutton, "Fundamentals of Finite Element Analysis", Tata McGrawHill, 2017.
2. Reddy, J.N. "Introduction to the Finite Element Method", 4thEdition, Tata McGrawHill,2018.
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, 2007.
4. Seshu. P, "Text Book of Finite Element Analysis", PHI Learning Pvt. Ltd., NewDelhi, 2013.
5. Bhatti Asghar M, "Fundamental Finite Element Analysis and Applications", John Wiley & Sons, 2005 (Indian Reprint 2013).

ME1603A	HYDRAULICS AND PNEUMATICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide students with an understanding of the fluids and components utilized in modern industrial fluid power system and manufacturing Industries.
- To develop a measurable degree of competence in the design, construction and operation of fluid power circuits.

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 - Pumping Theory – Pump Classification – Construction, Working, Advantages, Disadvantages – Fixed and Variable displacement pumps

UNIT II HYDRAULIC ACTUATORS AND CONTROL COMPONENTS 9

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

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 – Introduction to fluidics and pneumatic logic

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.

TOTAL:	45	PERIODS

OUTCOMES:

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

ME1603.1 Apply the working principles of fluid power systems and hydraulic pumps.
ME1603.2 Apply the working principles of hydraulic actuators and control components.
ME1603.3 Design and develop hydraulic circuits and systems.
ME1603.4 Apply the working principles of pneumatic circuits and power system and its components.
ME1603.5 Identify various troubles shooting methods in fluid power systems.
ME1603.6 Explain the working of automation with different Hydraulic and Pneumatic systems.

TEXTBOOKS:

1. Srinivasan.R., “Hydraulic and Pneumatic Controls”, Vijay Nicole Imprints, 3rd edition, 2019.
2. Anthony Esposito, “Fluid Power with Applications”, Prentice Hall, 2009

REFERENCES:

1. Jagadeesha. T., “Pneumatics Concepts, Design and Applications “, Universities Press, 2015.
2. Dudelyt, A. Pease and John T. Pippenger, “Basic Fluid Power”, Prentice Hall, 1987.
3. Majumdar, S.R., “Oil Hydraulics Systems – Principles and Maintenance”,TataMcGraw Hill, 2001.
4. Joshi.P., Pneumatic Control”, Wiley India, 2008.
5. Shanmugasundaram.K., “Hydraulic and Pneumatic Controls”. Chand & Co, 2006
6. James A. Sullivan, “Fluid Power Theory and Applications”, Fourth Edition, Prentice Hall, 1997

ME1604A	COMPUTER AIDED DESIGN AND MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide an overview of how computers are being used in mechanical component design
- To understand the application of computers in various aspects of Manufacturing viz., Design, Proper planning, Manufacturing cost, Layout & Material Handling system.

UNIT I	**INTRODUCTION**	**9**

Product cycle- Design process- sequential and concurrent engineering- Computer aided design – CAD system architecture- Computer graphics – co-ordinate systems- 2D and 3D transformations - homogeneous coordinates – Line drawing -Clipping- viewing transformation- Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control. Automation in CAD/CAM & related Concepts.

UNIT II	**GEOMETRIC MODELING**	**9**

Representation of curves- Hermite curve- Bezier curve- B-spline curves-rational curves- Techniques for surface modeling – surface patch- Coons and bicubic patches- Bezier and B-spline surfaces. Solid modeling techniques- CSG andB-rep

UNIT III	**CAD STANDARDS**	**9**

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

UNIT IV	**FUNDAMENTAL OF CNC AND PART PROGRAMING**	**9**

Introduction to NC systems and CNC – Machine axis and Co-ordinate system- CNC machine tools - Principle of operation CNC- Construction features including structure- Drives and CNC controllers - 2D and 3D machining on CNC- Introduction of Part Programming, types – Detailed Manual part programming on Lathe & Milling machines using G codes and M codes- Cutting Cycles, Loops, Sub program and Macros- Introduction of CAM package

UNIT V	**GROUP TECHNOLOGY AND FLEXIBLE MANUFACTURING SYSTEM (FMS)**	**9**

Introduction, needs of GT, part families, classification and coding systems, Simple Problems in Opitz Part Coding system, GT machine cells, benefits of GT. Computer integrated manufacturing (CIM) system, Types of Flexibility, FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control.

TOTAL:	**45**	**PERIODS**	

OUTCOMES:

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

- Explain the 2D and 3D transformations, clipping algorithm, Manufacturing models and Metrics
- Explain the fundamentals of parametric curves, surfaces and Solids
- Summarize the different types of Standard systems used in CAD
- Apply NC & CNC programming concepts to develop part programme for Lathe & Milling Machines

- Summarize the different types of techniques used in Cellular Manufacturing and FMS
- Apply fundamentals of CAD concepts and techniques for modelling industrial components.

TEXTBOOKS:

1. Ibrahim Zeid "Mastering CAD CAM" Tata McGraw-Hill PublishingCo.2007
2. Radhakrishnan P, Subramanyan S. and Raju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi,2000

REFERENCES:

1. Chris McMahon and Jimmie Browne "CAD/CAM Principles", "Practice and Manufacturing management "Second Edition, Pearson Education, 1999.
2. William M Neumann and Robert F.Sproul "Principles of Computer Graphics", McGraw Hill Book Co. Singapore, 1989.
3. Donald Hearn and M. Pauline Baker "Computer Graphics"'. Prentice Hall, Inc,1992.
4. Foley, Wan Dam, Feiner and Hughes - "Computer graphics principles & practice" Pearson Education -2003
5. Mikell.P.Groover "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India, 2008.

ME1613A	THERMAL ENGINEERING LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To study the valve timing, p-V diagram and performance of IC Engines
- To Study the characteristics of fuels/Lubricates used in IC Engines
- To study the heat transfer phenomena, predict the relevant coefficient using implementation
- To study the performance of refrigeration cycle / components

LIST OF EXPERIMENTS

1. Valve Timing diagram of four stroke engine.
2. Port Timing diagram of two stroke engine.
3. Performance & Heat Balance Test on 4 – stroke Diesel Engine.
4. Morse Test on Multi-cylinder Petrol Engine.
5. Determination of Flash Point and Fire Point of various fuels / lubricants
6. Determination of viscosity in Redwood Viscometer
7. Effectiveness of Parallel / counter flow heat exchanger.
8. Determination of Stefan – Boltzmann constant.
9. Heat transfer from pin-fin apparatus (natural & forced convection modes)
10. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
11. Determination of Thermal conductivity of insulating powder.
12. Determination of heat transfer coefficient under forced convection from a tube.

13. Determination of Thermal conductivity of composite wall.
14. Performance test on a reciprocating air compressor
15. Determination of COP of a refrigeration system

	TOTAL:	**60**	**PERIODS**

OUTCOMES:

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

- Conduct tests on heat conduction apparatus and evaluate thermal conductivity of materials.
- Conduct tests on natural and forced convective heat transfer apparatus and evaluate heat transfer coefficient.
- Conduct tests on radiative heat transfer apparatus and evaluate Stefan Boltzmann constant and emissivity.
- Conduct tests to evaluate the performance of parallel/counter flow heat exchanger apparatus and reciprocating air compressor.
- Conduct tests to evaluate the performance of refrigeration and air conditioning test rigs.

Conduct tests to evaluate Convective and Radiative heat transfer.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	**NAME OF THE EQUIPMENT**	**Qty.**
1	I.C Engine – 2 stroke and 4 stroke model	1 SET
2	Apparatus for Flash and Fire Point	1 No.
3	Redwood Viscometer apparatus	1 No.
4	4-stroke Diesel Engine with mechanical/electrical loading.	1 No.
5	4-stroke Diesel Engine with hydraulic loading.	1 No.
6	Multi-cylinder Petrol Engine	1 No.
7	Lagged pipe apparatus	1 No.
8	Forced convection inside tube apparatus	1 No.
9	Composite wall apparatus	1 No.
10	Thermal conductivity of insulating powder apparatus	1 No.
11	Stefan-Boltzmann apparatus	1 No.
12	Emissivity measurement apparatus	1 No.
13	Parallel/counter flow heat exchanger apparatus	1 No.
14	Single/two stage reciprocating air compressor	1 No.
15	Refrigeration test rig	1 No.

ME1614A	**INNOVATIVE PROJECT**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

OBJECTIVES:

The main objective is to give an opportunity to the student to get hands on training in the fabrication of one or more components of a complete working model, which is designed by them.

GUIDELINE FOR REVIEW AND EVALUATION

The students may be grouped into 2 to 4 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 to be submitted by the group and the fabricated model, which will be reviewed and evaluated for internal assessment by a committee constituted by the Head of the Department. At the end of the semester examination the project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

	TOTAL:	**60**	**PERIODS**

OUTCOMES:

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

- Design the machine element or the mechanical product.
- Fabricate the machine element or the mechanical product.
- Develop the solutions for specific real time problems.
- Apply the principles of engineering and codes of practice while developing solutions.
- Able to develop team work.
- Demonstrate the working model of the machine element or the mechanical product.

ME1605A	**DESIGN OF JIGS, FIXTURES AND PRESS TOOL**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To understand the functions and design principles of Jigs, fixtures and press tools

To gain proficiency in the development of required views of the final design

UNIT I	**LOCATING AND CLAMPING PRINCIPLES:**	**9**

Objectives of tool design- Function and advantages of Jigs and fixtures – Basic elements – principles of location – Locating methods and devices – Redundant Location – Principles of clamping – Mechanical actuation – pneumatic and hydraulic actuation Standard parts – Drill bushes and Jig buttons – Tolerances and materials used.

UNIT II	**JIGS AND FIXTURES**	**9**

Design and development of jigs and fixtures for given component- Types of Jigs – Post, Turnover, Channel, latch, box, pot, angular post jigs – Indexing jigs – General principles of milling, Lathe, boring, broaching and grinding fixtures – Assembly, Inspection and Welding fixtures – Modular fixturing systems- Quick change fixtures.

UNIT III	**PRESS WORKING TERMINOLOGIES AND ELEMENTS OF CUTTING DIES**	**9**

Press Working Terminologies - operations – Types of presses – press accessories – Computation of press capacity – Strip layout – Material Utilization – Shearing action – Clearances – Press Work Materials – Centre of pressure- Design of various elements of dies – Die Block – Punch holder, Die set, guide plates – Stops – Strippers – Pilots – Selection of Standard parts – Design and preparation of four standard views of simple blanking, piercing, compound and progressive dies.

UNIT IV	**BENDING AND DRAWING DIES**	**9**

Difference between bending and drawing – Blank development for above operations – Types of Bending dies – Press capacity – Spring back – knockouts – direct and indirect – pressure pads – Ejectors – Variables affecting Metal flow in drawing operations – draw die inserts – draw beads-ironing – Design and development of bending, forming, drawing, reverse redrawing and combination dies – Blank development for axisymmetric, rectangular and elliptic parts – Single and double action dies.

UNIT V	**FORMING TECHNIQUES AND EVALUATION**	**9**

Bulging, Swaging, Embossing, coining, curling, hole flanging, shaving and sizing, assembly, fine Blanking dies – recent trends in tool design- computer Aids for sheet metal forming Analysis – basic introduction - tooling for numerically controlled machines- setup reduction for work holding – Single minute exchange of dies – Poka Yoke

TOTAL:	**45**	**PERIODS**

OUTCOMES:

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

- Summarize the different methods of Locating Jigs and Fixtures and Clamping principles
- Design and develop jigs and fixtures for given component
- Discuss the press working terminologies and elements of cutting dies
- Distinguish between Bending and Drawing dies.
- Discuss the different types of forming techniques
- Design jigs, fixtures and press tool for different components and come up with the cost of making the tool.

TEXTBOOKS:

1. Joshi, P.H. “Jigs and Fixtures”, Second Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2010.
2. Joshi P.H “Press tools - Design and Construction”, wheels publishing, 1996

REFERENCES:

1. ASTME Fundamentals of Tool Design Prentice Hall of India.
2. Design Data Hand Book, PSG College of Technology, Coimbatore.
3. Donaldson, Lecain and Goold “Tool Design”, 5th Edition, Tata McGraw Hill, 2017.
4. Hoffman “Jigs and Fixture Design”, Thomson Delmar Learning, Singapore, 2004.
5. Kempster, “Jigs and Fixture Design”, Third Edition, Hoddes and Stoughton, 1974.
6. Venkataraman. K., “Design of Jigs Fixtures & Press Tools”, Tata McGraw Hill, New Delhi, 2005.

ME1606A	DESIGN FOR MANUFACTURE AND ASSEMBLY	L	T	P	C
		3	0	0	3

OBJECTIVES:

To know the concept of design for manufacturing and assembly

To know the computer application in design for manufacturing and assembly.

UNIT I	INTRODUCTION	5

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances Geometric tolerances - Assembly limits -Datum features - Tolerance stacks.

UNIT II	FACTORS INFLUENCING FORM DESIGN	13

Working principle, Material, Manufacture, Design- Possible solutions - Materials choice – Influence of materials on form design - form design of welded members, forgings and castings.

UNIT III	COMPONENT DESIGN - MACHINING CONSIDERATION	8

Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability – Design for accessibility - Design for assembly – Product design for manual assembly - Product design for automatic assembly – Robotic assembly.

UNIT IV	COMPONENT DESIGN – CASTING CONSIDERATION	10

Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA

UNIT V	COMPONENT DESIGN – WELDING CONSIDERATION	9

Appraisal of various welding processes, factors in design of weldments, general design guidelines, pre and post treatment of welds, effects of thermal stresses in weld joints.

TOTAL:	45	PERIODS

OUTCOMES:

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

- Understand the design principles for manufacturability
- Understand the factors influencing form design
- Apply the machining considerations when design the components for machinability
- Apply the casting considerations when design the components for casatability
- Apply the welding considerations when design the components for weldability

Apply the design principles with manufacturing and assembly considerations.

TEXTBOOKS:

1.Harry Peck , Designing for manufacture, Pitman– 1973

REFERENCES:

1. Boothroyd, G, 1980 Design for Assembly Automation and Product Design. New York, Marcel Dekker.

2. Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994.

3. Bralla, Design for Manufacture handbook, McGraw hill, 1999.

4. Dickson, John. R, and Corroda Poly, Engineering Design and Design for Manufacture and Structural Approach, Field Stone Publisher, USA, 1995.

5. Fixel, J. Design for the Environment McGraw Hill., 1996.

6. Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. Reason Pub., 1996.

7. Kevin Otto and Kristin Wood, Product Design. Pearson Publication, (Fourth Impression) 2009.

ME1607A	MATERIAL CHARACTERIZATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To expose the students with thermal, microscopic, electrical and spectroscopic methods of characterization.
- To study and understand the various Non-Destructive Evaluation and Testing methods, theory and their industrial applications.

UNIT I	OPTICAL METALLOGRAPHIC TECHNIQUES	9

Importance of material characterization –classification of material characterization techniques – mechanical characterization process –measurement of hardness –fracture toughness through nano indentation –adhesion test-surface profilometry – tribological studies of materials, Optical microscopic techniques. Macro examination-applications –metallurgical microscope –principle, construction and working, metallographic specimen preparation.

UNIT II	SURFACE ANALYSIS TECHNIQUES	9

Importance of surface characterization techniques–principle, working and applications of AFM, Surface area, pore volume measurements by B.E.T. method, Mercury porosimetry -Particle size measurement, Principle and working of SEM, STEM, TEM, imaging dark and bright field–specimen preparation techniques–merits and demerits-applications

UNIT III	X RAY DIFFRACTION & ION BEAM TECHNIQUES	9

Characteristic X–ray spectrum-Bragg's Law–Diffraction methods-Laue method, rotating crystal method, powder method –X ray diffractometer–determination of crystal structure–lattice parameter-measurement of residual stress. Rutherford Backscattering Spectrometry (RBS), Secondary Ion Mass Spectroscopy, Electron backscatter diffraction (EBSD), Focused Ion Beam (FIB), elastic recoil detection analysis and nuclear reaction analysis

UNIT IV	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 V	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.

TOTAL:	45	PERIODS

OUTCOMES:

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

- categorize the various types of material characterization techniques
- illustrate the several types of surface characterization techniques
- visualize the importance of X-ray diffraction and Ion beam techniques
- elaborate the different methods of non-destructive testing
- summarize the various methods available for non-destructive evaluation

describe the practical applications of several surface analysis techniques

TEXTBOOKS:

1. A. Mammoli, C. A. Brebbia and A. Klemm, Materials Characterization, WIT Press, 1stedition, (2011).
2. Baldev Raj, T.Jayakumar, M.Thavasimuthu “Practical Non-Destructive Testing”, Narosa Publishing House, 2009.

REFERENCES:

B. D. Cullity, Elements of X-ray Diffraction, Prentice Hall, 3rd edition, (2001).
2. V. A. Phillips, Modern Metallographic Techniques and their Applications, John Wiley & Sons, 1stedition, (1972).
3. V. T. Cherepin and A. K. Mallic, Experimental Techniques in Physical Metallurgy, Asia Publishing Company, (1967)
4. V. Voort, Metallography: Principle and practice, ASM International, (1999).
5. Paul E Mix, “Introduction to Non-destructive testing: a training guide”, Wiley, 2nd Edition New Jersey, 2005
6. Charles, J. Hellier, Handbook of Non-destructive evaluation”, McGraw Hill, New York 2001.
7. K. R. Hebbar, Basics of X-Ray Diffraction and its Applications, I.K. International Publishing House Pvt Ltd, (2007)
8. Ravi Prakash, “Non-Destructive Testing Techniques”, 1st revised edition, New Age International Publishers, 2010.

ME1608A	RENEWABLE ENERGY SOURCES	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

- Describing the current energy scenario in terms of conventional renewable energy and future plan.
- Applying the principle of various solar energy generating devices.
- Applying the principle of various wind energy devices.
- Applying the principle of various bio energy devices.

Applying the principle of various ocean and geothermal energy devices

UNIT I	ENERGY SCENARIO	9

Indian energy scenario in various sectors - domestic, industrial, commercial, agriculture, transportation and others - Present conventional energy status - Present renewable energy status - Potential of various renewable energy sources - Global energy status-Per capita energy consumption in various countries - Future energy plans.

UNIT II	SOLAR ENERGY	9

Solar radiation – Measurements of solar radiation and sunshine – Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems – Solar PV applications

UNIT III	WIND ENERGY	9

Wind data and energy estimation – Betz limit - Site selection for wind farms – characteristics Horizontal axis wind turbine – components - Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems – Environmental issues - Applications.

UNIT IV	BIO-ENERGY	9

Bio resources - Biomass direct combustion - thermochemical conversion - biochemical conversion - mechanical conversion - Biomass gasifier - Types of biomass gasifiers - Cogeneration - Carbonisation - Pyrolysis - Biogas plants – Digesters - Biodiesel production - Ethanol production - Applications.

UNIT V	OCEAN AND GEOTHERMAL ENERGY	9

Small hydro - Tidal energy - Wave energy - Open and closed OTEC Cycles – Limitations - Geothermal energy - Geothermal energy sources - Types of geothermal power plants - Applications - Environmental impact.

TOTAL:	45	PERIODS

OUTCOMES:

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

- Describe the current energy scenario in terms of conventional renewable energy and future plan.
- Apply the principle of various solar energy generating devices.

- Apply the principle of various wind energy devices.
- Apply the principle of various bio energy devices.
- Apply the principle of various ocean and geothermal energy devices.

Understand techniques in direct energy conversion.

TEXTBOOKS:

1. G.D. Rai, "Non-Conventional Energy Sources", Standard Publishers Distributors, 1992.

2. John Twidell, Tony Weir, and Anthony D. Weir, Renewable Energy Resources, Taylor & Francis, 2006.

REFERENCES:

1. B.H. Khan, "Non-Conventional Energy Resources", McGraw Hill, 2009.
2. G.N. Tiwari, "Solar Energy – Fundamentals Design, Modelling and applications", Alpha Science, 2015.
3. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, 2012.
4. N.K. Bansal, Non-Conventional Energy Resources, Vikas Publishing House, 2014.
5. S.P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", Tata McGraw Hill, 2009.

ME1609A	GAS DYNAMICS AND JET PROPULSION	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

(Use of Standard Gas Tables permitted)

UNIT I FUNDAMENTALS OF COMPRESSIBLE FLOW **9**

Basics of Thermodynamics & Fluid Mechanics, Energy and momentum equations of compressible fluid flows – Stagnation states, Mach waves and Mach cone – Effect of Mach number on compressibility.

UNIT II ISENTROPIC FLOWS (VARIABLE AREA DUCT) **9**

Isentropic flow through variable area ducts, T-s and h-s diagrams for nozzle and diffuser flows, area ratio as a function of Mach number, mass flow rate through nozzles and diffusers, effect of friction in flow through nozzles.

UNIT III FLOW THROUGH CONSTANT AREA DUCT **9**

One-dimensional flow with heat addition (Rayleigh flow) - analysis and working equations for perfect gas - thermal chocking - reference state and Rayleigh table. One-dimensional flow with friction (Fanno flow) - analysis and working relations for perfect gas - limiting point - friction chocking - reference state and Fanno table.

UNIT IV	NORMAL AND OBLIQUE SHOCKS	9

Governing equations – Normal and oblique shocks, causes and effects of shocks, Prandtl-Meyer and Rankin-Hugoniot equation equations – Applications.

UNIT V	PROPULSION SYSTEMS	9

Fundamentals of jet & Rocket propulsion – Thrust power and propulsive efficiency – principle, propulsion cycle, power and efficiency calculations of Ram jet, Turbojet, Turbofan and Turbo Prop engines. Rocket engines – Propellants - Feeding systems – Ignition and combustion – Theory of rocket propulsion – Performance – Staging – Terminal and characteristic velocity – Applications - space flights

TOTAL:	45	PERIODS

OUTCOMES:

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

- Derive and apply equations for one-dimensional compressible flow from integral forms of the governing equations
- Determine geometric design parameters required to accelerate or decelerate an isentropic flow for a given type of nozzle or diffuser, operating under specified conditions
- Estimate the length of a one-dimensional constant area duct to achieve desired changes in properties via the effects of friction and heat transfer
- Evaluate changes in physical properties when a normal shock & oblique shock occurs
- Understand different components of aircraft propulsion systems using principles of thermodynamics
- Analyze different aircraft propulsion systems.

TEXTBOOKS:

1. John D. Anderson, Jr., "Modern Compressible Flow with Historical Perspective", McGraw-Hill, 3rd Edition 2004.
2. Yahya S. M., "Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion", New Age International (P) Ltd., 3rd Edition, 2003.

REFERENCES:

1. Robert D. Zucker, Oscar Biblarz, "Fundamentals of Gas Dynamics", Wiley India Pvt. Ltd., 2nd Edition, 2011.
2. Radhakrishnan E., "Gas Dynamics", Prentice Hall of India, New Delhi, 2006.
3. Saravanamuttoo, GFC Rogers, and Cohen. H, "Gas Turbine Theory", Pearson Education, 5th Edition, 2003.
4. Philip Hill, Carl Peterson, "Mechanics and Thermodynamics of Propulsion", Pearson Education, 2nd Edition, 2011.
5. Babu V., "Fundamentals of Gas Dynamics", John Wiley & Sons, 2015. 6. Oosthuizen P. H. and Carscallen W.E., "Compressible Fluid Flow", McGraw Hill, 1997.
6. Ganesan V., "Gas Turbine", Tata McGraw-Hill, New Delhi, 2005.

ME1610A	OPERATIONS RESEARCH	L	T	P	C
		3	0	0	3

OBJECTIVES:

To learn the basics of deterministic optimization tools.

UNIT I LINEAR MODELS **9**

The phase of an operation research study – Linear programming – Graphical method– Simplex algorithm – Duality formulation – Sensitivity analysis.

UNIT II TRANSPORTATION MODELS AND NETWORK MODELS **9**

Transportation Assignment Models –Traveling Salesman problem-Networks models – Shortest route – Minimal spanning tree – Maximum flow models –Project network – CPM and PERT networks – Critical path scheduling – Sequencing models.

UNIT III INVENTORY MODELS **9**

Inventory models – Economic order quantity models – Quantity discount models – Stochastic inventory models – Multi product models – Inventory control models in practice.

UNIT IV QUEUEING MODELS **9**

Queueing models - Queueing systems and structures – Notation parameter – Single server and multi server models – Poisson input – Exponential service – Constant rate service – Infinite population – Simulation..

UNIT V DECISION MODELS **9**

Decision models – Game theory – Two person zero sum games – Graphical solution- Algebraic solution– Linear Programming solution – Replacement models – Models based on service life – Economic life– Single / Multi variable search technique – Dynamic Programming – Simple Problem

TOTAL: 45 PERIODS

OUTCOMES:

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

- Formulate and solve linear programming problems.
- Solve duality, transportation and assignment.
- Understand about Inventory Control Techniques
- Understand and formulate Queuing Models
- Understand about the Decision models
- Formulate and optimize various problems.

TEXTBOOKS:

1. G.Srinivasan., “Operations Research Principles and Applications”, PHI, 2008.
2. R.Panneerselvam, “Operations Research”, PHI, 2006

REFERENCES:

1. Philips, Ravindran and Solberg, “Operations Research”, John Wiley,2002

2. Hamdy A Taha, “Operations Research – An Introduction”, Prentice Hall India, 2003.
3. Ronald L Rardin, “Optimisation in Operations Research”, Pearson, 2003.
4. David R. Anderson, et al, “An Introduction to Management Science” – Quantitative approaches to Decision Making, Thomson, 2003.
5. Hillier and Lieberman, “Introduction to Operations Research”, TMH, 2000.

ME1611A	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Teach the need for quality, its evolution, basic concepts, contribution of quality gurus, TQM framework, Barriers and Benefits of TQM.
- Explain the TQM Principles for application.
- Define the basics of Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.
- Describe Taguchi's Quality Loss Function, Performance Measures and apply Techniques like QFD, TPM, COQ and BPR.
- Illustrate and apply QMS and EMS in any organization.

UNIT I	INTRODUCTION	9

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

UNIT II	TQM PRINCIPLES	9

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

UNIT III	TQM TOOLS & TECHNIQUES I	9

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

UNIT IV	TQM TOOLS & TECHNIQUES II	9

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

UNIT V	QUALITY MANAGEMENT SYSTEM	9

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

SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001-Benefits of EMS.

	TOTAL:	**45**	**PERIODS**

OUTCOMES:

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

- Ability to apply TQM concepts in a selected enterprise.
- Ability to apply TQM principles in a selected enterprise.
- Ability to understand Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.
- Ability to understand Taguchi's Quality Loss Function, Performance Measures and apply QFD, TPM, COQ and BPR.
- Ability to apply QMS and EMS in any organization.
- Summarize the basic concepts in total quality management relevant to manufacturing and service sectors.

TEXTBOOKS:

1. Dale H.Besterfiled, Carol B.Michna,Glen H. Bester field, MaryB.Sacre, Hemant Urdhwareshe and RashmiUrdhwareshe, "Total Quality Management", Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression,2013.

REFERENCES:

1. Joel.E. Ross, "Total Quality Management – Text and Cases", Routledge.,2017.
2. Kiran.D.R, "Total Quality Management: Key concepts and case studies, Butterworth – Heinemann Ltd, 2016.
3. Oakland, J.S. "TQM – Text with Cases", Butterworth – Heinemann Ltd., Oxford, Third Edition, 2003.
4. Suganthi,L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., .

ME1612A	**ENTREPRENEURSHIP AND DEVELOPMENT OF INDUSTRIES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

Study of this subject provides an understanding of the scope of an entrepreneur, key areas of development, financial assistance by the institutions, methods of taxation and tax benefits, etc.

UNIT I	**ENTREPRENEURSHIP**	**9**

Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth.

UNIT II	**MOTIVATION**	**9**

Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Self Rating, Business Game, 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, Network Analysis Techniques of PERT / CPM – Taxation – Income Tax, Excise Duty – Sales Tax.

UNIT V	SUPPORT TO ENTREPRENEURS	9

Sickness in small Business – Concept, Magnitude, Causes and Consequences, Corrective Measures – Government Policy for Small Scale Enterprises – Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger and Sub Contracting.

TOTAL:	45	PERIODS

OUTCOMES:

Upon completion of the course, students will be able to

- Understand the concept of entrepreneurship
- Understand self-rating processes and development methods
- Understand good practices involved in business, survey and market analysis
- Understand fundamentals of financing and accounting
- Understand consequences and government policies.
- Gain knowledge and skills needed to run a business successfully

TEXTBOOKS:

1. S.S.Khanka, "Entrepreneurial Development" S.Chand & Co. Ltd. Ram Nagar New Delhi, 1999.

2. Kurahko & Hodgetts, " Enterprenuership – Theory, process and practices", Thomson learning 6th edition.

REFERENCES:

1. Hisrich R D and Peters M P, "Entrepreneurship" 5th Edition Tata McGraw-Hill, 2002.

2. Mathew J Manimala," Enterprenuership theory at cross roads: paradigms and praxis" Dream tech, 2nd edition 2006.

3. Rabindra N. Kanungo, "Entrepreneurship and innovation", Sage Publications, New Delhi, 1998.

4. EDII "Faulty and External Experts – A Hand Book for New Entrepreneurs Publishers: Entrepreneurship Development", Institute of India, Ahmadabad, 1986.

HS1601A	PROFESSIONAL COMMUNICATION	L	T	P	C
		0	0	2	1

OBJECTIVES:

The course aims to:

- Enhance the employability and career skills of students
- Orient the students towards grooming as a professional
- Enable them to become employable, industry ready graduates
- Build their self-esteem and guide them in achieving success in interviews
- Aid them to fit into any professional working environment

UNIT I — **6**

Introduction to Employability Skills – Hard Skills & Soft Skills - Career Skills - Professional Grooming with Values - Emotional Intelligence- General Awareness of Current Affairs

UNIT II — **6**

Presentation Skills -Topic Selection – Organizing the Material – Introducing Oneself to the Audience – Introducing the Topic – Answering Questions - Presenting the Visuals/Graphics Effectively – Mini Presentation (General and Technical – 5 Minutes)

UNIT III — **6**

Group Discussion (GD) Strategies – Introduction to GD Activities – Preparation Tips for GDs - Participating in GDs on Current Issues -Understanding Group Dynamics- Brainstorming the Topic – Questioning and Clarifying – Mock GDs

UNIT IV — **6**

Job Interview Tips - Etiquette – Dress Code – Non-Verbal Communication during GDs and Interviews – Tips and Practice for Attending Interviews –Telephone/Skype Interview – One-to-one interview & Panel Interview – Self-Introduction Practice- FAQs related to Job interviews –Mock Interview

UNIT V — **6**

Recognizing Differences between Group and Teamwork – Multitasking – Stress Management – Networking professionally- Importance of Team Spirit – Respecting Social Protocols- Work Ethics - Developing a Long-term Career plans – Making career changes

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course Learners will be able to:

- Present oneself as an efficient candidate with adequate soft skills
- Make effective presentations
- Participate confidently in Group Discussions
- Attend job interviews successfully
- Develop and then demonstrate soft skills in any work environment as a complete professional

RECOMMENDED SOFTWARE

Globearena

https://placement.freshersworld.com/

Related Online Repositories for Soft Skill Development

Videos from TED and YouTube

REFERENCES:

1. Butterfield, Jeff Soft Skills for Everyone. Cengage Learning: New Delhi, 2015
2. E. Suresh Kumar et al. Communication for Professional Success. Orient Blackswan: Hyderabad, 2015
3. Interact English Lab Manual for Undergraduate Students. Orient BalckSwan: Hyderabad, 2016.
4. Raman, Meenakshi and Sangeeta Sharma. Professional Communication. Oxford University Press: Oxford, 2014
5. S. Hariharan et al. Soft Skills. MJP Publishers: Chennai, 2010.
6. Singh, Prachi, Professional Communication JBC Press: Daryaganj, 2015.
7. Eric H. Glendinning, Oxford English for Careers Technology for Engineering and Applied Sciences:Student Book, Oxford University Press, Oxford, 2013.

ME1701A	STATISTICAL QUALITY CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart knowledge to enable the students to design and implement Statistical Process Control in any industry.
- To design and implement acceptance sampling inspection methods in industry.

UNIT I	QUALITY FUNDAMENTALS	9

Importance of quality- evolution of quality- definitions of quality- dimensions of quality- quality control- quality assurance- areas of quality- quality planning- quality objectives and policies- quality costs- economics of quality- quality loss function- quality Vs productivity- Quality Vs reliability

UNIT II	CONTROL CHARTS FOR VARIABLES	9

Process variation- preliminary decisions- control limits and their computation- construction and application of X bar, R and S charts- warning and modified control limits- process adjustment for trend, - Comparison of process variation with specification limits- O.C. curve for X bar chart.

UNIT III	STATISTICAL PROCESS CONTROL	9

Process stability- process capability study using control charts- capability evaluation- Cp, Cpk and Cpm – capability analysis using histogram and normal probability plot- machine capability study- gauge capability study - setting statistical tolerances for components and assemblies- individual measurement charts- X-chart, moving average and moving range chart, multi-vari chart.

UNIT IV	CONTROL CHARTS FOR ATTRIBUTES	9

Limitations of variable control charts- Control charts for fraction non-conforming- p and np charts, variable sample size, operating characteristic function, run length- Control chart for nonconformities (defects)- c, u, ku charts, demerits control chart- applications.

UNIT V	ACCEPTANCE SAMPLING	9

Need- economics of sampling- sampling procedure- single and double sampling- O.C. curves- Average outgoing quality- Average sample number- Average total inspection- Multiple and sequential sampling- Standard sampling plans- Military, Dodge-Roming, IS 2500.

TOTAL:	45	PERIODS

OUTCOMES:

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

- Understand the fundamentals of quality, productivity and policies.
- Illustrate the various control charts for the variables.
- Develop the statistical process control techniques and measurement charts.
- Gain knowledge about the control charts for the variable attributes.
- Learn the acceptance sampling for the total inspection

- implement statistical process control and acceptance sampling procedures in manufacturing environment to improve quality of processes / products.

TEXTBOOKS:

1. Douglus C. Montgomery, "Introduction to Statistical Quality Control", Wiley-India, Seventh Edition, 2013.
2. Krishnaiah K.," Applied Statistical Quality Control and Improvement", PHI, 2014.

REFERENCES:

1. Amitava Mitra, "Fundamentals of Quality Control and Improvement", Wiley, Third Edition, 2008.
2. Dale H. Besterfield, Quality Control, Pearson Education Asia, Eigth Edition, 2008.
3. Eugene L. Grant and Richard S. Leaven Worth, "Statistical Quality Control", McGraw-Hill Education, Seventh Edition, 2000.
4. Besterfield D. H. (2009). Quality Control. 8th Edition. Ed. PrenticeHall.
5. Devor R. E., Chang T-H. and Sutherland J. W. (2006). Statistical Quality Design and Control. 2nd Edition. Ed. PrenticeHall.

ME1702A	POWER PLANT ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Providing an overview of power plants and detailing the role of Mechanical Engineers in operating the different types of power plant and its maintenance.
- Understanding of Power Plant Economics, environmental and safety aspects of power plant operation.

UNIT I	COAL BASED THERMAL POWER PLANTS	9

Thermal power plant -General layout – working-coal handling and its methods, stages in coal storage, Pulverized fuel handling system- Ash handling system- Gravity system- electrostatic precipitation (ESP) system- FBC Boilers-Feed water treatment- Mechanical method, Advantages and disadvantages-limitations of Thermal power plant.

UNIT II	DIESEL AND GAS TURBINE POWER PLANTS	9

General layout and Components of Diesel power plant- fuel system, lubrication system, air intake and exhaust system, Site selection of diesel power plant and Comparative study of diesel power plant with steam power plant.

Gas turbine power plant- Schematic diagram & working of open and closed cycle gas turbine power plant, Components of Gas turbine power plant- Advantages -disadvantages- limitations of Gas turbine power plant.

UNIT III	NUCLEAR POWER PLANTS	9

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

UNIT IV	POWER FROM RENEWABLE ENERGY	9

General layout and essential elements of Hydroelectric power plant and its working- Principle, Construction and working of Wind, Tidal, Solar Photo Voltaic (SPV), Solar Thermal, Geo Thermal and Biogas. Fuel Cell Basics – types – working and its performance.

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

Load distribution parameters, Peak load, Base load, Load factor, Load curve, demand factor- Various factor affecting the operation of power plant- Power tariff methods-factors involved in fixing a tariff for power- Pollution control technologies in Waste Disposal Options for Coal and Nuclear Power Plants.

TOTAL:	45	PERIODS

OUTCOMES:

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

- Explain the layout, construction and working of the components inside a thermal power plant.
- Explain the layout, construction and working of the components inside a Diesel, Gas and Combined cycle power plants.
- Explain the layout, construction and working of the components inside nuclear power plants.
- Explain the layout, construction and working of the components inside Renewable energy power plants.
- Explain the applications of power plants while extend their knowledge to power plant economics and environmental hazards.
- Apply their knowledge to audit the various power plants

TEXTBOOKS:

1. Nag. P.K., "Power Plant Engineering", Third Edition, Tata McGraw – Hill Publishing Company Ltd., 2008
2. Arora and Domkundwar ., “Power plant engineering” Eighth Edition, Dhanpat rai & CO (P) LTD

REFERENCES:

1. R K Rajput “A Text Book of Power Plant Engineering” Fifth Edition, Laxmi Publications.
2. El-Wakil. M.M., "Power Plant Technology", Tata McGraw – Hill Publishing Company Ltd., 2010.
3. Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University, 2004.
4. Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, "Power Plant Engineering", Second Edition, Standard Handbook of McGraw – Hill, 1998.

5. P K Das and A K Das “An Introduction to Thermal Power Plant Engineering and Operation” First Edition, Notion Press, 2018.

ME1703A	MECHATRONICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the interdisciplinary applications of Electronics, Electrical, Mechanical and Computer Systems for the Control of Mechanical and Electronic Systems.
- To impart knowledge about the elements and techniques involved in Mechatronics systems which are very much essential to understand the emerging field of automation

UNIT I	INTRODUCTION TO MECHATRONICS AND SENSORS	9

Introduction to Mechatronics – Systems – Concepts of Mechatronics approach – Need for Mechatronics – Emerging areas 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	ELECTRICAL ACTUATION SYSTEMS	9

Electrical Actuation Systems – Mechanical Switches – Solid State Switches – Solenoids – working principle of DC and AC Motors – speed control of AC and DC drives, Stepper Motors- switching circuitries for stepper motor – AC & DC Servo motors

UNIT III	SYSTEM MODELS AND CONTROLLERS	9

Building blocks of Mechanical, Electrical, Fluid and Thermal Systems, Rotational – Transnational Systems, Electromechanical Systems – Hydraulic – Mechanical Systems. Continuous and discrete process Controllers – Control Mode – Two – Step mode – Proportional Mode – Derivative Mode – Integral Mode – PID Controllers – Digital Controllers

UNIT IV	PROGRAMMING LOGIC CONTROLLERS	9

Programmable Logic Controllers – Basic Structure – Input / Output Processing – Programming – Mnemonics – Timers, Internal relays and counters – Shift Registers – Master and Jump Controls – Data Handling – Analogs Input / Output – Selection of a PLC.

UNIT V	DESIGN OF MECHATRONICS SYSTEM	9

Stages in designing Mechatronics Systems – Traditional and Mechatronic Design - Possible Design Solutions. Case studies of Mechatronics systems- Pick and place Robot- Autonomous mobile robot-Wireless surveillance balloon- Engine Management system- Automatic car park barrier

TOTAL:	45	PERIODS

OUTCOMES:

CO1 Discuss the interdisciplinary applications of Electronics, Electrical, Mechanical and Computer Systems for the Control of Mechanical, Electronic Systems and sensor technology.
CO2 Discuss various Electrical Actuators.
CO3 Discuss system models and different types of controllers

CO4 Explain the architecture, programming and application of programmable logic controllers to problems and challenges in the areas of Mechatronic engineering.
CO5 Discuss various Actuators and Mechatronics system using the knowledge and skills acquired through the course and also from the given case studies

TEXTBOOKS:

1. Bolton, W, "Mechatronics", Pearson education, second edition, fifth Indian Reprint, 2003
2. Smaili.A and Mrad.F, "Mechatronics integrated technologies for intelligent machines", Oxford university press, 2008

REFERENCES:

1.Rajput. R.K, A textbook of mechatronics, S. Chand & Co, 2007 68
2. Michael B. Histand and David G. Alciatore, "Introduction to Mechatronics and Measurement Systems", McGraw-Hill International Editions, 2000.
3. Bradley D. A., Dawson D., Buru N.C. and. Loader A.J, "Mechatronics", Chapman and Hall, 1993.
4. Dan Necsulesu, "Mechatronics", Pearson Education Asia, 2002 (Indian Reprint).
5. Lawrence J. Kamm, "Understanding Electro – Mechanical Engineering", An Introduction to Mechatronics, Prentice – Hall of India Pvt., Ltd., 2000.
6. Nitaigour Premchand Mahadik, "Mechatronics", Tata McGraw-Hill publishing Company Ltd, 2003 ME2402
7. Krishna Kant, "Microprocessors & Microcontrollers", Prentice Hall of India, 2007

ME 1724A	COMPUTER AIDED ANALYSIS LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To give exposure to software tools needed to analyze engineering problems.
- To expose the students to different applications of simulation and analysis tools.

LIST OF EXPERIMENTS

A. SIMULATION

1.C/MATLAB basics, Dealing with matrices, Graphing-Functions of one variable and two variables
2. Use of C/Matlab to solve simple problems in vibration
3. Mechanism Simulation using Multibody Dynamic 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 axi – symmetric components.
5. Thermal stress and heat transfer analysis of plates.
6. Thermal stress analysis of cylindrical shells.
7. Vibration analysis of spring-mass systems.
8. Model analysis of Beams.
9. Harmonic, transient and spectrum analysis of simple systems.

TOTAL: 60 PERIODS

OUTCOMES:	

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

- Simulate the working principle of air conditioning system, hydraulic and pneumatic cylinder and cam follower mechanisms using MATLAB.
- Analyze the stresses and strains induced in plates and brackets.
- Analyze the stresses and strains induced in beams.
- Analyze the stresses and strains in heat transfer problems.
- Calculate the natural frequency of 2D components and beams.
- Calculate the mode shape analysis of 2D components and beams.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1	Computer Work Station	15
2	Printer	01
3	Multibody Dynamic Software Suitable for Mechanism simulation and analysis	15 LICENSES
4	C / MATLAB	5LICENSES

ME1725A	**MECHATRONICS AND AUTOMATION LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

OBJECTIVE:	

- To know the method of programming the microprocessor and *Arduino.*
- To understand the simulation of basic electrical, hydraulic & pneumatic Systems which enable the students to understand the concept of mechatronics

LIST OF EXPERIMENTS

1.	Programming of *Arduino UNO*
2.	Simulation of *Arduino Programs by using Tinkercad*
3.	Traffic light interface.
4.	Stepper motor interface.
5.	Study of IOT.
6.	Study of hydraulic, pneumatic and electro-pneumatic circuits.
7.	Simulation of basic hydraulic, pneumatic and electrical circuits using software.
8.	Introduction to Networking using Cisco Packet Tracer

TOTAL: 60 PERIODS

OUTCOMES:	

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

- Demonstrate the functioning of mechatronics system with various pneumatic, hydraulic and electrical systems.
- Demonstrate the functioning of Arduino with the help of Tinkercad
- Demonstrate the Interfacing of stepper Motor and Traffic Light Kit.
- Gain knowledge about the basics of Internet of Things.

- Demonstrate the interfacing of Internet of things with Cisco Packet Tracer.
- Demonstrate the method of programming the microprocessor and *Arduino and* to understand the simulation of basic electrical, hydraulic & pneumatic Systems.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Quantity
1	Hydraulics and Pneumatics Systems Simulation Software	10
2	Microcontroller kit with stepper motor and drive circuit sets	2
3	Arduino UNO kits	5
4	Arduino IDE software	10
5	Traffic light interface.	2
6	Cisco Packet Tracer software	10
7	Tinkercad software	10

PROFESSIONAL ELECTIVES

ME1704A	VIBRATION AND NOISE ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To familiarize the students with the sources of vibration and noise in machines.
- To make design modifications to reduce the vibration and noise to improve life of the components.

UNIT I	FORCED VIBRATIONS	9

Introduction, analysis of forced vibration with constant harmonic excitation, MF, rotating and reciprocating unbalances, excitation of support (Relative and absolute amplitudes), force and motion transmissibility, energy dissipated due to damping and numerical problems.

UNIT II	NUMERICAL METHODS FOR MULTI DOF SYSTEMS	9

Maxwell's reciprocal theorem, influence coefficients, Rayleigh's method, Dunkerley's method, stodola method, orthogonality principle, method of matrix iteration and numerical. signal analysis, dynamic testing of machines and structures.

UNIT III	VIBRATION MEASURING INSTRUMENTS AND WHIRLING OF SHAFTS	9

Seismic instruments, vibrometers, accelerometer, frequency measuring instruments and numerical. Whirling of shafts with and without damping. Introduction, Vibration isolation theory, Vibration isolation and motion isolation for harmonic excitation, practical aspects of vibration analysis, vibration isolation, Dynamic vibration absorbers and Vibration dampers.

UNIT IV	TRANSIENT VIBRATION OF SINGLE DEGREE-OF FREEDOM SYSTEMS	9
Impulse excitation, arbitrary excitation, Laplace transforms formulation, Pulse excitation and rise time, Shock response spectrum, Shock isolation.		
UNIT V	**NOISE: SOURCES, ISOLATION AND CONTROL**	**9**
Major sources of noise on road and in industries, noise due to construction equipment and domestic appliances, industrial noise control, strategies-noise control at source (with or without sound enclosures), noise control along the path (with or without partitions and acoustic barriers); noise control at the receiver, ear defenders, earplugs, semi-insert protectors. loudness; weighting networks; equivalent sound level, auditory effects of noise; hazardous noise, exposure due to machines and equipment's; hearing conservation and damage risk criteria, daily noise doze.		
	TOTAL:	**45 PERIODS**

OUTCOMES:

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

- Characterize the single and multi-degrees of freedom systems subjected to free and forced vibrations with and without damping.
- Apply the method of vibration measurements and its controlling.
- Determine vibratory responses of SDOF and MDOF systems to harmonic, periodic and non-periodic excitation.
- Analyze the mathematical model of a linear vibratory system to determine its response.
- Obtain linear mathematical models of real-life engineering systems.
- Apply the principles of vibration and noise reduction techniques to real life engineering problems.

TEXTBOOKS:

1. Mechanical Vibrations S. S. Rao Pearson Education
2. Fundamentals of Mechanical Vibration S. Graham Kelly McGraw-Hill

REFERENCES:

1. Mechanical Vibrations G. K. Grover Nem Chand and Bros.
2. Theory of Vibration with Application William T. Thomson, Marie Dillon Dahleh, Chandramouli Pearson Education 5th edition
3. Mechanical Vibrations V. P. Singh Dhanpat Rai & Company
4. Mechanical Vibrations and Noise engineering Amberkar A.G. PHI
5. Vibrations and Acoustics – Measurements and signal analysis, C Sujatha, Tata McGraw Hill

ME1705A	CONCURRENT AND REVERSE ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the principles behind the design of the product,
- To identify ways & methods to redesign and improve the performance of the existing products.

UNIT I	**INTRODUCTION**	**9**
Extensive definition of Concurrent Engineering (CE), CE design methodologies, Review of CE techniques like DFM (Design for manufacture), DFA (Design for assembly), QFD (Quality function deployment), RP (Rapid Prototyping), TD (Total design), organizing for CE, CE toolbox, Collaborative product development		
UNIT II	**USE OF IT & DESIGN STAGE**	**9**
IT Support Solid modeling, product data management, Collaborative product commerce, expert systems, Software hardware component design. Lifecycle design of products, opportunities for manufacturing enterprises, Modality of Concurrent engineering design, Automated analysis idealization control, CE in optimal structural design, and Real-time constraints.		
UNIT III	**MANUFACTURING CONCEPTS & ANALYSIS**	**9**
Manufacturing competitiveness, Checking the design process, Conceptual design mechanism-Qualitative Physical approach, intelligent design for manufacturing system, JIT system, Low inventory, Modular, Modeling, and reasoning for computer-based assembly planning, Design of Automated manufacturing.		
UNIT IV	**BASICS OF REVERSE ENGINEERING**	**9**
Need of reverse engineering, Methodologies for Reverse Engineering, understanding of Reverse Engineering through examples, process for Reverse Engineering, Phases of Reverse Engineering, Conceptual System Reasons for Reverse Engineering, Difficulties in Reverse Engineering, Levels of abstraction: Application level, Functional level, Structural level		
UNIT V	**REVERSE ENGINEERING METHODOLOGY & TOOLS**	**9**
Detailed study of Reverse Engineering for Branch Specific learning, Dissemble the existing selected artefact/product / component/ process/ system to study technical aspects and design detail, Reverse engineering in various computer software/ application, Case Studies: Application & Implementation level		
	TOTAL: **45** **PERIODS**	

OUTCOMES:

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

- Familiarize with the fundamentals of concurrent engineering and design methodologies
- Design the system with Artificial Intelligence and Lifecycle design of products
- Design an Automated manufacturing system
- Understanding Process of Reverse Engineering
- Understand various computer software and application in Reverse engineering
- Design complex shape product with suitable technique in Reverse Engineering methods

TEXTBOOKS:

1. Concurrent Engineering Fundamentals: Integrated Product Development-Prasad, Prentice Hall. Author: Biren Prasad ISBN: 0133969460, 9780133969467 Edition: 2, illustrated Publisher: Prentice Hall PTR, 1996

2. Reverse Engineering, Wills, Linda M., Newcomb, Philip (Eds.), Springer, 1996, ISBN 978-0-585-27477-53.

REFERENCES:

1. Integrated Product Development-Anderson MM and Hein, L. Berlin, Springer Verlag. 1987 Publication: Lundtofte
2. Successful Implementation of Concurrent Product and Process-Sammy G Sinha, Wiley 1993 ISBN: 0471285102, 9780471285106
3. V. Raja and K. Fernandes, Reverse Engineering: An Industrial Perspective, Springer-Verlag, 2008. ISBN: 978-1-84628-855-5.
4. K. Otto and K. Wood, Product Design: Techniques in Reverse Engineering and New Product Development, 1st edition, Prentice Hall, 2001. ISBN-13: 978-0130212719.
5. Concurrent Engineering: Automation Tools and Technology-Andrew Kusaik, Wiley-Interscience; 1st edition (18 December 1992); Cbs Publishers & Distributors Pvt. Ltd 01149349026
6. Reversing: Secret of Reverse Engineering, Eldad Eilam,Wiley Publishing, Inc. ISBN-13 978-0764574818 Edition 1st Publisher Wiley Publication date 15 April 2005

ME1706A	MICRO MACHINING AND NANOCOMPOSITES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart knowledge on the techniques of micro-machining, mechanics of operation and their applications
- To familiarize the principle behind fabrication of various types of nano-composites and nano-ceramics

UNIT I	INTRODUCTION	9

Introduction to Micro-manufacturing, Features of Micro-Machining, Need and applications, types, mechanics of micromachining, minimum chip thickness, micro turning, micro drilling and micro end milling.

UNIT II	MICRO MACHINING	9

Mechanical Micro machining – Ultra Sonic Micro Machining – Abrasive Jet Micro Machining – Water Jet Micro Machining – Abrasive Water Jet Micro Machining – Micro turning – Chemical and Electro Chemical Micro Machining – Electric discharge micro machining.

UNIT III	MICRO FORMING AND WELDING	9

Micro extrusion – Micro and Nano structured surface development by Nano plastic forming and Roller Imprinting – Micro bending with LASER – LASER micro welding – Electron beam for micro welding.

UNIT IV	NANO CERAMICS & METAL BASED NANOCOMPOSITES	9

Definition of nanocomposites - Nanofillers, Classification of nanofillers, Synthesis and

properties of nanofillers - Types of nanocomposites, Metal-Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques, Metal-metal nanocomposites, some simple preparation techniques and their new electrical and magnetic properties.

UNIT V	POLYMER BASED NANOCOMPOSITES	9

Preparation and characterization of di-block Copolymer based nanocomposites; Polymer-carbon nanotubes-based composites, their mechanical properties, and industrial possibilities.

	TOTAL:	45	PERIODS

OUTCOMES:

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

- describe the principle and mechanics behind micro-machining
- categorize the various types of micro-machining-based processes
- understand the principle of operation of micro-forming and micro-welding
- elaborate the concept of nano-ceramics and their techniques of preparation
- characterize several types of polymer-based nano-composites
- demonstrate the techniques behind micro-machining process and practical applications of nano-composites

TEXTBOOKS:

1. Jain V.K., "Introduction to Micro machining", Narosa Publishing House, 2011.
2. P. M. Ajayan, L.S. Schadler, P. V. Braun, "Nano-composites Science and Technology", 2006

REFERENCES:

1. Jain V. K., Micro Manufacturing Processes, CRC Press, Taylor & Francis Group, 2012
2. T.J. Pinnayain, G.W. Beall, "Polymer-Clay Nanocomposites", Wiley, New York, 2001.
3. N.B. Singh, "Nanocomposites", Jenny Stanford Publishing, 2022
4. Thomas M. Adams and Richard A. Layton, "Introduction MEMS, Fabrication and Application," Springer 2012.
5. Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture" Tata McGraw Hill, New Delhi, 2002
6. Kaushik Kumar, Divya Zindani, Nisha Kumari, J. Paulo Davim, "Micro and Nano Machining of Engineering Materials", Springer Cham 2019

ME1707A	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce Governing Equations of viscous fluid flows and to introduce numerical modeling and its role in the field of fluid flow and heat transfer
- To enable the students to understand the various discretization methods, solution procedures and turbulence modeling.

UNIT I	GOVERNING EQUATIONS AND BOUNDARY CONDITIONS	9

Basics of computational fluid dynamics – Need of CFD as tool - Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Physical boundary conditions – Time-averaged equations for Turbulent Flow – 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**

Finite difference method - forward, backward and central difference schemes, explicit and implicit methods. Properties of numerical solution methods. Stability analysis, error estimation, difference between the Finite Difference and Finite Volume methods.

UNIT III	**FINITE VOLUME METHOD FOR CONVECTION DIFFUSION**	**9**

One-dimensional steady convection and diffusion – Different schemes -Central, upwind, properties of discretization schemes – Conservativeness, Boundedness, Transportiveness, Hybrid, Power-law and Quick schemes.

UNIT IV	**FLOW FIELD ANALYSIS**	**9**

Finite volume methods -Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants.

UNIT V	**TURBULENCE MODELS AND MESH GENERATION**	**9**

Turbulence Energy equations – one dimensional model, mixing length model, Two equation (k-Є) models. Choice of grid, grid- oriented velocity components, Cartesian velocity components, staggered and collocated arrangements, adaptive grids.

TOTAL:	**45**	**PERIODS**

OUTCOMES:

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

- Derive the governing equations and boundary conditions for Fluid dynamics
- Analyze Finite difference and Finite volume methods for Diffusion
- Analyze Finite volume method for Convective diffusion
- Analyze Flow field problems
- Explain and solve the Turbulence models and Mesh generation techniques
- Apply the concepts learnt to solve a fluid dynamics problem using CAE software

TEXTBOOKS:

1. John D Anderson, — Computational Fluid Dynamics – The Basics with Applications‖, McGraw Hill, New Delhi, 2010.
2. Muralidhar K. and Sundararajan T., —Computational Fluid Flow and Heat Transfer‖, Narosa Publications, 2009.

REFERENCES:

1. Patankar, S.V. "Numerical Heat Transfer and Fluid Flow", Hemisphere Publishing Corporation, 2004.
2. Chung, T.J., "Computational Fluid Dynamics", Cambridge University, Press, 2002.
3. Ghoshdastidar P.S., "Heat Transfer", Oxford University Press, 2005

4. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 1995.
5. Prodip Niyogi, Chakrabarty, S.K., Laha, M.K. "Introduction to Computational Fluid Dynamics", Pearson Education, 2005.
6. Anil W. Date, "Introduction to Computational Fluid Dynamics", Cambridge University Press, 2005

ME1708A	CRYOGENICS ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide the knowledge of evolution of low temperature science and properties of materials at low temperature.
- To familiarize with various gas liquefaction systems and design aspects of cryogenic storage and transfer lines

UNIT I	INTRODUCTION TO CRYOGENIC SYSTEMS	9

Low Temperature properties of Engineering Materials, Mechanical properties- Thermal properties- Electric and magnetic properties – Cryogenic fluids and their properties. Applications of Cryogenics: Applications in space, Electrical Power and Cutting Tool Industry.

UNIT II	LIQUEFACTION SYSTEMS	9

Ideal system, Joule Thomson expansion, Adiabatic expansion, Linde Hampson Cycle, Claude & Cascaded System, Magnetic Cooling, Stirling Cycle, Cryo Coolers.

UNIT III	GAS LIQUEFACTION SYSTEMS	9

Introduction-Production of low temperatures-General Liquefaction systems- Liquefaction systems for Neon. Hydrogen and Helium –Critical components of Liquefaction systems

UNIT IV	CRYOGENIC REFRIGERATION SYSTEMS & CRYOGENIC INSTRUMENTATION	9

Ideal Refrigeration systems Refrigeration using liquids and gases as refrigerant- Refrigerators using solids as working media, Pressure flow-level and temperature measurements. Types of heat exchangers used in cryogenic systems Cryo pumping Applications

UNIT V	CRYOGENIC FLUID STORAGE AND TRANSFER SYSTEMS	9

Cryogenic Storage vessels and Transportation, Thermal insulation and their performance at cryogenic temperatures, Super Insulations, Vacuum insulation, Powder insulation, Cryogenic fluid transfer systems.

	TOTAL:	45	PERIODS

OUTCOMES:

The students will be able to

- Know the properties of material at cryogenic temperatures.

- Understand the concepts about various liquefaction systems.
- Understand the concepts about various gas liquefaction systems.
- Get ideas on cryogenic refrigeration systems, cryogenic instrumentation and cryogenic heat exchangers.
- Apply the cryogenic concept in fluid storage and transfer systems.
- Know the merits of cryogenic systems

TEXTBOOKS:

1. J. H. Boll Jr, Cryogenic Engineering, Prentice-Hall, 1963.
2. R. B. Scott, Cryogenic Engineering, Van Nostrand Co., 1959

REFERENCES:

1. Klaus D.Timmerhaus and Thomas M.Flynn, Cryogenic Process Engineering, Plenum Press, New York, 1989.
2. Randal F.Barron, Cryogenic systems, McGraw Hill, 1986
3. J G Weisend II, Handbook of cryogenic engineering, Taylor and francis, 1998.
4. Thomas Flynn, Cryogenic Engineering, Revised and Expanded, Taylor & Francis, 2004
5. Advances in Cryogenic Engineering: Proceedings of the 1968 Cryogenic Engineering Conference Case Western Reserve University Cleveland, Ohio August 19–21, 1968 by K. D. Timmerhaus Springer

ME1709A	PRODUCT LIFE CYCLE MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

- Explaining the history, concepts and terminology of PLM and Applying the functions, features of PLM and different modules offered in commercial PLM/PDM tools.
- Implementing PLM/PDM approaches for industrial applications and Integrating PLM/PDM with other applications.

UNIT I	INTRODUCTION TO PLM	9

Introduction to PLM, Need for PLM, opportunities of PLM, Different views of PLM - Engineering Data Management (EDM), Product Data Management (PDM), Collaborative Product Definition Management (CPDM), Collaborative Product Commerce (CPC), Product Lifecycle Management (PLM). PLM/PDM Infrastructure – Network and Communications, Data Management, Heterogeneous data sources and applications.

UNIT II	PLM/PDM FUNCTIONS AND FEATURES	9

User Functions – Data Vault and Document Management, Workflow and Process Management, Product Structure Management, Product Classification and Programme Management. Utility Functions – Communication and Notification, data transport, data translation, image services, system administration and application integration.

UNIT III	DETAILS OF MODULES IN A PDM/PLM SOFTWARE	9
Case studies based on top few commercial PLM/PDM tools		

UNIT IV	ROLE OF PLM IN INDUSTRIES	9
Case studies on PLM selection and implementation (like auto, aero, electronic) - other possible sectors, PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten step approach to PLM, benefits of PLM for–business, organization, users, product or service, process performance		

UNIT V	BASICS ON CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE	9
PLM Customization, use of EAI technology (Middleware), Integration with legacy data base, CAD, SLM and ERP.		

TOTAL:	45	PERIODS

OUTCOMES:

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

- Explain the history, concepts and terminology of PLM
- Apply the functions and features of PLM/PDM
- Apply different modules offered in commercial PLM/PDM tools
- Implement PLM/PDM approaches for industrial applications.
- Integrate PLM/PDM with other applications.
- Analyse the case studies.

TEXTBOOKS:

1. AnttiSaaksvuori and AnselmiImmonen, “Product Lifecycle Management”, Springer Publisher, 2008.
2. Michael Grieves, “Product Life Cycle Management”, Tata McGraw Hill, 2006.

REFERENCES:

1. ArieKarniel and Yoram Reich, Managing the Dynamics of New Product Development Processes: A New Product Lifecycle Management Paradigm, Springer, 2011.
2. IvicaCrnkovic, Ulf Asklund and AnnitaPerssonDahlqvist, “Implementing and Integrating Product Data Management and Software Configuration Management”, Artech House Publishers, 2003.
3. John Stark, “Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question”, Springer Publisher, 2007.
4. John Stark, “Product Lifecycle Management: 21st Century Paradigm for Product Realisation”, Springer Publisher, 2011.
5. Kevin Roebuck, Product Lifecycle Management (PLM): High-impact Strategies - What You Need to Know: Definitions, Adoptions, Impact, Benefits, Maturity, Vendors, Emereo, 2011.

ME1710A	TRIBOLOGY IN DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart knowledge in the friction, wear and lubrication aspects of machine components and understand the material properties which influence the tribological characteristics of surfaces.
- To understand the analytical behavior of different types bearings and design of bearings based on analytical /theoretical approach

UNIT I	**SURFACE INTERACTION AND FRICTION**	**7**

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

UNIT II	**WEAR AND SURFACE TREATMENT**	**8**

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

UNIT III	**LUBRICANTS AND LUBRICATION REGIMES**	**10**

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 LUBRICATION**	**10**

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.

UNIT V	**HIGH PRESSURE CONTACTS**	**10**

Rolling contacts of Elastic solids- contact stresses – Hertzian stress equation- Spherical and cylindrical contacts-Contact Fatigue life- Oil film effects - Film shape within and outside contact zones-Film thickness and friction calculation.

	TOTAL:	**45**	**PERIODS**

OUTCOMES:

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

- familiarize with the surface interaction and friction.
- understand the concepts of wear and surface treatment.
- decide the lubricants and lubrication regimes for different operating conditions.
- understand the concepts of hydrodynamic and hydrostatic lubrication.
- gaining knowledge in the high-pressure contacts and the elasto hydrodynamic lubrication.
- apply the concepts to the industrial problems and identify the wear and friction.

TEXTBOOKS:

1. G.W. Stachowiak and A.W. Batchelor, Engineering Tribology, Butterworth - Heinemann, UK, 4th Edition, 2013.
2. S.K. Basu, S.N. Sengupta and B.B. Ahuja, Fundamentals of Tribology, Prentice –Hall of India Pvt Ltd, New Delhi, 1st edition, 2010.

REFERENCES:

1. Bharat Bhushan, Introduction to Tribology, John Wiley & Sons, New York, 2nd edition, 2013.
2. Harish Harani, Fundamentals of Engineering Tribology, Cambridge, 1st edition, 2017.
3. Michael M. Khonsari and E. Richard Booser, Applied Tribology Bearing Design and Lubrication, United Kingdom: Wiley, 3rd revised edition, 2017.
4. R. Gohar and H. Rahnejat. Fundamentals of Tribology, World Scientific Publishing Company, 3rd Edition, 2018.
5. Williams J.A., Engineering Tribology, Oxford University Press, 1994.

ME1711A	OPTIMIZATION TECHNIQUES FOR ENGINEERING SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart knowledge on various categories of existing engineering problems and solutions to such problems through various optimization techniques and approaches.
- To enable students to learn different approaches of optimizing (maximizing or minimizing) an engineering problem or a function.

UNIT I INTRODUCTION **9**

Classification of optimization problems, concepts of design vector, Design constraints, constrains surface, objective function surface and multi-level optimization, parametric linear programming

UNIT II LINEAR PROGRAMMING **9**

Linear programming methods for optimum design: Review of Linear programming methods for optimum design – Post optimality analysis – Application of LPP models in design and manufacturing.

UNIT III NON-LINEAR OPTIMIZATION **9**

Unconstrained one variable and multi variable optimization, KKT Conditions, Constrained optimization, Quadratic programming, Convex programming, Separable programming, Geometric programming, Non-Convex programming

UNIT IV OPTIMIZATION ALGORITHMS **9**

Optimization algorithms for solving unconstrained optimization problems – Gradient based method: Cauchy's steepest descent method, Newton's method, Conjugate gradient method. Optimization algorithms for solving constrained optimization problems – direct methods –

penalty function methods – steepest descent method – Engineering applications of constrained and unconstrained algorithms.

UNIT V	MODERN METHODS OF OPTIMIZATION	9

Modern methods of Optimization: Genetic Algorithms – Simulated Annealing – Ant colony optimization – Tabu search – Neural-Network based Optimization – Fuzzy optimization techniques – Applications.

	TOTAL:	45	PERIODS

OUTCOMES:

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

- The students will be able to classify optimization problems.
- Understand the Linear programming methods and is application.
- Understand the Optimization algorithms and its Engineering applications.
- Learn the unified and exact mathematical basis as well as the general principles of various soft computing techniques.
- Develop Soft skills to solve optimization problems.
- Implement nontraditional optimization techniques like swam, ant colony and fuzzy systems.

TEXTBOOKS:

1. Engineering Optimization Theory and Practice, S.S.Rao, New Age International (P) Ltd, Publishers
2. Deb K. – 'Optimization for Engineering Design Algorithms and Examples' – PHI – 2000

REFERENCES:

1. Christos H. Papadimitriou, Kenneth Steiglitz, Combinatorial Optimization, PHI 2006
2. Fredrick S.Hillier and G.J.Liberman, "Introduction to Operations Research", McGraw Hill Inc. 1995.
3. Kalymanoy Deb, "Optimization for Engineering Design", PHI,2003
4. Ravindran – Phillips –Solberg, "Operations Research – Principles and Practice", John Wiley India, 2006.
5. Arora J. – 'Introduction to Optimization Design' – Elsevier Academic Press, New Delhi – 2004
6. Saravanan R. – 'Manufacturing Optimization through Intelligent Techniques' – Taylor & Francis (CRC Press) – 2006
7. Hardley G. -'Linear Programming' – Narosa Book Distributors Private Ltd. – 2002

ME1712A	FAILURE ANALYSIS AND DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce students to apply the appropriate material selection for a given application
- Students to understand the examination of various failure modes to identify failure mechanism in real life examples.

UNIT I	**MATERIAL SELECTION AND DESIGN**	**9**
Factors affecting the behavior of materials in components effect of component geometry and shape factors, designing with high strength and low toughness materials, designing for hostile environments, the design process, materials selection in design, processes and their influence on design, systematic process selection. Material life cycle assessment and energy – selecting materials for eco design		
UNIT II	**FRACTURE MECHANICS**	**9**
Ductile fracture, brittle fracture, cleavage-fractography, ductile-brittle transition, fracture mechanics approach to design-energy criterion, stress intensity approach, time dependent crack growth and damage. Griffith theory, energy release rate, Instability and R-curve, stress analysis of cracks stress intensity factor, K-threshold, Crack growth instability analysis, crack tip stress analysis. Crack tip opening displacement (CTOD), J-integral, relationship between J and CTOD.		
UNIT III	**WEAR FAILURES AND ELEVATED TEMPERATURE FAILURES**	**9**
Types of wear, different methods of wear measurement, analysis wear failures, wear at elevated temperatures, wear on different materials, role of friction on wear, stick slip friction, creep, stress rupture, elevated temperature fatigue, metallurgical instabilities, environmental induced failure.		
UNIT IV	**FAILURE ANALYSIS TOOLS**	**9**
Reliability concept and hazard function, life prediction, life extension, application of poisson, exponential and Weibull distribution for reliability, bath tub curve, parallel and series system, MTBF,MTTR, FMEA definition-Design FMEA, process FMEA, analysis causes of failure, modes, ranks of failure modes, fault tree analysis, microscopic failure analysis, industrial case studies.		
UNIT V	**FAILURE ANALYSIS AND PREVENTION**	**9**
Introduction: Need and scope of failure analysis and prevention, Fundamental sources of failures: Deficient design, Fundamental sources of failures: Improper Manufacturing and improper service conditions, General procedure of failure analysis: NDT for failure analysis-selection, preservation, cleaning & sectioning of samples, Determination of type of fracture - Microscopy and Macroscopy of fracture surfaces, Application of fracture mechanics.		
	TOTAL:	**45 PERIODS**
OUTCOMES:		

On completion of the course, students should:

- Understand the process of materials selection and be able to use available tools for making decisions on materials selection for engineering applications.
- Understand and be able to identify the common modes of failure of engineering components
- Be able to use, a framework for assessing engineering failures, including determining the mode of failure and making recommendations on failure prevention.
- Understand and be able to identify the common modes of failure of engineering components

- To be able to incorporate the materials failure knowledge in selecting appropriate materials for engineering applications
- Understand the need to various failures and design

TEXTBOOKS:

- Collins. J. A., Failure of Materials in Machine Design, John Wiley & Sons, 1981
- Suresh S, Fatigue of Materials, Cambridge University Press, 1998

REFERENCES:

1. Anderson T L, “Fracture Mechanics: Fundamentals and Applications”, Taylor and Francis, 2005.
2. ASM Metals Handbook, "Failure Analysis and Prevention", ASM Metals Park, Ohio, USA, Vol. 10, 1995. 3. Michael F Ashby, “Materials Selection in Mechanical Design”, Butterworth – Heinemann, 2005.
4. Michael F Ashby, Hugh Shercliff and David Cebon, “Materials – Engineering, Science, Processing and Design”, Butterworth – Heinemann, 2007.
5. Shigley and Mische, "Mechanical Engineering Design", McGraw Hill, 1992.

ME1713A	FLEXIBLE MANUFACTURING SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the concepts of Flexible Manufacturing systems
- To familiarize the principles of group technology and justify flexible manufacturing systems

UNIT I	PLANNING AND SCHEDULING OF FLEXIBLE MANUFACTURING SYSTEMS	9

Introduction to Flexible Manufacturing System (FMS) - Development of Manufacturing Systems - Benefits - Major Elements of FMS - Types of Flexibility - FMS Application and Flexibility – Single product, Single batch, n-product, n-batch Scheduling Problem-Knowledge Based Scheduling System.

UNIT II	COMPUTER CONTROL AND SOFTWARE FOR FLEXIBLE MANUFACTURING SYSTEMS	9

Introduction - Composition of FMS - Hierarchy of Computer Control - Computer Control of Work Center and Assembly Lines - FMS Supervisory Computer Control. Computer Software for FMS - Introduction, System Issues, Types of Software Specification and Selection - Trends.

UNIT III	FLEXIBLE MANUFACTURING SYSTEM SIMULATION AND DATA BASE	9

Introduction-Application of Simulation -Simulation Process-Model of FMS - Simulation Software - Limitation - Manufacturing Data Systems - Data Flow - FMS Database Systems - Planning for FMS Database.

UNIT IV	GROUP TECHNOLOGY AND JUSTIFICATION OF FLEXIBLE MANUFACTURING SYSTEMS	9

Introduction - Matrix Formulation - Mathematical Programming Formulation - Graph Formulation - Knowledge Based System for Group Technology - Economic Justification of FMS - Application of Possibility Distributions in FMS Systems -Justification.

UNIT V	IMPLEMENTATION OF FMS AND FACTORIES OF THE FUTURE	9

FMS application in Machining, Sheet Metal Fabrication, Prismatic Component Production - Aerospace Application - FMS Development towards Factories of the Future - Artificial Intelligence and Expert Systems in FMS - Design Philosophy and Characteristics for Future.

TOTAL:	45	PERIODS

OUTCOMES:

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

- Be familiarized with concepts of Flexible Manufacturing Systems
- Perceive Computer Control and Software for Flexible Manufacturing Systems
- Be acquainted with Flexible Manufacturing System Simulation and Database
- Evaluate principles of Group Technology and justify Flexible Manufacturing Systems
- Describe various flexible manufacturing systems and their applications.
- Prepare themselves for the Factory of Future.

TEXTBOOKS:

1. Jha.N.K., "Handbook of flexible manufacturing systems", Academic Press Inc., United States of America, 2012, ISBN-13: 978-03-231-3935-9.
2. Raouf A. and Daya B.M., "Flexible manufacturing systems: recent development", Elsevier Science, Netherlands, 2005, ISBN-13 978-04-448-9798-5.

REFERENCES:

1. GrooverM.P., "Automation, production systems and computer integrated manufacturing", Prentice Hall of India Pvt., New Delhi, 2016, ISBN-13: 978-93-325-7249-2.
2. Kalpakjian S., "Manufacturing Engineering and Technology", Addison-Wesley Publishing Co., United States of America, 2013, ISBN-13: 978-01-331-2874-1.
3. Ohno T., "Toyota production system: Beyond large-scale production", Productivity Press (India) Pvt. Ltd., 1992, ISBN-13: 978-09-152-9914-0.
4. Radhakrishnan P. and Subramanyan S., "CAD/CAM/CIM", Wiley Eastern Ltd., New Age International Ltd., India, 2009, ISBN-13: 978-81-224-2236-8.
5. Lonnie Allan Wilson "How to implement Lean Manufacturing" McGraw Hill; 2nd edition,2015.

ME1714A	LOGISTICS AND SUPPLY CHAIN MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To Explain about Supply Chain Network Design
- To Illustrate about the issues related to Logistics in Supply Chain.

UNIT I	**INTRODUCTION**	**9**
Role of Logistics and Supply chain Management: Scope and Importance - Evolution of Supply Chain – Examples of supply Chains - Decision Phases in Supply Chain - Competitive and Supply chain Strategies – Drivers of Supply Chain Performance and Obstacles.		
UNIT II	**SUPPLY CHAIN NETWORK DESIGN**	**9**
Role of Distribution in Supply Chain – Factors influencing Distribution network design – Design options for Distribution Network- Distribution Network in Practice - Role of network Design in Supply Chain – Framework for network Decisions.		
UNIT III	**LOGISTICS IN SUPPLY CHAIN**	**9**
Role of transportation in supply chain – Factors affecting transportations decision – Design option for transportation network – Tailored transportation – Routing and scheduling in transportation - 3PL- 4PL- Global Logistics - Reverse Logistics; Reasons, Activities and issues.		
UNIT IV	**SOURCING AND COORDINATION IN SUPPLY CHAIN**	**9**
Role of Sourcing in supply chain - Supplier selection - Contracts - Design Collaboration - Sourcing planning and analysis - Supply chain co-ordination - Bull whip effect – Effect of lack of coordination in supply chain and obstacles – Building strategic partnerships and trust within a supply chain.		
UNIT V	**IT AND EMERGING CONCEPTS IN SUPPLY CHAIN**	**9**
The role IT in supply chain-The supply chain IT framework - Customer Relationship Management – Internal supply chain management – supplier relationship management – future of IT in supply chain – E-Business in supply chain- Introduction to Warehouse Management, Risks in Supply Chain, Lean supply Chains, Sustainable supply Chains.		

	TOTAL:	**45**	**PERIODS**

OUTCOMES:

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

- Understand the scope of Supply Chain Management and the Drivers of SC performance
- Design suitable SC network for a given situation.
- Solve the issues related to Logistics in SCM.
- Understand Sourcing, Coordination and current issues in SCM.
- Appraise about the applications of IT in SCM and apply SCM concepts in selected enterprise.
- Develop logistics solutions to cater the industry needs.

TEXT BOOK:

1. Sunil Chopra, Peter Meindl and D.V. Kalra, “Supply Chain Management: Strategy, Planning, and Operation", Pearson Education, 2016.
2. Gianpaolo Ghiani , Gilbert Laporte and Roberto Musmanno , “Introduction to logistics systems management”, Wiley 2013.

REFERENCES:

1. David J.Bloomberg, Stephen Lemay and Joe B.Hanna, Logistics, PHI 2010
2. G. Srinivasan (2010) Quantitative Models in Operations and Supply Chain Management, PHI, Learning (P) Ltd, New Delhi.
3. Jeremy F.Shapiro ,Modeling the supply chain, Thomson Duxbury, 2002.
4. Sople Vinod V, Logistics Management, Pearson Education, 2010.
5. James B.Ayers, "Handbook of Supply chain management", St.Lucle press, 2000.

ME1715A	INDUSTRIAL ROBOTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the functions of the basic components of a Robot, use of various types of Sensors and image processing fundamentals
- To impart knowledge in Robot Kinematics and Programming,safety issues and economics.

UNIT – I	INTRODUCTION	9

Robot - Definition - Robot Anatomy - Co ordinate 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; Selection and Design Considerations.

UNIT– III	SENSORS AND MACHINE VISION	9

Principles and Applications of the following types of sensors- Position sensors - Piezo Electric Sensor, Optical Encoders, , Range Sensors Triangulations Principles, Structured, Lighting Approach, Time of Flight, Rangefinders, 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,

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) Manipulator Dynamics, Manipulator Mechanism Design-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

Robot work cell- Implementation of Robots in Industries-Various Steps; Safety Considerations for Robot Operations - Economic Analysis of Robots..			
	TOTAL:	**45**	**PERIODS**

OUTCOMES:

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

- Explain the concepts of industrial robots, classification, specifications and coordinate systems. Also summarize the need and application of robots in different sectors.
- Illustrate the different types of robot drive systems as well as robot end effectors.
- Apply the different sensors and image processing techniques in robotics to improve its ability.
- Develop robotic programs for different tasks and familiarize with the kinematics motions of robot
- Examine the implementation of robots in various industrial sectors and interpolate the economic analysis of robots.
- Explain the safety considerations in a given robotic application**.**

TEXTBOOKS:

1. Klafter R.D., Chmielewski T.A and Negin M., “Robotic Engineering - An Integrated Approach”, Prentice Hall, 2003.
2. Groover M.P., “Industrial Robotics -Technology Programming and Applications”, McGraw Hill, 2001.

REFERENCES:

1.Craig J.J., “Introduction to Robotics Mechanics and Control”, Pearson Education, 2008.
2. Deb S.R., “Robotics Technology and Flexible Automation” Tata McGraw Hill Book Co., 1994.
3. Koren Y., “Robotics for Engineers", McGraw Hill Book Co., 1992.
4. Fu.K.S.,Gonzalz R.C. and Lee C.S.G., “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill Book Co., 1987.
5. Janakiraman P.A., “Robotics and Image Processing”, Tata McGraw Hill, 1995.
6. Rajput R.K., “Robotics and Industrial Automation”, S.Chand and Company, 2008. 7.

ME1716A	**REFRIGERATION & AIR CONDITIONING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To understand the underlying principles of operations in different Refrigeration & Air conditioning systems and components.
- To provide knowledge on design aspects of Refrigeration & Air conditioning systems

UNIT I	**INTRODUCTION**	**9**
Introduction to Refrigeration - Unit of Refrigeration and C.O.P. – Ideal cycles- Refrigerants Desirable properties – Classification.		
UNIT II	**VAPOUR COMPRESSION REFRIGERATION SYSTEM**	**9**

Vapor compression cycle: p-h and T-s diagrams - deviations from theoretical cycle – sub cooling and super heating- effects of condenser and evaporator pressure on COP – problems. Equipment's: Type of Compressors, Condensers, Expansion devices, Evaporators.

UNIT III	**OTHER REFRIGERATION SYSTEMS**	**9**

Working principles of Vapour absorption systems and adsorption cooling systems – Steam jet refrigeration- Ejector refrigeration systems- Thermoelectric refrigeration- Air refrigeration - Magnetic - Vortex and Pulse tube refrigeration systems

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, Dry bulb temperature, Psychrometric chart; Psychrometric of air-conditioning processes, mixing of air streams.

UNIT V	**AIR CONDITIONING SYSTEMS AND LOAD ESTIMATION**	**9**

Air conditioning loads: Outside and inside design conditions; Heat transfer through structure, Solar radiation, Infiltration and ventilation, internal heat load, calculation of summer & winter air conditioning load, Classifications, Layout of plants, Air Conditioning Systems with Controls: Temperature, Pressure and Humidity sensors, Actuators & Safety controls.

	TOTAL:	**45**	**PERIODS**

OUTCOMES:

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

- Explain the basic concepts of Refrigeration
- Explain the Vapor compression Refrigeration systems and to solve problems
- Discuss the various types of Refrigeration systems
- Calculate the Psychrometric properties and its use in psychrometric processes
- Explain the concepts of Air conditioning and to solve problems
- Apply the knowledge of the refrigeration and air conditioning system principles.

TEXTBOOKS:

1. Arora, C.P., "Refrigeration and Air Conditioning", 3rd edition, McGraw Hill, New Delhi, 2010.
2. Stoecker, W.F. and Jones J. W., "Refrigeration and Air Conditioning", McGraw Hill, New Delhi, 1986.

REFERENCES:

1. ASHRAE Hand book, Fundamentals, 2010.
2. Jones W.P., "Air conditioning engineering", 5th edition, Elsevier Butterworth-Heinemann, 2007.
3. Roy J. Dossat, "Principles of Refrigeration", 4th edition, Pearson Education Asia, 2009.
4. Ballaney. P.L." Thermal Engineering", Khanna publishers, 24th Edition 2012.
5. Kothandaraman, C.P., Domkundwar. S and Domkundwar A.V.," A course in Thermal Engineering", Dhanpat Rai & Sons, 2016.

ME1717A	ADVANCED FINITE ELEMENT ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To develop a thorough understanding of the advanced finite element analysis techniques with an ability to effectively use the tools of the analysis.
- To solve the practical problems arising in engineering design.

UNIT I	BENDING OF PLATES AND SHELLS	9

Review of Elasticity Equations – Bending of Plates and Shells – Finite Element Formulation of Plate and Shell Elements - Conforming and Non-Conforming Elements – C0 and C1 Continuity Elements –Degenerated shell elements- Application and Examples

UNIT II	NON-LINEAR PROBLEMS	9

Introduction – Iterative Techniques – Material non-linearity – Elasto Plasticity – Plasticity – Visco Plasticity – Geometric Non linearity – large displacement Formulation –Solution procedure Application in Metal Forming Process and Contact Problems.

UNIT III	DYNAMIC PROBLEM	9

Direct Formulation – Free, Transient and Forced Response – Solution Procedures – Eigen solution-Subspace Iterative Technique – Response analysis-Houbolt, Wilson, Newmark – Methods – Explicit & Implict Methods- Lanchzos, Reduced method for large size system equations

UNIT IV	FLUID MECHANICS AND HEAT TRANSFER	9

Governing Equations of Fluid Mechanics – Solid structure interaction - Inviscid and Incompressible Flow – Potential Formulations – Slow Non-Newtonian Flow – Metal and Polymer Forming – Navier Stokes Equation – Steady and Transient Solution.

UNIT V	ERROR ESTIMATES AND ADAPTIVE REFINEMENT	9

Error norms and Convergence rates – h-refinement with adaptivity – Adaptive refinement

TOTAL:	45	PERIODS

OUTCOMES:

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

- Understand the Finite Element Formulation of Plate and Shell Elements and its application.
- Gain knowledge in material & geometric non-and plasticity.
- Solve problems under dynamic conditions by applying various techniques.
- Arrive at the solutions for fluid mechanics and heat transfer problems.
- Acquire knowledge in error norms, convergence rates and refinement.
- Solve the real-world engineering problems using FEA.

TEXTBOOKS:

1. S.S.Rao, “Finite Element Analysis”, 2002 Edition.
2. Reddy J.N., “An Introduction to the Finite Element Method”, Third Edition, McGraw Hill, International Edition, 2005.

REFERENCES:

1. Bathe K.J., "Finite Element Procedures in Engineering Analysis", Prentice Hall, 1990.
2. Cook R.D., "Concepts and Applications of Finite Element Analysis", John Wiley and Sons Inc., New York, 1989.
3. Zienkiewicz, O.C. and Taylor, R.L., "The Finite Element Method", Fourth Edition, Volumes 1&2, McGraw Hill International Edition, Physics Services, 1991.
4. Chandrupatla T. R., 'Finite Elements in Engineering', Pearson Edition, 2011, 4th Edition.
5. K. H. Huebner, D. L. Dewhirst, D. E. Smith and T. G. Byron, 'The Finite Element Method for Engineers', John Wiley & Sons Inc., New York, 2001, 4th Edition

ME1718A	ADVANCED WELDING AND JOINING TECHNOLOGIES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To develop in students, welding ideas and concepts for design of engineering products in industry by using various techniques.
- To equip students to work in modern welding technology.

UNIT I	WELDING – AN OVERVIEW	9

Importance and application of welding, classification of welding processes- Brief review of conventional welding process: Gas welding, Arc welding, MIG, TIG welding. Resistance welding. Electro slag welding, Friction welding etc. Welding of MS.CI, Al, Stainless steel & Maurer/Schaefflar Diagram. Soldering & Brazing.

UNIT II	SOLID STATE WELDING	9

Advanced solid state welding techniques- Principle and working and application of Plasma Arc welding, Laser beam welding, Electron beam welding, Ultrasonic welding, Friction stir Welding, Cold Metal Transfer Welding & Microwave welding.

UNIT III	ADVANCED JOINING TECHNIQUES	9

Principle and working and application of Resistance Welding, Explosive welding & Cladding, Underwater welding, Spray-welding / Metallizing, Hard facing, Reduced Pressure EB Welding, Metal to Composite Joining, Squeeze Type Resistance Spot Welding, MIG Brazing.

UNIT IV	HEAT FLOW WELDING AND WELD DESIGN	9

Calculation of peak temperature; Width of Heat Affected Zone (HAZ); cooling rate and solidification rates; weld thermal cycles and temperature distribution; residual stresses and their measurement; weld distortion and its prevention. Types of welds & joints, Joint Design, Welding Symbols, weld defects, Inspection/testing of welds, Introduction to Welding Procedure Specification & Procedure Qualification Record.

UNIT V	REPAIR & MAINTENANCE WELDING:	9

Hard facing, Cladding, Surfacing, Metallizing processes and Reclamation welding. Weld ability: Effects of alloying elements on weld ability, welding of plain carbon steel, Cast Iron and aluminum. Micro & Macro structures in welding, Metallurgical consideration of weld, Life predication of welded joints.

	TOTAL:	**45**	**PERIODS**

OUTCOMES:

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

- Understand the fundamentals of welding techniques
- Understand the concept of solid-state welding process
- Understand the concept of advanced joining techniques
- Understand the concept of heat flow welding and weld designs
- Understand the concept of repair & maintenance welding
- Understand the modern welding techniques used in industries

TEXTBOOKS:

1. "Welding Handbook", Volumes 1, 2 and 3, 9th edition, American Welding Society
2. Larry J and Jeffus L, "Welding Principles and Applications", 5th edition, Delmer Publications.

REFERENCES:

1. Granjon H., 'Fundamentals of Welding Metallurgy', Jaico Publishing House, 1994
2. Omer W. B., 'Design of Weldments', James.F. Lincoln Arc Welding Foundation, 1991
3. Bhattacharya.M, 'Weldment Design',Association of Engineers,1991
4. Welding Institute Canada, 'Welding for Challenging Environments', Pergamon Press, 1996
5. Parmar R S, Welding Engineering and Technology, Khanna Publishers, 1997

ME1719A	**NANO SCIENCE AND MATERIALS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To learn about basis of nanomaterial science, preparation method.
- To learn about types and applications of Nanomaterials.

UNIT I	**INTRODUCTION**	**8**

Definition of Nano, Scientific revolution - Atomic Structure and atomic size, emergence and challenges of nanoscience, carbon age-new form of carbon (CNT to Graphene), influence of nano over micro/macro, size effects and crystals, large surface to volume ration, surface effects on the properties. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties.

UNIT II	**SYNTHESIS OF NANOMATERIALS**	**9**

Solution route synthesis of Nanomaterials-Co-precipitation hydrolysis – Sol-gel technique – sonochemical method- combustion technique –Phytochemical synthesis- colloidal precipitation – template process – growth of nanorods – solid-state sintering – grain growth-Ultra high vacuum systems – laser ablation - RF/DC magnetron sputtering – microwave plasma evaporation -– Preliminary aspects of lithography – Nano-imprint lithography.

UNIT III	**NANOMATERIALS**	**12**

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	NANOSTRUCTURED MATERIALS CHARACTERIZATION TECHNIQUES	9

X-ray diffraction (XRD), SEM, EDAX, TEM, Elemental mapping, FTIR, UV-Visible spectrophotometer, Laser Raman Spectroscopy, Nanomechanical Characterization using Nanoindentation, Differential Scanning Calorimeter (DSC), Differential Thermal Analyzer (DTA), Thermo gravimetric Analysis (TGA), TEM, X-ray Photoelectron Spectroscopy (XPS), Electrochemcial Characterization measurements.

UNIT V	NANOTECHNOLOGY –ENVIRONMENTAL APPLICATIONS & HEALTH IMPACTS	7

Nano computers, molecular switch, super chip, nanocrystal, Nanoprobes in medical diagnostics and biotechnology, Nano medicines, Nano crystalline silver for bacterial inhibition, Nanoparticles for sun barrier products, Application of nanotechnology in remediation of pollution, toxicity of nanoparticles, effects of inhaled nanosized particles, skin exposure to nanoparticles, impact of CNTs on respiratory systems.

	TOTAL:	45	PERIODS

OUTCOMES:

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

- To familiarize about the science of nanomaterial
- To enlighten the knowledge about various synthesis procedures of nanomaterial
- To know about various types of nanomaterials
- To understand about different characterization techniques for nanostructured materials.
- To learn about nanotechnology and its applications in environmental
- To apply the principles and techniques in the engineering discipline areas.

TEXTBOOKS:

1. Introduction to Nanotechnology – Charles P.Poole Jr and Frank J.Owens .,Wiley India Pvt.Ltd.,2007
2. John Dinardo. N, “Nanoscale charecterisation of surfaces & Interfaces”, 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000

REFERENCES:

1. Timp. G, “Nanotechnology”, AIP press/Springer, 1999.
2. Edelstein. A.S. and R.C. Cammearata, eds., “Nanomaterials: Synthesis, Properties and Applications”, Institute of Physics Publishing, Bristol and Philadelphia, 1996.
3. Akhlesh Lakhtakia (Editor), “The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations”. Prentice-Hall of India (P) Ltd, New Delhi, 2007.
4. Nanostructures and Nanomaterials – Guozhong Cao, Imperial College Press., 2004

5. Characterization of Nanophase materials –Z. L Wang (ed), Wiley-VCH, New York, 2000.

ME1720A	ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart knowledge on the principle, methods, possibilities and limitations as well as environmental effects of various additive manufacturing technologies.
- To familiarize the characteristics of the different materials that are employed in various additive manufacturing technologies

UNIT I	INTRODUCTION	6

Overview – Need - Development of Additive Manufacturing Technology -Principle – AM Process Chain- Classification –Rapid Prototyping- Rapid Tooling – Rapid Manufacturing – Applications- Benefits – Small Case studies

UNIT II	LIQUID AND SOLID BASED RAPID PROTOTYPING SYSTEMS	10

Classification of RP systems, Fusion Deposition Modeling – Principle– process parameters– applications, Laminated Object Manufacturing– Principle– process parameters – applications, Stereo lithography systems– Principle– process parameters, process–process details– applications, Selective Laser Sintering (SLS) - Direct Metal Sintering (DMLS) System –Direct Metal Deposition- Principle– process parameters–applications-Solid ground curing

UNIT III	DATA PREPARATION FOR RAPID PROTOTYPING TECHNOLOGIES	10

Basic Concept – Digitization techniques – Model Reconstruction – Data Processing for Rapid Prototyping: CAD model preparation –Data requirements-geometric modelling techniques: Wire frame, surface and solid modelling-data formats- data interfacing, Part Orientation and support generation, support structure design, – Model Slicing and contour data organization, direct and adaptive slicing, –Tool path Generation.

UNIT IV	THREE-DIMENSIONAL PRINTING	10

Three-Dimensional Printing - Principle, basic process, physics of 3DP, types of printing process capabilities, material system, solid based, liquid based and powder based 3DP systems, strength and weakness, Applications and case studies.

Shape Deposition Manufacturing (SDM): Introduction, basic process, shape decomposition, mold, SDM and applications, Selective laser Melting, Electron Beam Melting–Rapid Manufacturing.

UNIT V	RAPID TOOLING	9

Classification: Soft tooling, production tooling, Bridge tooling, direct and indirect – fabrication processes, Applications. Case studies – automotive, aerospace and electronics industries.

	TOTAL:	45	PERIODS

OUTCOMES:

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

- explain the importance of Rapid Prototyping Technology
- differentiate liquid based and solid based Rapid Prototyping
- design RPT solutions for data preparation
- understand the concept of Three-Dimensional Printing
- design RPT solutions based on tooling
- understand the potential of various additive Manufacturing technologies to support design and manufacturing in industrial scenario

TEXTBOOKS:

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. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering Applications: A tool box for prototype development", CRC Press, 2007.
2. Andreas Gebhardt, **"**Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing**"** Hanser Gardner Publication 2011.
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.
5. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006

ME1721A	DESIGN OF EXPERIMENTS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart knowledge on design of experiments to a problem situation using traditional experimental designs as well as Taguchi methods
- To develop skill to conduct experiments and analyze the data to determine the optimal process parameters that optimize the process.

UNIT I **EXPERIMENTAL DESIGN FUNDAMENTALS** **9**

Importance of experiments, experimental strategies, basic principles of design, terminology, ANOVA, steps in experimentation, sample size, normal probability plot, linear regression models

UNIT II **SINGLE FACTOR EXPERIMENTS** **9**

Completely randomized design, Randomized block design, Latin square design. Statistical analysis, estimation of model parameters, model adequacy checking, pair wise comparison tests.

UNIT III	MULTI FACTOR EXPERIMENTS	9
Two and three factor full factorial experiments, Randomized block factorial design, Experiments with random factors, rules for expected mean squares, approximate F- tests. 2K factorial Experiments.		
UNIT IV	**SPECIAL EXPERIMENTAL DESIGNS:**	**9**
Blocking and confounding in 2^k designs. Two level Fractional factorial design, nested designs, Split plot design, Response Surface Methods.		
UNIT V	**TAGUCHI METHODS**	**9**
Steps in experimentation, design using Orthogonal Arrays, data analysis, Robust design- control and noise factors, S/N ratios, parameter design, Multi-level experiments, Multi-response optimization.		
	TOTAL: **45** **PERIODS**	

OUTCOMES:

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

- Understand the fundamentals of Experimental Design
- Understand the concepts and develop Single Factor Experiments
- Understand the concepts and develop Multi Factor Experiments
- Explain about the special experimental design
- Explain and Design experiments using Taguchi methods
- Apply the concepts learnt to design experiments and find optimum solution for industrial problems.

TEXTBOOKS:

1. Krishnaiah, K. and Shahabudeen, P. Applied Design of Experiments and Taguchi Methods, PHI learning private Ltd., 2012.
2. Montgomery, D.C., Design and Analysis of experiments, John Wiley and Sons, Eighth edition, 2012.

REFERENCES:

1. Montgomery, D.C., Design and Analysis of Experiments, Minitab Manual, John Wiley and Sons, Seventh edition, 2010.
2. Nicolo Belavendram, Quality by Design; Taguchi techniques for industrial experimentation, Prentice Hall, 1995.
3. Phillip J.Rose, Taguchi techniques for quality engineering, McGraw Hill, 1996.
4. George E. P. Box, J. Stuart Hunter and William G. Hunter, Statistics for Experimenters: Design, Innovation, and Discovery, John Wiley and Sons, Second Edition, 2005
5. Scott E. Maxwell and Harold D. Delaney, Designing Experiments and Analyzing Data: A Model Comparison Perspective, Taylor & Francis Group, Second Edition 2004

ME1722A	HEAT TRANSFER IN NANOFLUIDS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the mechanisms of heat transfer under steady state, transient conditions and extended surfaces.
- To learn the thermal analysis and sizing of heat exchangers and to understand the basic concepts of mass transfer. (Use of standard HMT data book permitted)

UNIT I	NANO MATERIALS AND SYNTHESIS	9

Basic classification of Nano materials, Methods of preparation of nanomaterial's, bottom up and top-down approaches, Nanoparticle synthesis techniques.

UNIT II	CHARACTERIZATION TOOLS	9

Characterization techniques- X-ray diffraction, Scanning Electron Microscope, Transmission Electron Microscope, Optical Methods Fluorescence Microscopy, Atomic Force Microscopy.

UNIT III	NANOFLUIDS PREPARATION AND PROPERTIES	9

Preparation of Nanofluids, Ultra sonication, effect of surfactant, Thermo-Physical properties of Nano fluids, measurement of Specific heat, density, viscosity, thermal conductivity and pH value.

UNIT IV	HEAT TRANSFER ENHANCEMENT	9

Convective heat transfer enhancement of Nanofluids - Mechanism of heat transfer- Brownian motion, Interfacial layer - Particle cluster.

UNIT V	NANOFLUIDS FOR HEAT TRANSFER APPLICATIONS	9

Applications of Nanofluids for heat transfer enhancement in various heat exchangers, application to electronic cooling, Environmental and safety aspects.

TOTAL:	45	PERIODS

OUTCOMES:

At the end of the course students will be able to

- Get a basic knowledge of Nano materials & preparation methods
- Gain knowledge about Characterization techniques of nanofluids
- Gain knowledge about heat transfer application of nanofluids
- Identify, formulate, and solve fluid dynamic and thermal engineering problems involving nanofluids.
- Have the capability to carry out a Nanofluid based research project and heat transfer application.
- Apply the knowledge of nanotechnology in fluids and thermal engineering.

TEXTBOOKS:

1. T.Pradeep, Nano: The Essentials, Tata Mc Graw- Hill Publishing Company Limited, New Delhi.
2. Ozisik, M.N., Heat Transfer - A Basic Approach, McGraw-Hill, 1987

REFERENCES:

1. T.Pradeep, Nano: The Essentials, Tata Mc Graw- Hill Publishing Company Limited, New Delhi.
2. Sarit K Das ,Stephen U S Choi and Wenhua Yu, Nanofluids: Science and Technology, Wiley-Interscience (2007).
3. Guozhong Cao Nanostructures & Nanomaterials, Imperial College press, World Scientific Publishing Co. Pte. Ltd.(2003).
4. Greg F.Naterer,"Advanced Heat Transfer",CRC Press,2021.
5. Sarit K. Das, S. U. S. Choi, W. Yu, and T. Pradeep, Nanofluids: Science and Technology, John Wiley & Sons, 2008.

ME1723A	INDUSTRIAL MANAGEMENT AND SAFETY ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Understand the philosophies of management gurus, learning various Industrial Engineering Practices like Operations Management techniques.
- Identify unsafe conditions and solve problem of accidents for improved safety.

UNIT I	INTRODUCTION TO MANAGEMENT	9

Entrepreneurship and organization – Nature and Importance of Management, Functions of Management, Taylor's Scientific Management Theory, Fayol's Principles of Management, Maslow's Theory of Human Needs, Douglas McGregor's Theory X and Theory Y, Herzberg's Two-Factor Theory of Motivation, Systems Approach to Management, Leadership Styles, Social responsibilities of Management.

UNIT II	DESIGNING ORGANIZATIONAL STRUCTURES	9

Departmentalization and Decentralization, Types of Organization structures – Line organization, Line and staff organization, functional organization, Committee organization, matrix organization, Virtual Organization, Cellular Organization, team structure, boundary less organization, inverted pyramid structure, lean and flat organization structure and their merits, demerits and suitability.

UNIT III	OPERATIONS MANAGEMENT	9

Objectives- product design process- Process Selection-Types of production system (Job, batch and Mass Production), Plant location-factors- Urban-Rural sites comparison- Types of Plant Layouts- Design of product layout- Line balancing (RPW method) Value Analysis-Definition-types of values- Objectives- Phases of value analysis- Fast diagram.

UNIT IV	INTRODUCTION TO SAFETY AND HAZARDS	9

Evolution of modern safety concepts – Fire prevention – Mechanical hazards – Boilers, Pressure vessels, Electrical Exposure. Chemical exposure – Toxic materials – Radiation Ionizing and Non-ionizing Radiation - Industrial Hygiene – Industrial Toxicology.

UNIT V	**HAZARD ANALYSIS**	**9**

System Safety Analysis –Techniques – Fault Tree Analysis (FTA), Failure Modes and Effects Analysis (FMEA), HAZOP analysis and Risk Assessment.

	TOTAL:	**45**	**PERIODS**

OUTCOMES:

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

- Apply principles of management
- Design the organization structure
- Apply techniques for plant location, design plant layout and value analysis
- Identify and prevent chemical, environmental mechanical, fire hazard.
- Able to perform hazard analysis.
- Understand the safety requirements in working environment

TEXTBOOKS:

1. O.P. Khanna," Industrial Engineering and Management", Dhanpat Rai Publications, 2018
2. John V. Grimaldi, "Safety Management", AITB S Publishers, 2003.

REFERENCES:

1. Paneer Selvam, "Production & Operation Management", PHI,2012
2. NVS Raju, "Industrial Engineering Management "Cengage Learning,2013
3. David L. Goetsch, "Occupational Safety and Health for Technologists", Engineers and Managers, Pearson Education Ltd. 5th Edition, 2005.
4. Deshmukh L M, "Industrial Safety Management", Tata McGraw-Hill Publishing Company Ltd.,2005
5. Safety Manual, "EDEL Engineering Consultancy", 2000

ME1801A	ENGINEERING ECONOMICS AND COST ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart knowledge on economic principles, project financing and cost benefit analysis
- To develop knowledge on replacement, maintenance and depreciation analysis.

UNIT I	INTRODUCTION TO ECONOMICS	9

Introduction to Economics- Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics- Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis- V ratio, Elementary economic Analysis – Material selection for product design and process planning.

UNIT II	VALUE ENGINEERING	9

Value engineering –Aim, function and procedure. Interest formulae and their applications –Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment present worth factor-Equal payment series capital recovery factor-Uniform gradient series annual equivalent factor, Effective interest rate – Case studies.

UNIT III	CASH FLOW	9

Methods of comparison of alternatives – Present worth method, Future worth method, Annual equivalent method, Revenue dominated cash flow diagram - Cost dominated cash flow diagram, Rate of return method – Case studies.

UNIT IV	REPLACEMENT AND MAINTENANCE ANALYSIS	9

Replacement and Maintenance analysis – Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset – capital recovery with return and concept of challenger and defender – Case studies.

UNIT V	DEPRECIATION	9

Depreciation- Introduction, Straight line method of depreciation, declining balance method of depreciation, Sum of the years digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation, service output method of depreciation-Evaluation of public alternatives- Introduction, Examples, Inflation adjusted decisions – Procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset – Case studies.

	TOTAL:	45	PERIODS

OUTCOMES:

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

- Describe the basic concepts and terms in the economics.
- Understand about value engineering.
- Apply the different cashflow diagrams for comparing the various alternatives for specific applications.
- Make a decision regarding maintenance and replacement for engineering machineries.

- Apply the various methods to evaluate the depreciation
- Make students take decision based on economic analysis for the growth of the industry.

TEXTBOOKS:

1. Panneer Selvam, R, Engineering Economics, Prentice Hall of India Ltd, New Delhi, 2013,Second Edition
2. Riggs, Bedworth and Randhwa, "Engineering Economics", McGraw Hill Education India,1996, Fourth Edition

REFERENCES:

1. Chan S.Park, Contemporary Engineering Economics, Prentice Hall of India, 2010,Fifth Edition.
2. Donald.G. Newman, Jerome.P.Lavelle, "Engineering Economics and analysis" Engg. Press, Texas, 2010.
3. Degarmo, E.P., Sullivan, W.G and Canada, J.R, "Engineering Economy", Macmillan, New York, 2011.
4. Zahid A khan: Engineering Economy, "Engineering Economy", Dorling Kindersley, 2012.
5. Sullivan and Wicks, "Engineering Economy", Pearson,2011.

ME1808A	PROJECT WORK	L	T	P	C
		0	0	16	8

OBJECTIVES:

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students in preparing project reports and to face reviews and viva voce examination.

The students in a group of maximum 4, works on a topic approved by the Head of the Department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is to be submitted at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL:	**150**	**PERIODS**

OUTCOMES:

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

- take up any challenging practical problems and find solution by formulating proper methodology.

ME1802A	GREEN MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To acquire a broad understanding of sustainable manufacturing, green product and process
- To understand the analytical tools, techniques in green manufacturing, structures of sustainable manufacturing, environmental and management practice

UNIT I INTRODUCTION **9**

Need for Green Manufacturing, Motivations and Barriers to Green Manufacturing, Environmental Impact of Manufacturing, Strategies for Green Manufacturing, Environmental effects of design – Environmental damage – In efficient energy use – Design for recycling, The Policy Environment—Present Atmosphere and Challenges for Green Manufacturing

UNIT II GREEN DESIGN METHODS **9**

Mass balance analysis – Design for disassembly design for recycle – Risk analysis – Materials selection, Material flow and cycles – Material recycling – Emission less manufacturing, Issues in Green Supply Chains (GSC), Techniques/Methods of Green Supply Chain, Future of Green Supply Chain.

UNIT III GREEN PRODUCTION SYSTEMS **9**

Life Cycle of Green Production Systems, Economic and Ecological Benefits of Green Systems, Machine Tools and Energy Consumption, Process Parameter Optimization, Dry Machining and Minimum Quantity Lubrication, Remanufacturing, Reuse, Approaches for Sustainable Factory Design, Micro fabrication Processes, Facility Systems, Green Manufacturing in the Semiconductor Industry: Concepts and Challenges, Use-Phase Issues with Semiconductors.

UNIT IV SUSTAINABLE ECONOMIC ENVIRONMENT **9**

Solar energy devices – wind energy resources – Full cost accounting methodology – Selection of natural friendly materials.

UNIT V ENVIRONMENTAL IMPLICATIONS OF NANO-MANUFACTURING **9**

Introduction, Nano-manufacturing Technologies, Conventional Environmental Impact of Nano-manufacturing, Unconventional Environmental Impacts of Nano-manufacturing, Life Cycle Assessment (LCA) of Nanotechnologies.

TOTAL: 45 PERIODS

OUTCOMES:

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

- List out Strategies and Designs involved.
- Explain different designing methods in green manufacturing
- Analyze about green production systems.
- Identify nature friendly materials.
- Understand nano manufacturing and its environmental impact.
- Explain the Designs, production systems, sustainable environment and Nano manufacturing in Green Manufacturing.

TEXTBOOKS:

1.Dornfield David, Green Manufacturing, Springer, 2015

2.Davim.J.Pauls, Green Manufacturing Processes and Systems, Springer, 2013

REFERENCES:

1. Cairncrss and Francis – Costing the earth – Harvard Business School Press – 2009

2. Gradel T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2010
3. World commission on Environment and Development (WCED), Our Common Future, Oxford University Press 2005.
4. Rao M.N. and Dutta A.K. "Wastewater treatment", Oxford & IBH publishing Co. Pvt. Ltd.,New Delhi, Second Edition, 2006

ME1803A	PLANT LAYOUT AND MATERIAL HANDLING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the factors in selection of plant location, various types of plant layouts
- To introduce the concepts of material handling equipment, analyse materials handling systems

UNIT I	PLANT LOCATION AND FACILITIES	9

Factors to be considered – influence of location on plant layout, selection of plant site, Consideration in facilities planning and layout. Equipments required for plant operation, Capacity, serviceability and flexibility and analysis in selection of equipments, space requirements, and man power requirements.

UNIT II	PLANT LAYOUT	9

Need for layout, types of layouts, factors influencing product, process. Fixed and combination layout: tools and techniques for developing layout, process chart, flow diagram, string diagram, template and scale models – machine data. Layout planning procedure. Visualization of layout, revision and improving existing layout, balancing of fabrication and assembly lines.

UNIT III	MATERIAL HANDLING	9

Importance and scope. Principles of material handling. Planning, operating and costing Principles, types of material handling systems, factors influencing their choice.

UNIT IV	MODERN MATERIALS HANDLING SYSTEMS	9

AGV systems –Rail Guided Vehicles- Fundamentals of Automated storage and Retrieval systems - AS/RS – Fundamentals of Automated Assembly systems – Bar-code techniques – Robotics in material handling system-Importance of Packaging, layout for Packaging – Packaging machinery – wrapping and Packing materials, cushion materials.

UNIT V	ANALYSIS OF MATERIAL HANDLING	9

Motion analysis, flow analysis, graphic analysis, safety analysis, equipment cost analysis, palletization analysis, analysis of operation.

TOTAL:	45	PERIODS

OUTCOMES:

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

- Understand the factors for selection of plant site.

- Apply various techniques and tools of layout planning and get knowledge on industrial layouts.
- Explain principles of material handling systems
- Select the materials handling systems for modern practices.
- Analyze motion, flow, safety, operation.
- Select appropriate material handling equipment for a given application

TEXTBOOKS:

1. S. C. sharma, Plant layout and material handling, Khanna publishers,2000.
2. Agarwal, Plant layout and material handling, Jain brothers' publication,2017.

REFERENCES:

1. Shubin J A, Plant layout, P H I publications,1965
2. Oberman. Ya, Material handling, Mir publishers,1985
3. S.C. Sharma, Material Management and Material Handling, Khanna Publishers,1995.
4. Facility layout and Location - Francies,R.L. and White,J.A., McGraw Hill 2 nd edition,1991.
5. Plant Layout Design - James M Moore, Mac Millon Co.1962 LCCCN61- 5204.

ME1804A	INVENTORY MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart the fundamental knowledge in Inventory and materials management.
- To familiarize different inventory models and techniques available, so that students could create material requirement plan for a product and managing the material according to their requirement.

UNIT I	INVENTORY MANAGEMENT	9

Basic Inventory systems – Functions of Inventory – Objectives – Inventory Systems – Inventory systems under risk – Distribution inventory management.

UNIT II	INVENTORY MODELS	9

Inventory models – Fixed Order Versus Fixed Interval systems – Developing Special Quantity Discount Models – Inventory Model for Manufactured Items – Economic Lot Size for instantaneous stock Replenishment .

UNIT III	INVENTORY CONTROL TECHNIQUES	9

Inventory classification, use in controlling inventory – Setup time and inventory control – safety stock determination considering service level- Strategies to increase Inventory Turns – Reduce throughput time, Reduce WIP, eliminate waste, and reduce inventory.

UNIT IV	MATERIAL REQUIREMENT PLANNING	9

MRP – Purpose of MRP – Inputs to MRP – MRP Logic – Outputs to MRP – Planning Factors – Resource Planning – ERP.

UNIT V	MATERIAL MANAGEMENT	9

JIT – Zero inventory concept, Excess Inventory – Materials management in JIT – World Class Manufacturing environment – Vendor Managed Inventory – Vendor Relationship in JIT.

	TOTAL:	**45**	**PERIODS**

OUTCOMES:

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

- explain the view of the inventory system and outline its distribution.
- calculate fixed orders and fixed interval systems and formulate inventory models.
- understand the importance of inventory control techniques and determine safety stocks.
- understand inputs and outputs of MRP and review resource planning and ERP.
- explain the Materials management in JIT.
- explain the VMI (Vendor Managed Inventory) and vendor relationship in JIT.

TEXTBOOKS:

1. Inventory Management, Martin K. Starr & Miller,1962
2. Foundations of Inventory Management – Zipkin, McGraw Hill, 2000.

REFERENCES:

1. Spencer B. Smith, "Computer Based Production and Inventory Control", Prentice Hall, 1994.
2. Lee J. Krajewski, Larry P. Ritzman, "Operations Managements "Addison-Wesley, 2000.
3. Seetharama L. Narasimhan, Dennis W. Mc Leavy, Peter J. Billington, "Production Planning and Inventory Control", PHI,2002.
4. Principles of Inventory and Materials Management – Richard J. Tersine, Prentice Hall PTR, 1993.

ME1805A	**ENERGY AUDITING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To understand the energy utilization pattern audit.
- To suggest methodologies for energy saving.

UNIT I **INTRODUCTION** **9**

Objectives of Energy Management – Energy Audit Types – Audit Methodology – Types of energy audits – Energy Costs – Benchmarking and Energy Performance – Matching energy Usage to Requirement – Energy index – Cost index - Pie charts- Sankey diagrams - Load profiles - General energy audit.

UNIT II **INSTRUMENTS FOR ENERGY AUDITING** **9**

Instrument characteristics – sensitivity, readability, accuracy, precision, hysteresis. Error and calibration. Measurement of flow, velocity, pressure, temperature, speed, Lux, power and humidity. Analysis of stack, water quality, power and fuel quality.

UNIT III **ENERGY CONSERVATION** **9**

List of Energy Intensive Industries - Sankey diagram – Material and Energy balance – Energy Conservation - Rules for Efficient Conservation of Materials and Energy - Identification of Energy Conservation opportunities - Energy Conservation Schemes and Measures - Energy flow networks - Optimizing Energy Inputs and Energy Balance -Energy Conservation in compressed air, Cooling Tower and Refrigeration systems.

UNIT IV	ENERGY MONITORING AND TARGETING	9

Defining monitoring and targeting system – Elements of monitoring and targeting – Data and Information analysis, Techniques – Energy Consumption, Production, Cumulative sum of differences (CUSUM). Global Environmental Concerns: Climate Change Problem and Response – Conference of Parties – Prototype Carbon Fund.

UNIT V	CASE STUDIES	9

Necessity of Energy Audit Coal/Gas/Oil fired/thermal power Stations. Energy intensity of Indian Industries, Preliminary and Detail Audit procedure for Thermal Power Plant; Equipment required for the measurement of flow, level, temperature, pressure, current, voltage.

TOTAL:	45	PERIODS

OUTCOMES:

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

- understand the principles of energy auditing and various types.
- explain the illumination methods and demonstrate the operation of various energy audit instruments.
- analyze the energy conservation systems
- evaluate about the energy monitoring and targeting techniques
- understand the global environmental concerns
- implement energy audit in any type of industries and suggest the relevant and appropriate conservation measures

TEXTBOOKS:

1. Smith, CB Energy Management Principles, Elsevier,2015
2. Hamies, Energy Auditing and Conservation; Methods Measurements, Management and Case study, Hemisphere, Washington, 1980

REFERENCES:

1. Trivedi, PR, Jolka KR, Energy Management, Commonwealth Publication, New Delhi, 1997
2. Write, Larry C, Industrial Energy Management and Utilization, Hemisphere Publishers, Washington, 1988
3. Diamant, RME, Total Energy, Pergamon, Oxford, 1970
4. Handbook on Energy Efficiency, TERI, New Delhi, 2001
5. Energy Manager Training Manual (4 Volumes) available at website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.2004.
6. Guide book for National Certification Examination for Energy Managers and Energy Auditors (Could be downloaded from www.energymanagertraining.com)

ME1806A	BIOMATERIALS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study the characteristic features of bio materials in medicine.

- To know biocompatibility and functionality of biomaterials for implementing in living system.

UNIT I	BIOMATERIALS AND PROPERTIES	9

Introduction to biomaterials and requirements for biomaterial. Classification of biomaterials: metallic, ceramic, synthetic and natural polymers. Properties of biomaterials: bulk properties and surface properties.

UNIT II	PHYSIO-CHEMICAL CHARACTERIZATION	9

Material Characterization: X-ray Diffraction Analysis (XRD), FT- Raman and micro-Raman analysis, electron spectroscopy for chemical Analysis (ESCA) and X-ray photo electron spectroscopy (XPS), mechanical testing: tensile, compression, wears, fatigue, corrosion studies and fracture toughness. Thermal and viscoelastic properties.

UNIT III	SURFACE CHARACTERIZATION	9

Surface properties and adhesion, contact angle measurement, Scanning Electron Microscopy (SEM), Transmission Electron Microcopy (TEM), Scanning Tunneling Microscopy and Atomic Force Microscopy (AFM). Secondary ion mass spectrometry and confocal laser scanning microscopy.

UNIT IV	BIOMATERIAL TESTING	9

Bio functionality and biocompatibility, preservation techniques for biomaterials, in vitro & in vivo assessment of tissue compatibility, testing of blood (HLA typing and blood grouping) – materials, interactions and animal models.

UNIT V	BIOMATERIALS APPLICATIONS	9

Materials for bone and joint replacement - stainless steel, titanium-based materials and porous metals. Ceramics: alumina, zirconia, calcium phosphate and bioactive glass, bone cement. Polymers: PMMA and polyethylene, rubber and fluorocarbon polymers. Materials for oral and maxillofacial surgery, ophthalmology and intelligent textiles for medical applications.

TOTAL:	45	PERIODS

OUTCOMES:

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

- Apply the knowledge of science and engineering and to function on multidisciplinary team
- Analyze different types of materials and their properties.
- Explain the basic principles and features of polymeric materials and understand key relationship between the structure, property and processing of polymers.
- Analyze the roles of the natural and synthetic polymer in designing the medical device.
- Explain methods to repair and regenerate injured or lost functional tissue with materials, autologous or stem cells.
- Understand the applications of Biomaterials.

TEXTBOOKS:

1. Sujata V. Bhatt, ―Biomaterials" Alpha Science Intl Ltd, 3rd Edition, 2017
2. Joon B.Park Joseph D.Bronzino -Biomaterials – Principles and Applications– CRC Press, 2003.

REFERENCES:

1. H.H.Willard, "Instrumental Methods of Analysis", CBS Publishers, 1992.
2. Park J.B., "Biomaterials Science and Engineering", Plenum Press, 1984.
3. Myer Kutz ,"Standard Handbook of Biomedical Engineering & Design", McGraw-Hill, 2003.
4. John Enderle, Joseph D. Bronzino, Susan M. Blanchard, "Introduction to Biomedical Engineering'', Elsevier, 2005.
5. AC ANAND, J F Kennedy, M. Miraftab, S. Rajendran, "Medical Textiles and Biomaterials for Healthcare", Woodhead Publishing Limited, 2006.
6. D F Williams, "Medical and Dental Materials: A comprehensive Treatment'', VCH Publishers, 1992.
7. BD Ratner, AS Hoffmann, FJ Schoen, JE Lemmons, "An introduction to Materials in Medicine", Academic Press, 1996.

ME1807A	PROCESS PLANNING AND COST ESTIMATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To explain the steps involved in preparing a process plan for a given product.
- To provide an overview for cost estimation of a given product.

UNIT I PROCESS PLANNING **9**

Defining process planning –Drawing interpretation –Material selection process and methods – Selection of Production Processes – Selection of Process Parameters – Factors to be considered in selecting: Processes; Process Sequencing; Operation Sequencing; Equipment & Tool Selection; Tool Holding Devices; Measuring Instruments – Computer Aided Process Planning – Retrieval / Variance CAPP and Generative CAPP - Case Study in Process Planning.

UNIT II FUNDAMENTAL OF ESTIMATING AND ELEMENTS OF COST **9**

Concept and Purpose of Estimating, Functions of Estimating Department, Concept of Costing, costing versus Estimating, Types of Estimates, Importance of Estimates, Estimating Procedure, Cost Estimators and their Qualifications, Principal Constituents in a Cost Estimate – Elements of Cost – Introduction, Material Cost, Labour Cost, Expenses and Cost of Product (Ladder Cost).

UNIT III OVERHEADS AND DEPRECIATION **9**

Overheads, Allocation or Distribution of Overhead Cost, Depreciation and Calculation Methods, Interest on Capital, Idleness Costs, Repair and Maintenance Cost.

UNIT IV ESTIMATION OF CASTING, FORGING & WELDING COSTS **9**

Estimation of cost for Casting processes, Welding processes and Forging processes.

UNIT V ESTIMATION OF MACHINING TIME AND COST **9**

Estimation of Machining Time and Cost – Lathe operations, Drilling, Milling, Shaping, Planning, and Grinding operations.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Create a Process Plan for a given Product.

- Identify Cost elements for a given Product.
- Allocate Overhead to different departments in manufacturing a product.
- Estimate cost for Casting and Forging products.
- Analyze the costs for machining a product
- Prepare cost effective and competitive process plans.

TEXTBOOKS:

1. Adithan, M, Process Planning and Cost Estimation, New Age International Publishers, 2015.
2. Peter Scallan, Process planning, The Design/Manufacture Interface, Butterworth Heinemann, 2003.

REFERENCES:

1. Chitale A. K., and Gupta R. C., "Product Design and manufacturing", Prentice Hall of India, New Delhi,2011.
2. Gideon Halevi, "Process and operation planning", Kluwer academic publishers (Printed ebook), 2003.
3. Narang G.B.S. & Kumar.V, "Production and Costing", Khanna Publishers, 2000
4. Phillip F. Ostwald & Jairo Munoz, "Manufacturing Processes and Systems", 9th Edition, Wiley student edition, 2002.
5. Robert Creese, Adithan M. &Pabla B. S., "Estimating and Costing for the Metal Manufacturing Industries", Marcel Dekker, 1992.