



School of Engineering and Applied Sciences

B. Tech Mechanical Engineering

Syllabus

AY: 2019-2023

**Department of Mechanical Engineering
SRM University-Andhra Pradesh.**

Semester-I					
Course Code	Course Name	L	T	P	C
EGL 111	Communicative English (Non-Minerva)	3	0	0	3
EGL 112	Communicative English (Minerva)				
CDC 101	Soft Skills	1	0	0	1
MAT 112	Single Variable Calculus	3	0	0	3
CHE 101	Chemistry	2	0	0	2
CHE 101 L	Chemistry Lab	0	0	2	1
ENG 111	Basic Electronics	3	0	0	3
ENG 111 L	Basic Electronics Lab	0	0	2	1
CSE 101	Introduction To Programming Using Python (Non -Minerva)	3	0	0	3
CSE 101 L	Introduction To Programming Using Python Lab (Non -Minerva)	0	0	2	1
CSE 102	Introduction To Programming Using Python (Minerva)	3	0	2	4
TOTAL		15	0	6	18

Semester-II					
Course Code	Course Name	L	T	P	C
ECO 121	Principles Of Economics	3	0	0	3
CDC 102	Soft Skills-II	1	0	0	1
MAT 115	Statistics	3	0	0	3
EGL 121	Critical Thinking	3	0	0	3
ME 225 L	3D Printing	0	0	2	1
ME 103 L	Mechanical Engineering Tools Lab	0	0	2	1
ENG 105 L	Engineering Graphics Lab	0	0	2	1
ENG 105	Engineering Graphics	2	0	0	2
MAT 121	Multi Variable Calculus	3	0	0	3
PHY 221	Electricity And Magnetism	2	0	0	2
PHY 221 L	Electricity And Magnetism Lab	0	0	2	1
TOTAL		17	0	8	21

Semester-III					
Course Code	Course Name	L	T	P	C
ENG 115	Engineering Mechanics	3	0	0	3
MAT 211	Linear Algebra	3	0	0	3
CDC 221	Aptitude	1	1	0	1
ME 141	Thermodynamics	3	0	0	3
ME 141 L	Thermodynamics Lab	0	0	2	1
ME 121	Material Science and Metallurgy	3	0	0	3
ME 121 L	Material Science and Metallurgy Lab	0	0	2	1
ME 171	Kinematics And Mechanisms	3	0	0	3
ME 171 L	Kinematics And Mechanisms Lab	0	0	2	1
CSE 230	Industry Standard Coding Practice-1	0	0	4	1
TOTAL		16	1	10	20

Semester-IV					
Course Code	Course Name	L	T	P	C
ME 221	Elements Of Structure	3	0	0	3
ME 221 L	Elements Of Structure Lab	0	0	2	1
MAT 131	Differential Equations	3	0	0	3
ME 222	Fluid Mechanics	3	0	0	3
ME 222 L	Fluid Mechanics Lab	0	0	2	1
ENV 111	Environmental Science	2	0	0	2
ENV 111 L	Environmental Science Lab	0	0	2	1
ME	ME ELECTIVE				
ME 405	Mechanics of Composite Materials	3	0	0	3
ME 223	Alternative Energy Sources				
OE	Open Elective	3	0	0	3
ISES 212	Industry Specific Employability Skills-IV	1	1	0	1
CSE 330	Industry Standard Coding Practice-2	0	0	4	1
TOTAL		18	1	10	22

Semester-V					
Course Code	Course Name	L	T	P	C
ME 321	Fluid Machinery	3	0	0	3
ME 321 L	Fluid Machinery Lab	0	0	2	1
ME 224	Machine Design	3	0	0	3
ME 224 L	Machine Design Lab	0	0	2	1
ME 272	Dynamics And Control	3	0	0	3
ME 272 L	Dynamics And Control Lab	0	0	2	1
ME 201	University Research Opportunity	0	0	4	2
CSE 331	Industry Standard Coding Practice-3	0	0	4	1
ISES 311	Industry Specific Employability Skills-V	1	1	0	0
ME	ME ELECTIVE				
ME 430	Mechatronics (Robotics Specialization)	3	0	0	3
ME 410	Thermal Power Engineering				
ME 415	Refrigeration and Air Conditioning				
ME 401	Cad-Cam (Additive Manufacturing Specialization)				
	Open Elective	3	0	0	3
ME 132	Numerical Methods	3	0	0	3
ME 132 L	Numerical Methods Lab	0	0	2	1
TOTAL		19	1	16	25

Semester-VI					
Course Code	Course Name	L	T	P	C
ME 230	Heat And Mass Transfer	3	0	0	3
ME 230 L	Heat And Mass Transfer Lab	0	0	2	1
ME 322	Manufacturing Technology	3	0	0	3
ME 322 L	Manufacturing Technology Lab	0	0	2	1
ME 226	Measurement & Instrumentation	3	0	0	3
ME 226 L	Measurement & Instrumentation Lab	0	0	2	1
ISES 312	Industry Specific Employability Skills-VI	1	1	0	0
ME	ME ELECTIVE				
ME 427	Robotics (Robotics Specialization)	3	0	0	3
ME 228	Manufacturing Science (Additive Manufacturing Specialization)				
	Open Elective	3/4	0	0	3/4
	Me Elective	3	0	0	3
TOTAL		19	1	6	21

Semester-VII					
Course Code	Course Name	L	T	P	C
ME 450	Multidisciplinary Design Project	0	0	4	2
ME	ME ELECTIVE				
ME 402	Multibody Dynamics (Robotics Specialization)	3	0	0	3
ME 412	Additive Manufacturing Process (Additive Manufacturing Specialization)				
ME	ME ELECTIVE				
ME 411	Artificial Intelligence (Robotics Specialization)	3	0	0	3
ME 413	Design And Modeling Aspects of AM (Additive Manufacturing Specialization)				
	Open Elective	3/4	0	0	3/4
	Open Elective	3/4	0	0	3/4
	Open Elective	3/4	0	0	3/4
ME 451	Seminar	0	0	2	1
TOTAL		12	0	6	15

Semester-VIII					
Course Code	Course Name	L	T	P	C
ME 602	Design Project/Industrial Project	0	0	30	15
TOTAL		0	0	30	15

List of Open Electives in IV Semester					
Course Code	Course Name	L	T	P	C
CSE 202	Web Technology	3	0	0	3
CSE 202 L	Web Technology Lab	0	0	2	1
ME 228	Manufacturing Science	3	0	0	3
ME 416	Surface Engineering	3	0	0	3
ME 562	Mechanical Behavior of Materials	3	0	0	3
ME 223	Alternate Energy Sources	3	0	0	3
PHY 307M	Special Theory of Relativity	3	0	2	4
PSY 111	Psychology for Everyday Living	4	0	0	4
HIS 200	India and Its People	4	0	0	4
HIS 005	Introduction to Gender	4	0	0	4
MAT 355	Calculus of Variation	4	0	0	4
IDEA 103	User Experienced Design	3	0	0	3
IDEA 104	Dream-Discover-Disrupt	3	0	0	3
MOOC100	Introduction to Robotics	3	0	0	3
MOOC101	Psychology of Stress, Health and Well-being	3	0	0	3
MOOC102	Introduction to Film Studies	3	0	0	3
MOOC103	German - I	3	0	0	3

List of Open Electives in V-Semester					
Course Code	Course Name	L	T	P	C
CSE 202	Web Technology	3	0	0	3
CSE 202 L	Web Technology lab	0	0	2	1
ECE 418	Machine Learning	3	0	2	4
EEE 422	Optimization Techniques	3	0	0	3
ME 418	Introduction to Electric Vehicles	3	0	0	3
IDEA 102	Design Thinking	3	0	0	3
MAT 305	Introduction to Science and Technology	4	0	0	4
PSY 111	Psychology for Everyday Living	4	0	0	4
PSY 116	Neuro Linguistic Programming - Level I	3	0	0	3
BIO 112	Basic Microbiology	4	0	0	4
PHY 223	Introduction to Quantum Computations	3	1	0	4
HIS 005	Introduction to Gender	3	0	0	3
ECO 251	Indian economy	4	0	0	4
EGL 167	Code Name Language	4	0	0	4
MAN 001	Mandarin	3	0	0	3
TLC 101	Cognitive Learning Theories	2	1	0	3
EEE 305	Advanced Control Systems	3	0	0	3
EEE 305 L	Advanced Control Systems lab	0	0	2	1
MAT 307	Combinatorics and graph theory	4	0	0	4
PHY 301	Atomic and Molecular Physics	3	0	0	3
COM 101	Business Organization and Management	3	0	0	3
COM 107	Finance for Engineering	3	0	0	3
IDEA 104	Dream Discover Disrupt	3	0	0	3
JOU 001	Media through the ages: From print to social	3	0	0	3

List of Electives					
Course Code	Course Name	L	T	P	C
ME 401	CAD-CAM	3	0	0	3
ME 402	Multibody Dynamics	3	0	0	3
ME 405	Mechanics of composite materials	3	0	0	3
ME 406	Computational fluid dynamics	3	0	0	3
ME 408	Advanced materials	3	0	0	3
ME 409	Thermal design of electronic equipment's	3	0	0	3
ME 410	Thermal Power Engineering	3	0	0	3
ME 411	Artificial intelligence and expert systems	3	0	0	3
ME 412	Additive manufacturing process	3	0	0	3
ME 413	Design and modeling aspects of am	3	0	0	3
ME 415	Refrigeration and air conditioning	3	0	0	3
ME 416	Surface engineering	3	0	0	3
ME 417	Compressible flow	3	0	0	3
ME 418	Introduction to electric vehicles	3	0	0	3
ME 427	Robotics	3	0	0	3
ME 430	Mechatronics	3	0	0	3
ME 433	Introduction to high performance computing	3	0	0	3
ME 434	Elements of mechatronics	3	0	0	3
ME 435	Fundamentals of hydraulics and pneumatics	3	0	0	3
ME 436	Industrial tribology	3	0	0	3
ME 437	Process planning and cost estimation	3	0	0	3
ME 438	Internal combustion engines	3	0	0	3
ME 439	Industrial engineering	3	0	0	3
ME 440	Advanced fluid mechanics	3	0	0	3
ME 441	Operations Research	3	0	0	3
ME 442	Advanced Engineering Thermodynamics	3	0	0	3
ME 443	Finite element methods	3	0	0	3
ME 444	Micro controller and its application in robotics	3	0	0	3
ME 445	Machinery fault diagnostics and signal processing	3	0	0	3
ME 446	Advanced strength of materials	3	0	0	3
ME 447	Computer Graphics	3	0	0	3
ME 448	Automotive engineering	3	0	0	3
ME 449	Fatigue, fracture mechanics and creep	3	0	0	3
ME 452	Flexible manufacturing systems	3	0	0	3
ME 453	Combustion engineering	3	0	0	3
ME 454	Gas turbine technology	3	0	0	3
ME 455	Fuel cell technology	3	0	0	3
ME 456	Advanced thermodynamics	3	0	0	3
ME 457	Fundamentals of Vibration and Noise	3	0	0	3
ME 458	Gas Dynamics and Space Propulsion	3	0	0	3
ME 459	Design of Transmission Systems	3	0	0	3
ME 460	Additive manufacturing technology	3	0	0	3

SEMESTER-I

SEMESTER-I

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
EGL 111	Communicative English	HS	3	0	0	3

UNIT I: RHETORIC AND PUBLIC SPEAKING

Rhetoric, Critical Thinking and Public Speaking; Thinking Outside the Box; How to Deliver a Speech; Fundamentals of Persuasion.

UNIT II: NONVERBAL COMMUNICATION

Nonverbal Communication; Spatial distance, Eye contact and appearances; How nonverbal communication is more important than words.

UNIT III: COMMUNICATION AND THE MEDIA

Persuasion and the media; Radio, television, film, Social media and the internet; How the media sells ideas, images. Products and lifestyles; Fundamentals of Informative/Scientific. Speeches and Research; The Heart of the Speech – Powerful Narratives; The Power of Narrative.

UNIT IV: SMALL GROUP COMMUNICATION

Small group communication; Leadership, Conflict and persuasion in groups. The importance of small groups in business. Dr. A. Fisher's Fundamentals of Small Groups; Group Problem Solving; Learning to say no – don't say you will when you won't. Don't say yes and then don't do it, be true to your word.

UNIT V: PERSUASION, IDEOLOGY AND MEDIA BIAS

Advanced Rhetoric, Ideology, Persuasive Fallacies, How to Construct a Persuasive Speech, How to Present Scientific Data in a Speech, Unmasking Media Bias and Ideology, Full circle – the dangers of rhetoric and ideology.

TEXTBOOKS/REFERENCES

1. Communication: Principles for a Lifetime. Beebe, Beebe and Ivy, 6th Edition, Pearson Publishing.
2. Qualitative Communication Research Methods (2011) Bryan C. Taylor and Thomas R. Lindlof. Sage Publications, New Delhi, India, 3rd Edition.
3. The Fundamentals of Small Group Communication (2008) Scott A. Myers and Carolyn M. Anderson. Sage Publications, New Delhi, India.

SEMESTER-I

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
CDC 101	Soft Skills	HS	1	0	0	1

UNIT I: KNOW THEY SELF

SWOT Analysis, Psychometric Analysis using simple tests, Grooming, Social Etiquette, Activity.

UNIT II: PERSONALITY DEVELOPMENT

Personality Construct, KASAB Model, Components of perception, Perceptual errors, Perception as a precursor of attitude and behavior, Activity.

UNIT III: COMMUNICATION

Verbal and Non-Verbal Communication, Three V's of communication, Visual or Kinesics, Vocal (Articulation), Verbal, Active listening, Barriers to listening, GARF (Giving and Receiving Feedback), Activity.

UNIT IV: PRESENTATION SKILLS

The four Ps of presentation, Different types of presentations and importance, handling different types of target audience, Techniques and Tips to give an effective presentation. Activity.

UNIT V: TIME MANAGEMENT & GOAL SETTINGS

Pressure Cooker (Activity based on Planning, Organizing and Prioritization). Roller Coaster (Activity on setting SMARTER goals, planning & organizing, short- & long-term goals). Activity.

TEXTBOOKS/REFERENCES

1. Mitchell S. Green – 2017, Know Thyself: The Value and Limits of Self-Knowledge.
2. Debbie Hindle, Marta Vaciago Smith - 2013 , Personality Development: A Psychoanalytic Perspective.
3. Lani Arredondo - 2000, Communicating Effectively.
4. Patsy McCarthy, Caroline Hatcher - 2002, Presentation Skills: The Essential Guide for Students.
5. Martha Davis, Elizabeth Robbins Eshelman, Matthew McKay - 2008, Time Management and Goal Setting: The Relaxation and Stress.

SEMESTER-I

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
MAT 112	Single Variable Calculus	BS	3	0	0	3

UNIT I: SEQUENCES AND SERIES

Sequences, series, Sum of a series, Geometric series, p-series, Comparison test, root test, ratio test.

UNIT II: LIMITS AND CONTINUITY

Limit of a function at a point, one sided limits, Continuity, Limits involving infinity.

UNIT III: DIFFERENTIATION

Derivative at a point, Derivative as a function, Product Rule, Quotient Rule, Chain Rule, Implicit Differentiation, Rolle's Theorem, Mean Value Theorem.

UNIT IV: APPLICATIONS OF DERIVATIVES

Maxima and minima, Monotonic functions and first derivative test, Related rates, Concavity and curve sketching, Optimization problems, Newton's Method, Taylor and MacLaurin Series.

UNIT V: INTEGRATION

Area as a limit of finite sums, Definite and indefinite integral, Fundamental Theorem of Calculus, Integration by substitution and integration by parts, Area between curves, Arc length.

TEXTBOOKS

1. Thomas' Calculus, 14th Edition, (2018) – J. Hass, C. Heil, M. Weir, Pearson Education.
2. Introduction to Real Analysis, Fourth Edition (2014) – R. Bartle, D. Sherbert, John Wiley and Sons.

REFERENCES

1. Calculus and Analytic Geometry, Ninth Edition (2017) – G. Thomas, R. Finney, Addison Wesley.

SEMESTER-I

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
CHE 101	Chemistry	BS	2	0	0	2

UNIT I: CHEMICAL BONDING

Ionic, covalent, and metallic bonds. Theories of bonding: Valence bond theory, nature of covalent bond, sigma (σ) bond, Pi(π) bond. Hybridization: Types of hybridizations, sp², sp³, sp³d, d²sp³. Shapes of molecules (VSEPR Theory): BeCl₂, CO₂, BF₃, H₂O, NH₃, CH₄, PCl₅, XeF₂, SF₆, XeF₄. Molecular orbital theory: Linear combination of atomic orbitals (LCAO Method), bond order, homo(H₂, O₂, N₂) and hetero nuclear diatomic molecules(NO, CO). Non-covalent interactions: Vander Waals interactions, dipole-dipole interactions, and hydrogen bonding.

UNIT II: PHASE RULE AND KINETICS

Phase rule: Introduction, Definition of the terms used in phase rule with examples. Application of phase rule to water system, Sulphur system and lead-silver system. Kinetics: Order and molecularity of reactions, zero order, first order and second order reactions.

UNIT III: WATER TECHNOLOGY

Standards for drinking water, Methods of Treatment of water for domestic and industrial purposes: Sedimentation, Coagulation, Filtration, Sterilization, Break point chlorination. Determination of Hardness of water by EDTA method. Demineralization of water. Softening of water: Lime-soda Process, Ion exchange process, Zeolite process. Boiler Troubles: Priming, Foaming, Scale, Sludge, Corrosion, Caustic Embrittlement.

UNIT IV: POLYMER CHEMISTRY

Classification of polymers: Natural and synthetic. Thermoplastic and Thermosetting. Degree of polymerization. Types and mechanism of polymerization: Addition (Free Radical, cationic and anionic); condensation and copolymerization. Properties of polymers: T_g, Tactility, Molecular weight average, number average and poly dispersity index. Techniques of polymerization: Bulk, emulsion, solution and suspension.

UNIT V: ELECTROCHEMISTRY

Arrhenius theory of electrolytic dissociation, classification of electrolytes; degree of Dissociation of acids, dissociation constant of weak acids, concept of Ph and pOH, buffer solutions, solubility product, common ion effect indicators and theory of acid base indicators, conductance of solutions-specific, molar and equivalent conductance, Variation of molar conductance with dilution for strong and weak electrolytes; Migration of ions-Kohlrausch's law of independent migration of ions, Ostwald's dilution law; Nernste equation for single electrode and electrochemical cells.

TEXTBOOKS/REFERENCES

1. A. Bahl and B. S. Bahl, G. D. Tuli, Essentials of physical chemistry, S Chand Publication, 2014, ISBN: 8121929784. P.W. Atkins, T.L. Overton, J.P. Rourke, M.T. Weller and F.A. Armstrong Shriver and Atkins' Inorganic Chemistry, 5th Ed., Oxford University Press, London, 2010, ISBN 978-1-42-921820-7.
2. Atkins, P.W.; de Paula, J. Physical chemistry, 8th ed., 2006 Oxford University Press. ISBN 0-19-870072-5.
3. B. R. Puri, L. R. Sharma & M. S. Pathania, Principles of Physical Chemistry, 46th Ed., 2013, Vishal Publication Company.
4. F.W. Billmeyer, Text Book of Polymer Science, 3rd Ed., John Wiley & Sons, New York, 2003.
5. J. Bard and L.R. Faulkner, Electrochemical methods – Fundamentals and applications, 2nd Ed., John Wiley and Sons, 2001.
6. Jain P.C. & Monika Jain, Engineering Chemistry, Dhanpat Roy & Sons, 2015.

SEMESTER-I

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
CHE 101 L	Chemistry Lab	BS	0	0	2	1

LIST OF EXPERIMENTS

1. Volumetric titration of HCl vs NaOH
2. Conductometric titration of HCl vs NaOH
3. Standardization of potassium permanganate by Oxalic acid
4. Iodometric Determination of Ascorbic Acid (Vitamin C)
5. Determination of hardness of water by EDTA method
6. Determination of strength of given hydrochloric acid using pH meter
7. Estimation of iron content of the given solution using potentiometer
8. Determination of sodium and potassium by flame photometry.

SEMESTER-I

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ENG 111	Basic Electronics	ES	3	0	0	3

UNIT I: ELECTRICAL QUANTITIES AND THEIR MEASUREMENTS

Ohm's law, Permanent magnet, ammeter, voltmeter, Measurement of resistance using Wheatstone bridge, Measurement of capacitance using different methods, Measurement of inductance using different methods.

UNIT II: SEMICONDUCTOR DEVICES

Forward and reverse bias of PN junction diode, Half wave, full wave bridge rectifiers, Bipolar junction transistors, Transistor as amplifier and buffer, photodiode/phototransistor.

UNIT III: AC CIRCUITS AND AMPLIFIERS

Phasor analysis, impedance, reactance, resonance, RLC, characteristics of amplifiers, Integrator and differentiator design, Differential operational amplifier, Parallel and series reactance Common mode rejection ratio.

UNIT IV: ELECTRONIC FILTERS

Low and high frequency noise in electronic circuits, Low pass, high pass, band pass filters, Fourier transform, bode plot, bandwidth, Higher order filters, Applications of filters.

UNIT V: DIGITAL LOGIC FUNDAMENTALS

Different number systems, Logic gates AND OR NOT NOR X-OR X-NOR, Adders/subtractors, multiplexers, D'morgan laws.

TEXTBOOKS/REFERENCES

1. Principles of electronics by V K Mehta & Rohit Mehta, 2010 edition, S Chand and Co. Publisher, ISBN: 9788121924504.
2. Electronic devices and circuits by David A. Bell, 2008 edition, Oxford University Press, ISBN: 9780195693409.
3. Introduction to digital logic design by John P. Hayes, 1993 edition, Pearson Edition, ISBN: 9780201154610.
4. Electronic measurements and Instrumentation by A K Sawhney, 2015 edition, Dhanpat Rai and Co., ISBN: 9788177001006.

SEMESTER-I

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ENG 111 L	Basic Electronics Lab	ES	0	0	2	1

LIST OF EXPERIMENTS

1. Introduction to Resistor, bread board, DMM and verification of Ohm's law.
2. Verification of Kirchhoff's laws (KCL, KVL).
3. Study of I-V characteristics of PN **junction** diode.
4. Design of half-wave rectifier using PN junction diode with and without **capacitor** filter.
5. Design of positive and negative clipping circuits using PN junction diodes.
6. Study of current and voltage gain characteristics of a NPN transistor in common-emitter configuration.
7. Drain characteristics of common source JFET.
8. Design of inverting and non-inverting amplifier **circuits** using op-amp IC 741.
9. Study of **integrator** and differentiator circuits using op-amp IC 741.
10. Design of Schmitt Trigger Using IC 741.

SEMESTER-I

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
CSE 101	Introduction to programming using Python	ES	3	0	0	3

UNIT I: INTRODUCTION TO PYTHON

Knowledge, Machines, Languages, Types, Variables Operators and Branching -- Core elements of programs: Bindings, Strings, Input/Output, IDEs, Control Flow, Iteration, Guess and Check – Simple Programs: Approximate Solutions, Bisection Search, Floats and Fractions, Newton-Raphson.

UNIT II: FUNCTIONS

Decomposition and Abstraction, Functions and Scope, Keyword Arguments, Specifications, Iteration vs Recursion, Inductive Reasoning, Towers of Hanoi, Fibonacci, Recursion on non-numeric, Files.

UNIT III: TUPLES AND LISTS

Tuples, Lists, List Operations, Mutation, Aliasing, Cloning – Dictionaries: Functions as Objects, Dictionaries, Example with a Dictionary, Fibonacci and Dictionaries, Global Variables – Debugging: Programming Challenges, Classes of Tests, Bugs, Debugging, Debugging Examples– Assertions and Exceptions, Assertions, Exceptions, Exception Examples.

UNIT IV: CLASSES AND INHERITANCE

Object Oriented Programming, Class Instances, Methods Classes Examples, Why OOP, Hierarchies, Your Own Types – An Extended Example: Building a Class, Visualizing the Hierarchy, adding another Class, Using Inherited Methods, Gradebook Example, Generators.

UNIT V: COMPUTATIONAL COMPLEXITY

Program Efficiency, Big Oh Notation, Complexity Classes Analyzing Complexity – Searching and Sorting Algorithms: Indirection, Linear Search, Bisection Search, Bogo and Bubble Sort, Selection Sort, Merge Sort.

TEXTBOOKS/REFERENCES

1. Introduction to Computation and Programming using Python, by John Guttag, PHI Publisher, Revised and Expanded version (Referred by MIT)
2. Python Programming using problem solving Approach by Reema Thareja, Oxford University, Higher Education Oxford University Press; First edition (10 June 2017), ISBN-10: 0199480173.
3. Data Structures and Algorithms in Python by Michael T Goodrich and Robert to Thamassia, Micheal S Goldwasser, Wiley Publisher (2016).

SEMESTER-I

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
CSE 101 L	Introduction to programming using Python lab	ES	0	0	2	1

LIST OF EXPERIMENTS

1. A company decided to give bonus of 5% to employee if his/her year of service is more than 5 years. Ask user for their salary and year of service and print the net bonus amount.
2. Write a program that computes the real roots of a quadratic function. Your program should begin by prompting the user for the values of a, b and c. Then it should display a message indicating the nature of real roots, along with the values of the real roots (if any).
3. Write a Python program to find the factorial of the given number (Example: $5! = 5*4*3*2*1 = 120$)
4. Write a Python program to read the numbers from the keyboard using a loop, perform the sum and average of all the input numbers until “-10” is encountered.
5. Write a Python program to count the number of strings where the string length is 2 or more and the first and last character are same from a given list of strings.
6. Write a python program for bubble sort algorithm. What is the best case and worst-case time complexity of Bubble sort algorithm? Explain with an example, where the list of elements is not sorted then what would be the output after each iteration/pass.
7. Write a python program for Selection sort algorithm. What is the worst case or average case time complexity of selection sort algorithm?
8. Write a Program in python using object-oriented concept to make calculator which has the following operations: Addition, Subtraction, Multiplications, Divisions, Exponentials, Modulus.
9. Define is inheritance? Explain with suitable example: Single level inheritance, Multiple Inheritance, Multi-level Inheritance.
10. Write a Program in python using object-oriented concept to create a base class called Polygon and there are three derived classes named as triangle, rectangle and square. The base class consists of the input function for accepting sides length and the derived classes must have output function for displaying area of triangle, rectangle and square.

SEMESTER-II

SEMESTER-II

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ECO 121	Principles of Economics	HS	3	0	0	3

UNIT I: INTRODUCTION TO ECONOMICS

Why study economics? Scope and method of economics; the economic problem: scarcity and choice; the question of what to produce, how to produce and how to distribute output, Science of economics; the basic competitive model; prices, Property rights and profits; incentives and information; rationing, Opportunity sets; economic systems; reading and working with graphs.

UNIT II: DEMAND AND SUPPLY

Determinants of individual demand/supply; demand/supply schedule and demand/supply curve; market versus individual demand/supply. Shifts in the demand/supply curve, demand and supply together. How prices allocate resources; elasticity and its application. Controls on prices; taxes and the costs of taxation. Consumer surplus; producer surplus and the efficiency of the markets.

UNIT III: CONSUMER THEORY

The consumption decision - budget constraint, the consumption decision - budget constraint, consumption and income/price changes, Demand for all other goods and price changes, Utility and preferences (indifference curves); properties of indifference curves, Consumer 's optimum choice, Income and substitution effects, Applying consumer theory: Labour.

UNIT IV: PRODUCER THEORY

Production, short- run production function and returns to factor, Average-marginal relationship, Long- run production function and laws of return to scale- role of technology ,Cost function and cost structure of a firm in the short- run, Long run cost function and cost structure.

UNIT V: TYPES OF MARKET

Perfect competition -features, Perfect competition- profit maximization, Shut-down and break-even points. Monopoly: marginal revenue; marginal cost; profit maximization. Shutdown rule; market power; price discrimination. Monopolistic competition and product differentiation.

TEXTBOOKS/REFERENCES

1. Principles of microeconomics, N. Gregory Mankiw, Publisher: Cengage Learning fifth edition.
2. Perloff, Jeffrey M. *Microeconomics*. 5th ed. Addison Wesley, 2008. ISBN: 9780321558497.

SEMESTER-II

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
CDC 102	Soft Skills-II	HS	1	0	0	1

UNIT I: MOTIVATION

Maslow's theory of Motivation Soldiers' Walk and The Japanese Fan (Activities on factors of motivation), Steps to ward off de-motivation.

UNIT II: CREATIVITY AND INNOVATION

Activity on Brain Storming, Types of Creativity, Common Barriers of creativity, Sources of New Idea, Activity topics to enhance the power of aesthetics and precision. Aim is to create interest in research, Activity.

UNIT III: CRITICAL AND LATERAL THINKING

Importance's of Critical and Lateral thinking, Fill Me Up, Stimulating Lateral Thinking, Activity to enhance critical and lateral thinking.

UNIT IV: TEAM DYNAMICS

Importance of Team Dynamics, Story boarding, Frenzy, Activities Come to my Island, Striking Cars, Defend the Egg, Tallest Tower, Activities on the different stages of team building, team communication, coordination and collaboration.

UNIT V: MINI PROJECT

Individual projects on topics provided by faculties.

TEXTBOOKS/REFERENCES

1. Maslow, A. H. (1943) A Theory of Human motivation. In R. J. Lowry (1973) Dominance, Self-Esteem, Self-Actualization: Germinal Papers of A.H. Maslow (pp. 153-173). Belmont, California: Wadsworth Publishing Company, Inc.
2. Sparking Student Creativity, Practical ways to promote innovative and problem solving, Patti Drapeau.
3. Teach yourself to think, Edward de Bono, 1995.

SEMESTER-II

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
MAT 115	Statistics	BS	3	0	0	3

UNIT I

Basic principle of counting, permutations, combinations, Multinomial coefficients, sample space and events, Axioms of probability, sample spaces having equally likely outcomes, Conditional probability, Bayes` theorem, independent events.

UNIT II

Random variable, discrete random variable, expected value, Expectation of a function of a random variable, variance, Discrete probability distributions- Bernoulli, Binomial, Poisson, Geometric, negative. Binomial distributions expected value of sums of random variables. Cumulative distribution function and its properties.

UNIT III

Continuous random variables, Expectation and variance – their properties, Continuous probability distributions – uniform, normal, exponential distributions, Distribution functions.

UNIT IV

Joint distribution functions, Independent random variables and their sums, conditional distributions, Joint probability distribution of functions of random variables, Covariance, correlation.

UNIT V

Definition of statistics, population and sample, Representative sample, Descriptive statistics – classification and tabulation of univariate data, Graphical representation, frequency curves.

TEXTBOOKS/REFERENCES

1. Sheldon Ross, A First course in probability (Ninth edition)
2. Michael Baron, Probability and Statistics for computer scientists.

SEMESTER-II

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
EGL 121	Critical Thinking	HS	3	0	0	3

UNIT I

Analyzing Problems, Science of Learning, Logical Thinking.

UNIT II

Analyzing Decisions, Applying logic.

UNIT III

Evaluating Claims and Justifications, Fallacy Detection, Understanding Bias, Mitigating Bias.

UNIT IV

Evaluate and Use Strategies, Identifying the Right Problem and Sub problems, Gaps and Constraints.

UNIT V

Solving Problems, Using Analogies in Problem Solving, Innovative Thinking.

SEMESTER-II

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 225 L	3D Printing	C	0	0	2	1

UNIT I: CAD MODELLING

Concepts of CAD, Algorithms used in design, Design of Assembly (Spur gear, Helical screw, simple design), Introduction to G Code. Lab practice of Solid works software.

UNIT II: INTRODUCTION TO 3DP

What is a Mesh? Historical Review of 3DP, From CAD to CAM, CAD Overview, Introductory lecture on 3D printer and Rapid Prototyping, Introduction to Rapid prototype, Introduction to different types of 3D Printers, Introduction to RepRap, Materials used for printing.

UNIT III: CTRL+P

Design for 3DP, Understand the basics of G code generation, CAM Skills, Mesh Repair, Get to Know the 3D Printer, Weekly Assignments (3DP).

UNIT IV: HANDS ON EXPERIENCE WITH AND TROUBLE SHOOTING

Installation of 3DP, bed levelling, filament loading and unloading, pre heating, nozzle cleaning and various techniques while printing the complex shapes.

TEXTBOOKS

1. 3D Printing and Additive Manufacturing (Principles and Applications), By Chee Kai Chua and Kah Fai Leong.

REFERENCES

1. Getting Started with 3D Printing: A Hands-on Guide to the Hardware, Software, and Services Behind the New Manufacturing Revolution by Liza and Nick.

SEMESTER-II

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 103 L	Mechanical Engineering Tools Lab	ES	0	0	2	1

LIST OF EXPERIMENTS

1. Step fitting of two metal plates using fitting tools.
2. Drilling & Tapping for generating hole and internal thread on a metal plate.
3. Simple turning of cylindrical surface on MS rod using lathe machine tool.
4. Plumbing of bathroom/kitchen fitting using various plumbing components and tools.
5. Butt joint of two metal plates using arc welding process.
6. Lap joint of two metal plates overlapping on one another using arc welding process.
7. T-joint of a metal plate at perpendicular direction over another plate using arc welding process.
8. MIG welding of metal plates.
9. Cross halving joint of two wooden pieces at perpendicular direction.
10. Dovetail halving joint of two wooden pieces in the shape of dovetail.
11. To make circular shapes, grooving in wood piece using wood turning lathe.
12. To make duster from wooden piece using carpentry tools.
13. To make rectangular shaped tray using GI sheet.
14. To make geometrical shape like frustum, cone and prisms using GI sheet.
15. To make bigger size scoop using GI sheet. To forge chisel from MS rod using black smithy.

REFERENCES

1. Lab Manual.
2. Kannaiah.P and Narayanan.K.C, “*Manual on Workshop Practice*”, Scitech Publications, Chennai, 1999.
3. Gopal.T.V, Kumar.T, and Murali.G, “*A first course on workshop practice – Theory, Practice and Work Book*”, Suma Publications, Chennai, 2005.

SEMESTER-II

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ENG 105	Engineering Graphics	ES	2	0	0	2

UNIT I: PROJECTION OF POINTS, LINES, PLANES, SOLIDS

Projection of points, Projection of lines, Projection of planes, Projection of solids, use of software tool to create projections.

UNIT II: SECTIONS AND DEVELOPMENTS

Sections of solids, True shape of the section, Development of surfaces of sectioned solids, CAD exercises.

UNIT III: ISOMETRIC VIEWS

Isometric projections of simple and truncated solids, Isometric to orthographic and vice versa, Perspective projection, CAD exercises.

UNIT IV: GEOMETRIC DIMENSIONING AND TOLERANCES

GD and T rules and concepts, Geometric characteristics and modifiers, Fourier transform, bode plot, bandwidth, Datums and datum references, CAD exercises.

UNIT V: FREE HAND SKETCHING AND CAD

Free hand sketching of real objects, Free hand sketching of multiple views from pictorial views, CAD exercises, Assignments of 2D and 3D drawings.

TEXTBOOKS/REFERENCES

1. Bhatt, N.D, Engineering Drawing, Charotar Publishers, 2014.
2. Bhatt, N.D, Machine Drawing, Charotar Publishers, 2014.
3. Venugopal, K. and Prabhu Raja, V., Engineering Graphics, Eighth Edition (Revised), New Age International Publishers, Chennai, 2007.
4. Narayanan, K. L. and Kannaiah, P., Engineering Graphics, Scitech Publications, Chennai, 1999.

SEMESTER-II

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ENG 105 L	Engineering Graphics Lab	ES	0	0	2	1

LIST OF EXPERIMENTS

1. GUI familiarity, features, commands.
2. Shortcuts, mouse features, drop down menus etc.
3. Sketch entities Inference line, centreline, line, circle, arc, ellipse.
4. Rectangle, slots, polygon, spline, points, text, snap, grid Sketch Tools Fillet, chamfer, offset, trim.
5. Extend, mirror, copy, rotate, scale, sketch.
6. Blocks, create blocks, add/remove, explode
7. Relations, dimensioning
8. Part modeling, extrude, revolve, swept, extruded cut.
9. Loft, reference, curves, fillet, pattern.
10. Assembly modeling, mating.
11. Manipulating components
12. Surface modeling tools.
13. All views of the object, dimensions.
14. Drafting tools.
15. Simulation express, stress-strain analysis.

SEMESTER-II

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
MAT 121	Multivariable Calculus	BS	3	0	0	3

UNIT I: VECTORS AND MATRICES

Three-dimensional coordinate system, vectors, dot products, vector products, lines and planes.

UNIT II: PARTIAL DERIVATIVES

Functions of several variables, Limits and continuity for several variable functions, Partial derivatives, The chain rule, Directional derivatives, Gradient.

UNIT III: DOUBLE INTEGRAL AND LINE, INTEGRAL IN PLANES

Extreme values, saddle points, lagrange multipliers.

UNIT IV: TRIPLE INTEGRALS IN 3D

Double and integrated integrals, area by double integration.

UNIT V: SURFACE INTEGRALS IN 3D

Triple integration and applications.

TEXBOOKS

1. Edwards, Henry C Thomas- Calculus, 14th edition. Chapters 12 to 16 relevant sections.
2. G.B. Thomas, Jr.and R. L. Finney, Calculus and Analytic Geometry, 9th Edn., Pearson Education India, 1996.

REFERENCES

1. T. M. Apostol, Calculus - Vol.2, 2nd Edn., Wiley India, 2003.

SEMESTER-II

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
PHY 221	Electricity and Magnetism	BS	2	0	0	2

UNIT I: INTRODUCTION TO VECTOR ALGEBRA

Introduction to vectors, scalar and vector product. Gradient of a scalar field. Divergence and Curl of vector fields and their physical significance. Gauss and Stokes theorems. Coordinate systems—introduction to Cartesian system. Spherical and Cylindrical coordinate systems.

UNIT II: ELECTROSTATICS

Coulomb's law and electric field. Gauss Law, Electric Potential, Potential Energy, Conductors under Electrostatic Equilibrium, Capacitors.

UNIT III: DIELECTRICS AND POLARIZATION

Introduction to Electric Dipole and dipole Moment. Potential and field due to electric dipole. Polarization in dielectrics. Modification of Gauss's Law in terms of electric displacement. Electric Susceptibility and dielectric constant. Bound charges.

UNIT IV: MAGNETOSTATICS

Magnetic force and cyclotron, Biot-Savart Law for magnetic fields, Magnetic field due to various current loops, Ampere's circuital law. Equation of Continuity, Magnetization in Materials.

UNIT V: INTRODUCTION TO ELECTRODYNAMICS

Introduction to time-varying fields, Faraday's law of induction, Generalization of Ampere's law. Maxwell's equations. Derivation of wave equation. Planar Waves in free space.

TEXTBOOKS/REFERENCES

1. Introduction to Electrodynamics –David J. Griffiths; 4th Edition, 2012, PHI Eastern economy editions.
2. Electricity and Magnetism- A. S. Mahajan and A. A. Rangwala, 1st Revised Edition, 2007, McGraw-Hill Education.

SEMESTER-II

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
PHY 221 L	Electricity and Magnetism Lab	BS	0	0	2	1

LIST OF EXPERIMENTS

1. To find the dielectric constant of the medium using parallel plate capacitor.
2. To find the band gap energy of a semi-conductor using Four-probe method.
3. To find the band gap energy of a semi-conductor using Four-probe method.
4. Find the magnetic field due to Helmholtz coils and verify its relation by varying the distance.
5. Use Faraday's law for finding the total magnetic flux through the coil.
6. To find the type and concentration of charge carriers using hall probe.
7. Verify the Biot-Savart law for a given circular coil.
8. To find the fill factor of a given solar cell using I-V characteristics.
9. To find the type of material using the deflection in magnetic field.
10. To study the Hysteresis curve for a given magnetic material.
11. Practice session I and remedial session.
12. Practice session II and remedial session
13. Model Exam.
14. Model Exam.
15. Model Exam.

SEMESTER-III

SEMESTER-III

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ENG 115	Engineering Mechanics	ES	3	0	0	3

UNIT I: STATICS OF PARTICLES AND RIGID BODIES

Forces on particles, Resolution of forces, Free body diagrams, Equilibrium of particles, Equilibrium of particles (Numerical Problems), Forces in a plane, Forces in space (Numerical Problems), Force equivalence, Force equivalence (Numerical Problems), Rigid body equilibrium, Rigid Body equilibrium (Numerical Problems).

UNIT II: FRICTION

Laws of friction, dry friction, wedge friction, rolling friction, Ladder friction.

UNIT III: ANALYSIS OF TRUSSES AND CENTROIDS

Types of loads, type of supports, reaction, Simple trusses, method of joints, Method of joints, Method of sections (Numerical Problems), Method of Joints (Numerical Problems), Center of gravity-lines, areas, Volumes, Determination of centroid-integration method, Determination of centroid-integration method (Numerical Problems).

UNIT IV: MOMENT OF INERTIAS OF SURFACE AND VOLUMES

Determination of moment of inertia using area integration method, Analytical method, radius of gyration, Polar moment of inertia, Moment of inertia of different sections.

UNIT V: DYNAMICS

Rectilinear motion, Projectile motion, Newtons second law of motion, Alembert's principle, Work, energy, Impulse momentum, Impact/collision of elastic bodies, Oblique impact, Curvilinear motion.

TEXTBOOKS/REFERENCES

1. Ferdinand. P. Beer. E, Russell Johnston Jr., David Mazurek, Philip J Cornwell, Vector. Mechanics for Engineers: Statics and Dynamics, McGraw - Hill, New Delhi, 10th Edition, 2013.
2. R.K.Bansal, Engineering Mechanics, Laxmi Publications Ltd, 2005.
3. Meriam J.L and Kraige L.G., Engineering Mechanics, Volume I - statics, Volume II - dynamics, John Wiley & Sons, New York, 7th Edition, 2012.
4. Timoshenko, Young, Engineering Mechanics, Tata Mc-Graw Hill Book Company, 5th Edition, New Delhi.

SEMESTER-III

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
CDC 221	Aptitude	HS	1	1	0	1

UNIT I

Percentages, profit and loss, SI and CI, Time and work, Average and progression.

UNIT II

Time – speed and distance, Number system and arrangements.

UNIT III

Ratio and proportions, Mixtures and Alligation, Direction problems, Direction problems, coding and decoding, Number series and Alphabet series.

UNIT IV

Antonyms, synonyms, odd words, Idioms and phrasal verbs, same word with different part of speech.

UNIT V

Word analogy. Sentence completion, Text completion, Sentence equivalence.

TEXTBOOKS/REFERENCES

1. Arun Sharma – How to prepare for Quantitative Aptitude, Tata Mcgraw Hill.
2. RsAgarwal,A Modern Approach to Verbal and Non Verbal Reasoning,S.Chand Publications.
3. Verbal Ability and Reading comprehension-Sharma and Upadhyay.
4. Charles Harrington Elstor, Verbal Advantage: Ten Easy Steps to a Powerful Vocabulary, Large Print, September 2000.
5. GRE Word List 3861 – GRE Words for High Verbal Score, 2016 Edition.
6. The Official Guide to the GRE-General Revised Test, 2nd Edition, Mc Graw Hill Publication.

SEMESTER-III

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
MAT 211	Linear Algebra	BS	3	0	0	3

UNIT I: MATRICES AND GAUSSIAN ELIMINATION

Introduction, Geometry of linear equations, Gaussian elimination, Matrix notation and matrix multiplication, Triangular factor and row exchanges, Inverses and transposes.

UNIT II: VECTOR SPACES

Vector spaces and subspaces, Solving $Ax=0$ and $Ax=b$, Linear independence, Basis and dimension, The four fundamental subspaces, Graphs and networks, Linear transformations.

UNIT III: ORTHOGONALITY

Orthogonal vectors and subspaces, Cosines and projections onto lines, Projection and least squares, Orthogonal bases, Gram-Schmidt.

UNIT IV: DETERMINANTS

Introduction, Properties of the determinant, Formulas for the determinant, Applications of determinants.

UNIT V: EIGENVALUES AND EIGENVECTORS

Introduction, Diagonalization of a matrix, Difference equations and power of A^k , Differential equations f or e^{At} , Complex matrices and similarity transformations.

TEXTBOOKS/REFERENCE

1. G. Strang, Linear Algebra and Its applications, Nelson Engineering, 4th Edn., 2007.
2. K. Hoffman and R. Kunze, Linear Algebra, Prentice Hall of India, 1996.
3. S. Axler, Linear Algebra Done Right, 2nd Edn., UTM, Springer, Indian edition, 2010

SEMESTER-III

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 141	Thermodynamics	C	3	0	0	3

UNIT I: BASIC CONCEPTS AND FIRST LAW OF THERMODYNAMICS

Basic concepts, Microscopic and macroscopic approach. Thermodynamic system and surrounding, Properties of a system, Intensive and extensive, Specific and total quantities, Path and point functions, Thermodynamic process, cycle and equilibrium, Quasi-static, Reversible and Irreversible processes, Heat and work transfer, displacement work, flow work and other modes of work, p-V diagram, Zeroth law of thermodynamics, concept of temperature, First law of thermodynamics, energy, enthalpy, specific heats, Application of first law, Tutorials, Control volume analysis, steady flow energy equation and its applications, Tutorials on steady flow energy equation.

UNIT II: SECOND LAW OF THERMODYNAMICS AND ENTROPY

Limitations of first law, cyclic heat engine, energy reservoirs, refrigerator and heat pump, Statements of second law and their equivalence, Reversibility and Irreversibility, causes of irreversibility, Carnot cycle, Reversed Carnot cycle, Carnot theorem, Tutorials based on second law of thermodynamics, Clausius theorem, Clausius inequality, Concept of entropy, T-s diagram, principle of increase of entropy, Entropy change of ideal gases and its evaluation, Introduction to energy.

UNIT III: PROPERTIES OF STEAM AND VAPOUR POWER CYCLE

Steam formation, properties of steam, Calculation of steam properties using steam tables and Mollier chart, Simple Rankine cycle. Flow diagram, p-v, T-s and h-s diagrams. Tutorials, Reheat cycle. Flow diagram, T-s and h-s diagrams. Tutorials, Regenerative cycle. Flow diagram, T-s and h-s diagrams. Tutorials, Dryness fraction measurements.

UNIT IV: FUELS AND COMBUSTION

Classification of fuels, combustion equations: theoretical and excess air, stoichiometric air fuel ratio. Tutorials on combustion, Volumetric analysis and gravimetric analysis, Tutorials on air-fuel ratio and analysis of products of combustion, Analysis of exhaust gas, Calorific value of fuels, Determination of calorific values.

UNIT V: THERMODYNAMIC RELATIONS

Maxwell equations, Tds equations. Equations for dH and dU, Tds equations. Equations for dH and dU, Difference in heat capacities, Joule-Thomson Co-efficient, Clausius-Clapeyron equation, Properties of Gas mixtures, Dalton's law of partial pressures, Properties of Gas mixtures- Tutorials.

TEXTBOOKS/REFERENCES

1. Kenneth A. Kroos, and Merle C. Potter, “*Thermodynamics for Engineers*”, SI Edition, 1st Edition, Cengage Learning India Pvt. Ltd., Delhi, 2015.
2. Mahesh M. Rathore, “*Thermal Engineering*”, Tata McGraw Hill Education Private Ltd., New Delhi, Reprint 2012.
3. Yunus. A Cengel and Michael A Boles, “*Thermodynamics – An Engineering Approach, 8th Edition*”, Tata McGraw Hill- Education, New Delhi, 2015.
4. Rayner Joel, “*Basic Engineering Thermodynamics*”, 5th Edition, Addison Wesley Longman Limited, First ISE reprint 1999.
5. William Z. Black, James G. Hartley, “*Thermodynamics*”, Pearson, 3rd Edition, 2010.
6. Michael J Moran, and Howard N Shapiro, “*Fundamentals of Engineering Thermodynamics*”, John Wiley & Sons, New York, 8th Edition, 2015.
7. Nag.P.K, “*Engineering Thermodynamics*”, Tata McGraw Hill Education, New Delhi, 5th Edition, 2013.

SEMESTER-III

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 141 L	Thermodynamics lab	C	0	0	2	1

LIST OF EXPERIMENTS

1. Valve timing diagram for four stroke diesel or petrol engines.
2. Port timing of a two stroke petrol engine.
3. Reciprocating air compressor.
4. Determination of cop of a refrigeration system
5. Study of steam boilers.
Part I: introduction to the types of steam boilers
Part II: study of various types of boilers.
Part III: study of boiler mountings & accessories
6. Performance test on ac test rig.
7. Demonstration of various parts of bmw engine.

SEMESTER-III

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 121	Material Science and Metallurgy	C	3	0	0	3

UNIT I: METAL STRUCTURE

Crystal structures, Elastic-plastic behavior, Deformation mechanisms, Slip, twinning Imperfections, Types of fracture, Three Stages in creep, Fatigue mechanism.

UNIT II: MATERIAL PROPERTIES

Testing of metals, Properties, strength, plasticity, stiffness, Properties, toughness, brittleness, ductility, Hardness, Creep and fatigue tests.

UNIT III: HEAT TREATMENT

Solidification, crystal growth, rule, Phase diagram, Gibbs Phase rule, Equilibrium diagrams, lever rule, Iron Carbon diagram, solidification of steel and cast irons. Heat treatment, TTT curves, annealing, normalizing, hardening, tempering, induction hardening, age hardening. Martempering, austempering, carburising, cyaniding, nitriding, flame and induction hareneng, age hardening. Ferrous, Non-ferrous metals, Cast Iron, Steel, Copper, Aluminium alloys.

UNIT IV: COMPOSITE MATERIALS

Composites, Fibre reinforced composites, Manufacturing methods, Metal matrix composites.

UNIT V: POWDER METALLURGY

Powder metallurgy: Powder characterization, size analysis, compaction and sintering, Manufacturing methods: Mechanical, chemical and physical, Additive manufacturing.

TEXTBOOKS/REFERENCES

1. Willium D Callister, “ Material Science and Engineering” John Wiley and Sons, 2014 edition.
2. U.C.Jindal , “Material Science and Metallurgy “ U.C.Jindal, Pearson Publication, 2011 edition.
3. Allen Cottrell “Introduction to Metallurgy” University Press, 2000 edition.
4. R. Srinivasan “Engineering materials and metallurgy”, McGraw Hill, 2009 edition.
5. Anish Upadhya and G S Upadhaya, “Powder Metallurgy: Science, Technology and Materials, Universities Press, 2011.

SEMESTER-III

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 121 L	Material Science and Metallurgy Lab	C	0	0	2	1

LIST OF EXPERIMENTS

1. Introduction.
2. Polish the samples until one can see the microscopic phases clearly.
3. To determine the hardness of the given Specimen using Vicker's hardness test.
4. To find the Brinell Hardness number for the given metal specimen.
5. To determine the Rockwell hardness number of the given specimen.
6. Heat treat given materials at different levels.
7. Study micrographs of differently heat-treated materials and compare them.
8. Measure the hardness of given materials using End Quench hardness tester.
9. Mini project-Design of heat cycle to improve properties of given alloy.

SEMESTER-III

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 171	Kinematics and Mechanisms	C	3	0	0	3

UNIT I: MECHANISMS

Introduction to mechanism and its elements. Degrees of freedom, its application in different mechanism. Four Bar Chain, Grashof's law, Kutzbach's and Gruebler's criterion, Inversion of kinematic chain: Four bar chain, Single and double slider crank chain, Velocity analysis of Four bar mechanism by relative velocity (RV) method. Tutorial on velocity analysis of single slider crank mechanism. Tutorial on velocity analysis of six bar linkages. Acceleration analysis of Four bar mechanism by relative velocity method. Tutorial on acceleration analysis of single slider crank and six bar linkages. Instantaneous center (IC) method, Kennedy's theorem. Tutorial on velocity analysis for different mechanisms by IC method.

UNIT II: FORCE ANALYSIS AND FLYWHEELS

Inertia forces, D'Alembert's principle, Velocity and acceleration of the reciprocating parts in Engines, Tutorial on derivation and calculation of gas forces, dynamically equivalent systems, Tutorial on determination of equivalent system for connecting rod, turning moment diagram (TMD) for different engines, Fluctuation of energy (ΔE), coefficient of fluctuation of energy, Tutorial on calculation of ΔE using TMD and torque equations, Tutorial on flywheel applications.

UNIT III: BALANCING

Need for balancing, Static and dynamic balancing of rotating masses. Tutorial on balancing of several masses rotating in same plane by analytical and graphical methods, Construction of force and couple polygon, Tutorial on balancing of several masses rotating in different planes using couple and force polygon, Partial balancing of reciprocating masses, Tutorial on effects of partial balancing in locomotives, balancing of in-line engines, Balancing of V engines, Balancing of radial engines.

UNIT IV: CAMS

Cam terminology, types of cams and followers, Types of follower motion and its derivatives, under cutting, Displacement, velocity and acceleration for different follower motion, Tutorial on construction of cam profile for radial follower with different motion, Tutorial on construction of cam profile for offset follower, with different motion, Cams with special contours, Tutorial on velocity and acceleration for cams with specified contours.

UNIT V: GEAR, GEAR TRAINS AND GYROSCOPES

Gear terminology, types, law of gearing, Tutorial on path of contact, arc of contact, sliding velocity, Minimum number of teeth, Interference and under cutting, Gear train, types and applications, Tutorial on velocity ratio, torque calculations in epicyclic gear train, Introduction to automobile differential, Gyroscopic forces, couple, precessional angular motion, Gyroscopic effects on airplane and ship, Tutorial on gyroscopic effect on two and four wheelers.

TEXTBOOKS/REFERENCES

1. Rattan, S. S, “*Theory of Machines*”, McGrawHill Education, 4th edition, 2015.
2. John J Uicker, Gordon R Pennock, Joseph E Shigley, “*Theory of Machines and Mechanisms*”, Oxford University Press, 4th Edition, 2014.
3. Thomas Bevan, “*The Theory of Machines*”, Pearson India Education Services Pvt. Ltd., 3rd Edition, 2010.
4. Robert L Norton, “*Design of machinery - An introduction to the synthesis and analysis of mechanisms and machines*”, McGrawHill Education, 5th edition, 2011.
5. William Cleghorn, Nikolai Dechev, “*Mechanics of Machines*”, Oxford University Press, 2nd Edition, 2014.
6. George H Martin, “*Kinematics and Dynamics of Machines*”, Waveland Press, Inc., 2nd Edition, 2002.
7. G H Ryder, MDBennett, “*Mechanics of Machines*”, Macmillan Education Ltd., 2nd Edition, 1990.

SEMESTER-III

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 171 L	Kinematics and Mechanisms Lab	C	0	0	2	1

LIST OF EXPERIMENTS

1. Analysis of Cam and Follower.
2. Dynamic analysis of Epi-cyclic gear trains.
3. Dynamic analysis of Gyroscope.
4. Dynamic analysis of Porter Governor.
5. Dynamic analysis of Prolegomenon.
6. Dynamic Balancing of rotating masses.
7. Dynamic Balancing of reciprocating masses.
8. Measurement of cutting forces in Drilling, turning and Milling using Dynamometers.
9. Study of Free Vibration of helical springs.
10. Free damped and un-damped torsional vibration of single rotor systems.
11. Free & forced vibration of equivalent spring mass system.
12. Transmissibility Ratio in Vibrating Systems.
13. Free and forced transverse vibration analysis for beams.
14. Whirling of shaft.
15. Vibration measurement using strain gauge.
16. Free vibration analysis with Impact hammer.
17. Forced vibration analysis with exciter.
18. Transmission loss analysis using Sound level meter.

SEMESTER-III

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
CSE 230	Industry Standard Coding Practice-I	ES	0	0	4	1

UNIT I

Problem Solving with - Basic coding practices, Expression Evaluation, Operators Usage, Expressions, Control Structures, Loop & Iterations for all test case scenarios.

UNIT II

Problem Solving using time efficient logics, linear list data, Array problems, 2D Arrays and Matrix Data for all test case scenarios.

UNIT III

Problem Solving with - Pointers & Memory referencing, String Handling, functions for all test case scenarios.

UNIT IV

Problem Solving with - parameter passing, Recursions, Recursion Analysis, Structures and unions, Enumerations & Memory allocation for all test case scenarios.

UNIT V

Problem solving with - String manipulations. Lists, display patterns, strings, matrix, tuples, dictionaries, modules, packages, exception handling using Python.

TEXTBOOKS/REFERENCES

1. Problem solving with C++ -9e- Walter Savitch – Pearson.
2. The complete Reference C, Fourth REdition – Herbert Schildt – MC Graw Hill.
3. Programming in Python 3, A complete introduction to Python language - 2e - Mark Summerfield – Addison-Wiley.

SEMESTER-IV

SEMESTER-IV

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 221	Elements of Structure	C	3	0	0	3

UNIT I: CONCEPT OF STRESSES AND STRAINS

Concept of stress and strain, Hooke's law, Tensile, compressive, and shear stresses, Poisson's ratio. Elastic constants and their relationship, volumetric strain, bars of uniform and varying sections subjected to single load and varying loads. Tutorial on stress, stress, Hooke's law, elastic constants and volumetric strain, bars of uniform and varying sections subjected to single load and varying loads. Analysis of bars of composite sections & Tutorial. Concept of Thermal stresses in simple and composite bars & Tutorial. Principal plane, principal stress, Analytical method: Direct stress in two mutually perpendicular directions accompanied by a simple shear stress & Tutorial. Mohr's circle: direct stress in two mutually perpendicular directions with and without shear stress & Tutorial.

UNIT II: ANALYSIS OF BEAMS

Introduction to types of beams and loads, Shear force and bending moment diagrams for cantilever beam due to pure point load, pure Uniformly Distributed Load (UDL), pure Uniformly Varying Load (UVL) & Tutorial. Shear force and bending moment diagrams for simply supported beam due to pure point load, pure UDL, pure UVL & Tutorial. Shear force and bending moment diagrams for overhanging beam due to pure point load, pure UDL, pure UVL & Tutorial. Theory of pure bending derivation and bending stress in simple beams of sections having at-least one axis of symmetry & Tutorial. Tutorial on bending stress in simple beams sections having at-least one axis of symmetry & Tutorial. Derivation of shear stress distribution in beams of different sections (rectangular, circular), having at-least one axis of symmetry & Tutorial.

UNIT III: TORSION OF SHAFTS

Theory of pure torsion, derivation of shear stress produced in terms of torque in a circular shaft. Strength, stiffness of shaft and Torsional rigidity & power transmitted. Tutorial on solid shaft, finding the dimensions. Expression for torque in terms of polar moment of inertia in a circular shaft subjected to torsion. Tutorial on hollow shaft, finding dimensions, percentage of material savings. Circular shafts in series and parallel & Tutorial. Concepts on Strain energy due to torsion & Tutorial. Circular shaft subjected to combined bending and torsion & Tutorial. Composite Shaft & Tutorial.

UNIT IV: DEFLECTION OF BEAMS

Relationship between deflection, slope, radius of curvature, shear force and bending moment & Tutorial. Slope and deflection of cantilever beam with a point load, UDL by Double integration method & tutorial. Slope and deflection of simply supported beam with a point load, UDL by Double integration method & tutorial. Slope and deflection of simply supported beam with an eccentric, point load, UDL by Macaulay's method & tutorial. Slope and deflection of cantilever beam and simply supported beam with point load and UDL by moment area method & tutorial. Castigliano's theorem & tutorial.

UNIT V: COLUMNS AND CYLINDERS

Columns and struts, Members subjected to combined bending and axial loads, Expression for crippling load with different end conditions based on Euler's theory & tutorial. Rankine's theory & tutorial. Thin cylindrical shells subjected to internal pressure, change in dimensions of thin cylindrical shells due to internal pressure & tutorial. Thin spherical shells subjected internal pressure, change in dimensions of thin spherical shells due to internal pressure & tutorial. Lamé's theory on stresses in Thick cylinders & tutorial. Stresses in compound thick cylinder and Shrink fit & tutorial.

TEXTBOOKS/REFERENCES

1. Ferdinand P. Beer, E. Russell Johnston Jr., John T. DeWolf, David F. Mazurek," *Mechanics of Materials*", 7th Edition, McGraw Hill, 2014.
2. William A. Nash, "*Theory and Problems of Strength of Materials*", Schaum's Outline Series, McGraw Hill International Edition, 3rd Edition, 2007.
3. Egor P. Popov, "*Engineering Mechanics of Solids*", 2nd edition, Prentice Hall of India Private Limited, New Delhi, 2009.
4. James M. Gere,"*Mechanics of Materials*", Eighth Edition, Brooks/Cole, USA, 2013.
5. Shigley. J. E, "Applied Mechanics of Materials", International Student Edition, McGraw Hill Koyakusha Limited, 2000.

SEMESTER-IV

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 221 L	Elements of Structure Lab	C	0	0	2	1

LIST OF EXPERIMENTS

1. Tensile test on Mild steel rod.
2. Compression test of Concrete cubes and cylinders.
3. Test on open coil and closed coil Helical springs.
4. Izod & Charpy impact test.
5. Torsion test on Graded steels.
6. Deflection test on beams of different materials using Maxwell reciprocal theorem.
7. Double shear test on metallic materials.
8. Rockwell & Brinell hardness test of metallic materials.
9. Bend test of metallic rods.
10. Fatigue testing of materials under notched and unnotched conditions.
11. Comparison of mechanical properties of Unhardened, Quenched and tempered specimen.
12. Strain measurement on rods and beams.
13. Study on photo elasticity.
14. Buckling analysis.
15. Creep Test.

SEMESTER-IV

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
MAT 131	Differential Equations	BS	3	0	0	3

UNIT I: FIRST ORDER DIFFERENTIAL EQUATIONS

Geometric meaning of $y' = f(x, y)$, Direction Fields, Euler's Method, Classification of ODEs (Linear, Non-linear, Exact, Separable), Integrating Factor, Bernoulli Equations, Initial Value Problem, Modelling (Free falling object, Radioactivity, RL-circuit).

UNIT II: SECOND AND HIGHER ORDER LINEAR ODES

Homogeneous Linear ODEs, Modelling of Free Oscillations of a Mass-Spring System, Euler-Cauchy Equations, Non-homogeneous ODEs, Variation of Parameters, Modelling (Forced Oscillations, Electric Circuits).

UNIT III: SYSTEM OF ODES

Modelling Engineering problems (Electric Network, Mixing problem in two tanks etc.) as systems of ODEs, Wronskian, Phase-Plane Method, Critical Points & Stability, Qualitative Methods for Nonlinear Systems, Nonhomogeneous Linear Systems of ODEs.

UNIT IV: SERIES SOLUTIONS OF ODES

Introduction to power series method, Legendre's equation & polynomials, Frobenius Method, Bessel's Equations & Functions.

UNIT V: LAPLACE TRANSFORMS

Laplace transforms of standard functions, Shifting Theorems, transforms of derivatives and integrals, Unit step function, Dirac's delta function, Inverse Laplace transforms, Convolution theorem (without proof), Application: Solutions of ordinary differential equations using Laplace transforms.

TEXTBOOKS

1. William Boyce and Richard DiPrima, Elementary Differential Equations and Boundary Value Problems, 11th Edition, Wiley-India.
2. Erwin Kreyszig Advanced Engineering Mathematics, 10th Edition, Wiley-India.
3. Mary L. Boas, Mathematical Methods in Physical Sciences, 3rd Edition, Wiley-India.

REFERENCES

1. Mary L. Boas, Mathematical Methods in Physical Sciences, 3rd Edition, Wiley-India.
2. S. Vaidyanathan, Advanced Applicable Engineering Mathematics, CBS Publishers.

SEMESTER-IV

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 222	Fluid Mechanics	C	3	0	0	3

UNIT I: PROPERTIES OF FLUIDS AND FLUIDSTATICS

Properties of fluids: density, specific weight, specific volume, specific gravity, vapour pressure. Viscosity: Dynamic and Kinematic viscosity, Newton's law of viscosity, factors affecting viscosity. Types of fluids, Tutorial-Problems on fluid properties. Surface tension, compressibility and bulk modulus concepts. Fluid statics- Pascal's law, Hydrostatic law. Manometry: Types of manometers, Piezometer, U-tube Manometer. Tutorials on manometers.

UNIT II: FLUID KINEMATICS AND DYNAMICS

Types of flow, Lagrangian and Eulerian approach Velocity and Acceleration of fluid particle, Tutorial problems on Velocity and Acceleration of fluid particle. Fluid flow pattern: Streamline, streak line, path line. Continuity equation Fluid dynamics: Euler's equation of motion, Bernoulli's Equation. Applications of Bernoulli's equation in flow measurement Devices: Venturi meter, Orifice meter, Pitot tube, nozzle flow meter, Impulse momentum equation.

UNIT III: DIMENSIONAL ANALYSIS AND FLOW THROUGH PIPES

Dimensional analysis: Dimensions Dimensional homogeneity. Rayleigh method, Buckingham's Pi-theorem, non-dimensional analysis. Model analysis: Advantages and applications of model testing, Similitude. Dimensionless number: Reynold's number, Froude's number, Euler's number, Weber number, Mach number. Reynold's model law – Problems, Froude's model law – Problems Euler's model law, Weber model law and Mach model law Laminar and Turbulent flow, Reynold's experiment, Flow through circular pipes –Hagen Poiseuille law. Turbulent flow – Derivation of Darcy Welsbach equation, Tutorial – Problems on Darcy Welsbach equation. Minor loss due to sudden enlargement, sudden contraction, inlet and exit of pipes, problems. Flow through pipes in series and parallel – problems.

UNIT IV: HYDRAULIC MACHINES

Hydraulic turbines- classification, Impulse and reaction turbine. Design parameters and performance of Pelton turbine. Design parameters and performance of Francis turbine. Design parameters and performance of Kaplan turbine. Classification of pumps; Positive-displacement and non-positive pumps. Centrifugal pump, Performance curves and velocity triangles. Cavitation's in pumps, Thomas's cavitation number.

UNIT V: BOUNDARY LAYER THEORY

Boundary layer theory: laminar and turbulent boundary layer over a flat plate. Displacement, Momentum, Energy thickness: derivations and problems. Momentum integral equation derivation Separation of flow over bodies: stream lined and bluff bodies, Flow over cylinders. Aerofoil description, definition of parameters involved in aerofoil, velocity and pressure acting over the aerofoil.

TEXTBOOKS/REFERENCES

1. Robert W. Fox, Alan T. McDonald, Philip J. Pritchard, “*Introduction to Fluid Mechanics*”, Wiley, 8th Edition, 2013.
2. Frank M.White, “*Fluid Mechanics*”, McGraw-Hill, 7th Edition, New Delhi, 2011.
3. Irving H.Shames, “*Mechanics of Fluids*”, McGraw Hill, 3rd Edition, 2014.
4. Yunus A Cengel& John M. Cimbala, *Fluid Mechanics*, Tata McGraw Hill Edition, New Delhi, 3rd Edition, 2015.
5. Modi P.N, & Seth S.M, “*Hydraulics and Fluid Mechanics*”, Standard Book House, New Delhi, 20th Edition, 2015.

SEMESTER-IV

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 222 L	Fluid Mechanics Lab	C	0	0	2	1

LIST OF EXPERIMENTS

1. Experiment on venturi meter
2. Reynolds flow apparatus
3. Experiment on orifice meter
4. Experiment on loss of head in pipe fittings - minor losses
5. Experiment on friction in pipes – major losses
6. Impact of jet on vanes
7. Free vortex flow experimental setup
8. Pitot tube
9. Bernoulli's theorem apparatus

SEMESTER-IV

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ENV 111	Environmental Science	BS	2	0	0	2

UNIT I: ENVIRONMENTAL EDUCATION & SUSTAINABILITY

What is environmental education (EE)? The evolution of EE, Principles of Sustainability, Sustainable technologies.

UNIT II: ECOLOGICAL SYSTEM

Earth Systems – atmosphere, Earth Systems – Hydrosphere, Earth Systems – Lithosphere, Earth Systems – Biosphere, Ecosystems - Structure and Function, Major Biomes, Water, nutrients (phosphorous, nitrogen) and Carbon cycles.

UNIT III: ENVIRONMENTAL POLLUTION- ITS ROLE ON GLOBAL CLIMATE CHANGE AND HUMAN HEALTH

Air pollution – composition of air, sources of pollution and their classification, Air pollutants – classifications, Air Quality Index (AQI), Air pollution control devices, Water pollution - Water sources, use and classifications, Water pollutants, Water pollution control devices.

UNIT IV: BIODIVERSITY & ITS CONSERVATION

Biodiversity – definition and types, Concepts of species richness, evenness, and their regulation. Species diversity cline, Island biogeography – equilibrium model, Vulnerability of island species, Conservation Biology – Historical perspective of extinction, Difference between past extinction and present, Biodiversity Hotspots – global distribution, Values of Biodiversity – Why do we care? World’s Biodiversity is in serious trouble – frogs as global “canaries of mines” Human impacts on biodiversity – Habitat destruction, Pollution, Ecosystem disruption, Habitat fragmentation, over exploitation, and introduction of invasive species, Preservation of endangered species.

UNIT V: ENVIRONMENTAL ETHICS, ECONOMICS, AND POLICY

Concepts of Sustainable ethics – Frontierism, Leopold’s Land Ethics, and transition to Sustainable ethics, Principles of Sustainable ethics, Frontier ethics vs sustainable ethics, Developing and implementing sustainable ethics and overcoming the obstacles of sustainable ethics, utilitarianism and natural rights, Fundamentals of Environmental Economics – concepts of resources, Capital, Supply, Demand, and Market equilibrium, Classical Economics, Neoclassical economics, Ecological Economics and Externalization of costs, Ecosystem Services – Can we internalize all costs? Resource depletion, Hubbert Curve, and Carbon bubble, Scarcity and innovation, Economic models for growth, Measuring growth – GNP, GDP, GPI, Cost-Benefit Analysis. Can market reduce pollution? – Carbon credit, Environmental Policies – international laws and policies. Environmental Laws and Policies of India.

TEXTBOOKS/REFERENCES

1. Basu. M, Xavier. S. “*Fundamentals of Environmental Studies*”, 1st edition, Cambridge University Press, 2016.
2. Danial. D. C. “*Environmental Science*”, 8th edition, Jones and Barlett Publishers, MA, 2010.
3. Raven P. Biology – 11th Edition, McGraw hill.
4. Cunningham and Cunningham. Environmental Science – A global concern Tata McGraw-Hill Education India.

SEMESTER-IV

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ENV 111 L	Environmental Science Lab	BS	2	0	0	1

LIST OF EXPERIMENTS

1. Water parameters- Test for alkalinity and turbidity of water.
2. Determination of dissolved oxygen in water.
3. Test for total suspended solids and total dissolved solids.
4. Determination of total hardness of water by EDTA titration.
5. Determination of biological oxygen demand of wastewater.
6. Determination of chemical oxygen demand of wastewater.
7. Test for iron content in river water.

SEMESTER-IV

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 405	Mechanics of Composite Materials	TE	3	0	0	3

UNIT I: INTRODUCTION

Definition, Need, General characteristics, Applications, Fibers-Glass, Carbon, Ceramic and Aramid fibers, Polymer Matrices, Ceramic Matrices, Metal Matrices, Characteristics of fibers and matrices, Smart materials, types and characteristics.

UNIT II: MECHANICS AND PERFORMANCE

Characteristics of fiber reinforced Lamina, Laminates, Interlaminar stresses, Static Mechanical Properties, Fatigue and Impact properties, Environmental effects, Fracture Behavior and Damage Tolerance.

UNIT III: MANUFACTURING

Bag Moulding, Compression moulding, Pultrusion, Filament winding, Other Manufacturing Processes, Quality Inspection method.

UNIT IV: ANALYSIS

Analysis of an orthographic lamina, Hooke's law, stiffness and compliance matrices, Strengths of orthographic lamina, Stress analysis of laminated composite Beams, Stress analysis of laminated composite Plates, Stress analysis of laminated composite Shells, Free vibration.

UNIT V: DESIGN

Failure predictions in a Unidirectional Lamina, Failure predictions for Unnotched Laminates, Laminated Design Consideration, Bolted and Bonded Joints, Design examples.

TEXTBOOKS

1. Mallick, P.K., "*Fibre Reinforced composites: Materials*", Manufacturing and Design: Marcel DekkerInc., 1993.
2. Halpin, J.C., "*Primer on Composite Materials, Analysis*", Techomic Publishing Co., 1984.
3. Agarwal, B.D., and Broutman L.J., "*Analysis and Performance of Fibre Composites*", John Wiley andSons, New York, 1990.
4. Malick, P.K. and Newman S., (eds), "*Composite Materials Technology: Processes and Properties*",Hansen Publisher, Munich, 1990.

SEMESTER-IV

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 223	Alternate Energy Sources	TE	3	0	0	3

UNIT I: SOLAR ENERGY

Solar radiation and its measurements, Types of solar thermal collectors, Solar thermal applications for water heaters, solar stills and solar pond. Solar thermal applications for refrigeration and air- conditioning system. Solar thermal applications for solar dryer, solar cookers and solar furnaces. Sensible and latent heat thermal energy storage systems. Solar thermal power generation systems, Solar photovoltaic systems: basic working principle and components, Applications of solar photovoltaic systems.

UNIT II: WIND ENERGY

Basic principle of wind energy conversion system. Wind data, site selection and energy estimation. Components of wind energy conversion systems. Types of Horizontal axis and Vertical axis wind turbine. Design consideration of horizontal axis wind turbine. Aerofoil theory Analysis of aerodynamic forces acting on the blade. Performance of wind turbines. Introduction to solar and wind hybrid energy systems, environmental issues of wind energy.

UNIT III: OCEAN, HYDRO AND GEOTHERMAL ENERGY

Wave characteristics and wave energy, Tidal energy and its types, Estimation of energy and power in single basin tidal system, Ocean thermal energy conversion for open system. Ocean thermal energy conversion for closed system. Hydro power plants for small, mini and micro system. Exploration of geothermal energy. Geothermal power plants. Challenges, availability, geographical distribution, scope and economics for geothermal plant.

UNIT IV: BIOMASS

Sources of biomass, Pyrolysis, combustion and gasification process, Updraft and downdraft gasifier. Fluidized bed gasifier. Fermentation and digestion process. Fixed and floating digester biogas plants. Design considerations of digester. Operational parameter of biogas plants. Economics of biomass power generation.

UNIT V: DIRECT ENERGY CONVERSION SYSTEMS

Basic principle of thermo electric and thermionic power generations, Fuel cell principles and its classification, Phosphoric acid fuel cell, polymer electrolyte membrane fuel cell, molten carbonate fuel cell and solid oxide fuel cell, Fuel cell conversion efficiency, applications of fuel cell, Magneto hydrodynamic power generation for open cycle, Magneto hydrodynamic power generation for closed cycle, Hydrogen energy: properties and its production methods, Electrolysis, thermo-chemical methods, fossil fuel methods and solar energy methods, Hydrogen storage, transportation and applications.

TEXTBOOKS/REFERENCES

1. Tiwari.G.N, Ghosal.M.K, “Fundamentals of renewable energy sources”,1st Edition, UK, Alpha Science International Ltd, 2007.
2. Godfrey Boyle, “Renewable energy”, 2nd Edition, Oxford University Press, 2010.
3. Twidell.J.W and Weir.A.D, “Renewable Energy Resources”,1st Edition, UK,E.&F.N. Spon Ltd, 2006.
4. Domkundwar.V.M, Domkundwar. A.V, “Solar energy and Non-conventional sources of energy”, Dhanpat rai & Co. (P) Ltd, 1st Edition, New Delhi, 2010.
5. G.D Rai, “Non-Conventional Energy Sources”, Khanna Publishers, 5th Edition, New Delhi, 2011.
6. B.H Khan, “Non-conventional Energy Resources”, 2nd Edition, New Delhi, Tata McGraw Hill, 2009.
7. S.P. Sukatme, J.K. Mayak, “Solar Energy-Principles of thermal collection and storage”, 3rd edition, New delhi, McGraw Hill,2008.

SEMESTER-IV

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ISES 212	Industry Specific Employability Skills-IV	HS	1	1	0	1

UNIT I

Permutation and Combination, Probability, Geometry, and Algebra.

UNIT II

Clocks, Calendars and Blood Relations, Arrangements, Cubes and Syllogism.

UNIT III

Introduction to Different Parts of an Argument in Reasoning, Assumption of an Argument Strengthening of an Argument, Weakening of an argument, Para jumbles.

UNIT IV

Word Analogy, Sentence Completion & Text Completion, Sentence Equivalence.

UNIT V

Reading Comprehension, Identification of errors, Sentence correction.

TEXTBOOKS/REFERENCES

1. Arun Sharma – How to prepare for Quantitative Aptitude, Tata Mcgraw Hill.
2. RsAgarwal,A Modern Approach to Verbal and Non Verbal Reasoning,S.Chand Publications.
3. Verbal Ability and Reading comprehension-Sharma and Upadhyay.
4. Manhattan GMAT Sentence Correction Guide, 5th Edition.
5. R.S.Aggarwal, A Modern Approach to Verbal & Non-Verbal Reasoning. S.Chand Publications.
6. The Official Guide to the GRE-General Revised Test, 2nd Edition, Mc Graw Hill Publication.

SEMESTER-IV

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
CSE 330	Industry Standard Coding Practice-2	ES	0	0	4	1

UNIT I

Problems Solving with: Structure Pointers, formation of links, Operations on Linked lists, Operations on a circular linked list, Operations on a double linked list & Industry Standard Practice Questions.

UNIT II

Problem Solving with - Stack Operations, Queue data structure Implementation, Linear / Binary Search Algorithms, Sorting Algorithms, Industry Standard Practice Questions.

UNIT III

Problem Solving with - Nonlinear data structures, trees operations, application of search property on a binary tree, tree balancing.

UNIT IV

Problem Solving with - Multiway search structures, Operations on a 2-4 tree, nonlinear structures, red, black trees & operations, Tries, String Algorithms & Industry Standard Practice Questions.

UNIT V

Problem Solving with – features of Object-oriented programming, leveraging Standard Template Libraries. Industry Standards of leveraging DBMS concepts, SQL Queries, Entity Relationship Models, Query Optimization, Transactions & Concurrency, Normalization & Industry Standard Practice Questions.

TEXTBOOKS/REFERENCES

1. Fundamentals of Data Structures in C++ - 2e- Sahni Horowitz - Universities Press.
2. Algorithms -4e- Robert Sedgewick & Kevin Wayne - Addison-Wesley Professional.
3. C++ Standard Library A Tutorial and Reference – 2e - Nicolai M. Josuttis - Addison Wesley Longman
4. An Introduction to Database Systems – 8e - C.J. Date – Pearson.
5. Competitive Programming – 3e – Steven Halim, Felix Halim

SEMESTER-V

SEMESTER-V

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 321	Fluid Machinery	C	3	0	0	3

UNIT I: HYDRAULIC POWER GENERATING AND UTILIZING SYSTEMS

Introduction to fluid power system, Hydraulic fluids functions, types, properties, selection and application. POWER GENERATING ELEMENTS: Construction, operation, characteristics of External Gear pump, internal Gear pump. Construction, operation, characteristics of Lobe, Gerotor and Screw pumps. Construction, operation, characteristics of Un balanced and balanced vane pump. Construction, operation, characteristics of pressure compensated vane pump. Construction, operation, characteristics of bent axis piston pump, swash plate piston pump and Radial Piston Pump. Construction and working of single acting, double acting hydraulic linear actuators. Special cylinders: Tandem, Rodless, Telescopic, Cushioning arrangement for cylinders to reduce the impact on the cylinders, Various cylinder mountings, Construction and working of Gear, Vane, Piston motors to obtain rotary motion.

UNIT II: HYDRAULIC VALVES AND ACCESSORIES

Construction and working of manually operated 2/2, 3/2, 4/2,4/3, directional control valves, construction and working of pilot and solenoid operated 2/2, 3/2, 4/2, 4/3, directional control valves. Construction and working of pressure relief, compound pressure relief, pressure sequence valves. Construction and working of pressure reducing, counterbalance valves. Working principle of check valve, throttle valve, one way FCV, pressure compensated FCV, and their applications. Importance of proportional valves, Servo valves and its applications. Need for intensifier in hydraulic systems, applications. Different switches, filters, seals, fittings and other accessories used in hydraulic systems, Functions, types and applications of accumulators in Hydraulics.

UNIT III: PNEUMATIC SYSTEMS

Introduction, comparison with hydraulic systems and electrical systems, Construction, operation, characteristics and symbols of reciprocating and rotary compressors. Construction, operation, characteristics and symbols of 3/2, 5/2, 5/3 manual operated, pilot operated and solenoid operated DCVs. Need for air treatment, Filter, Regulator, Lubricator, Muffler and Dryers. Introduction to fluidic devices, working of Bi-stable, mono- stable devices and application circuits. Introduction to Electro Pneumatics, logic circuits, constructing electrical ladder diagrams for various fluid power applications.

UNIT IV: DESIGN OF FLUID POWER SYSTEMS

Speed, force and time calculations in fluid power systems, Calculation of pressure and pressure drop across components in fluid power circuits, Sizing of actuators, pumps, reservoirs for specific requirement Finding the capacity (Sizing) of accumulators required for hydraulic systems, Calculations on Heat generation in fluid. Design of hydraulic/pneumatic circuit for a practical application Selection of different components such as reservoir, various valves, actuators, filters, pumps based on design. Design of hydraulic/pneumatic circuits for simple reciprocation, regenerative, speed control of actuators. Design of hydraulic/pneumatic circuits for sequencing, synchronization and

transverse. Cascading circuits for two and three cylinders, Fail-safe circuit, counterbalance circuit, actuator locking.

UNIT V: APPLICATIONS, MAINTENANCE AND TROUBLE SHOOTING

Industrial hydraulic circuits for riveting machine, actuator locking Working of hydraulic press and pump unloading circuits, Hydraulic/ pneumatic circuits for material handling systems. Preventive and breakdown, maintenance procedures in fluid power systems. Trouble shooting of fluid power systems, fault finding process equipment's / tools used, causes and remedies. Safety aspects involved fluid power systems.

TEXTBOOKS/REFERENCES

1. Anthony Esposito, "*Fluid Power with applications*", Prentice Hall International, 2009.
2. Majumdar.S.R, "*Oil Hydraulic Systems: Principles and Maintenance*", Tata McGraw Hill, 2006.
3. Majumdar.S.R, "*Pneumatic systems – principles and maintenance*", Tata McGraw-Hill, New Delhi, 2006.
4. Werner Deppert / Kurt Stoll, "*Pneumatic Application: Mechanization and Automation by Pneumatic Control*", Vogel verlag, 1986.
5. John Pippenger, Tyler Hicks, "*Industrial Hydraulics*", McGraw Hill International Edition, 1987.
6. Andrew Parr, "*Hydraulics and Pneumatics: A technician's and engineer's guide*", Elsevier Ltd, 2011.
7. FESTO manual, "*Fundamentals of Pneumatics*", Vol I, II and III.
8. Hehn Anton, H., "*Fluid Power Trouble Shooting*", Marcel Dekker Inc., NewYork, 1995.
9. Thomson, "*Introduction to Fluid power*", Prentice Hall, 2004.

SEMESTER-V

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 321 L	Fluid Machinery Lab	C	0	0	2	1

LIST OF EXPERIMENTS

1. Performance test on axial flow fan.
2. Performance test on centrifugal pump (variable speed) test rig.
3. Performance test on centrifugal pump for series operation.
4. Performance test on centrifugal pump for parallel operation.
5. Performance test on reciprocating pump operation.
6. Performance test on pelton wheel turbine.
7. Performance test on francis turbine.

SEMESTER-V

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 224	Machine Design	C	3	0	0	3

UNIT I: FUNDAMENTALS OF MECHANICAL DESIGN

Basic definitions, types of design, Criteria for Design based on strength, fatigue, stiffness, wear, resistance, vibration resistance, heat resistance and reliability. Overview of Engineering materials, Theories of failure, Rankine theory, Guest's theory, St. Venant's theory, Maximum strain, energy theory and Distortion energy theory. Problems on Theories of failure, Design of members subjected to combined stresses with eccentric load, Problems on combined stresses with eccentric load, Eccentric loading in curved beams, crane hooks, frames, clamps.

UNIT II: DESIGN FOR VARIABLE STRESSES

Members subjected to variable stresses, Failure and endurance limit. Stress concentration, Methods of reducing stress concentration, Notch sensitivity. Combined steady and variable stresses. Problems on variable stresses using Soderberg method. Problems on variable stresses using Gerber method. Problems on variable stresses using Goodman method. Members subjected to impact loads; Members subjected to dynamic loads.

UNIT III: DESIGN OF SHAFTS AND TEMPORARY JOINTS

Shafts: Types, Materials, Manufacturing and stresses, Design for Strength based on twisting moment, bending moment and combination of axial, bending and torsional loads, Cotter joints: Types, design procedure and problems on Socket and spigot cotter joint. Knuckle joints: Design procedure and problems on knuckle joint. Bolted joints: Design procedure and problems on bolted joints with eccentric load parallel to axis of bolt. Design procedure and problems on bolted joints with eccentric load perpendicular to axis of bolt.

UNIT IV: DESIGN OF PERMANENT JOINTS

Riveted joints: Types, materials, failures, Design procedure and problems on riveted joints for pressure vessels, Design procedure and problems on riveted joints for structural applications. Design procedure and problems on eccentric loaded riveted joint. Welded joints: Types and strength Design procedure and problems on axially loaded welded joints. Design procedure and problems on eccentric loaded welded joints.

UNIT V: DESIGN OF GEARS AND SPRINGS

Design of spur gears, Design helical gears, Design bevel gears, Design of worm gears, Springs: Stresses and deflections in helical springs, Design procedure and problems on helical springs, Design procedure and problems on helical springs with fatigue load. Leaf springs: Construction, Nipping, Materials. Design procedure and problems on leaf springs.

TEXTBOOKS/REFERENCES

1. Robert C.Juvinalland Kurt M. Marshek “*Fundamentals of Machine Component Design*”, John wiley& sons, 5th Edition, 2011.
2. Spotts.M.F, ShoupT.E, “*Design of Machine Elements*”, Prentice Hall of India Eighth Edition, 2006.
3. Joseph Edward Shigley and Charles ,R.Mischke, “*Mechanical Engineering Design*”,McGraw-Hill International Editions, 8th edition., 2008.
4. William Orthwein, “*Machine Component Design*”, Vol. I and II, JaicoPublishing house, New Edition, 2006.
5. Khurmi, R.S. and Gupta J.K, “Machine design ”, S.Chand publishing , 14th Edition, 2014.
6. P.S.G Tech., “*Design Data Book*”, KalaikathirAchchagam, 2012.
7. Gitin M Maitra, , “*Handbook of Gear Design*”, Tata Mcgraw-Hill, 2010.

SEMESTER-V

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 224 L	Machine Design Lab	C	0	0	2	1

LIST OF EXPERIMENTS

1. Critical speed of shaft or whirling of shaft
2. Cam analysis apparatus
3. Journal bearing test rig
4. Motorised gyroscope apparatus
5. Universal governor apparatus
6. Balancing of rotating masses
7. Universal vibration apparatus
8. Photo elastic test bench

SEMESTER-V

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 272	Dynamics and Control	C	3	0	0	3

UNIT I: FREE VIBRATION

Introduction to vibration terminologies and types of vibration, Equation of motion for free undamped single Degree of freedom system by Newton's and energy method, Tutorials on single Degree of Freedom undamped free vibration systems. Equation of motion for free damped single Degree of freedom systems. Tutorials on free damped single Degree of freedom systems. Torsional Vibration of Two Rotor and three rotor Systems. Tutorials on Torsional Vibration of Two Rotor and three rotor Systems. Torsional Vibration of Geared Systems with Two and three rotor System.

UNIT II: FORCED VIBRATION

Equation of motion for harmonically excited single Degree of Freedom system, Tutorials on harmonically excited single Degree of Freedom system, Forced vibration due to unbalanced rotating and reciprocating systems, Tutorials on Forced vibration due to unbalanced rotating and reciprocating systems, Forced vibration due to Base excitation by Absolute and relative amplitude Method. Tutorials on Forced vibration due to Base excitation by absolute and Relative amplitude Method. Force Transmissibility and Vibration isolation. Tutorials on Force Transmissibility and Vibration isolation, Whirling of shaft and tutorials.

UNIT III: MULTI DEGREE OF FREEDOM

Equation of motion for free undamped two and three degrees of Freedom systems and tutorials, Equation of motion for two and three DOF using Lagrangian energy method for Un-damped free vibration, Co-ordinate Coupling and tutorials, Concept of Linear and torsional undamped Vibration absorber, Tutorials on Linear and torsional undamped Vibration Absorber.

UNIT IV: LANGARANGIAN DYNAMICS

Virtual work, generalized forces, Derivation of langarangian equations, Eigen value problems, Equilibrium analysis.

UNIT V: VIBRATION MESUREMENT

Vibration measuring devices and Vibration exciters, Free and Forced vibration Tests, Balancing Machines, single plane and two plane balancing, Condition monitoring techniques and signal analysis, Basics of Noise terminologies and their relations, Noise Control Methods at source, along Path and at receiver.

TEXTBOOKS

1. Gian carlogenta, Vibration dynamics and control, 1993, Springer.
2. Leonard meirovitch , Dynamics and Control, Abe books, 1985.
3. Lazlo Kevizsky, Control Engineering, 2018.
4. Gopal, Control Systems, 1997.
5. Iyengar, Mechanical vibrations, 2010.

SEMESTER-V

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 272 L	Dynamics and Control Lab	C	0	0	2	1

LIST OF EXPERIMENTS

1. Motor control using 4dof development platform.
2. Control of magnetic levitation system.
3. Control of cartwheel inverted pendulum.
4. Kinematic analysis of 3dof robot.
5. Control of 3dof robot.
6. Speed control of dc motor.

SEMESTER-V

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 201	University Research Opportunity	PR	0	0	4	2

DESCRIPTION OF TOPIC

A Multidisciplinary project to be taken up by a team of maximum of ten students. Development of prototype product, a 3D model, simulation, blueprint for a larger project and any other development work are permitted. The contribution of the individuals in the project should be clearly brought out. A combined report is to be submitted. A presentation is to be made for the reviewers on the work done by the candidate.

Assessment component	Expected outcome	Evaluators	Criteria or basis	Marks
Project proposal (Review – I)	<p>A short presentation to be delivered on:</p> <ul style="list-style-type: none"> • A brief, descriptive project title (2-4 words). This is critical! • The 3 nearest competitors (existing solutions) and price. • Team members name, phone number, email, department/degree program, and year. • A description of the product opportunity that has been identified. To include: Documentation of the market need, shortcomings of existing competitive products, and definition of the target market and its size. • Proposed supervisor /guide 	Panel of reviewers	<p>Viability / feasibility of the project</p> <p>Extent of preliminary work done.</p>	0
Review II	<ul style="list-style-type: none"> • Mission Statement /Techniques • Concept Sketches, Design 	Panel of reviewers	Originality, Multi-disciplinary	20
	<p>Specifications / Modules & Techniques along with System architecture</p> <ul style="list-style-type: none"> • Coding 		component, clarity of idea and presentation,	

			team work, handling Q&A.	
Review III	<ul style="list-style-type: none"> • Final Concept and Model / Algorithm/ Technique • Drawings, Plans / programmed output • Financial Model / costing • Prototype /Coding • Final Presentation and Demonstration. 	Panel of reviewers	Originality, Multi-disciplinary component, clarity of idea and presentation, teamwork, handling Q&A.	50
Final technical Report	A good technical report.	Supervisor / Guide	Regularity, systematic progress, extent of work and quality of Work.	30
			Total	100

SEMESTER-V

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
CSE 331	Industry Standard Coding Practice-3	ES	0	0	4	1

UNIT I

Problem solving with - Descriptive statistics, Mean/median/mode, Measures of dispersion/range variance, deviations, mean/median/mode problems, Random variables, Univariate & Bivariate random variables.

UNIT II

Problem solving with - Graphs, Handshaking Lemma, Simple Graphs, DFS/BFS, connected components, coloring, Introduction to DAGs, Spanning Trees, Articulation Points/ Connected points.

UNIT III

Problem solving with - Greedy Methods: Coin change, Fractional Knapsack, Activity Selections/ Job sequencing with Deadlines, Spanning Trees, Dynamic Programming: 0/1 Knapsack, Substructures, longest common substring/subsequence, Longest Increasing sub sequence, Grid based Problems.

UNIT IV

Problem solving with - Divide & Conquer Strategies: Quick/Merge Sort, Min/Power functions, Backtracking, N Queens problem, Finding the path & Grid based problems, iterative/loop free approaches.

UNIT V

R Language Constructs, calculations, Operators, vectors, lists, Practice problems implementing R language, Matrices and data frame, Conditional statements and loops, Problem Solving on R language examples.

TEXTBOOKS/REFERENCES

1. An Introduction to Statistical Learning: with Applications in R - Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani.
2. Introduction to Algorithms by Thomas H. Corman, The MIT Press, 3rd Edition.
3. Introduction to Algorithms: A Creative Approach by Udi Mander, Pearson.
4. R Cookbook - Paul Teetor, O'reilly.
5. Competitive Programming – 3e – Steven Halim, Felix Halim.

SEMESTER-V

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ISES 311	Industry Specific Employability Skills-V	HS	1	1	0	0

UNIT I

Types and Properties of Numbers and Remainders, LCM, GCD, Fractions and decimals, Surds and Progressions.

UNIT II

Permutations, Combinations and Probability, Data Interpretation.

UNIT III

Geometry and Coordinate Geometry, trigonometry and Mensuration.

UNIT IV: REASONING

Syllogism and Non-Verbal Reasoning, Analytical Reasoning.

TEXTBOOKS/REFERENCES

1. Arun Sharma – How to prepare for Quantitative Aptitude, Tata Mcgraw Hill.
2. R.S Agarwal, A Modern Approach to Verbal and Non Verbal Reasoning S.Chand Publications.
3. Arun Sharma– How to Prepare for Data Interpretation & Logical Reasoning for the CAT.

SEMESTER-V

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 430	MECHATRONICS	TE	3	0	0	3

UNIT I: INTRODUCTION TO MECHATRONICS

Introduction to Mechatronics systems, Mechatronics system components and Measurement Systems, Control Systems, Open and Closed Loops Systems temperature control, Water level controller and Shaft speed control, Transfer function: Laplace transform, system in series and System with feedback loop. Sequential Controllers: Washing machine control, Sequential Controllers: Digital camera.

UNIT II: SENSORS AND TRANSDUCERS

Introduction to sensors and transducers and classifications, Principle and working of Resistive, capacitive, inductive and resonant transducers, Optical measurement systems for absolute and incremental encoders, Photo electric sensor and vision system, Fiber optic transducers, Solid state sensors and transducers for magnetic Measurements Temperature measurements, Chemical measurements, piezoelectric sensor and Accelerometers, Ultrasonic sensors and transducers for flow and distance.

UNIT III: ELECTRICAL DRIVES AND CONTROLLERS

Introduction, Electromagnetic Principles, Solenoids and Relays, Electrical drives of stepper motors, servo motors, Operational amplifier, A/D converters & D/A converters, Signal processing, Multiplexer and Introduction to Data acquisition system, Proportional, Integral, Derivative and PID controller, Introduction to Micro controller: M68HC11 and ATMEGA328.

UNIT IV: PROGRAMMABLE LOGIC CONTROLLERS

Basic structure, Programming units and Memory of Programmable logic controller, Input and Output Modules, Mnemonics for programming, Latching and Internal relays, Timers, Counters and Shift Registers, Master relay and Jump Controls, Programming the PLC using Ladder diagram for Simple applications.

UNIT V: MECHATRONICS SYSTEM DESIGN AND APPLICATION

Mechatronics in Engineering Design, Traditional and mechatronics design, Car Park barriers using PLC, Pick and Place robots and Bar code reader, Wind screen wiper using stepper motor control, Car Engine management systems, Case studies for Coin counters, Robot walking machine, Boiler control using PID.

TEXTBOOKS

1. Bolton.W, “*Mechatronics*”, Addison Wesley, 4th Edition, New Delhi, 2010.
2. Bradley.D.A, Dawson.DBurdN.C.and Loader A.J, “*Mechatronics*”, Chapman and Hall Publications,New York, 1993.
3. Jacob Fraden, “*Handbook of Modern Sensors Physics, Designs, and Applications*”, Third Edition,Springer-Verlag New York, 2004.
4. James Harter, “*Electromechanics, Principles and Concepts and Devices*”, Prentice Hall, New Delhi,1995.
5. David W. Pessen, “*Industrial Automation Circuit Design and Components*”, John Wiley, New York,1990.

6. Rohner.P, "*Automation with Programmable Logic Controllers*", Macmillan / McGraw Hill, New York,1996.
7. Brian Morris, "*Automatic Manufacturing Systems Actuators, Controls and Sensors*", McGraw Hill,New York, 1994.
8. Godfrey C. Onwubolu, "*Mechatronics Principles and applications*", Butterworth-Heinemann, NewDelhi, 2006.

SEMESTER-V

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 410	Thermal Power Engineering	TE	3	0	0	3

UNIT I: AIR STANDARD CYCLES

Carnot, Otto, Diesel, Dual and Stirling cycles, p-v and T -s diagrams, description, efficiencies and mean effective pressures. Comparison of Otto and Diesel cycles. IC engine components, their functions, engine performance and efficiency.

UNIT II: GAS POWER CYCLES

Gas turbine (Brayton) cycle; description and analysis. Regenerative gas turbine cycle. Intercooling and reheating in gas turbine cycles. Introduction to Jet Propulsion cycles – Turbojet, Turbofan, Turboprop, Afterburner and Rockets.

UNIT III: VAPOR POWER CYCLES

Carnot vapour power cycle, drawbacks as a reference cycle. Simple Rankine cycle; description, T-S diagram, analysis for performance. Comparison of Carnot and Rankine cycles. Effects of pressure and temperature on Rankine cycle performance. Actual vapour power cycles. Ideal and practical regenerative Rankine cycles, open and closed feed water heaters. Reheat Rankine cycle, Cogeneration, Combined Gas-Vapor Cycles, Binary Vapor Cycles, Characteristics of an Ideal working fluid in vapour power cycles.

UNIT IV: STEAM GENERATOR

Boiler types, applications, and comparison; Boiler system requirements, Water Tube Boiler, Fire Tube Boiler, Mountings and Accessories. Performance calculations, Boiler trial.

UNIT V: CONDENSER

Condenser system elements; types and their advantages/disadvantages; Its effect on Rankine efficiency.

UNIT VI: STEAM TURBINE

Impulse and reaction turbine, velocity triangle, degree of reaction, efficiencies, losses, Velocity and Pressure compounding.

TEXTBOOKS

1. Thermodynamics, Yunus A, Cengel & Michael A Boles, Tata McGraw Hill, 7th Edition.
2. Engineering Thermodynamics P.K. Nag Tata McGraw Hill 6th Edition 2018.
3. P. K. Nag, Powerplant Engineering, 2nd Ed., Tata McGraw Hill, 2002.

REFERENCES

1. M. J. Moran & H N Shapiro, Fundamentals of Engineering Thermodynamics, 3rd Ed., John Wiley, 1995.
2. M. M. ElWakil, Power Plant Technology, McGraw Hill International, 1992.

SEMESTER-V

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 415	Refrigeration and Air Conditioning	TE	3	0	0	3

UNIT I: VAPOUR COMPRESSION REFRIGERATION SYSTEMS

Review of thermodynamic principles of refrigeration, Simple vapour compression system, Calculation: COP of VCR system, Method for improving COP in VCR system, Multistage and multiple evaporator system, Cascade system, COP comparison with sub cooling and super heating, Tutorial: problem on sub-Cooling, and super heating.

UNIT II: ABSORPTION REFRIGERATION SYSTEMS

Absorption refrigeration cycle, Water lithium bromide systems, Tutorial: LiBr COP calculation, Ammonia Absorption Refrigeration system, Tutorial: ammonia COP calculation, COP calculation of single effect absorption system, Refrigeration absorbent combinations, Comparison of absorption system with vapor compression systems, Tutorial: COP comparison of vapor compression systems with vapor absorption system.

UNIT III: REFRIGERATION EQUIPMENTS & CONTROL

Compressors –type, Condenser’s type, Cooling towers type, Evaporators, Expansion devices type, Refrigerants: properties, Selection of refrigerants-alternate refrigerants, Refrigeration plant controls, Testing and charging of refrigeration units.

UNIT IV: DESIGN OF AIR CONDITIONING SYSTEMS

Different heat sources of Conduction and radiation, Load: occupants load, equipment load, fresh air load, infiltration air load, Tutorial: conduction, radiation, Tutorial: load calculation, Estimation of total heat load (SHL+LHL), Bypass factor (BPF), Effective sensible heat factor (ESHF), Tutorial: SHF& ESHF, Cooling coils and dehumidifier air washers.

UNIT V: APPLICATIONS OF REFRIGERATION AND AIR CONDITIONING SYSTEMS

Preservation of different products, Ice factory, Dairy plant refrigeration systems, Application of air conditioning in hotels, Application of air conditioning in restaurants, Application of air conditioning in theatres, Application of air conditioning in auditorium, Application of air conditioning in hospitals, Cryogenics applications.

TEXTBOOKS

1. Arora.S.C and Domkundwar.S, “A course in Refrigeration and Air conditioning”, DhanpatRai(P) Ltd., New Delhi, 2012.
2. Ananthanarayanan.P.N, “Basic Refrigeration and Air Conditioning”, Tata McGraw Hill, 3rd Edition, New Delhi, 2006.
3. Manohar Prasad, “Refrigeration and Air conditioning”, New Age International (P) Ltd, New Delhi, 2010.
4. Roy J. Dossat,”Principles of Refrigeration”, Pearson Education Asia, 4th Edition, 2001.
5. Arora, C. P., “Refrigeration and Air Conditioning”, Tata McGraw Hill, New Delhi, 2006.

SEMESTER-V

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 401	Computer Aided Design and Manufacturing	TE	3	0	0	3

UNIT I

What is CAD. What is CAM. Applications of CAD/CAM in Engineering, Specific applications of CAD/CAM in Mechanical engineering. What is Geometric Modelling and its applications in Mechanical engineering, Introduction to computer graphics and its application in Mechanical engineering. Computer Graphics Software's useful for Mechanical engineers, Introduction, representation of points, transformations and matrices, transformation of points, Transformation of straight lines, midpoint transformation, Transformation of parallel lines, transformation of intersecting lines, Rotation, Reflection and Scaling, Combined transformations and Transformation of The unit square, Rigid body transformations and Translations and Homogeneous Coordinates, Rotation About an Arbitrary Point, Homogeneous Coordinate system and Overall Scaling.

UNIT II

Introduction about 3D Transformations, Three-Dimensional Scaling, Three-Dimensional Shearing, Reflection, Three-Dimensional Rotation, Translation, Three-Dimensional Combined transformations, Three-Dimensional rotations about an axis parallel to a coordinate axis, Three-Dimensional rotation about an arbitrary axis in space, Three-Dimensional reflection through an arbitrary plane, affine and perspective geometry, Introduction to orthographic projections, axonometric projections, oblique projections, perspective transformations.

UNIT III

Introduction about plane and space curves, Curve Representation, Implicit and Explicit representation of curves, Parametric and Non-parametric curves General and parametric representation for conic sections (Circle, Ellipse, Parabola, Hyperbola). Representation of space curves, Cubic Splines and Hermite cubic curve, normalized cubic splines. Representation of Bezier Curves. B-spline Curves and end conditions for periodic B-spline curves. B-spline Curve Fit, B-spline Curve Subdivision. Rational B-spline Curves, NURBS and Introduction about surfaces. Coons Bi-cubic surface, Bezier surfaces, B-spline surfaces, B-spline surface Fitting and subdivision and Rational B-spline surfaces.

UNIT IV

Introduction to conventional Manufacturing Processes, Removing, Forming, Deforming and joining, Introduction to CAD, CAM and CAD-CAM. Integration equipment's. Integrating CAD, NC and CAM. Machine tools. Role of process planning in CAD/CAM Integration, Computer Aided Process Planning.

Development, Benefits, Model and Architecture. CAPP Approaches.

UNIT V

Introduction to CAM, Point to point and continuous path machining, Introduction to NC, CNC and DNC – NC Programming, Basics, Languages, G Code, M Code, APT – Tool path generation and verification. NC Programming for Rectangular and circular pockets, NC Programming for drilling, peck drilling and boring, NC Programming for circular and rectangular array, NC Programming for turning, facing, threading and knurling. Production Control – Cellular Manufacturing.

TEXTBOOKS/REFERENCES

1. Mathematical Elements for Computer Graphics by David Rogers (Author), J. Alan Adams (Author) New York: London, McGraw-Hill, c1990, ISBN 10: 0070535302.
2. CAD/CAM: Principles and Applications by P N Rao.

SEMESTER-V

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 132	Numerical Methods	C	3	0	0	3

UNIT I: CURVE FITTING/ NUMERICALSOLUTIONS

Curve fitting, straight line, parabola, Newton Raphson method, Bisection method, Iterative methods, Power methods.

UNIT II: FINITE DIFFERENES AND INTEGATION

Forward difference and backward difference, Central difference, interpolation, Divided differences, Inverse interpolation.

UNIT III: NUMERICAL DIFFERENTIAION AND INTEGRATION

Numerical differentiation, applications, Numerical integration, applications, Simpsons rule, Trapezoidal rule.

UNIT IV: NUMERICAL SOLUTIONS OF FIST ORDER ODE

Taylor series method, Euler's methods and applications, Runge kurta method, Predictor corrector method.

UNIT V: NUMERICAL SOLUTION OF PDE

Solution of elliptic equations, Solution of Laplace equations, Solution of parabolic equations, Solutions of hyperbolic equations.

TEXTBOOKS/REFERENCES

1. B.S.Grewal, Numerical methods in engineering and science, Khanna publisher, 2012.
2. M.K.Venkatraman, Numerical methods in engineering, National publishing, 2005.
3. S.S.Sastri, Numerical methods analysis, 2005.

SEMESTER-V

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 132 L	Numerical Methods Lab	C	0	0	2	1

LIST OF EXPERIMENTS

1. Introduction to Numpy and Python.
2. Python plotting (line plots and contour plots) using Matplotlib.
3. Solution of linear algebraic equations using Direct methods Solution of linear algebraic equations using Iterative methods, Jacobi, SOR, SUR
4. Solution of the equations using Iterative solvers Newton Raphson and Bisection.
5. Curve fitting using least squares regression (linear and quadratic)
6. Solution of ordinary differential Equation using Euler, RK2 – (Heun and midpoint), RK4
7. Differentiation of a function using central, forward, backward Finite difference methods/.
8. Solution of the Partial differential equations (Laplace equation of temperature distribution) using the Finite difference method.

SEMESTER-VI

SEMESTER-VI

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 230	Heat and Mass Transfer	C	3	0	0	3

UNIT I: INTRODUCTION

Definitions of heat and heat transfer. Difference between heat transfer and thermodynamics. Basic Modes and Laws of Heat Transfer. Examples of Heat and Mass Transfer. Engineering Applications of Heat Transfer.

UNIT II: CONDUCTION

Fourier's law of heat conduction for homogeneous, isotropic media in Cartesian coordinates and its extension to heterogeneous, isotropic media (differential form). Vectorial form of Fourier's law for heterogeneous, isotropic continua. Fourier's law in cylindrical and spherical coordinates. Derivation of heat conduction equation in Cartesian coordinates for heterogeneous, isotropic materials. Heat conduction equation in Cartesian coordinates for (Case of constant thermal conductivity). Significance of thermal diffusivity. Heat conduction equations in cylindrical and spherical coordinates for constant thermal conductivity. Simple One-dimensional (1D) Steady Heat Conduction Problems: Plane Wall, Cylinder, and Sphere, Hollow (cylinder and sphere). Temperature distribution and heat transfer. Concepts of conductive and convective resistances. Conductive and Convective Resistances in Series. Special one-dimensional steady state situations – Heat generation, pin fins, other fin configurations, Two-dimensional steady state situations (brief). Transient conduction: Lumped capacitance model, One dimensional transient problem analytical solution, One dimensional Heisler charts, Product solutions.

UNIT III: CONVECTION

Forced Convection: Review of fluid mechanics (brief) fundamentals, order of magnitude analysis of momentum and energy equations. Laminar flow heat transfer in circular pipe – constant heat flux and constant wall temperature, thermal entrance region. Turbulent flow heat transfer in circular pipe, pipes of other cross sections. Heat transfer in laminar flow and turbulent flow over a flat plate, Reynold's analogy. Flow across a cylinder and sphere, flow across banks of tubes. Natural Convection: Introduction, governing equations. Natural Convection: Vertical plate, horizontal cylinder, horizontal plate, enclosed spaces.

UNIT IV: RADIATION

Basic ideas, spectrum, basic definitions, Laws of radiation. Black body radiation, Planck's law, Stefan Boltzmann law, Wien's Displacement law, Lambert cosine law. Radiation exchange between black surfaces, shape factor. Radiation exchange between gray surfaces – Radiosity-Irradiation method Parallel plates, Enclosures (non-participating gas), Gas radiation.

UNIT V: HEAT EXCHANGERS, CONDENSATION AND BOILING

Heat Exchangers: Types of heat exchangers, LMTD approach – parallel, counter-flow. Heat Exchangers: Multi-pass and cross flow heat exchanger, NTU approach – parallel and counterflow, shell and tube, cross flow heat exchanger. Condensation and Boiling: Dimensionless parameters, boiling modes. Condensation and Boiling: Correlations Forced convection boiling, laminar film condensation on a vertical plate, turbulent film condensation.

UNIT VI: MASS TRANSFER

Analogy between heat and mass transfer, mass diffusion, Fick's law of diffusion, boundary conditions. Steady mass diffusion through a wall, transient mass diffusion, mass convection, limitations of heat and mass transfer analogy.

TEXTBOOKS/REFERENCES

1. F. P. Incropera, D. P. Dewitt, T. L. Bergman and A. S. Lavine, "Fundamentals of Heat and Mass Transfer", 7th Ed., John Wiley and Sons, 2011.
2. J. P. Holman, "Heat Transfer", 10th Ed., McGraw Hill, 2009.
3. Yunus A. Çengel, Afshin J. Ghajar, "Heat and mass transfer: fundamentals and applications", McGraw-Hill Education, 2015.
4. P. K. Nag, "Heat and Mass Transfer", 3rd Ed., McGraw Hill.
5. M. N. Ozisik, Heat Transfer-A Basic Approach, McGraw Hill, 1985.
6. Frank Kreith, Raj M. Manglik and Mark S. Bohn, "Principles of Heat Transfer", 7th Ed., Cengage Learning, 2011.
7. A. Bejan, Convective Heat Transfer, 3rd Ed., John Wiley and Sons, 2004.
8. C. P. Kothandaraman and S. Subramanyan, "Heat and Mass transfer data book 6th Ed. (Multi-color, edition) ",, New Age International Publishers, 2018.

SEMESTER-VI

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 230 L	Heat and Mass Transfer Lab	C	0	0	2	1

LIST OF EXPERIMENTS

1. Thermal conductivity of insulating powder.
2. Critical radius of insulating material.
3. Cross flow experiment with heated cylinder.
4. Heat transfer in natural convection.
5. Heat transfer in forced convection.
6. Pin – fin apparatus.
7. Emissivity measurement apparatus.
8. Heat pipe demonstration.
9. Unsteady state heat transfer apparatus.
10. Critical heat flux apparatus.
11. Parallel / counter flow heat exchanger.
12. Condensation in drop and film forms.

SEMESTER-VI

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 322	Manufacturing Technology	C	3	0	0	3

UNIT I: CASTING

Introduction to Casting, Patterns and its types and materials, Pattern Allowances, Molding and its types, Molding sand, Gates and Risers, Numerical problems on pouring time and Caine's rule, Cores, Core making, Shell casting, Investment Casting, Die casting, Centrifugal Casting, Casting defects and remedies.

UNIT II: MECHANICAL WORKING OF METALS

Introduction to Hot and Cold Working, Hot and Cold Rolling, Types of rolling viz. Two, three, four, multi and Universal rolling, Open die and Closed die forging, Wire drawing, Hot, Cold, Forward, backward and tube extrusion, Shearing, Piercing, Trimming and Stretch forming, Theory of Bending, bending length and Bending force calculations, Drawing, Blank size and drawing force calculations, Tube forming, Embossing and coining, Progressive, Compound and Combination dies and defects informing.

UNIT III: THEORY OF METAL CUTTING

Orthogonal and oblique cutting, Classification of cutting tools namely single point, and multipoint, Tool signature for single point cutting tool, Mechanics of orthogonal cutting and Force relationship, Merchant Circle and Determination of shear angle, Chip formation, cutting tool materials, Tool wear and Taylor's tool life calculation, Machinability and Cutting Fluids.

UNIT IV: GEAR MANUFACTURING AND SURFACE FINISHING PROCESS

Gear Manufacturing viz Extrusion, Stamping and Powder Metallurgy, Gear Machining, Forming, Spur and Helical in milling machine, Gear Generating: Gear shaping, Gear hobbling, Grinding process, Types of Grinding machines viz. Surface, Cylindrical and Centerless, Grinding Wheel and its types, Grinding specifications and type of abrasive bonds, Selection of Cutting speed and work speed, dressing and truing, Lapping, Buffing, Honing, and Super finishing.

UNIT V: MACHINE TOOLS

Classification of Milling Machines and its basic Construction, Types of cutters in Milling machines, Types of milling operations (up and down, peripheral, face milling), Simple and differential Indexing methods and its calculations, shaping and slotting Machine, Its description and operations. Planers: Double house and open side, Quick return Mechanism, Work and tool holding Devices, Boring machine and its Specification, operations, Jig boring machine. Specification of Broaching machine, its types and operations (internal, surface), Tool nomenclature of broaching tool.

TEXTBOOKS

1. Mikell P. Groover, "*Fundamentals of Modern Manufacturing Materials, Processes, and Systems*", 4th Edition, John Wiley & Sons, Inc., 2010.
2. E. Paul DeGarmo, Black J.T and Ronald A. Kosher, "*Materials and Processes, in Manufacturing*", 8th Edition, Prentice – Hall of India, 1997.
3. Roy A. Lindberg, "*Processes and materials of manufacture*" Prentice Hall, 1998.
4. John A. Schey, "*Introduction to manufacturing processes*", McGraw-Hill, 3rd Edition, 2000.
5. James S Campbell, "*Principles of manufacturing materials and processes*" New Delhi : Tata McGraw Hill ,1983.
6. Serop Kalpakjian ,Steven R Schmid "*Manufacturing Engineering and Technology*" Pearson India, 4th Edition, 2002.

SEMESTER-VI

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 322 L	Manufacturing Technology Lab	C	0	0	2	1

LIST OF EXPERIMENTS

1. Performing plain turning, step turning and chamfering in Lathe.
2. Performing taper turning by compound rest/offset method and drilling in Lathe.
3. Performing External threading, Internal thread cutting and eccentric turning in Lathe.
4. Performing Taper boring and knurling in Lathe.
5. Performing V block shaping in shaper machine.
6. Performing Polygon milling in milling machine.
7. Spur Gear cutting in milling machine.
8. Spur Gear cutting in milling machine.
9. Performing surface grinding in Grinding machine.
10. Performing cylindrical grinding in Grinding machine.
11. Grinding of single point cutting tool in Tool and Cutter grinding machine.
12. Preparation of Sand mold using solid/split pattern with loose-piece pattern.

SEMESTER-VI

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 226	Measurement and Instrumentation	C	3	0	0	3

UNIT I: TYPES OF MEASUREMENTS, COMPARATOR AND GAUGE DESIGN

Introduction to Metrology, Need for inspection, Physical Measurement, Methods of measurements, Classification and characteristics of Measuring instruments, Role of NPL, Sources of Errors, Types of Errors, Statistical treatment of Errors, tutorial, Standards of Measurements, Calibration, Classification of standards. Limits, Fits, and Tolerances: Tutorial. Interchangeability and Selective Assembly. Inspection Gauges, Types of Gauges, Taylor's Principle, Gauge Design, Introduction to Comparators, Mechanical (Sigma), Electrical, Pneumatic comparator.

UNIT II: MEASUREMENTS OF SCREW THREAD, GEAR AND SURFACE FINISH

Measurements of various elements of external and internal thread, Measurement of Major, Minor diameter, Effective diameter, Two and three wire method, Best Wire Size, Measurements of various elements of Gear, Gear tooth Vernier, Constant chord method, Derivation, tutorial, Base tangent method, Derivation, tutorial, Circular pitch and Composite error measurement, Surface Finish: Surface topography definitions, Measurement of Surface Texture parameters, Methods for the evaluation of Surface finish.

UNIT III: OPTICAL METROLOGY AND FORM MEASUREMENT

Principle of light wave interference, Light sources, Measurements with optical flat, Types of Interferometers, Michelson, Twyman Green Specialization of Michelson, NPL flatness Interferometers, The Pitter NPL gauge. Laser interferometer, Laser micrometer, Surface Roughness measurement using Laser. Measurement of straightness using Autocollimator, Tutorial, Measurement of flatness using Autocollimator, Measurement of squareness, parallelism, circularity, roundness and run out.

UNIT IV: COORDINATE AND MACHINE TOOL METROLOGY

Introduction to Coordinate Metrology, difference between conventional and coordinate metrology, Components, types and construction of CMM, Types of measuring head and probes in CMM, measuring accuracy, causes of error and calibration of CMM, Tutorial, performance of CMM and its applications, Alignment Tests in machine tools.

UNIT V: THEORY OF CONTROL CHARTS & ACCEPTANCE SAMPLING

Definition of Quality, Chance Causes and assignable Causes, SQC, Benefits and Limitations, Theory of Control Charts, Control Charts for Variables - \bar{X} and R charts, Control Charts for attributes - P chart, np chart, Control charts for Non-Conformities - C and U chart, Basic Concepts of acceptance sampling and OC curve, AQL, LTPD, AOQL. Sampling Plans, Simple, Double and Multiple, tutorial. Sequential sampling plan, tutorial.

TEXTBOOKS

1. Jain.R.K, "*Engineering Metrology*", Khanna Publishers, New Delhi, 2012.
2. Gupta.R.C, "*Statistical Quality Control*", Khanna Publishers, New Delhi, 1994.

REFERENCES

1. Kevin Harding ,"*Handbook of Optical Dimensional Metrology*", CRC Press, A Taylor & Francis group, 2013.
2. Robert. J Hocken, Paulo H. Pereira, "*Coordinate Measuring Machines And Systems*", CRC Press, Taylor & Francis Group, 2011.
3. Connie Dotson, Roger Harlow and Richard L. Thompson, "*Fundamentals of Dimensional Metrology*", Thomson Delmar Learning", 4th edition, 2005.
4. Toru Yoshizawa, "*Handbook of Optical Metrology: Principles And Applications*", CRC Press, 2009.
5. Grant E. L., "*Statistical Quality Control*", McGraw Hill, New York, 1972.
6. *Statistical Quality Control*, M.Mahajan , Dhanpat Rai & co. Gagankapur ,2010.

SEMESTER-VI

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 226 L	Measurement and Instrumentation Lab	C	0	0	2	1

LIST OF EXPERIMENTS

1. Use of Precision Measuring Instrument (linear and angular) and Gauges.
2. Gear tooth measurement using Gear tooth Vernier.
3. Gear parameter measurement using Parkinson Gear Tester.
4. Thread Parameter measurement using floating carriage micrometer, thread micrometer.
5. Calibration of Measuring Instruments (Micrometer, Vernier Caliper, Vernier Height gauge and Dial Gauge).
6. Indirect method of measurement using standard balls and rollers.
7. Usage of various comparator mechanical electrical, pneumatic.
8. Circularity measurement using mechanical, Comparator, MM.
9. Attribute Control Charts using Go, No-Go gauges.
10. Variable Control Charts (\bar{x} bar-R chart) and process capability studies.
11. Various parameter measurement using Computerized profile projector.
12. Gear and Thread measurement using Computerized profile projector.
13. Straightness, flatness measurement using autocollimator.
14. Engine Bore Straightness using bore dial gauge.
15. Nomenclature of single point cutting tool using tool makers microscope.
16. Surface roughness measurement.
17. Demo on Interferometers and measurements using laser.
18. Fundamental measurement using CMM, automatic probing.
19. Angle measurements using Sine bar, Sine Center.
20. Measurement using Machine Vision system.

SEMESTER-VI

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ISES 312	Industry Specific Employability Skills-VI	HS	1	1	0	0

UNIT I

Antonyms, synonyms, odd words, Idioms and phrasal verbs, same word with different part of speech, Word analogy. Sentence completion.

UNIT II

Text completion, Sentence equivalence, Introduction to Different Parts of an Argument in Reasoning, Assumption of an Argument, strengthening of an Argument, Weakening of an argument.

UNIT III

Para jumbles, Sentence Completion & Text Completion, Reading Comprehension, Identification of errors, Sentence correction.

UNIT IV

Resume writing, Cover letter.

UNIT V

GD, PI.

TEXTBOOKS/REFERENCES

1. Verbal Ability and Reading comprehension-Sharma and Upadhyay.
2. Charles Harrington Elstor, Verbal Advantage: Ten Easy Steps to a Powerful Vocabulary, Large Print, September 2000.
3. GRE Word List 3861 – GRE Words for High Verbal Score, 2016 Edition.
4. The Official Guide to the GRE-General Revised Test, 2nd Edition, Mc Graw Hill Publication.
5. Soft Skills Training: A Workbook to Develop Skills for Employment Book by Frederick H. Wentz.
6. The Resume Writing Guide: A Step-by-Step Workbook for Writing ...Book by Lisa McGrimmon.

SEMESTER-VI

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 427	Robotics	TE	3	0	0	3

UNIT I: INTRODUCTION

Basic concepts of robotics (laws of robotics, robotic systems), ria definition. Robot anatomy (robot configurations, robot motions, joint notation scheme) , manipulators precision movement (spatial resolution, accuracy, repeatability) work volume, robot specifications. Types of robot drives, electric drive, hydraulic, pneumatic drives, basic robot motions, point to point control and continuous path control, kinematics: forward and inverse kinematics, problems on kinematics.

UNIT II: END EFFECTORS AND TRANSFORMATIONS

End effectors-introduction, classification, mechanical, magnetic grippers, vacuum and adhesive gripper, gripper force analysis and design, problems on gripper design, problems on force calculation, 2d transformation (scaling, rotation, translation), 3d transformation (scaling, rotation, translation), homogeneous transformations.

UNIT III: SENSORS AND CONTROL SYSTEMS

Sensor devices, types of sensors (contact, position and displacement sensors), force and torque sensors, proximity and range sensors, acoustic sensors, robot vision systems, sensing and digitizing, image processing and analysis, robot control system, unit control system, adaptive and optimal control.

UNIT IV: ROBOT CELL DESIGN

Robot work cell design and control, Safety considerations in cell design, Robot cell layouts, multiple, Multiple robots, Machine interface, Robot cycle time analysis.

UNIT V: ROBOT PROGRAMMING AND APPLICATIONS

Robot language, classification, Programming methods, off and online programming, Lead through method, powered and Manual lead through, Teach pendent method, VAL systems and language, Simple program. Application of Robots, Material handling, Constrains, Machine loading and unloading. Assembly Robot, Assembly operation, RCC device, Benefits-Inspection robot, used in Quality control, Welding Robot, features, sensors, Advantages, -Painting Robot, Requirement, and Spray painting, Mobile and microbots, types, mobility and application, Recent developments in robotics- safety considerations.

TEXTBOOKS

1. Mikell P. Groover, "*Industrial Robotics Technology Programming and Applications*", McGraw Hill Co.,Singapore, 2008.
2. Deb .S.R, "*Robotics technology and flexible automation*", Tata McGraw Hill publishing company limited, New Delhi, 2010.
3. Klawter R.D, Chmielewski T.A and Noggins, "*Robot Engineering: An Integrated Approach*", Prentice Hal of India Pvt. Ltd., New Delhi, 2010.
4. Fu K.S, Gonzalez, R.C., & Lee, C.S.G., "*Robotics control, sensing, vision and intelligence*", McGrawHill Book Co., Singapore, Digitized 2007.
5. Craig.J.J, "*Introduction to Robotics mechanics and control*", Addison- Wesley, London, 2008.

SEMESTER-VI

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 228	Manufacturing Science	TE	3	0	0	3

UNIT I: METAL CASTING PROCESS

Introduction to metal casting, Solidification of Metals, Characteristics of sand casting, Patterns, Pattern allowances Pattern materials, Types of patterns, Molding materials, Molding sand properties, Types of sand molds, Cores, Gating system, Casting Defects, Special casting processes, Cast structures, Melting furnaces, Methods of Sand testing.

UNIT II: METAL JOINING PROCESS

Classification of joining processes, Welding technique, Different welding processes: Gas Welding, Electric Arc Welding, Tungsten Inert-gas Welding (TIG), Gas Metal-Arc Welding (GMAW), Plasma Arc Welding (PAW), Submerged Arc Welding (SAW), Resistance Welding, Friction Stir Welding (FSW), Thermitic welding, Electron Beam Welding (EBW), Laser Beam Welding (LBW), Weld Defects.

UNIT III: BULK DEFORMATION PROCESS

Introduction to bulk deformation processes, Hot and cold working, Forging, Types of forging, Forging defects, Rolling, Defects in rolled products, Extrusion, Metal flow in extrusion, Rod drawing, Wire and Tube drawing, Swaging, Severe plastic deformation processes: Friction stir processing, Equal channel angular extrusion and high pressure torsion.

UNIT IV: METAL REMOVAL PROCESS

Mechanism of metal cutting, Types of tools, Tool Geometry, Tool Signature, Orthogonal and Oblique cutting, Mechanics of chip formation, Chip morphology, Tool wear and failure, Machinability, Cutting-tool materials, Cutting fluids, Brief description of metal removal processes: Turning, drilling, boring and Milling, Material removal rate and machining time.

UNIT V: POWDER METALLURGY

Production of metal powders, Particle size and shape, blending of metal powders, Compaction of metal powders, Shaping processes, Sintering, Finishing operations, Design considerations for powder metallurgy.

TEXTBOOKS

1. Manufacturing Science, 2nd Edition, A. Ghosh and A.K. Mallik.
2. P.N. Rao, Manufacturing Technology, 3rd Edition, Tata McGraw Hill Edu Pvt Ltd, 2012.

REFERENCES

1. S. Nagendra Parashar and R.K. Mittal, Elements of Manufacturing Processes, PHI Learning Pvt Ltd, 2011.
2. R.L. Timings, Manufacturing Technology, 2nd Edition, Pearson Edu Ltd, 2010.
3. Hajra Choudhury, Elements of Workshop Technology, Vol. I and II, Media Promoters Pvt Ltd, 2001.
4. S.Gowri, P.Hariharan, and A.SureshBabu, Manufacturing Technology I, Pearson Education, 2008.
5. Rajput R.K, A Text book of Manufacturing Technology, Lakshmi Publications, 2007

SEMESTER-VII

SEMESTER-VII

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 450	Multi-Disciplinary Design Project	PR	0	0	4	2

DESCRIPTION OF TOPIC

1. Introduction: Facilitating Multidisciplinary Projects.
2. Identifying and formulating a problem.
3. System Modelling.
4. Thinking perspectives: Decomposition–Composition Thinking, Hierarchical Thinking, Organizational. Thinking, Lifecycle Thinking, Safety Thinking, Risk Thinking, Socio-politico-cultural thinking, Environment thinking.
5. Decomposing a system – Identifying the major sub- Systems.
6. Mathematical Modeling and Governing equations for each sub systems.
7. Objectives, Constraints and Design Variables.
8. Conceptual Design.
9. Collaborative Design – Disciplinary teams satisfy the local constraints while trying to match the global constraints set by the project coordinator.
10. Tools for modeling, designing, analysis, data interpretation, decision making etc.
11. Design Analysis, evaluation and selection.
12. Costing and Financial model.
13. Documentation, reviewing and presentation.

SEMESTER-VII

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 402	Multibody Dynamics	TE	3	0	0	3

UNIT I

INTRODUCTION: What is MBD, Applications and scope of MBD, Objectives of MBD. PRELIMINARIES OF MBD: Kinematics- Position, velocity, acceleration, momentum, angular momentum. Kinetics- Force, moment, torque, equations of motion, Methods of formulations for MBD. MATHEMATICAL BACKGROUND FOR MBD: Vectors, Scalars, Arrays, Matrix, operation. Differentiation of vectors, arrays and matrices. Differential equations.

UNIT II: FUNDAMENTALS OF KINEMATICS

Kinematics of particles, Kinematics of a rigid body- position, velocity and acceleration of a rigid body, Array of coordinates, degrees of freedom, Constraint equations, Kinematics of joints, Numerical problems.

UNIT III: FUNDAMENTALS OF DYNAMICS

Newton's laws of motion- Dynamics of particle and system of particles. Dynamics of rigid body- Centroidal equations of motion, Numerical problems, Non centroidal equations of motion, Force elements, applied forces- Gravitational forces, point to point actuator, point to point spring, point to point damper, Combined elements, rotational elements, viscous friction, Reaction Force: Method of Lagrange multipliers, Coulomb friction. Numerical problems.

UNIT IV: BODY COORDINATE FORMULATION: KINEMATICS

General procedure, Formulation of kinematic joint constraints, Revolute, translational, composite and rigid joints, Numerical examples, Velocity and acceleration of joint constraints, Numerical examples, Formation of system Jacobian, Numerical examples, Numerical examples.

UNIT V: BODY COORDINATE FORMULATION: DYNAMICS

Dynamics of system of unconstrained bodies, Dynamics of two body system, Dynamics general unconstrained bodies, Numerical problems, Dynamics of System of constrained bodies, Numerical problems, Analysis of MBD system.

TEXTBOOKS/REFERENCES

1. Parviz E Nikravesh, "Planar Multibody Dynamics: Formulation, programming and applications", CRC Press, 2007.
2. Ahmed A Shabana, "Dynamics of Multibody systems", Third edition, Cambridge University Press.
3. Farid Americhem, "Fundamentals of Multibody Dynamics: Theory and Applications", Springer Science & Business Media, 2007.
4. Ahmed A. Shabana, Railroad Vehicle Dynamics: A Computational Approach, CRC Press.
5. Parviz E Nikravesh, "Computer Aided Analysis of Mechanical Systems", Prentice Hall Publications.

SEMESTER-VII

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 412	Additive Manufacturing Process	TE	3	0	0	3

UNIT I

Introduction to layered manufacturing, Importance of Additive Manufacturing Additive Manufacturing in Product Development. Classification of additive manufacturing processes, Common additive manufacturing technologies; Fused Deposition Modeling (FDM), Selective Laser Sintering (SLS), Stereo Lithography (SLA), Selection Laser Melting (SLM), Jetting, 3DPrinting, Laser Engineering Net Shaping (LENS), Laminated Object Manufacturing (LOM), Electron Beam Melting (EBM). Capabilities, materials, costs, advantages and limitations of different systems.

UNIT II

Material science for additive manufacturing-Mechanisms of material consolidation-FDM, SLS, SLM, 3D printing and jetting technologies. Polymer's coalescence and sintering, photo polymerization, solidification rates, Meso and macro structures, Process evaluation: process-structure relationships, structure property relationships.

UNIT III

Applications: Prototyping, Industrial tooling, Aerospace, Automotive, Medical etc., Quality control and reliability: Defects in FDM, SLS and SLM, Critical process parameters: geometry, temperature, composition, phase transformation, Numerical and experimental evaluation: roles of process parameter combination, process optimization.

UNIT IV

CAD Modelling for 3D printing: , 3D Scanning and digitization, data handling & reduction Methods, AM Software: data formats and standardization, Slicing algorithms:-uniform flat layer slicing, adaptive slicing, Process-path generation: Process-path algorithms, rasterization, part Orientation and support generation.

UNIT V

Lab: CAD Modeling: Introduction to CAD environment, Sketching, Modeling and Editing features, Different file formats, Export/Import geometries, Part orientation, Layer slicing, Process path selection, Printing, Numerical and experimental evaluation.

TEXTBOOKS/REFERENCES

1. Gibson, I., Rosen, D.W. and Stucker, B., “Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010.
2. Chua, C.K., Leong K.F. and Lim C.S., “Rapid prototyping: Principles and applications” second edition, World Scientific Publishers, 2010.
3. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press, 2011.
4. Kamrani, A.K. and Nasr, E.A., “Rapid Prototyping: Theory and practice”, Springer, 2006.
5. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications.

SEMESTER-VII

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 411	Artificial Intelligence	TE	3	0	0	3

UNIT I: INTRODUCTION TO AI

History, Definition of AI and Emulation of human cognitive process, Agents: types, An abstract view of modeling and Elementary knowledge, Computational and Predicate logic, Analysis of compound statements using simple, logic connectives, Nature of Environments.

UNIT II: PROBLEM SOLVING AGENTS

Problem Definition, formulating problems and Searching for solutions, Examples using production rules, Search /Strategies: Uninformed or Blinded search and Breadth first search, Uniform cost search: Depth first search, Depth limited search, Iterative deepening, Depth first search and Bi –directional search. Comparing uniformed search strategies and informed search strategies, Heuristic information and Hill climbing methods. Best First Search; Greedy Best First Search, Branch-and-Bound Search, Optimal search algorithm A* and iterative, deepening A*.

UNIT III: KNOWLEDGE ORGANISATION AND COMMUNICATION

Knowledge organization, manipulation and acquisition. Indexing and Retrieval techniques and Integration of knowledge in memory organization systems, Matching Techniques: Need for matching and simple matching problems, Partial matching, Fuzzy matching and RETE matching algorithm Perception Natural language: Overview of linguistics and Basics emantic analysis, Representation structures and Natural language generation uncertainty. Bayesian Networks and Bayesian Inference.

UNIT IV: PROGRAMMING LANGUAGE

Introduction to LISP: syntax, Input output statements, Numeric functions, User defined Functions, Predicate Logic and declaration of local variables, Interaction and recursion functions Property list and arrays.

UNIT V: EXPERT SYSTEMS

Introduction to expert systems, activities of an expert system, interpretation, prediction and diagnosis, design, planning and monitoring, debugging and repair, instruction and control, acquisition module frames of expert systems, knowledge base, production rules, semantic nets and inference engines, backward chaining and forward chaining.

TEXTBOOKS

1. Schalkoff, R.J., "*Artificial Intelligence: An Engineering Approach*", McGraw-Hill, 1990.
2. Elaine Rich and Kelvin Knight, "*Artificial Intelligence*", Tata McGraw Hill, New Delhi, 1991.
3. Stuart Russell and Peter Norvig, "*Artificial Intelligence: A modern approach*". Prentice Hall, New Jersey, 1995.
4. Donald A. Waterman, "*A Guide to Expert Systems*", Addison-Wesley Longman Publishing Co., Inc. Boston, MA, USA ©1985 ISBN:0-201-08313-2.
5. Nilson, N. J., "*Principles of Artificial Intelligence*", Springer Verlag, Berlin, 1980.
6. Eugene Charniak and Drew McDermot, "*Introduction to Artificial Intelligence*", Addison Wesley Longman Inc., 1998.
7. Patterson, "*Introduction to Artificial Intelligence and Expert systems*", Prentice Hall of India, New Delhi, 1990.

SEMESTER-VII

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 413	Design and Modelling aspects of AM	TE	3	0	0	3

UNIT I: ADDITIVE MANUFACTURING (AM)

Fundamentals of Additive Manufacturing; Additive Manufacturing Process chain; Application levels of additive manufacturing; Benefits enabled by additive manufacturing; Current areas of additive manufacturing. Overview of design for Additive Manufacturing (DFAM); Motivation; Potential of additive Manufacturing on Design; Generalizable DFAM strategies; Different design strategies of AM.

UNIT II: DESIGN FOR MANUFACTURING AND ASSEMBLY

Core DFAM Concepts and Objectives: Complex Geometry, Customized Geometry, Integrated Assemblies, Elimination of Conventional DFM Constraints; AM Unique Capabilities: Shape Complexity, Hierarchical Complexity, Functional Complexity, Material Complexity; Exploring Design Freedoms: Part Consolidation and Redesign, Hierarchical Structures, Industrial Design Applications.

UNIT III: TOPOLOGY OPTIMIZATION FOR AM

Motivation towards topology optimization for AM design; Topology optimization methods; Opportunities for Topological Optimization applied to AM; Parametric optimization; Topology optimization and generative design; Steps for topological optimization in AM; Case study.

UNIT IV: ADVANCED DESIGN FOR ADDITIVE MANUFACTURING

3D CAD slicing; Unidirection slicing; Multidirection slicing; 2D path planning; Raster path; Zigzag path; Contour path; Spiral path; Hybrid path; Continuous path; Hybrid and continuous path; Medial axis transformation (MAT) path; Adaptive MAT path.

UNIT V: DESIGN ANALYSIS AND OPTIMISATION

Aims of Using Design Analysis for AM; Special Considerations for Analysis of AM Parts: Material Data, Surface Finish, Geometry, Simplifying Geometry, Mesh-Based Versus Parametric Models, Geometry Distortion; Mesh: Parametric Models, Mesh-Based Models; Boundary Conditions; Optimisation; Topology Optimisation: Objective and Constraints, Common Settings, Post-processing and Interpreting Results; Parametric or Size Optimisation; Build Process Simulation: Layer-by-Layer Simulation; Scan Pattern Simulation; Limitations.

TEXTBOOKS/REFERENCES

1. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
2. Martin Leary, "Design for Additive Manufacturing", Springer, 2019.
3. Olaf Diegel, Axel Nordin, Damien Motte, "A Practical Guide to Design for Additive Manufacturing", Springer, 2020.
4. [Igor Shishkovsky](#), "New Trends in 3D Printing", Intech Open, 2016.
5. Amit Bandyopadhyay, Susmita Bose, "Additive Manufacturing: Second Edition", Taylor & Francis, CRC Press, 2019.
6. Neil Hopkinson, Richard Hague, Philip Dickens, "Rapid manufacturing-an industrial revolution for the digital age", Wiley, 2006.

SEMESTER-VIII

SEMESTER-VIII

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 602	Design Project/Industrial Project	PR	0	0	30	15

DESCRIPTION OF TOPIC

1. It is mandatory for every student to undergo this course.
2. Every student is expected to spend a minimum of 15-days in an Industry/ Company/ Organization, during the summer vacation.
3. The type of industry must be NOT below the Medium Scale category in his / her domain of the degree programmed.
4. The student must submit the "Training Completion Certificate" issued by the industry / company / Organization as well as a technical report not exceeding 15 pages, within the stipulated time to be eligible for making a presentation before the committee constituted by the department.
5. The committee will then assess the student based on the report submitted and the presentation made.
6. Marks will be awarded out of maximum 100.
7. Appropriate grades will be assigned as per the regulations.
8. Only if a student gets a minimum of pass grade, appropriate credit will be transferred towards the degree requirements, as per the regulations.
9. It is solely the responsibility of the individual student to fulfill the above conditions to earn the credits.
10. The attendance for this course, for the purpose of awarding attendance grade, will be considered 100%, if the credits are transferred, after satisfying the above (1) to (8) norms; else if the credits are not transferred or transferable, the attendance will be considered as ZERO.
11. The committee must recommend redoing the course, if it collectively concludes, based on the assessment made from the report and presentations submitted by the student, that either the level of training received, or the skill and / or knowledge gained is NOT satisfactory.

**OPEN ELECTIVES
IV-SEMESTER**

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
CSE 202	Web Technology	OE	3	0	0	3

UNIT I: WEB ESSENTIALS

Introduction to World Wide Web (WWW) Introduction to Communication Models. Web site design principles, planning the site and navigation. Introduction to Hypertext Markup Language (HTML) Form design using HTML. Basics of Extensible Hypertext Markup Language (XHTML) Basics of W3C Markup Validation Service.

UNIT II: CLIENT-SIDE SCRIPTING

Introduction to Cascading Style Sheets (CSS) Style sheets in HTML. Introduction to Java scripts.

UNIT III: HOST OBJECTS

Syntax variables and data types in Java scripts. Operators in Java scripts. Arrays and user defined functions in Java script. Java script objects.

UNIT IV: BROWSERS AND THE DOM

XML-Documents and Vocabularies. XML Namespaces. Ajax in web development. Event based parsing in XML. XPath and XSLT. Introduction to JSP. JSP and Servlets. Standard Tag Library in JSP.

UNIT V: WEB SERVICES

Web Servers (IIS, PWS and Apache). HTTP Request Types. Accessing Web Servers. Database connectivity. Applets and Servlets. JDBC connectivity. JSP and Web development Frameworks. Application programming interface (API) for Remote Procedure Calls (RPC). Simple Object Access Protocol (SOAP) and Representational State Transfer (REST) APIs

TEXTBOOKS/REFERENCES

1. Deitel, Deitel and Nieto, Internet, and Worldwide Web - How to Program, 5th Edition, PHI, 2011.
2. Jeffrey C. Jackson, "Web Technologies--A Computer Science Perspective", Pearson Education
3. Marty Hall and Larry Brown," Core Web Programming" Second Edition, Volume I and
4. II, Pearson Education, 2001. 4. Bates, "Developing Web Applications", Wiley, 2006.
5. Kalin, Martin. Java Web Services: Up and Running: A Quick, Practical, and Thorough,Introduction. " O'Reilly Media, Inc.", 2013.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
CSE 202 L	Web Technology Lab	OE	0	0	2	1

LIST OF EXPERIMENTS

1. Familiarize all the basic HTML tags.
2. Implement a static HTML personal webpage by using all the possible basic tags. [Each student can develop his own bio-data page]
3. To create an html file to link to different html page which contains images, tables, and also link within a page use Frames, Forms, etc. also.
4. Create an HTML file by applying the different styles using inline, external and internal style sheets.
5.
 - a. Create an html page to change the background color for every click of a button using Java script. write a Java script program to define a user defined function for sorting the values in an array.
 - b. Create an html page with 2 combo box populated with month & year, to display the calendar for the selected month & year from combo box using java script.
6. Develop a webpage with HTML and Java Script to read name and marks of five subjects obtained for that particular student using forms. Further, it should compute the Grade and display it as a message box.
7. Create a form to collect the name, email, user id, password and confirm password from the user. All the inputs are mandatory and email address should be entered in standard format. Also, the values entered in the password and confirm password textboxes should be the same. For the security reasons make sure that the password entered by the contains both small letters and capital letters, digits, special symbols also. If the given password does not contain all these give an error message to the user. After validating all the details using JavaScript display a message like “You have successfully entered all the details”.
8. Design an XML document to store information about the student of SRM University AP. The information must include Roll No Name, Branch, Year of Joining, and email id. Make up sample data for 3 students. Create a CSS style sheet and use it to display the document.
9. Develop a registration form with various graphical user component interfaces like Text boxes (Roll No), Text boxes (Name) option buttons (gender), Qualification (Check boxes), State (Combo), etc. and store the information given by the user into a MySql database using JSP.
10. Develop a webpage to display the details of a student. For this the user will enter Roll Number in the text box given and the details of that particular student should be retrieved from the database and display it on the same webpage. Use JSP to solve this problem.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 228	Manufacturing Science	OE	3	0	0	3

UNIT I: METAL CASTING PROCESS

Introduction to metal casting, Solidification of Metals, Characteristics of sand casting, Patterns, Pattern allowances Pattern materials, Types of patterns, Molding materials, Molding sand properties, Types of sand molds, Cores, Gating system, Casting Defects, Special casting processes, cast structures, Melting furnaces, Methods of Sand testing.

UNIT II: METAL JOINING PROCESS

Classification of joining processes, Welding technique, Different welding processes: Gas Welding, Electric Arc Welding, Tungsten Inert-gas Welding (TIG), Gas Metal-Arc Welding (GMAW), Plasma Arc Welding (PAW), Submerged Arc Welding (SAW), Resistance Welding, Friction Stir Welding (FSW), Thermite welding, Electron Beam Welding (EBW), Laser Beam Welding (LBW), Weld Defects.

UNIT III: BULK DEFORMATION PROCESS

Introduction to bulk deformation processes, Hot and cold working, Forging, Types of forging, forging defects, Rolling, Defects in rolled products, Extrusion, Metal flow in extrusion, Rod drawing, Wire and Tube drawing, Swaging, Severe plastic deformation processes: Friction stir processing, Equal channel angular extrusion and high-pressure torsion.

UNIT IV: METAL REMOVAL PROCESS

Mechanism of metal cutting, Types of tools, Tool Geometry, Tool Signature, Orthogonal and Oblique cutting, Mechanics of chip formation, Chip morphology, Tool wear and failure, Machinability, Cutting-tool materials, cutting fluids, Brief description of metal removal processes: Turning, drilling, boring and Milling, Material removal rate and machining time.

UNIT V: POWDER METALLURGY

Production of metal powders, Particle size and shape, blending of metal powders, Compaction of metal powders, shaping processes, Sintering, Finishing operations, Design considerations for powder metallurgy.

TEXTBOOKS

1. Manufacturing Science, 2nd Edition, A. Ghosh and A.K. Mallik.
2. P.N. Rao, Manufacturing Technology, 3rd Edition, Tata McGraw Hill Edu Pvt Ltd, 2012.

REFERENCES

1. S. Nagendra Parashar and R.K. Mittal, Elements of Manufacturing Processes, PHI Learning Pvt Ltd, 2011.
2. R.L. Timings, Manufacturing Technology, 2nd Edition, Pearson Edu Ltd, 2010.
3. Hajra Choudhury, Elements of Workshop Technology, Vol. I and II, Media Promoters Pvt Ltd, 2001

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 416	Surface Engineering	OE	3	0	0	3

UNIT I: INTRODUCTION TO SURFACE ENGINEERING

Differences between surface and bulk, Properties of surfaces, surface energy concepts, degradation of surfaces, wear and its type, Adhesive, Abrasive, Fretting, Erosion wear, Surface fatigue,

UNIT II: FRICTION AND LUBRICATION

Fundamentals, Types and measurement of solid, liquid and gaseous friction. Friction heat and calculation. Lubricants and additives, mechanism of solid, liquid and gaseous lubricants.

UNIT III: CORROSION

Different types of Corrosion and its prevention, Galvanic corrosion, Passivation, Pitting, Crevice, Microbial, High-temperature corrosion, Corrosion in nonmetals, polymers and glasses, Protection from corrosion through surface modifications.

UNIT IV: CHANGING THE SURFACE METALLURGY

Localized surface hardening (flame, induction, laser, electron-beam hardening, Laser melting, shot peening), Changing the surface chemistry: Phosphating, Chromating, Anodizing (electrochemical conversion coating), Carburizing, Nitriding, Ion implantation, Laser alloying, boriding, Organic coatings (paints and polymeric or elastomeric coatings and linings), Hot-dip galvanizing (zinc coatings), Ceramic coatings (glass linings, cement linings, and porcelain enamels), Advanced surface coating methods: Gaseous State (CVD, PVD etc), Solution State (Chemical solution deposition, Electrochemical deposition, Sol gel, electroplating), Molten or semimolten State (Laser cladding and Thermal spraying)

UNIT V: CHARACTERIZATION OF SURFACE AND COATINGS

Surface Characterization (physical and chemical methods, XPS, AES, RAMAN, FTIR etc), Structural Characterization, Mechanical Characterization (Adhesion, Hardness, Elastic Properties, Toughness, Scratch and Indentation etc.), Tribological Characterization, Corrosion tests.

TEXTBOOKS/REFERENCES

1. Introduction to Surface Engineering and Functionally Engineered Materials, Peter Martin; Wiley, 2011.
2. Materials and Surface Engineering: Research and Development, J. Paulo Davim; Woodhead Publishing review, 2012.
3. Pradeep L. Menezes, "Tribology for Scientists and Engineers", Springer, 2013.
4. Handbook, Friction, Lubrication and Wear Technology, Vol. 18, ASM.
5. Krishna, R., Anantraman, T.R., Pande, C.S., Arora, O.P., Advanced techniques for microstructural characterization (ed), Trans Tech Publication.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 562	Mechanical Behavior of Materials	OE	3	0	0	3

UNIT I

Introduction, Structure property relationship. Elasticity, Isotropic/Anisotropic.

UNIT II

Viscoelasticity. Elastic-Plastic Deformation. Mechanical testing.

UNIT III

Heat Treatment. Strain Hardening. Strain Rate and Temperature Effects on Deformation. Slip, Dislocations, Twinning, and Hardening.

UNIT IV

Ductile and Brittle Fracture. Fracture Mechanics. Creep. Fatigue. Cumulative Fatigue Damage. Wear processes.

UNIT V

Special topics: Residual Stresses, Ceramics, Glasses, Polymers, Composites, Mechanical Working, and Micromechanics

TEXTBOOKS

1. Meyers and Chawla, Mechanical Behavior of materials, Cambridge publication

REFERENCES

1. N. E. Dowling, Mechanical Behavior of Materials, Prentice-Hall.
2. R.W. Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, 4th Ed., John Wiley & Sons, 1995.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 223	Alternative Sources of Energy	OE	3	0	0	3

UNIT I: SOLAR ENERGY

Solar radiation and its measurements, Types of solar thermal collectors, Solar thermal applications for water heaters, solar stills and solar pond, Solar thermal applications for refrigeration and air- conditioning system, Solar thermal applications for solar dryer, solar cookers and solar furnaces, Sensible and latent heat thermal energy storage systems, Solar thermal power generation systems, Solar photovoltaic systems: basic working principle and components, Applications of solar photovoltaic systems.

UNIT II: WIND ENERGY

Basic principle of wind energy conversion system, Wind data, site selection and energy estimation, Components of wind energy conversion systems, Types of Horizontal axis and Vertical axis wind turbine, Design consideration of horizontal axis wind turbine, Aero foil theory, Analysis of aerodynamic forces acting on the blade, Performance of wind turbines, Introduction to solar and wind hybrid energy systems, environmental issues of wind energy.

UNIT III: OCEAN, HYDRO AND GEOTHERMAL ENERGY

Wave characteristics and wave energy, Tidal energy and its types, Estimation of energy and power in single basin tidal system, Ocean thermal energy conversion for open system, Ocean thermal energy conversion for closed system, Hydro power plants for small, mini and micro system, Exploration of geothermal energy, Geothermal power plants, Challenges, availability, geographical distribution, scope and economics for geothermal plant.

UNIT IV: BIOMASS

Sources of biomass, Pyrolysis, combustion and gasification process, Updraft and downdraft gasifier, Fluidized bed gasifier, Fermentation and digestion process, Fixed and floating digester biogas plants, Design considerations of digester, Operational parameter of biogas plants, Economics of biomass power generation.

UNIT V: DIRECT ENERGY CONVERSION SYSTEMS

Basic principle of thermo electric and thermionic power generations, Fuel cell principles and its classification, Phosphoric acid fuel cell, polymer electrolyte membrane fuel cell, molten carbonate fuel cell and solid oxide fuel cell, Fuel cell conversion efficiency, applications of fuel cell, Magneto hydrodynamic power generation for open cycle, Magneto hydrodynamic power generation for closed cycle, Hydrogen energy: properties and its production methods, Electrolysis, thermo-chemical methods, fossil fuel methods and solar energy methods, Hydrogen storage, transportation and applications.

TEXTBOOKS

1. Tiwari.G.N, Ghosal.M.K, “*Fundamentals of renewable energy sources*”,1st Edition, UK, Alpha Science International Ltd, 2007.
2. Godfrey Boyle, “*Renewable energy*”, 2nd Edition, Oxford University Press, 2010.
3. Twidell.J.W and Weir.A.D, “*Renewable Energy Resources*”,1st Edition, UK,E.&F.N. Spon Ltd, 2006.
4. Domkundwar.V.M, Domkundwar. A.V, “*Solar energy and Non-conventional sources of energy*”, Dhanpat rai & Co. (P) Ltd, 1st Edition, New Delhi, 2010.
5. G.D Rai, “*Non-Conventional Energy Sources*”, Khanna Publishers, 5th Edition, New Delhi, 2011.
6. B.H Khan, “*Non-conventional Energy Resources*”, 2nd Edition, New Delhi, Tata McGraw Hill, 2009.
7. S.P. Sukatme, J.K. Mayak, “*Solar Energy-Principles of thermal collection and storage*”, 3rd edition, New delhi, McGraw Hill,2008.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
PHY 307M	Special Theory of Relativity	OE	3	0	2	4

UNIT I: INTRODUCTION TO RELATIVITY

Inertial Frames, Universality of Newton's second law in all inertial frames, Classical Relativity, does universal rest (ether) exists? Michelson Morley Experiment Principle, Michelson Morley Experiment, Postulates of Special Theory of Relativity, Concept of transformation, Galilean Transformation, Simultaneity of two events in different inertial frames of reference and its frame dependence, Tutorial I, Tutorial II, Tutorial III.

UNIT II: LORENTZ TRANSFORMATION

Clock Synchronization in an Inertial Frame, Lorentz Transformation, Length Contraction, Time dilation, Examples of Length Contraction and Time dilation, Simultaneity Part I, Simultaneity Part II, Transformation of Velocities Part I, Transformation of Velocities Part II, Tutorial IV, Tutorial V, Tutorial VI.

UNIT III: RELATIVISTIC VELOCITY AND MOMENTUM

Velocity Transformation, Relative velocity with examples, Time like and Space Like intervals, Causality, need to redefine Momentum, Vector and Four-Vectors, Proper time interval, Velocity and Momentum-Energy Four Vector, Example on Relativistic velocity and momentum, Tutorial VII, Tutorial VIII, Tutorial IX.

UNIT IV: MASS ENERGY RELATION

Mass-Energy Relationship, Relationship between new energy and momentum, Relativistic Dynamics Part I, Relativistic Dynamics Part II, zero mass particles, Relativistic Mass, Geometry of Space-time, Spacelike and time-like interval, Light cone, Tutorial X, Tutorial XI, Tutorial XII

UNIT V: GEOMETRY OF SPACE-TIME

Four-Dimensional form of Maxwell's equations, Four dimensional Vector Potential. Stress-Energy Momentum Tensor, Conservation Laws, Lagrangian formulation of Electrodynamics Part I, Lagrangian formulation of Electrodynamics Part II, Relativistic treatment of Radiation, Four Dimensional form of Maxwell's equations, Four dimensional Vector Potential, Tutorial XIII, Tutorial XIV, Tutorial XV.

TEXTBOOKS

1. Resnick, Robert. *Introduction to Special Relativity*. New York, NY: Wiley, 1968. ISBN: 9780471717256.
2. French, Anthony Philip. *Special Relativity*. New York, NY: Norton, 1968. ISBN: 9780393097931.
3. Einstein, Albert A. *Relativity: The Special and the General Theory*. New York, NY: Three Rivers Press/Random House, 1995. ISBN: 9780517884416. (recommended)

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
PSY 111	Psychology for Everyday Living	OE	4	0	0	4

UNIT I: MYTHS AND MISCONCEPTIONS IN PSYCHOLOGY

Definition, nature and goals of psychology, Common myths and misconceptions about psychology, Schools of psychology; Basic and applied areas of psychology

UNIT II: THE ROLE OF PERCEPTION AND ATTITUDE TOWARDS UNDERSTANDING THE WORLD

Perception: Understanding perception, Gestalt laws of organization, common illusions, Perceptual constancy - depth perception, size perception, perception of movement, Attitude formation, Attitude change.

UNIT III: INTELLIGENCE AND LEARNING

Definitions and nature of intelligence, Emotional and social intelligence; Measuring IQ, EQ and SQ, Fundamentals of learning and its applications, Memory techniques.

UNIT IV: UNDERSTANDING THE SELF

Definition; Approaches to personality – trait and type, Psychoanalytical and humanistic theory, Tests of personality – MBTI and NEO-PI, Identity; Self-concept, self-esteem and self-efficacy.

UNIT V: STRESS, COPING AND QUALITY OF LIFE

Nature, sources of stress and its reactions, Factors influencing stress, coping with and managing stress - cognitive and behavioral techniques, Improving quality of life.

TEXTBOOKS/REFERENCES

1. Baron, R. A. (2001). Psychology. New Delhi: Pearson Education India.
2. Nolen-Hoeksema, S., Fredrickson, B.L. & Loftus, G.R. (2014). Atkinson & Hilgard's Introduction to Psychology. 16th Ed. United Kingdom: Cengage Learning.
3. Morgan, C. T., King, R. A., & Schopler, J. (2004). Introduction to Psychology. New Delhi: Tata McGraw Hill.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
HIS 200	India and its People	OE	4	0	0	4

UNIT I: THE MAKING OF MODERN INDIA; THROUGH THE EYES OF THE CONSTITUTION

Why do we need a constitution? Beginning of constitutionalism in India: Colonial and Anti-colonial legacies, Locating constituent Assembly debate: Consensus and Discontent. Reading preamble of the Indian constitution.

UNIT II: FUNDAMENTAL RIGHTS AND DIRECTIVE PRINCIPLES OF STATE POLICY

The crafting of Fundamental Rights and Directive Principles and their various interpretations, the centrality of Fundamental Rights in the Indian Constitution, Counter- hegemonic imagination of justice: Defining liberty and non- discrimination, The peculiarity of the Directive Principles of State Policies, The idea of constitutional insurgency, Cultural and educational rights to minorities in the Constitution.

UNIT III: ASYMMETRICAL FEDERALISM: CENTER-STATE RELATIONS

What is federalism? Constitutional provisions related to federalism, Relationship between State and Centre, Deliberative ambiguities of Indian Federalism, Special Provisions for Jammu and Kashmir, Himachal Pradesh, Northeastern states and tribal areas.

UNIT IV: FOUNDATIONS OF GOVERNANCE

Division of Power: Legislative, Executive, and Judiciary, Parliamentary form of government in India, Government of the Union and Government of the State, Role of Supreme Court and Judicial Activism in India.

UNIT V: CONSTITUTION AS A LIVING DOCUMENT

Constitution as a dialogue, Constitutional Amendments and the basic structure of the Indian constitution, Insertion of the 9th schedule in the constitution, The role of judiciary and citizen in defending, negotiating and interpreting the constitution.

TEXTBOOKS/REFERENCES

1. Arjun Thiruvengadam, Origin and Crafting of the Constitution, in The Constitution of India, a Contextual Analysis, Hart Publishing.
2. Granville Austin, The Indian Constitution: Cornerstone of a Nation, Oxford University Press, Oxford, 1966.
3. Kalpana Kannabiran, Tools of Justice: Non- discrimination and the Indian Constitution, Routledge, 2012.
4. Rajeev Bhargava (ed), Ethics and Politics of the Indian Constitution, Oxford University Press, New Delhi, 2008.
5. Subhash C. Kashyap, Our Constitution, National Book Trust, New Delhi, 2011.
6. Zoya Hassan, E. Sridharan, and R. Sudarshan (eds), India's Living Constitution: Ideas Practices, Controversies, Permanent Black, New Delhi, 2002.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
HIS 005	Introduction to Gender	OE	4	0	0	4

UNIT I: THE NATION AND ITS MANY ROOTS

What is a Nation? –Theories of Nationalism, The many names of India: India, Hindia, Aryavarta or Bharat, Mother India: Iconising a Nation

UNIT II: UNEARTHING THE PAST

The Evolutionary Past: Interbreeding Vs Replacement Theory, Out of Africa Theory, what is a civilization? Theories of Civilization, Indus Valley Civilization

UNIT III: STORIES OF GODS AND PEOPLE

The Emergence of Myths, Myth Vs Reality, Vedic Age in India, Tribes, Caste and Battles.

UNIT IV: POLITY AND GOVERNANCE

Religion, Economy and the State –Asoka, Chankya and the Buddha, Land the Economy: Exploring the Arthasastra, Social Order and the State: Through the Epics, Two millennia of pluralism: Jews, Christians and other religions in India.

UNIT V: TOWARDS UNDERSTANDING THE NATION

The Mughals in India, Multiple Identities – the same heritage, The Past as a Signifier

TEXTBOOKS

1. Y. N.Harari, A Brief History of Humankind, Harper, 2015.
2. Upinder Singh, A History of Ancient and Early Medieval India, Pearson, 2009.
3. Romila Thapar, Early India: From the Origins to AD 1300, University of California Press, 2004.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
MAT 355	Calculus of Variation	OE	4	0	0	4

UNIT I: METHOD OF VARIATIONS IN PROBLEMS WITH FIXED BOUNDARIES

Introduction – Functionals, Variation and Its Properties, Euler's Equation, Functionals Dependent on Higher-Order Derivatives, Variational Problems in Parametric Form, Some Applications.

UNIT II: VARIATIONAL PROBLEMS WITH MOVING BOUNDARIES

Elementary Problem with Moving Boundaries, One-Sided Variations.

UNIT III: SUFFICIENT CONDITIONS FOR AN EXTREMUM

Field of Extremals, The Function $E(x, y, p, y')$, Transforming the Euler Equations to the Canonical Form.

UNIT IV: VARIATIONAL PROBLEMS INVOLVING A CONDITIONAL EXTREMUM

Constraints of the Form $\varphi(x, y_1, y_2, \dots, y_n)$, Constraints of the Form $\varphi(x, y_1, y_2, \dots, y_n, y'_1, y'_2, \dots, y'_n)$, Isoperimetric Problems.

UNIT V: DIRECT METHODS IN VARIATIONAL PROBLEMS

Introduction to Direct Methods, Euler's Finite-Difference Method, Rayleigh-Ritz Method, Kantorovich's Method.

TEXTBOOKS/REFERENCES

1. L. Elsgolts, *Differential Equations and the Calculus of Variations*, University Press of the Pacific, 2003.
2. A S Gupta, *Calculus of Variations*, Prentice-Hall of India Pvt. Ltd., New Delhi, 2008.
3. I. M. Gelfand and S. V. Fomin, *Calculus of Variations*, Dover Publications. 1963.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
IDEA 103	User Experienced Design	OE	3	0	0	3

WHAT IS UX DESIGN

MODULE 1: INTRODUCTION TO USABILITY, INTERACTION DESIGN, DESIGN THINKING

3. The principle of ‘Visibility’, ‘Findability’, ‘Learnability’
4. Affordances
5. Mapping
6. Constraints
7. Feedback
8. Hick’s law
9. Fitt’s law
10. Interactive experience
11. Design thinking overview

MODULE 2: DESIGN PRINCIPLES & DESIGN GUIDELINES

12. Gestalt Principles
13. 10 rules of thumb
14. UI design failures

USER RESEARCH METHODS

15. Qualitative user research
16. Best practices of qualitative user research
17. Conducting ethical user research
18. Basics of recruiting participants for user research

MODULE 3: VISUAL PERCEPTION AND COLOR VISION

19. Visual Perception
20. Vision and Design using color
21. Color blindness
22. Context and other influences

MODULE 4: USABILITY CONSIDERATIONS

23. Task structure
24. Simplicity in design
25. Designing with experience in mind
26. Chunking
27. Banner blindness
28. Preventing errors
29. Context of use
30. Focus on users
31. The value of UX

UX DESIGN PROCESS

MODULE 5: PROJECT-I (in teams)

32. Applying Design thinking
33. Empathy & Ideation principles & tools

STORYTELLING

34. Role of Storytelling in Design thinking

INSTRUCTIONAL METHOD

- The course delivery method will be through online platforms (Zoom is preferred due to the breakout rooms options) depend upon the requirement of content and need of students. This will be an experiential learning throughout the course.
- The internal evaluation will be done based on continuous evaluation of students in the hands-on workshop assignments and classroom.
- Practical examination will be conducted at the end of semester for evaluation of performance of students in their given projects and also through questionnaire-based exam

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
IDEA 104	Dream-Discover-Disrupt	OE	3	0	0	3

MODULE 1: VENTURE IDEATION.

MODULE 2: MARKETING.

MODULE 3: CUSTOMER SEGMENTATION.

MODULE 4: CUSTOMER DISCOVERY.

MODULE 5: SOLUTION DESIGN

**OPEN ELECTIVES
V-SEMESTER**

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
CSE 202	Web Technology	OE	3	0	0	3

UNIT I: WEB ESSENTIALS

Introduction to World Wide Web (WWW) Introduction to Communication Models. Web site design principles, planning the site and navigation. Introduction to Hypertext Markup Language (HTML) Form design using HTML. Basics of Extensible Hypertext Markup Language (XHTML) Basics of W3C Markup Validation Service.

UNIT II: CLIENT-SIDE SCRIPTING

Introduction to Cascading Style Sheets (CSS) Style sheets in HTML. Introduction to Java scripts.

UNIT III: HOST OBJECTS

Syntax variables and data types in Java scripts. Operators in Java scripts. Arrays and user defined functions in Java script. Java script objects.

UNIT IV: BROWSERS AND THE DOM

XML-Documents and Vocabularies. XML Namespaces. Ajax in web development. Event based parsing in XML. XPath and XSLT. Introduction to JSP. JSP and Servlets. Standard Tag Library in JSP.

UNIT V: WEB SERVICES

Web Servers (IIS, PWS and Apache). HTTP Request Types. Accessing Web Servers. Database connectivity. Applets and Servlets. JDBC connectivity. JSP and Web development Frameworks. Application programming interface (API) for Remote Procedure Calls (RPC). Simple Object Access Protocol (SOAP) and Representational State Transfer (REST) APIs.

TEXTBOOKS/REFERENCES

1. Deitel, Deitel and Nieto, Internet, and Worldwide Web - How to Program, 5th Edition, PHI, 2011.
2. Jeffrey C. Jackson, "Web Technologies--A Computer Science Perspective", Pearson Education
3. Marty Hall and Larry Brown," Core Web Programming" Second Edition, Volume I and
4. II, Pearson Education, 2001. 4. Bates, "Developing Web Applications", Wiley, 2006.
5. Kalin, Martin. Java Web Services: Up and Running: A Quick, Practical, and Thorough,Introduction. " O'Reilly Media, Inc.", 2013.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
CSE 202 L	Web Technology Lab	OE	0	0	2	1

LIST OF EXPERIMENTS

1. Familiarize all the basic HTML tags.
2. Implement a static HTML personal webpage by using all the possible basic tags. [Each student can develop his own bio-data page]
3. To create an html file to link to different html page which contains images, tables, and also link within a page use Frames, Forms, etc. also.
4. Create an HTML file by applying the different styles using inline, external and internal style sheets.
5. a. Create an html page to change the background color for every click of a button using Java script. write a Java script program to define a user defined function for sorting the values in an array.
b. Create an html page with 2 combo box populated with month & year, to display the calendar for the selected month & year from combo box using java script.
6. Develop a webpage with HTML and Java Script to read name and marks of five subjects obtained for that particular student using forms. Further, it should compute the Grade and display it as a message box.
7. Create a form to collect the name, email, user id, password and confirm password from the user. All the inputs are mandatory and email address should be entered in standard format. Also, the values entered in the password and confirm password textboxes should be the same. For the security reasons make sure that the password entered by the user contains both small letters and capital letters, digits, special symbols also. If the given password does not contain all these give an error message to the user. After validating all the details using JavaScript display a message like "You have successfully entered all the details".
8. Design an XML document to store information about the student of SRM University AP. The information must include Roll No Name, Branch, Year of Joining, and email id. Make up sample data for 3 students. Create a CSS style sheet and use it to display the document.
9. Develop a registration form with various graphical user component interfaces like Text boxes (Roll No), Text boxes (Name) option buttons (gender), Qualification (Check boxes), State (Combo), etc. and store the information given by the user into a MySql database using JSP.
10. Develop a webpage to display the details of a student. For this the user will enter Roll Number in the text box given and the details of that particular student should be retrieved from the database and display it on the same webpage. Use JSP to solve this problem.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ECE 418	Machine Learning	OE	3	0	2	4

UNIT I

Introduction to machine learning, Supervised and Unsupervised Learning, Linear Regression, Logistic Regression, Generalized Linear Models.

UNIT II

Gaussian Discriminant Analysis (GDA), Naive Bayes, Support Vector Machines, K-Nearest Neighbor, Decision Trees, Random Forest.

UNIT III

Clustering in Machine Learning, Different Types of Clustering Algorithm, K-Means Clustering, Gaussian Mixture Models, Bias-variance trade off.

UNIT IV

Introduction to Neural Networks, Feed-forward Network, Gradient descent optimization, Error Backpropagation, Evaluation of error-function derivatives, Efficiency of backpropagation, under and over fitting.

UNIT V

Introduction to Convolutional neural network (CNN), Backpropagation in CNN, Sparse Kernel Machines, Markov Chain Monte Carlo, Introduction to Reinforcement learning.

TEXTBOOKS/REFERENCES

1. Christopher M. Bishop, "Pattern Recognition and Machine Learning" by Springer, 2007.
2. Tom M. Mitchell, "Machine Learning", First Edition by Tata McGraw-Hill Education, 2013.
3. Ethem Alpaydin, "Introduction to Machine Learning" 2nd Edition, The MIT Press, 2009.

LIST OF EXPERIMENTS

1. Implement Linear Regression on the given dataset using python/MATLAB.
2. Implement Naïve Bayes classifier using Python/MATLAB.
3. Implement Logistic Regression on the given dataset using python/MATLAB.
4. Implement SVM algorithm using Python/MATLAB.
5. Implement Decision tree classifier and Random Forest classifier using python/MATLAB.
6. Implement Random Forest classifier using python/MATLAB.
7. Implement K-means algorithm for clustering the data using python/MATLAB.
8. Implement K-Nearest Neighbour classifier using python/MATLAB.
9. Emulate logic gates using neural Network using python.
10. Implement single-Layer Neural Network for image/data analysis using Python/MATLAB.
11. Implement Convolution Neural Network for image/data analysis using Python/MATLAB.
12. Implement Markov model for analysis of stock market data using python/MATLAB

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
EEE 422	Optimization Techniques	OE	3	0	0	3

UNIT: I UNCONSTRAINED OPTIMIZATION

Basics: Set-constrained and unconstrained optimization; conditions for local minimizers, One-dimensional search methods: golden section, Fibonacci, bisection, Newton's and Secant methods; bracketing; line search, Gradient methods: steepest descent method; analysis of gradient methods.

UNIT: II METHODS

Newton's method: analysis; Levenberg-Marquardt modification; nonlinear least squares, Conjugate Gradient method: conjugate direction algorithm; conjugate gradient algorithm; non-quadratic problems, Quasi-Newton method: approximating the inverse Hessian; rank-one correction; DFP and BFGS algorithms, Least-squares analysis; RLS; linear equation with minimum norm; Kaczmarz's algorithm; general solution.

UNIT: III LINEAR PROGRAMMING

Linear Programming: standard form; convex polyhedral; basic solutions and properties, Simplex method: canonical augmented matrix; algorithm; matrix form; two-phase; revised method, Duality: Dual linear programs and properties.

UNIT: IV EQUALITY AND INEQUALITY CONSTRAINTS

Equality constraints: Problem formulation; tangent and normal spaces; Lagrange conditions; second-order conditions; minimizing quadratics with linear constraints, Inequality constraints: Karush-Kuhn Tucker conditions; second-order conditions.

UNIT: V CONSTRAINED OPTIMIZATION

Convex optimization: convex functions, convex optimization problems; semi-definite programming, Algorithms: Projections; projected gradient with linear constraints; Lagrangian algorithms; penalty methods, Multi-objective Optimization: Pareto solutions, Pareto front computation, from multi-objective to single-objective optimization; uncertain LP problems.

TEXTBOOKS/REFERENCES

1. E. K. P. Chong and S. H. Zak, "An Introduction to Optimization," 4th edition, Wiley, 2013.
2. D. G. Luenberger and Y. Ye, "Linear and Nonlinear Programming," 4th edition, Springer, 2016.
3. D. P. Bertsekas, "Nonlinear programming," Athena Scientific, 1999.
4. S. Boyd and L. Vandenberghe, "Convex optimization," Cambridge University Press, 2004.
5. M. Fathi and H. Bevarani, "Optimization in Electrical Engineering," Springer, 2019.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 418	Introduction to Electric Vehicles	OE	3	0	0	3

UNIT I: INTRODUCTION

History, EV Benefits, EV/HEV subsystems and configurations.

UNIT II: VEHICLE DYNAMICS

Vehicle dynamics, forces acting, power and torque calculations, Simulations, Drive cycles.

UNIT III: BATTERIES

Battery parameters, why Li, SoH & SoC estimation/self-discharge, Battery pack design/development, battery computations, Charging, BMS and its design, future batteries.

UNIT IV: ELECTRICAL COMPONENTS FOR EV AND HEV

EV Motors (IM, PM etc.) D-q circuit, DC-DC converters, DC-AC converters, control system overview.

UNIT V: EV DESIGN

Mechanical, Electrical and Thermal design consideration, Sample design calculations for EV and HEV's.

TEXTBOOKS

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. Electric Powertrain - Energy Systems, Power electronics and drives for Hybrid, electric and fuel cell vehicles by John G. Hayes and A. Goodarzi, Wiley Publication.

REFERENCES

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2018.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
IDEA 102	Design Thinking	OE	3	0	0	3

UNIT I: INTRODUCTION TO DESIGN THINKING

What is Design Thinking and why is it popular? Innovative thinking, what is a wicked problem and how can we solve it? The design thinking stages overview.

UNIT II: DESIGN THINKING - EMPATHISE

Power of Empathy, Probes for context mapping, Power of stories in building empathy for the target group.

USER RESEARCH METHODS

Qualitative user research, best practices of qualitative user research, Conducting ethical user research, Basics of recruiting participants for user research.

UNIT III: DESIGN THINKING – DEFINE/REDEFINE THE CHALLENGE

Define problem, Frame insights, Understand context.

UNIT IV: DESIGN THINKING – IDEATE

Brainstorm and ideate, Divergence to Convergence, Creative confidence.

UNIT V: DESIGN THINKING – PROTOTYPE & TEST

Prototype to product, Prototyping methods, Heuristic Evaluation.

PROJECT 1 (IN TEAMS)

Applying Design thinking, Empathy & Ideation principles & tools.

PROJECT 2 (IN TEAMS)

Applying Design thinking/Innovation principles and approach using specific tools.

STORYTELLING

Role of Storytelling in Design thinking o The course delivery method will be through online platforms (Zoom is preferred due to the breakout rooms options) depend upon the requirement of content and need of students. This will be an experiential learning throughout the course.

INSTRUCTIONAL METHOD

1. The course delivery method will be through online platforms (Zoom is preferred due to the breakout rooms options) depend upon the requirement of content and need of students. This will be an experiential learning throughout the course.
2. The internal evaluation will be done based on continuous evaluation of students in the hands-on workshop assignments and classroom.
3. Practical examination will be conducted at the end of semester for evaluation of performance of students in their given projects and also through questionnaire based exam.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
MAT 305	Introduction to Science and Technology Studies	OE	4	0	0	4

UNIT I: PHILOSOPHY OF SCIENCE: ISSUES AND PERSPECTIVES

What is science? Some Historical Background, Scientific reasoning- Induction, deduction and the problem of Hume, Scientific Explanation and Causality, Popper's Philosophy of Science, Scientific Revolutions.

UNIT II: PERSPECTIVES FROM SOCIOLOGY OF SCIENCE AND TECHNOLOGY

Questioning Functionalism in the Sociology of Science, the strong program, the social construction of Scientific and technological realities, Studying laboratories.

UNIT III: SCIENCE, TECHNOLOGY AND DEVELOPMENT: A CRITICAL ENQUIRY

Medicine, Agriculture, Environment, War.

UNIT IV: EXCLUSIONS IN SCIENCE AND TECHNOLOGY INSTITUTIONS

Under presentation of women in Science and Technology Institutions in India and abroad, Autobiographical Accounts, The Caste of Merit- excerpts.

UNIT V: FEMINIST AND OTHER CRITIQUES OF SCIENCE

The Mis-measure of Man IQ tests, Craniometry, Examples of how gender figures in doing science, The Medical Construction of gender: The case of Intersex babies, Feminist epistemologies of Science, Hidden Figures Movie

TEXTBOOKS/REFERENCES

1. Samir Okasha (2003). Philosophy of science: A very short introduction.
2. Sismondo, S. (2010). An introduction to science and technology studies.
3. S G Kulkarni. Philosophy of Science: issues and Perspectives.
4. Mary Wyer et al (2000) Women Science and Technology.
5. Ajantha Subramanian (2018) The Caste of Merit.
6. Stefan Jay Gould The Mismeasure of Man.
7. Ashish Nandy Science Hegemony and Violence.
8. Gita Chadha and Asha Achuthan (Eds) Review of Women Studies, Economic and Political Weekly.
9. Jayasree Subramanian (2007) Perceiving and Producing Merit: Gender and Doing Science in India.
10. Sumi Krishna & Gita Chadha (Eds) Feminists and Science

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
PSY 111	Psychology for Everyday Living	OE	4	0	0	4

UNIT I: MYTHS AND MISCONCEPTIONS IN PSYCHOLOGY

Definition, nature and goals of psychology, Common myths and misconceptions about psychology, Schools of psychology; Basic and applied areas of psychology

UNIT II: THE ROLE OF PERCEPTION AND ATTITUDE TOWARDS UNDERSTANDING THE WORLD

Perception: Understanding perception, Gestalt laws of organization, common illusions, Perceptual constancy - depth perception, size perception, perception of movement, Attitude formation, Attitude change.

UNIT III: INTELLIGENCE AND LEARNING

Definitions and nature of intelligence, Emotional and social intelligence; Measuring IQ, EQ and SQ, Fundamentals of learning and its applications, Memory techniques.

UNIT IV: UNDERSTANDING THE SELF

Definition; Approaches to personality – trait and type, Psychoanalytical and humanistic theory, Tests of personality – MBTI and NEO-PI, Identity; Self-concept, self-esteem and self-efficacy.

UNIT V: STRESS, COPING AND QUALITY OF LIFE

Nature, sources of stress and its reactions, Factors influencing stress, coping with and managing stress - cognitive and behavioral techniques, Improving quality of life.

TEXTBOOKS/REFERENCES

1. Baron, R. A. (2001). Psychology. New Delhi: Pearson Education India.
2. Nolen-Hoeksema, S., Fredrickson, B.L. & Loftus, G.R. (2014). Atkinson & Hilgard's Introduction to Psychology. 16th Ed. United Kingdom: Cengage Learning.
3. Morgan, C. T., King, R. A., & Schopler, J. (2004). Introduction to Psychology. New Delhi: Tata McGraw Hill.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
PSY 116	Fundamentals of Neuro Linguistic Programming-Level 1	OE	3	0	0	3

UNIT I: WHAT IS NLP?

Introduction to NLP, NLP Frames, NLP Presuppositions – Beliefs of Excellence. The Communication Model (Deletion, Distortion and Generalization) Components of the NLP Communication Model.

UNIT II: META PROGRAMS

Sensory Acuity and Calibration, Representation System (Modalities), Sub modalities Practicing Sub modalities, Identifying your primary representational system.

UNIT III: ANCHORING

Eye Accessing Cues Rapport – Unconscious responsiveness. State: Introduction to states, Anchoring Process, State Elicitation Summary, Stacking Anchors, Stacking Anchors Summary (X, Y, Z state).

UNIT IV: WELL-FORMED / WELL-DEFINED OUTCOMES

Pain and Pleasure exercise, Wellness Vision Planning (Wheel of Life) Ardell's model for Wellness Coaching. T-F-A-R Coaching Model Timeline Coaching.

UNIT V: COACHING PATTERNS

New Behaviour Generator, Circle of Excellence – Resourceful States. Walt Disney Strategy, Reframing Coaching using values Perceptual Positions (Relationship Coaching / Leadership Coaching).

TEXTBOOKS/REFERENCES

1. NLP The New Technology of Achievement – Edited by Steve Andreas and Charles Faulkner

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
BIO 112	Basic Microbiology	OE	4	0	0	4

UNIT I: INTRODUCTION TO MICROBIOLOGY

History of microbiology, Essential methods to study microbes: sterilization and disinfection: Methods of sterilization- physical methods (heat, filtration), radiation and chemical methods, Principles of microscopy, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur-germ theory of disease, Robert Koch- Koch's postulates, Joseph Lister, Alexander Fleming, Microbial growth, Growth media types - selective and differential media; Influence of environmental factors for microbial growth. Growth phases and kinetics; Maintenance and preservation of bacterial cultures.

UNIT II: BACTERIAL CELLS - STRUCTURE AND FUNCTION

Different groups of microorganisms and their general characteristics, Ultrastructure of Gram positive and Gram-negative bacterial cell wall, Size, shape and arrangement of bacterial cells. cell membrane, cytoplasmic matrix, pili, capsule, flagella Classification & molecular taxonomy-Phylogenetic tree; measuring diversity by 16S/18S rRNA, RAPD, T-RFLP.

UNIT III: MOLECULAR PATHOGENS

Viral structure and classification; Bacteriophage and its life cycle; Viral pathogenesis; Immune response to viral infections; Acute, chronic and latent viral infections; Viral vaccines, Viroid, Prions, Plasmid and transposable elements.

UNIT IV: MICROBIAL DISEASE AND ANTIMICROBIAL AGENTS

Microbial disease: - Tuberculosis, Typhoid, Infection caused by *E. coli*, *Staphylococcus*, *Sterptococcus*, Role of quorum sensing and biofilm in microbial disease, Action of antimicrobial drugs: inhibitors of cell wall synthesis, inhibitors of protein synthesis, inhibitors of nucleic acid synthesis, competitive inhibitors, antifungal, antiviral, anti- protozoan drugs, Mechanism of antibiotic resistance.

UNIT V: APPLIED MICROBIOLOGY

Microorganism of Industrial use, Basics of fermenter design, Primary and secondary metabolites, Strains-screening, adaptation and strain improvement Industrial production of antibiotics – penicillin; alcohol- ethanol. Food microbiology – Microorganisms in food, Introduction to probiotics and prebiotics, Food preservation Environmental microbiology – Bioremediation, Bioleaching, Microbial degradation of textile waste.

TEXTBOOKS/REFERENCES

1. Microbiology, 6th edition (1993), Pelczar, Chan and Krieg; McGraw Hill International
2. Prescott, Harley, and Klein's Microbiology, 8th edition, (2011), Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton, McGraw Hill International.
3. Stainer R. Y., Ingraham. J. L., Wheelis M. J., Painter P. R. (1999). General microbiology. MacMillan Educational Ltd. London.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
PHY 223	Introduction to Quantum Computation	OE	3	1	0	4

UNIT I: MATRIX, TENSOR AND DIRAC NOTATION

Basis vectors and orthogonality, Matrices Hilbert spaces, Inner and outer products, Tensors in index notation, Metric tensors, covariant and contravariant tensors, Unitary operators and projectors, Hermetian operator, Adjoint of operator, Wavefunction as vector and operator as metrics, Dirac notation, Tutorial 1, Tutorial 2, Tutorial 3.

UNIT II: INTRODUCTION AND OVERVIEW OF QUANTUM MECHANICS

Photon, Concept of Planck Constant, Photoelectric effect, Wave particle duality, Wave packet, Davisson and Germer Experiment, Superposition Principle, Young Double slit experiment, Qubits and pieces, Concept of Bloch sphere, Derivation on Bloch sphere representation, Tutorial 4, Tutorial 5, Tutorial 6.

UNIT III: FUNDAMENTALS OF QUANTUM COMMUNICATION

No-cloning theorem, Hidden Information of state, Einstein-Podolsky-Rosen Paradox, Bell states, Bell inequalities, Bell inequalities – Examples, Quantum entanglement, Quantum entanglement considering Heisenberg principal, Quantum teleportation, Tutorial 7, Tutorial 8, Tutorial 9.

UNIT IV: QUANTUM GATE

Pauli Gates, Phase Gate, Controlled phase shift, Hadamard gates, SWAP Gates, CNOT Gates, Toffoli gates, Combination of Gates, Circuit of Gates, Tutorial 10, Tutorial 11, Tutorial 12.

UNIT V: QUANTUM ALGORITHM, KEY DISTRIBUTION AND ERROR

Deutsch algorithm, Deutsch-Josza algorithm, Shor's Algorithm – Periodicity, Shor's period-finding algorithm, Introduction to Quantum key distribution, BB84 protocol, Quantum Error Correction, Quantum Error Correction Example, Physical Qubits, Tutorial 13, Tutorial 14, Tutorial 15.

TEXTBOOKS/REFERENCES

1. Phillip Kaye, Raymond Laflamme, and Michele Mosca (2007). An Introduction to Quantum Computing. Oxford University Press.
2. Michael A. Nielsen and Isaac L. Chuang (2000). Quantum Computation and Quantum information. Cambridge University Press.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
HIS 005	Introduction to Gender	OE	4	0	0	4

UNIT I: THE NATION AND ITS MANY ROOTS

What is a Nation? –Theories of Nationalism, The many names of India: India, Hindia, Aryavarta or Bharat, Mother India: Iconising a Nation

UNIT II: UNEARTHING THE PAST

The Evolutionary Past: Interbreeding Vs Replacement Theory, Out of Africa Theory, what is a civilization? Theories of Civilization, Indus Valley Civilization

UNIT III: STORIES OF GODS AND PEOPLE

The Emergence of Myths, Myth Vs Reality, Vedic Age in India, Tribes, Caste and Battles.

UNIT IV: POLITY AND GOVERNANCE

Religion, Economy and the State –Asoka, Chankya and the Buddha, Land the Economy: Exploring the Arthasastra, Social Order and the State: Through the Epics, Two millennia of pluralism: Jews, Christians and other religions in India.

UNIT V: TOWARDS UNDERSTANDING THE NATION

The Mughals in India, Multiple Identities – the same heritage, The Past as a Signifier

TEXTBOOKS

1. Y. N.Harari, A Brief History of Humankind, Harper, 2015.
2. Upinder Singh, A History of Ancient and Early Medieval India, Pearson, 2009.
3. Romila Thapar, Early India: From the Origins to AD 1300, University of California Press, 2004.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ECO 251	Indian Economy	OE	4	0	0	4

UNIT I: PERFORMANCE OF INDIAN ECONOMY SINCE 1947

Growth and Structural Changes, Features/characteristics of Indian economy, Human Development Index Traditional Methodology, Human Development Index: New Methodology, Sustainable Development, Capital Formation, Demographic Transition, Economic Planning in India, Reforms in Indian Economy.

UNIT II: KEY ISSUES OF INDIAN ECONOMY

Issues and Trends of Unemployment, Poverty in India, Problem of Inequality, Issues of Education, Gender Issues in India.

UNIT III: STRUCTURAL PERFORMANCE OF INDIAN ECONOMY

Importance and Features of Indian Agricultural, Trends in Performance and Productivity, Agricultural Markets and Institutions, Land Reforms, Green Revolution in Indian Agriculture, Agricultural Labour, Food Security, Public Distribution System, Trends, Productivity, and Growth of Industries, Industrial Policy in India, Industrial Sickness Small Scale Industries, Foreign Direct Investment in India.

UNIT IV

Trends and Performance in Services, WTO, India Foreign Trade, Monetary Policy, Fiscal Policy, Total contact hours.

TEXTBOOKS/REFERENCES

1. Jean Dreze and Amartya Sen, 2013. An Uncertain Glory: India and its Contradictions, Princeton University Press.
2. Himanshu, 2010, Towards New Poverty Lines for India, Economic and Political Weekly, January.
3. Kaushik Basu, 2009, —China and India: Idiosyncratic Paths to High Growth, Economic and Political Weekly, September.
4. Gaurav Datt and Ashwani Mahajan, 2019- Indian Economy. S Chand and Company Limited, New Delhi 2019.
5. Puri, V.K. & Mishra S.K, 2019- Indian Economy. Himalaya Publishing House, New Delhi 2019.
6. Jalan, Bimal. Indian Economy: Problems and Prospects. Penguin India; New edition, 2004.
7. Jean Dreze and Angus Deaton, 2009, Food and Nutrition in India: Facts and Interpretations, Economic and Political Weekly, February.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
EGL 167	Code Name Language	OE	4	0	0	4

UNIT I: THE REPRESENTATIONAL HIERARCHY

Introduction to the Triune Brain Model, Information Processing by the triune brain, The Visual, Auditory and Kinesthetic Learning Styles. The impact of belief & perception on language.

UNIT II: THE MAP IS NOT THE TERRITORY

The Beliefs of Excellence, Identifying the inner map, Asking Clean question, Arriving at well-formed outcome.

UNIT III: DECODING THE MAP

Introduction to the meta programs, Comprehending the thirteen filters, Sub modalities – an insight, Using sub modalities as a tool for change.

UNIT IV: REPROGRAMMING LANGUAGE

Meta Modelling – an overview, the three critical filters: Deletion, Distortion, Generalization, The Filter and Need connect, The Milton Model: Language to influence.

UNIT V: FROM PROGRAMMING TO REPROGRAMMING

The Role of Tools & Techniques in Language Re programming, The archetypes and corresponding metaphors, Demonstration of a few tools & techniques like Swish, Perceptual Positions, Coach & Crash, and Tetralema, Hands on sessions.

TEXTBOOKS/REFERENCES

1. Brandler Richard, John Grinder. *Frogs into Princes*. US: Eden Grove Editions, 1990.
2. Mukherjee Sudip. *Two Steps Ahead*. India: Notion Press, 2020.
3. Sullivan Wendy and Judy Rees. *Clean Language: Revealing Metaphors and Opening Minds*. UK: Crown House Publishing, 2008.
4. Dilts Robert. *Neuro Linguistic Programming: The Study of the structure of subjective experience*. USA: Meta Publications, 2009.
5. Brothers Jo Barbara (ed.) *Virginia Satir: Foundational Ideas*. USA: Haworth Press, 1991

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
MAN 001	Mandarin	OE	3	0	0	3

COURSE DESCRIPTION

This course is the first semester of four that forms an introduction to standard Mandarin Chinese and is designed for students with no previous background in spoken or written Mandarin. Students in this course focus on learning essential vocabulary, practicing pronunciation, and understanding simple grammatical structures. This knowledge prepares students to effectively communicate in Mandarin on a limited range of topics related to everyday situations and examine how culture and language interact. In-class activities and course assignments aim to assist students as they develop the oral proficiency and confidence necessary to initiate simple conversations. Out-of-classroom experiences such as cultural activities or guided interactions with native speakers supplement formal classroom instruction and provide ample opportunities for practical engagement.

TEXTBOOK & COURSE MATERIALS

1. A Course in Contemporary Chinese Volume 1 《當代中文課程 1》 by the Mandarin Training Center at National Taiwan Normal University. Publisher: Sanctum Books; First Indian edition (31 March 2021)
2. Supplementary vocabulary & cultural materials

METHOD OF INSTRUCTION

This course is delivered through a series of classroom instruction sessions, activities, homework, in-class practice, and non-classroom structured activities. All four skills of language learning (listening, speaking, reading, and writing) will be covered, with a particular focus on communication skills necessary in Chinese culture.

PART 2: OUTCOMES

1. This course will help student master Mandarin pronunciation, basic reading and writing skills, and to develop the ability to participate in simple, practical conversations on everyday topics.
2. In this course, students will learn to greet, to introduce themselves, to communicate with other people in Mandarin Chinese, and have basic knowledge and ability in Mandarin Chinese.

STUDENT LEARNING OUTCOMES

1. By the completion of this course, students will be able to:
2. Use Mandarin Chinese to confidently communicate on a range of topics related to everyday situations such (e.g. to introduce themselves, discuss family, hobbies, likes and dislikes).
3. Recognize and write approximately 150 Chinese characters.
4. Read and write simple sentences in Chinese.
5. Demonstrate listening comprehension in a number of simple circumstances.

KNOWLEDGE OUTCOMES

1. This course is designed to assist students to acquire and demonstrate knowledge about:
2. Essential vocabulary, pronunciation, and grammatical structures.
3. Understand how Chinese culture and Mandarin Chinese interact.
4. The differences and similarities between Chinese and the student's native language.

SKILLS OUTCOMES

1. This course is designed to assist students in acquiring or enhancing the following skills:
2. Basic communication skills in Mandarin Chinese.
3. Competency with the Pinyin-Chinese phonetics system.
4. Ability to read and write Chinese characters.
5. Confidence to initiate simple conversations with other people.

PART 3: TOPIC OUTLINE/SCHEDULE

WEEK 01: INTRODUCTION, GREETING.

1. Introduction of Mandarin Chinese & Pinyin (the Chinese phonetic system)
2. Greetings in normal and polite ways.

WEEK 02: LEARNING TO INTRODUCE PEOPLE.

1. Basic sentences with “是shì”
2. Answering question with “什麼shéme”
3. Way to ask questions with A-not-A and “嗎ma” in Chinese

WEEK 03: LEARNING TO DISCUSS LIKES/DISLIKES.

1. Answering question in Chinese (Affirmative and Negative answers with “不bù”)
2. Modification Marker “很hěn”
3. Contrastive question with “呢ne”

WEEK 04: LEARNING TO TALK ABOUT PEOPLE IN MY FAMILY MEMBERS AND THEIR NAMES.

1. Asking question with “幾jǐ”
2. Basic sentences with “有yǒu”

WEEK 05: LEARNING TO DESCRIBE PEOPLE, PLACES, AND POSSESSIONS.

1. Possessive word “的de”
2. Modifier Marker “的de”

WEEK 06: LEARNING TO TALK ABOUT THE NUMBER OF PEOPLE IN A FAMILY, PARTIAL EXAM.

1. Totality “都dōu”
2. Measure word “個ge” and “張zhāng”
3. Partial exam for Oral & writing

WEEK 07: LEARNING TO DESCRIBE LIKES/DISLIKES (E.G., SPORTS AND MOVIES).

1. Time words & Hobbies
2. To go do something with “去qù”
3. Placement of time words

WEEK 08: LEARNING TO EXPRESS WHAT TWO GROUPS HAVE IN COMMON.

1. Topic sentences
2. Word order in sentences (Chinese sentence orders, difference between English and Chinese)
3. The word order of Adverbs “也yě”, “都dōu” and “常cháng”

WEEK 09: LEARNING TO POLITELY ASK OTHERS OPINIONS AND MAKE SIMPLE SUGGESTIONS.

1. Asking question with “怎麼樣zěnmeyàng”
2. Particles with “吧ba” and “啊a”

WEEK 10: LEARNING TO FORM CHOICE QUESTIONS, FINAL EXAM

1. Asking choice question with “還是háishì”
2. Making sentences with “覺得juéde”
3. Final exam for Oral & writing

PART 4: GRADING POLICY**EVALUATION CRITERIA**

The grade for this course will be based on the following table.

Percentage (%)	Evaluation Area
60	Classroom performance (including performance of the basic conversation, participation in class activities, quizzes, and / or homework)
10	Partial Exam – Oral
10	Partial Exam – Writing
10	Final Exam – Oral
10	Final Exam – Writing
100	Total Points Possible

LATE WORK POLICY

Be sure to pay close attention to deadlines—there will be no makeup assignments or quizzes, or late work accepted without a serious and compelling reason and instructor approval.

GRADING SCALE

Final grades assigned for this course will be based on the percentage of total points earned and are assigned as follows:

Letter Grade	Corresponding Percentage Points	Performance
A	93-100%	Excellent Work
A-	90-92%	Nearly Excellent Work
B+	87-89%	Very Good Work
B	83-86%	Good Work
B-	80-82%	Mostly Good Work
C+	77-79%	Above Average Work
C	73-76%	Average Work
C-	70-72%	Mostly Average Work
D+	67-69%	Below Average Work
D	60-66%	Poor Work
F	0-59%	Failing Work

PART 5: COURSE POLICIES

ATTEND CLASS

Students are expected to attend all regularly scheduled classes and come prepared to participate fully in class activities. Students are further expected to be on time for all classes. Arriving late for class or an activity is disrespectful of both the instructor and fellow students.

PARTICIPATE

The participation grade will depend on both the quality and the quantity of student's comments and questions and shall account for a portion of the total course grade.

BUILD RAPPORT

If you find that you have any trouble keeping up with assignments or other aspects of the course, make sure you let your instructor know as early as possible. As you will find, building rapport and effective relationships are key to becoming an effective professional. Make sure that you are proactive in informing your instructor when difficulties arise during the semester so that they can help you find a solution.

COMPLETE ASSIGNMENTS

Assignments must be submitted by the given deadline or special permission must be requested from instructor before the due date. Extensions will not be given beyond the next assignment except under extreme circumstances. All discussion assignments must be completed by the assignment due date and time. Late or missing discussion assignments will affect the student's grade

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
TLC 101	Cognitive Learning Theories	OE	2	1	0	3

UNIT I: METACOGNITION, BRAIN, MEMORY AND LEARNING

The 3 Cos, where does learning happen? Actions pertaining to learning. What does the brain do? How does the brain learn? Memory, Intelligence, Thinking Levels.

UNIT II: LEARNING THEORIES

Classification of Knowledge, The “Science” of Education, Behaviourism, Cognitivism, Constructivism, Humanism, Dale’s cone of Learning, Glenn’s holistic thinking pyramid.

UNIT III: LEARNING INFLUENCERS

Discipline, Cognitive Factors, Self-Efficacy, Self-Regulation, Genetic Factors, External Factors, Generational Characteristics.

UNIT IV: LEARNING SUCCESS – 8 PILLARS

Beliefs, Habits, Resources, Skills & Strengths, Emotions, Motivation, Goals and Objectives, Mindset.

TEXTBOOKS

1. Schunk, D. H. (2019). Learning Theories: An Educational Perspective. United Kingdom: Pearson.

REFERENCES

1. Carey, B. (2014). How We Learn: The Surprising Truth About When, Where and Why It Happens. United Kingdom: Pan Macmillan.
2. Johnson, A. P. (2019). Essential Learning Theories: Applications to Authentic Teaching Situations. United States: Rowman & Littlefield Publishers.
3. <http://www.aussieeducator.org.au/education/theories.html>
4. <https://sites.google.com/a/nau.edu/educationallearningtheories/home>
5. <https://crlt.umich.edu/tstrategies/tslt>
6. https://www.researchgate.net/publication/347453692_A_Metacognition_Based_8_Pillars_Mindfulness_Model_and_Training_Strategies

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
EEE 305	Advanced Control Systems	OE	3	0	0	3

UNIT: I STATE VARIABLE ANALYSIS AND DESIGN

Review of classical control system, Review of classical control system, State variables, State models for physical systems, State variables, State models for physical systems, Solution of state equations. Transfer function, Eigenvalues and eigenvectors, Jacobian linearization technique, State transformations and diagonalization, Transformation to phase-variable canonical form, Controllability and observability, Duality property, Illustrative Problems.

UNIT: II POLE PLACEMENT DESIGN AND STATE OBSERVERS

Introduction, Stability Improvements by State Feedback, Necessary and Sufficient Conditions for Arbitrary Pole Placement, State Regulator Design, Design of State Observer, Compensator Design by the Separation Principle.

UNIT: III NON-LINEAR SYSTEMS ANALYSIS

Common Nonlinear System Behaviors, Common Nonlinearities in Control Systems, Describing Functions of Common Nonlinearities, Stability Analysis by Describing Function Method, Concept of Phase Plane Analysis, Construction of Phase Portraits, System Analysis on the Phase Plane, Variable Structure Systems.

UNIT: IV LYAPUNOV'S STABILITY ANALYSIS

Introduction, Lyapunov's Stability Criteria, the direct method of Lyapunov stability, Methods of constructing Lyapunov Function for Non-linear Systems, Illustrative examples.

TEXTBOOKS/REFERENCES

1. "Modern Control Engineering," K.Ogata, Pearson Education Asia/ PHI,4 th Edition, 2002. ISBN 978 - 81 - 203 - 4010 - 7.
2. Control Systems Engineering (For the Modules 1 and 2) I.J. Nagarath and M.Gopal New Age 5 th Edition, 2007.
3. Nonlinear Control, Hassan K. Khalil Pearson Education Limited, 2015.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
EEE 305 L	Advanced Control Systems Lab	OE	0	0	2	1

LIST OF PRACTICAL EXPERIMENTS

1. DC Motor modeling using LabVIEW
2. Speed control of DC Motor.
3. Position control of DC Motor.
4. Inverted pendulum control.
5. Characteristics of Brushed and Brushless DC motor.
6. Characteristics of Brushed and Brushless DC motor.
7. Position control of servo motor.
8. Tuning of PID controller gains for closed loop converter control.
9. Control system design for power systems.

TEXTBOOKS/REFERENCES

1. "Control Systems Engineering" (For the Modules 1 and 2) I.J. Nagarith and M.Gopal New Age, 5th Edition, 2007.
2. "Modern Control Engineering," K.Ogata, Pearson Education Asia/ PHI,4 th Edition, 2002. ISBN 978 - 81 - 203 - 4010 - 7.
3. "Nonlinear Control", Hassan K. Khalil Pearson Education Limited, 2015.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
MAT 307	Combinatorics and graph theory	OE	4	0	0	4

UNIT I: COUNTING PRINCIPLES AND TECHNIQUES

Combinatorics and Permutations, Binomial Coefficients and Multinomial Coefficients, The Pigeonhole Principle, the inclusion-Exclusion formula, Generating Functions: Newton's Binomial Theorem, Exponential Generating Functions, Partitions of Integers, Recurrence relations.

UNIT II: SPECIAL COUNTING NUMBERS

Partition number, Bell Numbers, Catalan numbers, Stirling numbers, Ramsey Numbers. System of distinct representatives.

UNIT III: AN INTRODUCTION TO GRAPH THEORY

Euler Circuits and Walks, Hamiltonian Cycles and Paths, Bipartite Graphs, Trees, Plane and planar graphs, Directed graphs.

UNIT IV: MORE ON GRAPH THEORY

Optimal Spanning trees, Connectivity, Colouring Planar Graphs, The Chromatic Polynomials, Graph of Symmetries, Burnside's Theorem.

UNIT V: APPLICATIONS

Problems involving scheduling and assignment, Isomer problem in Chemistry, If time permits, we also discuss a few applications in Computer Science: To prove lower bounds in computational models, Randomized algorithms, and various net- work problems.

TEXTBOOKS

1. Combinatorics and graph theory by J.M. Harris, J.L. Hirst and M.J. Mossinghoff, springer.
2. Introduction to Graph Theory by Douglas West.
3. Graph theory with applications by J. A. Bondy and U. S. R. Murty.
4. Graph Theory with Applications to Engineering and Computer Sciences by Narsingh Deo, Prentice-Hall, 1974.
5. An Introduction to Combinatorics and Graph Theory by David Guichard https://www.whitman.edu/mathematics/cgt_online/cgt.pdf.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
PHY 301	Atomic and Molecular Physics	OE	3	0	0	3

UNIT I: ATOMIC STRUCTURE

Rutherford model of atom, Rutherford Model numerical, Electron orbits, Bohr atom, Energy levels and spectra, Numerical on energy level and spectra, Sommerfield's elliptic orbits, Numerical on Somerfield's theory, Relativistic Corrections of Sommerfield's Theory, Tutorial 1, Tutorial 2, Tutorial 3.

UNIT II: VECTOR ATOM MODEL

Vector atom model, Concept of space, Concept of quantization, Electron spin, Magnetic moments of atoms, Numerical on quantization, Stern-Gerlach experiment, atomic excitation and atomic spectra, Numerical on atomic excitation and atomic spectra, Tutorial 4, Tutorial 5, Tutorial 6.

UNIT III: ONE AND TWO VALENCE ELECTRON SYSTEMS

Pauli Exclusion Principle, Electron configuration, Quantum states, Electron spin, Spin-Orbit Interaction, Energy levels of Na atom, Sodium Doublet, Spectral terms of two electron atoms, Terms for equivalent electrons, L-S and J-J coupling schemes, Singlet-Triplet separation for interaction energy of L-S coupling, Landé g-factor Landé Interval rule, Spectra of Helium atom, Zeeman Effect, Tutorial 7, Tutorial 8, Tutorial 9.

UNIT IV: ATOMIC AND MOLECULAR SPECTROSCOPY

EM spectrum, X-ray, Daune and Hunt's Rule, X-ray emission spectra, Bremsstrahlung effect, Mosley's law and its applications, Auger effect, electronic spectra of molecules. Rotational spectra of diatomic molecules, Raman Effect, Molecular Polarizability, Tutorial 10, Tutorial 11, Tutorial 12.

UNIT V: LASERS

Optical absorption and emission, Einstein coefficients, Optical pumping, Masers principles, Lasers principles, Numerical of Lasers, Ruby Laser principles, He-Ne Laser Principles, Solid state and semiconductor lasers, Tutorial 13, Tutorial 14, Tutorial 15.

TEXTBOOKS

1. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, R. Eisberg and R. Resnik 2nd Edition, 2006, Wiley.
2. Concepts of Modern physics, Arthur Besier, S. Rai Choudhury, Shobhit Mahajan, 7th Edition, 2015, Mcgraw Higher Ed.

REFERENCES

1. The Fundamentals of Atomic and Molecular Physics, Brooks, Robert L. 1 Edition, 2013, Springer-Verlag New York.
2. Physics of Atoms and Molecules, B. H. Bransden, C. J. Joachain, 2 Edition, Pearson Education India.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
COM 101	Business Organization and Management	OE	3	0	0	3

UNIT I

Historical Grassroots and Genesis of Business – How to do Business? –Introduction to Business Organization – Various Forms of Business Organization – Sole Trading – Partnership – Company Form of Business – Features of Company- Incorporation of a Company – MOA & AOA - Types of Companies - Case Study Analysis.

UNIT II

Relevance of SWOT/PESTEL analysis in establishing a Business Organization – Objectives of Business – Corporate Social Responsibilities- Sustainability of Business - Corporate Governance - Case Study Analysis.

UNIT III

Introduction to Management – Development of Management Thought – Principles of Management - Professionalization of Management – Relevance of Management to Business – Role of a Manager in Business – Skills and Qualities of a Manager – Successful and Effective Managers – Challenges before today’s managers - Case Study Analysis.

UNIT IV

Functions of Management - Overview of Planning – Types of Planning - Organizing (Levels of Management & Organizational Structures) – Directing – Coordinating and Control – Staffing – Reporting and Budgeting – Importance and Techniques of Control – Motivating Function of Manager - Case Study Analysis.

UNIT V

Best Practices in Management – Evidences from Indian and Western Counterpart – Contemporary Issues in Management – Knowledge Management – Innovation – Team Management - Learning Organizations – Case Study Analysis.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
COM 107	Finance for Engineering	OE	3	0	0	3

UNIT I: FINANCIAL REPORTING

Accounting Concept - Financial Records - Accounting Principles and Conventions – Preparation of Financial Statements – Profit and Loss Statement - Balance Sheet - Cash Flow Statement.

UNIT II: FINANCE FUNCTIONS

Introduction, Goals of financial management, Finance functions, Interface between Finance and Other Business Functions - Time Value of Money - Future Value - Effective Rate - Single and Multiple Payments – Discounting.

UNIT III: ENGINEERING ECONOMIC ANALYSIS

Classification of Capital Projects - Cost of Capital – Measurement of Cost of Capital - Evaluation Criteria for Capital Projects - Economic Analysis Techniques: Traditional and Discounted Cashflow methods - NPV vs. IRR.

UNIT IV: RISKS ANALYSIS AND MEASUREMENT

Concepts of Risk and Return - Types of Risks - Measurement of Return and Risk – Risk analysis in Engineering Projects: Risk-adjusted Discount Rate - Certainty Equivalent Approach - Capital Rationing: Approaches to Capital Rationing - Practical Issues in the Evaluation of Projects.

UNIT V: FINANCING OF CAPITAL PROJECTS

Sources of Finance: Lenders, Borrowers and Financial Institutions – Forms of Finance: Equity Instruments - Debt Instruments - Types of Loans - Long-term Debt - Short-term Debt - Public Issue and Private Placement of Financial Securities - Financial Markets - Equity Markets - Bond Markets - Futures and Derivatives Markets.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
IDEA 104	Dream-Discover-Disrupt	OE	3	0	0	3

MODULE 1: VENTURE IDEATION.

MODULE 2: MARKETING.

MODULE 3: CUSTOMER SEGMENTATION.

MODULE 4: CUSTOMER DISCOVERY.

MODULE 5: SOLUTION DESIGN.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
JOU 001	Media Through the Ages: From Print to social media	OE	3	0	0	3

UNIT I

Introduction to Communication, Definition of Communication, Types: Intra-personal, Inter-personal, Group, Public and Mass Communication. Means of Communication, Process of Communication, Functions of Communications, Seven C's of Communication.

UNIT II

Definition of Mass Communication – Nature and process, Functions and types, Print, Electronic and Digital, Communication and Public Opinion: Nature, Meaning and Process.

UNIT III

Newspapers and Freedom Struggle, Colonial Rule and the Struggle for Press Freedom, Press and the Civil Liberties.

UNIT IV

Evolution of television, Prasar Bharati and Public Service Broadcasting, Growth of Satellite channels, 24x7 News channels.

UNIT V

Characteristics of New Media, New media as a form of communication, Evolution of Internet in India, Web Blogs, Online News Streaming.

TEXTBOOKS/REFERENCES

1. Hasan Seema., (2010), *Mass Communication: Principles and Concepts*. Chennai, India: CBS Publisher.
2. Mcquail Denis, (2010) *Mass Communication Theory* (Sixth Edition). London, England: Sage Publications.
3. Narula Uma, (2009), *Mass Communication Theory and practice*. New Delhi, India: Her-Anand Publication.
4. Chandra Bipan (2016) *India's Struggle for Independence: 1857-1947* (reprint). New Delhi, India: Penguin Random House.
5. Desai A.R, (2016) *Social Background of Indian Nationalism* (reprint). India: Sage Publication.
6. Mehta Nalin (2015) *Behind a Billion Screens: What Television Tells Us About Modern India* (2015 edition): HarperCollins.
7. Mehta Nalin (2008) *India on Television*. New Delhi, India: HarperCollins

ELECTIVES

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 408	Advanced Materials	OE	3	0	0	3

UNIT I: SPECIAL STEELS

Metallurgical aspects, Composition, Properties and applications of: different types of Stainless steels, Dual phase steels, TRIP steels, Maraging steels, High speed steels, Hadfield steels, Free cutting steels, Ausformed steels, Tool Steels, manganese steels, chrome steels, electrical steels, bearing steels, spring steels, heat resistant steels, creep steels, HSLA steels etc.

UNIT II: ALLOY CAST IRON

Need of alloying. Silal, Nicrosilal, High silicon cast iron, Ni-hard, Heat resistant. cast iron: Composition, Properties and their applications.

UNIT III: LIGHT METALS AND THEIR ALLOYS

Aluminium, magnesium and titanium alloys: Metallurgical aspects, Properties and applications.

UNIT IV: SUPER ALLOYS

Iron base, nickel base and cobalt base super alloys: Strengthening mechanism, Composition, Properties and their applications.

UNIT IV: RAPID SOLIDIFICATION

Metallic glasses, Atomic arrangement, Comparison with crystalline alloys, properties & applications, Glass transition temperature, Glass forming ability, Techniques for Production of metallic glasses.

UNIT V: SMART MATERIALS

Shape memory alloys, Piezoelectric materials, Electro-rheological fluid, Magneto-rheological fluids.

UNIT V: BIOMATERIALS

Property requirement, biocompatibility, bio functionality, Important bio metallic alloys like: Ni-Ti alloy and Co-Cr-Mo alloys. Applications.

TEXTBOOKS/REFERENCES

1. The Science and Engineering of Materials by D. R. Askeland and P. P. Phule, Thomson Publication
2. Advances in Material Science by R. K. Dogra and A. K. Sharma.
3. Material science by Van Black.
4. Engineering Materials and Applications by R. A. Flinn and P. K. Trojan
5. Materials, their Nature, Properties and Fabrication by R. A. Lindberg and S. D. Sehgal, S Chand & Co.
6. Light Alloys: Metallurgy of Light Metals by I. J. Polmear
7. Engineering Materials: Properties and applications of Metals and alloys by CP Sharma, PHI
8. Engineering Materials: Polymers, ceramics and composites by AK Bhargava, PHI

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 562	Mechanical Behavior of Materials	OE	3	0	0	3

COURSE OBJECTIVES

The central theme of this course is the mechanical behavior of engineering materials, such as metals, ceramics, polymers, and composites, subjected to different types of loading. The main objectives are to provide students with basic understanding of phase transformation by heat treating and stress-induced hardening, linear and nonlinear elastic behavior, deformation under multiaxial loading, plastic deformation and yield criteria, dislocation plasticity and strengthening mechanisms, creep, stress concentration effects, brittle versus ductile fracture, fracture mechanisms at different scales, fatigue, contact deformation, and wear.

DESIRED COURSE OUTCOMES

Understand various types of deformation and failure of engineering materials subjected to various static and dynamic loadings. Correlate microscopic and macroscopic material behaviors. Learn how to engineer the material properties to meet certain specifications. Determine the safety factor for various possible failure modes and loadings. Obtain hands-on-experience with standardized mechanical testing techniques and learn how to present/interpret the measurements in a formal report.

UNIT I

Introduction, Structure property relationship. Elasticity, Isotropic/Anisotropic.

UNIT II

Viscoelasticity. Elastic-Plastic Deformation. Mechanical testing.

UNIT III

Heat Treatment. Strain Hardening. Strain Rate and Temperature Effects on Deformation. Slip, Dislocations, Twinning, and Hardening.

UNIT IV

Ductile and Brittle Fracture. Fracture Mechanics. Creep. Fatigue. Cumulative Fatigue Damage. Wear processes.

UNIT V

Special topics: Residual Stresses, Ceramics, Glasses, Polymers, Composites, Mechanical Working, and Micromechanics

TEXTBOOKS

2. Meyers and Chawla, Mechanical Behavior of materials, Cambridge publication

REFERENCES

3. N. E. Dowling, Mechanical Behavior of Materials, Prentice-Hall.
4. R.W. Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, 4th Ed., John Wiley & Sons, 1995.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 228	Manufacturing Science	OE	3	0	0	3

UNIT I: METAL CASTING PROCESS

Introduction to metal casting, Solidification of Metals, Characteristics of sand casting, Patterns, Pattern allowances Pattern materials, Types of patterns, Molding materials, Molding sand properties, Types of sand molds, Cores, Gating system, Casting Defects, Special casting processes, Cast structures, Melting furnaces, Methods of Sand testing.

UNIT II: METAL JOINING PROCESS

Classification of joining processes, Welding technique, Different welding processes: Gas Welding, Electric Arc Welding, Tungsten Inert-gas Welding (TIG), Gas Metal-Arc Welding (GMAW), Plasma Arc Welding (PAW), Submerged Arc Welding (SAW), Resistance Welding, Friction Stir Welding (FSW), Thermite welding, Electron Beam Welding (EBW), Laser Beam Welding (LBW), Weld Defects.

UNIT III: BULK DEFORMATION PROCESS

Introduction to bulk deformation processes, Hot and cold working, Forging, Types of forging, Forging defects, Rolling, Defects in rolled products, Extrusion, Metal flow in extrusion, Rod drawing, Wire and Tube drawing, Swaging, Severe plastic deformation processes: Friction stir processing, Equal channel angular extrusion and high pressure torsion.

UNIT IV: METAL REMOVAL PROCESS

Mechanism of metal cutting, Types of tools, Tool Geometry, Tool Signature, Orthogonal and Oblique cutting, Mechanics of chip formation, Chip morphology, Tool wear and failure, Machinability, Cutting-tool materials, Cutting fluids, Brief description of metal removal processes: Turning, drilling, boring and Milling, Material removal rate and machining time.

UNIT V: POWDER METALLURGY

Production of metal powders, Particle size and shape, blending of metal powders, Compaction of metal powders, Shaping processes, Sintering, Finishing operations, Design considerations for powder metallurgy.

TEXTBOOKS

1. Manufacturing Science, 2nd Edition, A. Ghosh and A.K. Mallik.
2. P.N. Rao, Manufacturing Technology, 3rd Edition, Tata McGraw Hill Edu Pvt Ltd, 2012.

REFERENCES

1. S. Nagendra Parashar and R.K. Mittal, Elements of Manufacturing Processes, PHI Learning Pvt Ltd, 2011.
2. R.L. Timings, Manufacturing Technology, 2nd Edition, Pearson Edu Ltd, 2010.
3. Hajra Choudhury, Elements of Workshop Technology, Vol. I and II, Media Promotors Pvt Ltd, 2001.
4. S.Gowri, P.Hariharan, and A.Suresh Babu, Manufacturing Technology I, Pearson Education, 2008.
5. Rajput R.K, A Text book of Manufacturing Technology, Lakshmi Publications, 2007.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 409	Thermal Design for Electronic Equipment's	TE	3	0	0	3

UNIT I: FUNDAMENTALS OF HEAT TRANSFER

Review of Conduction, Convection and Radiation heat transfer. Introduction to electronics packaging: Basic definitions of electronics packaging, classification of electronics packaging and self- heating in electronics packaging.

UNIT II: INTRODUCTION TO THERMAL MANAGEMENT OF ELECTRONICS PACKAGES AND DATACENTERS

Basic definitions of thermal management, classification of thermal management of electronics packages and datacenters. Concept of Contact resistance elastic-elastic contacts and elastic plastic contacts. Conjugate heat conduction and thermal spreading: Derivation of analytical solution of heat spreading in heat sink base. Fin analysis and heat sink design: Derivation of general thermal resistance network.

UNIT III

Natural convection in electronics packaging, Radiation in electronic packages. Forced convection in electronics, Liquid cold plates for electronics, Jet impingement analytical solution derivation, Boiling and Condensation. Immersion cooling of electronics, design considerations. Introduction to heat pipes, Phase change energy storage with PCM's. Microchannel heat exchangers, Piezoelectric fans and synthetic jets.

UNIT IV

Thermoelectric modules, derivation of analytical solution, Acoustic challenges, thermal modelling of electronics packages and printed circuits. Thermal design of fan heat sinks: fan/blower curves, parallel plate fins, manufacturing processes, design for manufacturability.

UNIT V

Thermal design of smartphones and tablets: case studies. Thermal design of IT data centers Part 1 (IT equipment loop). Thermal design of IT data centers Part 2 (IT facilities loop) chip to cooling tower Thermal design.

TEXTBOOKS

1. Lian-Tuu Yeh, Richard C. Chu, Dereje Agonafer, "Thermal management of microelectronic equipment _ heat transfer theory, analysis methods and design practices", ASME press, 2002
2. F. P. Incropera, D. P. Dewitt, T. L. Bergman and A. S. Lavine, "Fundamentals of Heat and Mass Transfer", 7th Ed., John Wiley and Sons, 2011
3. Allen D. Kraus and Avram Bar Cohen, "Design and Analysis of Heat Sinks", Wiley-Interscience, 2008
4. Tummala Rao R., "Fundamentals of Microsystems packaging", McGrawHill, 2004.

REFERENCES

1. Yunus A. Çengel, Afshin J. Ghajar, "Heat and mass transfer: fundamentals and applications", McGraw-Hill Education, 2015
2. Ho Sung Lee, "Thermal Design: Heat Sinks, Thermo-electrics, Heat Pipes, Compact Heat Exchangers, and Solar Cells", John Wiley and Sons, 2010
3. Adrian Bejan, Allan D. Kraus, "Heat Transfer Handbook", Wiley-Interscience, 2003
4. Ralph Reimberg, "Thermal Design of Electronic Equipment", CRC Press LLC, 2001

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 416	Surface Engineering	OE	3	0	0	3

UNIT I: INTRODUCTION TO SURFACE ENGINEERING

Differences between surface and bulk, Properties of surfaces, surface energy concepts, degradation of surfaces, wear and its type, Adhesive, Abrasive, Fretting, Erosion wear, Surface fatigue,

UNIT II: FRICTION AND LUBRICATION

Fundamentals, Types and measurement of solid, liquid and gaseous friction. Friction heat and calculation. Lubricants and additives, mechanism of solid, liquid and gaseous lubricants.

UNIT III: CORROSION

Different types of Corrosion and its prevention, Galvanic corrosion, Passivation, Pitting, Crevice, Microbial, High-temperature corrosion, Corrosion in nonmetals, polymers and glasses, Protection from corrosion through surface modifications.

UNIT IV: CHANGING THE SURFACE METALLURGY

Localized surface hardening (flame, induction, laser, electron-beam hardening, Laser melting, shot peening), Changing the surface chemistry: Phosphating, Chromating, Anodizing (electrochemical conversion coating), Carburizing, Nitriding, Ion implantation, Laser alloying, boriding, Organic coatings (paints and polymeric or elastomeric coatings and linings), Hot-dip galvanizing (zinc coatings), Ceramic coatings (glass linings, cement linings, and porcelain enamels), Advanced surface coating methods: Gaseous State (CVD, PVD etc), Solution State (Chemical solution deposition, Electrochemical deposition, Sol gel, electroplating), Molten or semimolten State (Laser cladding and Thermal spraying)

UNIT V: CHARACTERIZATION OF SURFACE AND COATINGS

Surface Characterization (physical and chemical methods, XPS, AES, RAMAN, FTIR etc), Structural Characterization, Mechanical Characterization (Adhesion, Hardness, Elastic Properties, Toughness, Scratch and Indentation etc.), Tribological Characterization, Corrosion tests.

TEXTBOOKS/REFERENCES

6. Introduction to Surface Engineering and Functionally Engineered Materials, Peter Martin; Wiley, 2011.
7. Materials and Surface Engineering: Research and Development, J. Paulo Davim; Woodhead Publishing review, 2012.
8. Pradeep L. Menezes, "Tribology for Scientists and Engineers", Springer, 2013
9. Hand book, Friction, Lubrication and Wear Technology, Vol. 18, ASM
10. Krishna, R., Anantraman, T.R., Pande, C.S., Arora, O.P., Advanced techniques for microstructural characterization (ed), Trans Tech Publication

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 433	Introduction to High Performance Computing	OE	3	0	0	3

UNIT I

Introduction to HPC Systems, architecture and OS concepts, Multi-core CPUs, GPU, systems and High-performance clusters.

UNIT II

Introduction to basic numerical methods (stencil computations (finite differences), linear system solutions, integration). Sequential implementation.

UNIT III

Programming paradigms: OpenMP and MPI, Thread Management, CUDA / OpenCL.

UNIT IV

Data Dependency Reduction. Data flow, Loop reordering. Purely Parallel Algorithms, Block Decomposition Methods, Parallel Programming Packages.

TEXTBOOKS

1. Introduction to High Performance Computing for Scientists and Engineers. Chapman & Hall/CRC Computational Science Series.

REFERENCES

1. J. J. Dongarra, I. B. Du_, D. C. Sorensen and H. A. van der Vorst, Solving Linear Systems on Vector and Shared Memory Computers, SIAM, 1991.
2. K. Hwang, Advanced Computer Architecture: Parallelism, Scalability, Programmability, McGraw-Hill, 1993.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 418	Introduction to Electric Vehicles	OE	3	0	0	3

UNIT I: INTRODUCTION

History, EV Benefits, EV/HEV subsystems and configurations.

UNIT II: VEHICLE DYNAMICS

Vehicle dynamics, forces acting, power and torque calculations, Simulations, Drive cycles.

UNIT III: BATTERIES

Battery parameters, why Li, SoH & SoC estimation/self-discharge, Battery pack design/development, battery computations, Charging, BMS and its design, future batteries.

UNIT IV: ELECTRICAL COMPONENTS FOR EV AND HEV

EV Motors (IM, PM etc.) D-q circuit, DC-DC converters, DC-AC converters, control system overview.

UNIT V: EV DESIGN

Mechanical, Electrical and Thermal design consideration, Sample design calculations for EV and HEV's.

TEXTBOOKS

- Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
- Electric Powertrain - Energy Systems, Power electronics and drives for Hybrid, electric and fuel cell vehicles by John G. Hayes and A. Goodarzi, Wiley Publication.

REFERENCES

- Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2018.
- James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 456	Advanced Thermodynamics	TE	3	0	0	3

UNIT I: GAS POWER CYCLES

Introduction to air standard cycles. Air standard efficiency, Assumptions. Otto cycle: Air standard efficiency, mean effective pressure, Power developed. Tutorials. Diesel cycle: Air standard efficiency, mean effective pressure and power developed. Tutorials. Dual cycle: Air standard efficiency, Mean Effective pressure and power developed. Tutorials. Comparison of Otto, Diesel and Dual cycles, Brayton cycle, Concept of reheat and regeneration in brayton cycle.

UNIT II: INTERNAL COMBUSTION ENGINES

Classification of IC engines. Basic operations, Actual P-V diagram of four stroke Otto cycle engine and four stroke diesel cycle engines, Engine performance parameters. Measurements of fuel and air consumption, brake power and in-cylinder pressure. Tutorials on engine performance parameters, Heat balance sheet, Engine performance curves.

UNIT III: AIR COMPRESSORS

Reciprocating air compressors, Construction and working. Compression with and without clearance, Equation for work. Volumetric efficiency. Tutorials on single stage compressor with and without clearance. Free air delivered. Multistage compression, Conditions for minimum work, Compressor efficiencies, Tutorials on multistage compressor with and without clearance. Rotary compressors, vane compressor, roots blower - Comparison between reciprocating compressors and rotary compressors.

UNIT IV: REFRIGERATION SYSTEMS

Vapor compression refrigeration system and its working principle. Classifications of refrigerants, properties, eco- friendly Refrigerants. Analysis of vapor compression refrigeration cycle, P-hChart. Factors affecting the performance of VCR system. Tutorials on performance of simple VCR cycle. Sub-cooling and superheating phenomena in VCR cycle, Tutorials on VCR system with sub-cooling and superheating. Simple and practical vapor absorption refrigeration System. Comparison between vapor compression refrigeration and vapour absorption refrigeration systems.

UNIT V: PSYCHROMETRY AND AIR CONDITIONING

Properties of atmospheric air and Psychrometric chart, Psychrometric processes, Tutorials on sensible heating and cooling, Tutorials on cooling and dehumidification, heating and Humidification, Adiabatic mixing of two air streams and property calculations. Summer, Winter and Year-round air conditioning systems. Window, Split and Centralized AC systems. Introduction to heat load calculations.

TEXTBOOKS

1. Eastop.T.D, Mcconkey.A, “*Applied Thermodynamics for EngineeringTechnologists*”, 5th Edition,Pearson Edition Publications, 2009.
2. Mahesh Rathore, “*Thermal Engineering*”,Tata McGraw Hill, New Delhi- Reprint2012.
3. Yunus A Cengel; Michael A Boles,“*Thermodynamics: An EngineeringApproach*”,8th edition TataMcGraw Hill, New Delhi-2015.
4. Kothandaraman.C.P, Domkundwar.S, AnandDomkundwar, “*A Course in ThermalEngineering*”,DhanpatRai& Co. (P) Ltd., 2010.
5. Rajput.R.K, “*Thermal Engineering*”, Laxmi Publications, 10th Edition, New Delhi, 2015.
6. Sarkar.B.K, “*Thermal Engineering*”, 3rd Edition, Tata McGraw Hill, New Delhi, 2009.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 457	Fundamentals of Vibration and Noise	TE	3	0	0	3

UNIT I: FREE VIBRATION

Introduction to vibration terminologies and types of vibration, equation of motion for free undamped single degree of freedom system by newton's and energy method, tutorials on single degree of freedom undamped free vibration systems. Equation of motion for free damped single degree of freedom systems. Tutorials on free damped single degree of freedom systems, torsional vibration of two rotor and three rotor systems. Tutorials on torsional vibration of two rotor and three rotor systems. Torsional vibration of geared systems with two and three rotor system.

UNIT II: FORCED VIBRATION

Equation of motion for harmonically excited single degree of freedom system, tutorials on harmonically excited single degree of freedom system, forced vibration due to unbalanced rotating and reciprocating systems. Tutorials on forced vibration due to unbalanced rotating and reciprocating systems. Forced vibration due to base excitation by absolute and relative amplitude method. Tutorials on forced vibration due to base excitation by absolute and relative amplitude method. Force transmissibility and vibration isolation. Tutorials on force transmissibility and vibration isolation, whirling of shaft and tutorials.

UNIT III: MULTI DEGREE OF FREEDOM SYSTEMS

Equation of motion for free undamped two and three degrees of freedom systems and tutorials, equation of motion for two and three. DOF using lagrangian energy method for un-damped free vibration. Tutorials on lagrangian energy method for un-damped free vibration. Co-ordinate coupling and tutorials, concept of linear and torsional undamped vibration absorber. Tutorials on linear and torsional undamped vibration absorber.

UNIT IV: NUMERICAL METHODS

Stiffness and flexibility influence coefficients and tutorials, Eigenvalue, Eigenvector and orthogonal Properties and Tutorials, Concept of Dun Kerley's and Rayleigh's method, Tutorials on Dun Kerley's and Rayleigh's method, Concept of Holzer's method for far coupled and tutorials, Concept of Holzer's method for close coupled system and tutorials. Concept of Matrix iteration method and tutorials.

UNIT V: VIBRATION AND NOISE MESUREMENT

Vibration measuring devices and Vibration exciters, Free and Forced vibration Tests, Balancing Machines, single plane and two plane balancing, Condition monitoring techniques and signal analysis. Basics of Noise terminologies and their relations, Noise Control Methods at source, along Path and at receiver.

TEXTBOOKS

1. Rao.S.S,“*Mechanical Vibrations*”,5th Edition,Pearson Education Inc.Delhi 2009.
2. Ambekar.A.G, “*Mechanical Vibrations and Noise engineering*”, PHI New Delhi, 2015.
3. Thomson.W.T, “*Theory of Vibration and its Applications*”,5th Edition, Prentice Hall, New Delhi, 2001.
4. Meirovitch, L., “*Elements of Vibration Analysis*”, Mc Graw – Hill Book Co., New York, 1986.
5. Rao.J.S and Gupta.K, “*Introductory course on theory and practice of mechanical vibrations*”, 2nd Edition,New Age International, New Delhi, 2014.
6. Keith Mobley.R, “*Vibration Fundamentals*”, Plant Engineering Maintenance Series, Elsevier, 2007.
7. Ramamurthi.V, “*Mechanical Vibration Practice with Basic Theory*”, 1st edition, Narosa Publishing House, Chennai, 2000.
8. Kewelpujara, “*Vibration and noise for engineers*”, Dhanpatrai& Sons, 2009.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 458	Gas Dynamics and Space Propulsion	TE	3	0	0	3

UNIT I: FUNDAMENTALS OF COMPRESSIBLE FLOW

Energy equation for compressible fluid flow, Stagnation state and Mach number, Various regimes of flow, reference velocities, Critical states, second kind Mach number, Crocco number. Equivalent of Bernoulli's equation for compressible flow, Effect of Mach number on compressibility. Types of waves - subsonic, sonic and supersonic waves. Mach cone, Mach angle. Problems in isentropic compressible flow.

UNIT II: FLOW THROUGH VARIABLE AREA DUCTS

Flow through variable area duct: T-S and h-s diagrams for nozzles and diffusers, Area ratio as a function of Mach number, Impulse function, Mass flow rate through nozzles and diffusers, Problems based on flow through nozzles and diffusers, Mass flow rate in terms of pressure ratio (Flinger's formula). Problems in variable area flow nozzles and diffusers. **Flow with normal shock:** Development, governing equations, Variation of flow parameters -static pressure & temperature, density, stagnation pressure and entropy across the shock, Impossibility of shock in subsonic flows, strength of a shock, Derivation of Prandtl – Meyer equation, Flow through nozzles and diffusers with shock, Wind tunnels.

UNIT III: FLOW THROUGH CONSTANT AREA DUCTS

Flow in constant area ducts with friction (Fanno flow), Fanno curves, Fanno flow equations, Variation of flow properties, Variation of Mach number with duct length, Problems in Fanno flow with and without normal shocks, Flow in constant area ducts with heat transfer – Rayleigh curve, constant entropy lines and constant enthalpy lines, Rayleigh flow equations, Flow properties and maximum heat transfer concept, Problems in Rayleigh flow.

UNIT IV: AIRCRAFT PROPULSION

Types of aircraft engines, Energy flow through Jet engines, Aircraft Propulsion Theory, thrust augmentation methods, Performance of Turbojet engines, Problems in Aircraft Engine Performance, Ramjet, pulse jet engines: Construction and working, Problems. Problems in aircraft propulsion.

UNIT V: ROCKET PROPULSION

Various types and applications of rockets, Solid, liquid propellants: Construction and fuels-oxidizers, Hybrid propellants, Different propulsion systems, Rocket Propulsion theory and performance, problems.

TEXTBOOKS

1. Robert. D. Zucker, Oscar Biblarz, "*Fundamentals of Gas Dynamics*", John Wiley and Sons, 2nd Edition, 2002.
2. John D. Anderson, "*Fundamentals of Aerodynamics*", McGraw-Hill Series in Aeronautical and Aerospace Engineering, 5th Edition, 2010.
3. Mattingly. J. D, "*Elements of Gas turbine Propulsion*", McGraw Hill, 2005.
4. James John, Theo Keith, "*Gas Dynamics*", Pearson, 3rd Edition, 2006.
5. Yahya. S. M, "*Fundamentals of compressible flow with Aircraft and Rocket Propulsion*", New Age International (P) Ltd, New Delhi, 3rd Edition, 2005.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 459	Design of Transmission Systems	TE	3	0	0	3

UNIT I: DESIGN OF FLEXIBLE DRIVES

Belt drives: types, selection of belt drives, belt materials and applications, Design procedure and problems on flat belt drives using fundamental equations & manufacturer's data. Design procedure and problems on V-belt drives using fundamental equations & manufacturer's data. Wire ropes: types, construction and designation of wire ropes, stresses in wire ropes. Design procedure and problems on wire ropes. Power transmission chains: types and applications. Design procedure and problems on power transmission chains and sprockets.

UNIT II: DESIGN OF PARALLEL GEARS

Review of gear fundamentals, Forces and stresses in gear tooth, Equivalent number of teeth, gear tooth failures, selection of gear materials, Design procedure and problems on spur gear based on strength consideration. Design procedure and problems on spur gear based on wear consideration. Design procedure and problems on helical gear based on strength consideration, Design procedure and problems on helical gear based on wear consideration.

UNIT III: DESIGN OF NON-PARALLEL GEARS

Straight bevel gear: Terminology, Forces and stresses on gear tooth, Design procedure and problems on bevel gear based on strength consideration, Design procedure and problems on bevel gear based on wear consideration. Worm gear: Thermal capacity, efficiency, forces and stresses, Design procedure and problems on worm gear based on strength consideration, Design procedure and problems on worm gear based on wear consideration.

UNIT IV: DESIGN OF GEAR BOXES

Geometric progression, standard step ratio, structural and ray diagrams, Number of teeth calculation, Meshing arrangement. Design procedure and problems on sliding mesh gear box. Design procedure and problems on constant mesh gearbox. Design of Multi speed gear box for machine tool applications, Variable speed gear box, Fluid couplings, Torque convertor for automotive applications.

UNIT V: DESIGN OF BEARINGS, CLUTCHES AND BRAKES

Sliding contact bearings: Types, assumptions and terminology in hydrodynamic lubricated journal bearing, Design procedure and problems on journal bearing, Rolling contact bearings: types, static and dynamic load rating, life and reliability, Selection of rolling contact bearings, Clutches: Types, Design of plate clutches, Design of cone clutches and internal expanding rim clutches, Brakes: Types, Energy considerations, Temperature rise, Design of band brakes, Design of external shoe brakes and internal expanding shoe brake.

TEXTBOOKS

1. Robert. C. Juvinall, Kurt. M. Marshek, “*Fundamentals of Machine Component Design*”, John Wiley&sons, 5th Edition, 2011.
2. Joseph Edward Shigley and Charles R. Mischke, “*Mechanical Engineering Design*”, McGraw –HillInternational Editions, New York, 6th Edition, 2003.
3. Spotts, M.F., Shoup, T.E., Hornberger, L.E., “*Design of Machine Elements*”, Prentice Hall of IndiaEighth Edition, 2004.
4. Paul H Black and O. E. Adams, P., “*Machine Design*”, 3rd edition, Mc Graw Hill Book Company, Inc., New York, USA, 2007.
5. Bernard Hamrock, Steven Schmid, Bo Jacobson, “*Fundamentals of Machine Elements*”, 2nd Edition, Tata McGraw-Hill Book Co., 2006.
6. Mehtha.N.K, “*Machine Tool Design and Numerical Control*”, Tata Mc-Graw Hill, *Third Edition*, 2012.
7. Darle W Dudley, “*Hand Book of Practical Gear Design*”, CRC Press, Florida, 2002.
8. P.S.G Tech., “*Design Data Book*”, KalaikathirAchchagam, 2012.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 435	Fundamentals of Hydraulics and Pneumatics	TE	3	0	0	3

UNIT I: BASICS OF FLUID POWER SYSTEMS

Introduction to fluid power, Advantages of fluid power, application of fluid power system, Types of fluid power systems, Properties of hydraulic fluids, general types of fluids, Fluid power symbols, Basics of Hydraulics, Applications of Pascal's Law, seals and fittings.

UNIT II: HYDRAULIC SYSTEM AND COMPONENTS

Sources of Hydraulic Power: Pumping theory, Pump Classification, Gear pumps: construction and working of internal and external gear pumps, Vane Pump: construction and working of unbalanced, balanced vane pumps, Piston pump: construction and working of axial, radial piston pumps, Construction of Control Components: Directional control valves, types 4/2, 4/3, check valve, flow control valve, Pressure control valves: construction and working of relief valve, reducing, sequencing, counter balance valves, Solenoid operated valves, Relays, Linear actuators: construction and working of single acting, double acting, and telescopic cylinders, Rotary actuators: construction and working of gear, vane and piston motors.

UNIT III: PNEUMATIC SYSTEMS AND COMPONENTS

Introduction, comparison with hydraulic systems and electrical systems, Properties of air, Construction, operation, characteristics and symbols of reciprocating and rotary compressors, Need for air treatment, Filter, Regulator, Lubricator, Muffler and Dryers. Construction, operation of 3/2, 5/2, 5/3 manual operated, pilot operated and solenoid operated DCVs, pneumatic actuators. Introduction to fluidic devices, working of Bi-stable, mono-stable devices. Fluidic logic application circuits. Pneumatic Sensor types and applications.

UNIT IV: DESIGN OF HYDRAULIC AND PNEUMATIC CIRCUITS

Speed, force calculations, and Sizing of actuators in fluid power systems, Design of hydraulic/pneumatic circuits for simple reciprocation, regenerative, speed control of actuators, Design of hydraulic/pneumatic circuits: synchronizing and sequencing circuits, Sequential circuit design for simple applications using cascade method, Electrohydraulic and Pneumatic logic circuits, ladder diagram design, PLC applications in fluid power control, Accumulators: Types, circuits, sizing of accumulators, Intensifier: Intensifier circuit and applications.

UNIT V APPLICATION, MAINTENANCE AND TROUBLE SHOOTING

Industrial hydraulic circuits for riveting machine, actuator locking, working of hydraulic press and pump unloading circuits, Hydraulic / pneumatic circuits for material handling systems, Preventive and breakdown, maintenance procedures in fluid power systems, Trouble shooting of fluid power systems, fault finding process equipment / tools used, causes and remedies, Safety aspects involved fluid power systems.

TEXTBOOKS

1. Anthony Esposito, "*Fluid Power with applications*", Prentice Hall International, 2009.
2. Anthony Esposito, "*Fluid Power with applications*", Prentice Hall International, 2009.
3. Majumdar.S.R, "*Pneumatic systems – principles and maintenance*", Tata McGraw-Hill, New Delhi, 2006.

REFERENCES

1. Werner Deppert , Kurt Stoll, "*Pneumatic Application:Mechanization and Automation by Pneumatic Contro* "l,Vogelverlag, 1986.
2. John Pippenger, Tyler Hicks, "*Industrial Hydraulics*", McGraw Hill International Edition, 1980.
3. Andrew Parr, "*Hydraulics and Pneumatics: A technician's and engineer's guide*", Elsevier Ltd, 2011.
4. FESTO, "*Fundamentals of Pneumatics*", Vol I, II and III.
5. Hehn Anton, H., "*Fluid Power Trouble Shooting*", Marcel Dekker Inc., NewYork, 1995.
6. Thomson, "*Introduction to Fluid power*", Prentice Hall, 2004.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 427	Robotics	TE	3	0	0	3

UNIT I: INTRODUCTION

Basic concepts of robotics (laws of robotics, robotic systems), ria definition. Robot anatomy (robot configurations, robot motions, joint notation scheme) , manipulators precision movement (spatial resolution, accuracy, repeatability) work volume, robot specifications. Types of robot drives, electric drive, hydraulic, pneumatic drives, basic robot motions, point to point control and continuous path control, kinematics: forward and inverse kinematics, problems on kinematics.

UNIT II: END EFFECTORS AND TRANSFORMATIONS

End effectors-introduction, classification, mechanical, magnetic grippers, vacuum and adhesive gripper, gripper force analysis and design, problems on gripper design, problems on force calculation, 2d transformation (scaling, rotation, translation), 3d transformation (scaling, rotation, translation), homogeneous transformations.

UNIT III: SENSORS AND CONTROL SYSTEMS

Sensor devices, types of sensors (contact, position and displacement sensors), force and torque sensors, proximity and range sensors, acoustic sensors, robot vision systems, sensing and digitizing, image processing and analysis, robot control system, unit control system, adaptive and optimal control.

UNIT IV: ROBOT CELL DESIGN

Robot work cell design and control, Safety considerations in cell design, Robot cell layouts, multiple, Multiple robots, Machine interface, Robot cycle time analysis.

UNIT V: ROBOT PROGRAMMING AND APPLICATIONS

Robot language, classification, Programming methods, off and online programming, Lead through method, powered and Manual lead through, Teach pendent method, VAL systems and language, Simple program. Application of Robots, Material handling, Constrains, Machine loading and unloading. Assembly Robot, Assembly operation, RCC device, Benefits-Inspection robot, used in Quality control, Welding Robot, features, sensors, Advantages, -Painting Robot, Requirement, and Spray painting, Mobile and microbots, types, mobility and application, Recent developments in robotics- safety considerations.

TEXTBOOKS

6. Mikell P. Groover, “*Industrial Robotics Technology Programming and Applications*”, McGraw Hill Co.,Singapore, 2008.
7. Deb .S.R, “*Robotics technology and flexible automation*”, Tata McGraw Hill publishing company limited, New Delhi, 2010.
8. Klafter R.D, Chmielewski T.A and Noggins, “*Robot Engineering: An Integrated Approach*”, Prentice Hal of India Pvt. Ltd., New Delhi, 2010.
9. Fu K.S, Gonzalez, R.C., & Lee, C.S.G., “*Robotics control, sensing, vision and intelligence*”, McGrawHill Book Co., Singapore, Digitized 2007.
10. Craig.J.J, “*Introduction to Robotics mechanics and control*”, Addison- Wesley, London, 2008.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 436	Industrial Tribology	TE	3	0	0	3

UNIT I: SURFACES AND FRICTION

Introduction to the concept of tribology, tribological problems, nature of engineering surfaces, surface topography, contact between surfaces, sources of sliding friction, friction due to ploughing, friction due to adhesion, friction characteristics of metals and non-metals, sources of rolling friction, stick slip motion, friction of ceramic materials and polymers, measurement of friction.

UNIT II: WEAR

Wear and types of wear, simple theory of sliding wear mechanism, abrasive wear, adhesive wear, corrosive wear, surface fatigue wear situations, wear of ceramics, wear of polymers, wear measurements.

UNIT III: FILM LUBRICATION THEORY

Coefficient of viscosity, fluid film in simple shear, viscous flow between very close parallel plates: tutorials, lubricant supply, lubricant flow rate, cold jacking, couette flow, cavitation's, film rupture, oil whirl, shear stress variation within the film, lubrication theory by Osborne Reynolds: tutorials, pressure fields for full Sommerfeld, half Sommerfeld, Reynolds boundary conditions.

UNIT IV: LUBRICANTS AND LUBRICATION TYPES

Types of lubricants, properties of lubricants, testing methods, hydrodynamic lubrication, elasto-hydrodynamic lubrication, hydrostatic lubrication.

UNIT V: SURFACE ENGINEERING AND MATERIALS FOR BEARINGS

Classification of Surface modifications and Surface Coatings, Surface modifications, Transformation hardening, Surface modifications, surface fusion, Thermo chemical Processes, Surface coatings, Materials for rolling element bearings, Materials for fluid film bearings, Materials for marginally lubricated and dry bearings.

TEXTBOOKS

1. Hutchings. I.M, "*Tribology, Friction and Wear of Engineering Material*, Edward Arnold, London, 1992.
2. Williams. J.A, "*Engineering Tribology*", Oxford University Press, 2005.
3. GwidonStachowiak, Andrew W Batchelor., "*Engineering tribology*", Elsevier Butterworth –Heinemann, USA, 2005.
4. Stolarski.T.A, "*Tribology in Machine Design*", Industrial Press Inc., 1990.
5. Bowden.E.P. and Tabor.D, "*Friction and Lubrication*", Heinemann Educational Books Ltd, 1974.
6. Cameron.A, "*Basic Lubrication Theory*", Longman, U.K., 1981.
7. Neale.M.J. (Editor), "*Tribology Handbook*", Newnes Butter worth, Heinemann, U.K., 1975.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 437	Process Planning and Cost Estimation	TE	3	0	0	3

UNIT I: PROCESS PLANNING

Production system and types of production, standardization and simplification, production design and selection, process planning, selection and analysis, manual/experience-based planning, variant type capp, generative type capp, processes analysis, break even analysis.

UNIT II: COSTING AND ESTIMATION

Objectives of costing and estimation: functions and procedure, introduction to costs, computing material cost, direct labor cost, analysis of overhead costs, factory expenses, administrative expenses, selling and distributing expenses, cost ladder, cost of product, depreciation, analysis of depreciation, problems indepreciation method.

UNIT III: ESTIMATION OF COSTS IN DIFFERENTSHOPS

Estimation in foundry shop: Pattern cost, Casting cost, Cost estimation in Foundry shop, Forging: Types, Operations, Estimation of Losses and time in forging, Estimation of Forging cost, Cost estimation in Forging shop: Tutorials.

UNIT IV: ESTIMATION OF COSTS IN FABRICATIONSHOPS

Welding, Types of weld joints, Gas welding, Estimation of Gas welding cost, Gas cutting, Arc welding: Equipment's, Cost Estimation, Cost estimation in Welding shop: Tutorials, Estimation in sheet metal shop, Shearing and forming, Cost estimation in Sheet metal shop.

UNIT V: ESTIMATION OF MACHINING TIMES AND COSTS

Machine shop operations, Estimation of Machining time, Estimation of machining time for turning, knurling and facing operations: Tutorials, Estimation of machining time for reaming, threading and tapping operations: Tutorials, Estimation of machining time for drilling, boring: Tutorials Estimation of machining time for shaping, planning: Tutorials, Estimation of machining time for milling and grinding operations: Tutorials, Case studies: Estimation of cost for a product.

TEXTBOOKS

1. Banga.T.R and Sharma.S.C, "*Estimating and Costing*", Khanna publishers, New Delhi, 17th Edition,2015.
2. Adithan.M.S and Pabla, "*Estimating and Costing*", Konark Publishers Pvt., Ltd, 1989.
3. Nanua Singh, "*System Approach to Computer Integrated Design and Manufacturing*", John Wiley & Sons, New York, 1996.
4. Joseph G. Monks, "*Operations Management, Theory and Problems*", McGraw Hill Book Company, New Delhi, 1982.
5. Narang.G.B.S and Kumar.V, "*Production and Planning*" , Khanna Publishers, New Delhi, 1995.
6. Chitale.A.K and Gupta.R.C, "*Product Design and manufacturing*", Prentice Hall of India, New Delhi,2007.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 438	Internal Combustion Engines	TE	3	0	0	3

UNIT I: COMPONENTS OF IC ENGINES AND PERFORMANCE

Classification of internal combustion engines, application of IC Engines, Function and operation of two stroke and four stroke engines, Comparison of SI and CI, two stroke and four stroke engines, Effects, limitations, and types of supercharging and scavenging process, Performance characteristics of IC engines, Numerical problems on performance and heat balance, Fuel air cycles and their significance.

UNIT II: ENGINE AUXILIARY SYSTEMS

Carburetion, mixture requirements at different loads and speeds, simple carburetor, Functional requirements and classification of an injection systems, injection pump, nozzle types, MPFI and EFI systems, Battery and magneto ignition systems, ignition timing and engine parameters, Properties of lubricants, mist, wet and dry sump lubrication systems, Liquid and air-cooled cooling system, coolant and antifreeze solutions.

UNIT III: COMBUSTION IN SI ENGINES

Homogeneous and heterogeneous mixture, combustion in spark ignition engines, stages of combustion in spark ignition engines, Flame front propagation, factors influencing flame speed, Rate of pressure rise, abnormal combustion, phenomenon of knock in SI engines, Effect of engine variables on knock, combustion chambers for SI engines, smooth engine operation, High power output and thermal efficiency, stratified charge engine.

UNIT IV: COMBUSTION IN CI ENGINES

Combustion in CI engine, stages of combustion in CI engines, Factors affecting the delay period, compression ratio, engine speed, output, atomization and duration of injection, injection timing, quality of fuel, intake temperature, intake pressure, Phenomenon of knock in CI engines, comparison of knock in SI and CI engines, Combustion chambers for CI engines, Homogenous charge compression ignition Engine.

UNIT V: ALTERNATE FUELS AND EMISSION

Liquid fuels, alcohol, methanol, ethanol; vegetable oil, biodiesel production, properties, advantages and disadvantages, Gaseous fuel - Hydrogen, CNG, LPG, Air pollution due to IC engines, hydrocarbon and CO emission, oxides of nitrogen, aldehydes, sulphur, lead and phosphorus emissions, Catalytic converter, exhaust gas recirculation, Flame ionization detector, non-dispersive infra-red detector, chemiluminescence analyzer, smoke types, Bosch smoke meter, Emission standards.

TEXTBOOKS

1. Ganesan.V, "*Internal Combustion Engines*", Tata McGraw-Hill, New Delhi, 2015.
2. Ramalingam.K.K, "*Internal Combustion Engines- Theory and practice*", SciTech publications India Pvt. Ltd., Chennai, 2010.
3. Thipse.S.S, "*Internal Combustion Engines*", Jaico Publication House, 2010.
4. Thipse.S.S, "*Alternate Fuels*", Jaico Publication House, 2010.
5. Mathur.M.L and Sharma.R.P, "*A course in Internal Combustion Engines*", DhanpatRai& Sons, New Delhi, 2010.
6. Heywood.J.B, "*Internal Combustion Engine Fundamentals*", McGraw Hill International, New York, 2008.
7. Domkundwar.V.M, "*A course in Internal Combustion Engines*", DhanpatRai& Sons, 2010.
8. Shyam.K.Agrawal, "*Internal Combustion Engines*", New Age International, 2012.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 230	Alternative Sources of Energy	TE	3	0	0	3

UNIT I: SOLAR ENERGY

Solar radiation and its measurements, Types of solar thermal collectors, Solar thermal applications for water heaters, solar stills and solar pond, Solar thermal applications for refrigeration and air- conditioning system, Solar thermal applications for solar dryer, solar cookers and solar furnaces, Sensible and latent heat thermal energy storage systems, Solar thermal power generation systems, Solar photovoltaic systems: basic working principle and components, Applications of solar photovoltaic systems.

UNIT II: WIND ENERGY

Basic principle of wind energy conversion system, Wind data, site selection and energy estimation, Components of wind energy conversion systems, Types of Horizontal axis and Vertical axis wind turbine, Design consideration of horizontal axis wind turbine, Aero foil theory, Analysis of aerodynamic forces acting on the blade, Performance of wind turbines, Introduction to solar and wind hybrid energy systems, environmental issues of wind energy.

UNIT III: OCEAN, HYDRO AND GEOTHERMAL ENERGY

Wave characteristics and wave energy, Tidal energy and its types, Estimation of energy and power in single basin tidal system, Ocean thermal energy conversion for open system, Ocean thermal energy conversion for closed system, Hydro power plants for small, mini and micro system, Exploration of geothermal energy, Geothermal power plants, Challenges, availability, geographical distribution, scope and economics for geothermal plant.

UNIT IV: BIOMASS

Sources of biomass, Pyrolysis, combustion and gasification process, Updraft and downdraft gasifier, Fluidized bed gasifier, Fermentation and digestion process, Fixed and floating digester biogas plants, Design considerations of digester, Operational parameter of biogas plants, Economics of biomass power generation.

UNIT V: DIRECT ENERGY CONVERSION SYSTEMS

Basic principle of thermo electric and thermionic power generations, Fuel cell principles and its classification, Phosphoric acid fuel cell, polymer electrolyte membrane fuel cell, molten carbonate fuel cell and solid oxide fuel cell, Fuel cell conversion efficiency, applications of fuel cell, Magneto hydrodynamic power generation for open cycle, Magneto hydrodynamic power generation for closed cycle, Hydrogen energy: properties and its production methods, Electrolysis, thermo-chemical methods, fossil fuel methods and solar energy methods, Hydrogen storage, transportation and applications.

TEXTBOOKS

8. Tiwari.G.N, Ghosal.M.K, “*Fundamentals of renewable energy sources*”, 1st Edition, UK, Alpha Science International Ltd, 2007.
9. Godfrey Boyle, “*Renewable energy*”, 2nd Edition, Oxford University Press, 2010.
10. Twidell.J.W and Weir.A.D, “*Renewable Energy Resources*”, 1st Edition, UK,E.&F.N. Spon Ltd, 2006.
11. Domkundwar.V.M, Domkundwar. A.V, “*Solar energy and Non-conventional sources of energy*”, Dhanpat rai & Co. (P) Ltd, 1st Edition, New Delhi, 2010.
12. G.D Rai, “*Non-Conventional Energy Sources*”, Khanna Publishers, 5th Edition, New Delhi, 2011.
13. B.H Khan, “*Non-conventional Energy Resources*”, 2nd Edition, New Delhi, Tata McGraw Hill, 2009.
14. S.P. Sukatme, J.K. Mayak, “*Solar Energy-Principles of thermal collection and storage*”, 3rd edition, New delhi, McGraw Hill, 2008.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 439	Industrial Engineering	TE	3	0	0	3

UNIT I: WORK MEASUREMENT AND WORK STUDY

Introduction to Work measurement and its Techniques, Production study and Time study, Standard time, Rating factors and Work sampling, Techniques of Work study, Human factors of Work study, Method study, Techniques and procedures of Productivity, Charging techniques, Motion economy principles, SIMO chart, Ergonomics and Industrial design.

UNIT II: PLANT LAYOUT AND MATERIAL HANDLING

Plant location and site selection, Types, need, factors influencing the plant layout, Tools and techniques for developing layout, process chart, flow diagram, string diagram, Template and Scale models, Layout Planning procedure, Assembly line balancing, Material Handling, scope and importance, Types of material handling systems, Factors influencing material handling, Methods of material handling.

UNIT III: WORK DESIGN ERGONOMICS, PRODUCTION & PRODUCTIVITY

Introduction to work design, Work design for increased productivity, the work system, design Introduction to job design, Environmental factors, organizational factors & behavioural factors influencing effective job design. Ergonomics, Objective's system approach of ergonomic model, Man machine system Production and Productivity, Definition of production, function and type of production, Definition of productivity and productivity measurement.

UNIT IV: PRODUCTION PLANNING AND CONTROL

Objectives and Functions of PPC, Aspects of product development and design, Process Planning, Principles of Standardization, Specialization and Simplification, Group Technology, Optimum Batch size, ABC analysis, Value Engineering.

UNIT V: WAGES AND INCENTIVES

Wages and salary administration, Meaning principles and techniques of wage fixation, Job evaluation, Merit rating, Methods of wage payment, Types, Advantages and disadvantages of Incentive scheme, Productivity base incentives, Case Example of Evaluation of incentive scheme.

TEXTBOOKS

1. Khanna.O.P, "*Industrial Engineering and Management*", DhanpatRai Publications Pvt Ltd, 2010.
2. Samuel Eilon, "*Elements of Production Planning and Control*", McMillan andCo., Digitized, 2007.
3. Kumar.B, "*Industrial Engineering and Management*", 9th edition, KhannaPublishers, New Delhi, 2005.
4. James M. Apple, "*Principles of Layout and Material Handling*", Ronald press,2007.
5. Maynard.H, "*Industrial Engineering Handbook*", McGraw Hill Book Co., NewYork, 2010.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 440	Advanced Fluid Mechanics	TE	3	0	0	3

UNIT I: INVISCID IRROTATIONAL FLOWS

The local continuity equation, path lines, streamlines, and stream functions, newton's momentum equation, equation for newtonian fluid, vorticity and circulation, non-newtonian fluids, moving coordinate systems, irrotational flows and the velocity potential, singularity distribution methods, forces acting on a translating sphere, added mass and the lagally theorem. Theorems for irrotational flow: mean value and maximum modulus theorems, maximum-minimum potential theorem, kelvin's minimum kinetic energy theorem.

UNIT II: EXACT SOLUTIONS OF THE NAVIER- STOKES EQUATIONS

Solutions to the steady-state navier-stokes equations, two-dimensional flow between parallel plates, poiseuille flow in a rectangular conduit, poiseuille flow in a round conduit, couette flow between concentric circular cylinders, unsteady flows: impulsive motion of a plate—stokes's first problem, oscillation of a plate—stokes's second problem, plane stagnation line flow, three-dimensional axi-symmetric stagnation point flow, flow into convergent or divergent channels.

UNIT III: THERMAL EFFECTS AND FLOW STABILITY

Thermal boundary layers forced convection on a horizontal flat plate, the integral method for thermal convection, linear stability theory of fluid flows, thermal instability in a viscous fluid—rayleigh- b nard convection. Stability of flow between rotating circular cylinders: couette-taylor instability.

UNIT IV: TURBULENT FLOWS

Statistical approach—one-point averaging, zero-equation turbulent models, one-equation turbulent models, two-equation turbulent models, stress-equation models, equations of motion in fourier space. Quantum theory models, large eddy models.

UNIT V: COMPUTATIONAL METHODS

Numerical calculus, numerical integration of ordinary differential equations, the finite element method, linear stability problems— invariant imbedding and riccati methods, errors, accuracy, and stiff systems, multi-dimensional methods: relaxation methods, surface singularities, one-step methods: forward time, centered space, dufort-frankel method, crank-nicholson method, hybrid method, upwind differencing.

TEXTBOOKS

1. Graebel. W.P, “*Advanced Fluid Mechancis*”, 1st Edition, Academic Press, Elsevier Inc., 2007.
2. K. Muralidhar and G. Biswas, “ *Advanced Engineering Fluid Mechanics*”, 3rd Edition, Narosa Publishers, 2015.
3. Stevan A Jones, “*Advanced Methods for Practical Applications in Fluid Mechanics*”, InTech Publishers, 2012.
4. Hyoung Woo Oh, “*Advanced Fluid Mechancis*”, InTech Publishers, 2012.
5. Roger Kinsky, “*Fluid Mechanics Advanced Applications*”, McGraw-Hill Education Europe, 1997.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 441	Operations Research	TE	3	0	0	3

UNIT I: LINEAR PROGRAMMING

Operation Research and decision making- Development, Definition, Characteristics, Necessity, Scope, Applications, Advantages, Limitations, Objectives, Phases, Types of mathematical models in OR and constructing the model. Linear Programming - Requirements, Assumptions, Applications, Formulation of linear programming problem, Advantages, Limitations, Simplex method - Graphical method of solution, Simplex method - Analytical - Canonical and Standard forms of LPP, Artificial Variables Techniques - Big M-method, Artificial Variables Techniques - Two Phase method, Problems in Artificial Variables Techniques, Assignment models [Balanced, Unbalanced, Maximization] -Mathematical Representation ,Comparison with Transportation models - Hungarian Method of Solution, Assignment models [Travelling Salesman Problem.] (Shortest Cyclic Route Models)

UNIT II: TRANSPORTATION MODELS AND REPLACEMENT MODEL

Transportation problem – Assumption, Definition, Formulation and Solution - North west corner method, Transportation problem – Least cost method, Transportation problem – Vogel’s approximation method, Transportation problem – MODI method, MODI method [Unbalance in transportation model] MODI method [Degeneracy in transportation model], Replacement Model, Replacement of items that deteriorate, Gradually, Fail suddenly, Group Replacement policy analysis – Problems.

UNIT III: SEQUENCING AND NETWORK ANALYSIS

Problem of Sequencing, Processing ‘n’ jobs through two and three machines, Problem of Sequencing, Processing ‘n’ jobs through two and three machines, Project - Planning, Scheduling, Controlling - Network Analysis – Constructing a project network - Fulkerson's Rule, Network computations – Earliest Completion time of a project and Critical path, Program Evaluation Review Technique, Total Slack, Free Slack, Probability of achieving completion date, Cost Analysis - Crashing the network - Resource Scheduling -Advantages, Limitations, Problems - Distinction between PERT and CPM - LPP Formulation.

UNIT IV: INVENTORY CONTROL AND QUEING THEORY

Introduction – Necessity for Maintaining Inventory, Inventory Costs – Types- Variables in an inventory problem – Lead time, Reorder Level, EOQ, Deterministic Inventory Models – Purchasing model with no shortages, Manufacturing model with no shortages, Purchasing model with shortages, Manufacturing model with shortages, Multi item deterministic model, safety stock, storage quantity discount, Queuing Models - Elements - Kendall's Notation - Poisson arrivals and exponential service times, Waiting time, Idle time cost, Single channel problem, Multi-channel problem, Poisson arrivals and service time.

UNIT V: DECISION THEORY AND GAME THEORY

Steps in Decision theory approach - Decision making Environments-Making under conditions of Certainty, Uncertainty, Conditions of Risk, Steps in Decision theory approach - Decision making Environments-Making under conditions of Certainty, Uncertainty, Conditions of Risk, Decision making conditions – problems, Decision trees. - Utility Theory, Theory of Games, Characteristics Game models - Definition - Rules - Pure Strategy, Optimal solution of two-person zero sum games, mixed strategies, Graphical solution of $(2 \times n)$ and $(m \times 2)$ games, Solution of $(m \times n)$ games by linear programming.

TEXTBOOKS

1. Premkumar Gupta and Hira, “*Operation Research*”, Third Edition S Chand Company Ltd., New Delhi 2003.
2. A.C.S.Kumar, “*Operation Research*”, Yes Dee Publishing Ltd., Chennai 2015.
3. Fredric.S.Hilleer and Gerold J. Lieberman, “*Introduction to Operation Research*”, 2nd Edition, CBS, 1974.
4. Handy, “A. Taha, “*Operations Research*”, 5th Edition, Prentice Hall of India, New Delhi, 1997.
5. Philip and Ravindran, “*Operational Research*”, John Wiley, 2000.
6. Sundaresan.V, GanapathySubramanian.K.S, “*Resource Management Techniques: Operations Research*” A.R Publications, 2003.
7. Panneerselvam.K, “*Operation Research*”, Prentice Hall of India, 2002.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 406	Computational Fluid Dynamics	TE	3	0	0	3

UNIT I: GOVERNING EQUATIONS AND MATHEMATICAL BEHAVIOR OF PARTIAL DIFFERENTIAL EQUATIONS

Introduction to computational fluid dynamics, Types of model flow, substantial derivative, Divergence of velocity. Continuity equation in conservation form, integral and differential form, Continuity equation in non-conservation form, integral and differential form, Manipulation of continuity equation, Three-dimensional momentum equation, Navier's Stokes equation, Energy equation, Different boundary conditions, Classification of PDE, Classification of PDE, Mathematical behavior of PDE, Well posed problems.

UNIT II: DISCRETIZATION TECHNIQUES

Explanation of finite difference method, Discretisation of wave equation, Discretisation of laplace equation, Numerical error types and stability criterion, One dimensional transient heat conduction equation discretization. Explicit, crank Nicholson and pure implicit method. Numerical error and stability of One-dimensional transient heat conduction equation. Grid independence test, Optimum step size.

UNIT III: SOLUTION TECHNIQUES

Laxwendroff Technique, Maccormmacks Technique, Relaxation Technique and its significance, TDMA Algorithm, Alternative Direction Implicit method, Pressure correction Technique, Staggered Grid, Numerical SIMPLE Algorithm, Stream function and Vorticity method.

UNIT IV: GRID GENERATION

Grid transformation of equations, Transformation of aerofoil from physical plane to Computational plane, Transformation of continuity and Laplace equation, Metrics and Jacobians, Stretched grid, Compressed grid, Adaptive grids, Body fitted coordinate system, Grid generation in irregular geometry, Modern development in grid generation.

UNIT V: FINITE VOLUME METHOD

Finite Volume methods of discretisation-Central differencing scheme, Upwind scheme, hybrid scheme, One dimensional conduction problem, One dimensional convection problem, One dimensional convection and diffusion problem with different boundary conditions, Steady state heat conduction problems, Transient heat conduction problems.

TEXTBOOKS

1. Anderson J.D., "*Computational Fluid dynamics*", McGraw Hill Int., New York, 2010.
2. Versteeg H.K., and Malalasekera W., "*An introduction to computational fluid dynamics, The finite volume method*", Longman, 2007.
3. Suhas.V. Patankar, "*Numerical Heat Transfer and Fluid Flow*", Hemisphere Publishing Corporation, 2009.
4. Muralidhar.K, and Sundararajan.T, "*Computational Fluid Flow and Heat Transfer*", Narosa Publishing House, New Delhi, Second Edition, 2008.
5. Ghoshdasdar.P.S, "*Computer simulation of fluid flow and heat transfer*", Tata McGraw Hill Publishing Company Ltd., 1998.
6. Anil W. Date, "*Introduction to computational fluid dynamics*", Cambridge University Press, Cambridge, 2009.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 442	Advanced Engineering Thermodynamics	TE	3	0	0	3

UNIT I: AVAILABILITY ANALYSIS AND THERMODYNAMIC PROPERTY RELATIONS

Reversible work, availability, irreversibility and second law efficiency for a closed system, availability analysis of simple cycles, exergy analysis and thermodynamic potentials, maxwell relations, generalized relations for changes in entropy, internal energy and enthalpy generalized relations for c_p and Clausius-Clapeyron equation and Joule – Thomson coefficient.

UNIT II: REAL GAS BEHAVIOUR AND MULTI – COMPONENT SYSTEMS

Different equations of state, fugacity, compressibility and principle of corresponding states, use of generalized charts for enthalpy and entropy departure, fugacity coefficient, Lee – Kesler generalized three parameter tables, fundamental property relations for systems of variable composition. Partial molar properties. Real gas mixtures, ideal solution of real gases and liquid activity, equilibrium in multi-phase systems. Gibbs phase rule for non – reactive components.

UNIT III: CHEMICAL THERMODYNAMICS AND EQUILIBRIUM

Thermochemistry, first law analysis of reacting systems, adiabatic flame temperature, entropy change of reacting systems, second law analysis of reacting systems, criterion for reaction equilibrium, equilibrium constant for gaseous mixtures, evaluation of equilibrium composition.

UNIT IV: STATISTICAL THERMODYNAMICS

Statistical thermodynamics- introduction, energy states and energy levels, macro and microscales, thermodynamic probability, Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics, distribution function, partition energy, statistical interpretation of entropy, application of statistics to gases-mono-atomic ideal gas.

UNIT V: IRREVERSIBLE THERMODYNAMICS

Conjugate fluxes and forces, entropy production, Onsager's reciprocity relations, thermo – electric phenomena, formulations.

TEXTBOOKS

1. Kenneth Wark Jr., "Advanced Thermodynamics for Engineers", McGraw – Hill Inc., 1995.
2. M.J. Moran and H.N. Shapiro, "Fundamentals of Engineering Thermodynamics", John Wiley and Sons, 2003.
3. Yunus Cengel, "Thermodynamics an engineering approach", McGraw – Hill Inc, 8th Edition, 2015.
4. Bejan, A., "Advanced Engineering Thermodynamics", John Wiley and Sons, 1988.
5. Holman, J.P., "Thermodynamics", 4th Edition, McGraw – Hill Inc., 1988.
6. Sonntag, R.E., and Van Wylen, G., "Introduction to Thermodynamics, Classical and Statistical Thermodynamics", John Wiley and Sons, 3rd Edition, 1991.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 443	Finite Element Methods	TE	3	0	0	3

UNIT I: BASIC CONCEPTS OF THE FINITE ELEMENT METHOD

Basics of FEA, Derive the stiffness matrix of Spring, bar and beam elements, Tutorial Problems on spring and bar elements, Derive the stiffness matrix of beam elements, Tutorial Problems on spring and bar elements, Local and global coordinate systems, assembly of elements, calculation of element stress, simple applications, trusses, Drive the stiffness matrix, Tutorial Problems on Trusses-stiffness matrix calculation, Tutorial Problems on Trusses, Member stress calculation.

UNIT II: VARIATIONAL AND WEIGHTED RESIDUAL APPROACHES

Variational problems, Euler's Equation, Example problem, solving first order differential equation using 2-node 1D element, Example problems, solving first order differential equation using 1D-sub-parametric elements, Weighted residual approaches, Galerkin formulation and Point-collocation, Example problems on Galerkin formulation, simple regular beam sections with different types of loads, Example problems on Point-collocation- simple regular beam sections with different types of loads, Weighted residual approaches, Sub-domain collocation, Least-square minimization, Example problems on Sub-domain collocation - simple regular beam sections with different types of loads, Example problems on Least-square minimization - simple regular beam sections with different types of loads.

UNIT III: TWO DIMENSIONAL ISOPARAMETRIC ELEMENTS AND GAUSS NUMERICAL INTEGRATION

Natural coordinate systems, Interpolation function for Triangular Elements (CST, LST and QST).

Interpolation function for 4-node,8-node and 9-node quadrilateral Elements, Element stiffness matrix formulation for two dimensional elements, Gauss Numerical Integration-Derivation of one point and two-point formula. Example Problems on Gauss Numerical Integration using one point and two-point formula (1D problems).

UNIT IV: EIGEN VALUE PROBLEMS FOR ONE-DIMENSION PROBLEMS (DYNAMIC CONSIDERATION)

Formulation- Hamilton's Principle-Characteristic polynomial technique, Element mass matrix formulation for one dimensional Elements (2-node iso parametric and 3-node sup – parametric elements) Example problems for 1-D Problems to find eigenvalues and eigenvectors- using 2-node isoparametric, Example problems for 1-D Problems to find eigenvalues and eigenvectors- using 3-node isoparametric.

UNIT V: STEADY ANALYSIS STATE HEAT TRANSFER

Introduction, straight uniform fin analysis, Derivation 1D Element matrices, Example Problems, straight uniform fin analysis, Example Problems, Taper fin analysis, Heat Flux Boundary conditions, Analysis of uniform fins using 1D Quadratic Elements, Two Dimensional Steady state Problems, using CST Elements, Example Problems for 2D steady Problems using CST Elements, 1-D and 2-D simple Problems using any commercial FEA software.

TEXTBOOKS

1. Hutton, D.V., “*Fundamentals of Finite Element Analysis*”, McGraw Hill, International Edition, 2004.
2. Segerlind, L.J., “*Applied Finite Element Analysis*”, John Wiley & Sons, 1984.
3. Chandrupatla, T.R., Belegundu, A.D., “*Introduction to Finite Elements in Engineering*”, Prentice Hall of India, 1997.
4. Zienkiewicz, O.C., “*Finite Elements and Approximation*”, Dover International, 2006.
5. Cook R.D., Malkus, D.S., Plesha, M.E., Witt, R.J., “*Concepts and Applications of Finite Element Analysis*”, 4th Edition, John Wiley & Sons, 2001.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 415	Refrigeration and air conditioning	TE	3	0	0	3

UNIT I: VAPOUR COMPRESSION REFRIGERATION SYSTEMS

Review of thermodynamic principles of refrigeration, Simple vapour compression system, Calculation: COP of VCR system, Method for improving COP in VCR system, Multistage and multiple evaporator system, Cascade system, COP comparison with sub cooling and super heating, Tutorial: problem on sub-Cooling, and super heating.

UNIT II: ABSORPTION REFRIGERATION SYSTEMS

Absorption refrigeration cycle, Water lithium bromide systems, Tutorial:LiBr COP calculation, Ammonia Absorption Refrigeration system, Tutorial: ammonia COP calculation, COP calculation of single effect absorption system, Refrigeration absorbent combinations, Comparison of absorption system with vapor compression systems, Tutorial: COP comparison of vapor compression systems with vapor absorption system.

UNIT III: REFRIGERATION EQUIPMENTS & CONTROL

Compressors –type, Condensers type, Cooling towers type, Evaporators, Expansion devices type, Refrigerants: properties, Selection of refrigerants-alternate refrigerants, Refrigeration plant controls, Testing and charging of refrigeration units.

UNIT IV: DESIGN OF AIR CONDITIONING SYSTEMS

Different heat sources of Conduction and radiation, Load: occupants load, equipment load, fresh air load, infiltration air load, Tutorial: conduction, radiation, Tutorial: load calculation, Estimation of total heat load (SHL+LHL), Bypass factor (BPF), Effective sensible heat factor (ESHF), Tutorial: SHF& ESHF, Cooling coils and dehumidifier air washers.

UNIT V: APPLICATIONS OF REFRIGERATION AND AIR CONDITIONING SYSTEMS

Preservation of different products, Ice factory, Dairy plant refrigeration systems, Application of air conditioning in hotels, Application of air conditioning in restaurants, Application of air conditioning in theatres, Application of air conditioning in auditorium, Application of air conditioning in hospitals, Cryogenics applications.

TEXTBOOKS

1. Arora.S.C and Domkundwar.S, “A course in Refrigeration and Air conditioning”, DhanpatRai(P) Ltd., New Delhi, 2012.
2. Ananthanarayanan.P.N, “Basic Refrigeration and Air Conditioning”, Tata McGraw Hill, 3rd Edition, New Delhi, 2006.
3. Manohar Prasad, “Refrigeration and Air conditioning”, New Age International (P) Ltd, New Delhi, 2010.
4. Roy J. Dossat, “Principles of Refrigeration”, Pearson Education Asia, 4th Edition, 2001.
5. Arora, C. P., “Refrigeration and Air Conditioning”, Tata McGraw Hill, New Delhi, 2006.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 411	Artificial Intelligence	TE	3	0	0	3

UNIT I: INTRODUCTION TO AI

History, Definition of AI and Emulation of human cognitive process, Agents: types, An abstract view of modeling and Elementary knowledge, Computational and Predicate logic, Analysis of compound statements using simple, logic connectives, Nature of Environments.

UNIT II: PROBLEM SOLVING AGENTS

Problem Definition, formulating problems and Searching for solutions, Examples using production rules, Search /Strategies: Uninformed or Blinded search and Breadth first search, Uniform cost search: Depth first search, Depth limited search, Iterative deepening, Depth first search and Bi –directional search. Comparing uniformed search strategies and informed search strategies, Heuristic information and Hill climbing methods. Best First Search; Greedy Best First Search, Branch-and-Bound Search, Optimal search algorithm A* and iterative, deepening A*.

UNIT III: KNOWLEDGE ORGANISATION AND COMMUNICATION

Knowledge organization, manipulation and acquisition. Indexing and Retrieval techniques and Integration of knowledge in memory organization systems, Matching Techniques: Need for matching and simple matching problems, Partial matching, Fuzzy matching and RETE matching algorithm Perception Natural language: Overview of linguistics and Basics emantic analysis, Representation structures and Natural language generation uncertainty. Bayesian Networks and Bayesian Inference.

UNIT IV: PROGRAMMING LANGUAGE

Introduction to LISP: syntax, Input output statements, Numeric functions, User defined Functions, Predicate Logic and declaration of local variables, Interaction and recursion functions Property list and arrays.

UNIT V: EXPERT SYSTEMS

Introduction to expert systems, activities of an expert system, interpretation, prediction and diagnosis, design, planning and monitoring, debugging and repair, instruction and control, acquisition module frames of expert systems, knowledge base, production rules, semantic nets and inference engines, backward chaining and forward chaining.

TEXTBOOKS

1. Schalkoff, R.J., "*Artificial Intelligence: An Engineering Approach*", McGraw-Hill, 1990.
2. Elaine Rich and Kelvin Knight, "*Artificial Intelligence*", Tata McGraw Hill, New Delhi, 1991.
3. Stuart Russell and Peter Norvig, "*Artificial Intelligence: A modern approach*". Prentice Hall, New Jersey, 1995.
4. Donald A. Waterman, "*A Guide to Expert Systems*", Addison-Wesley Longman Publishing Co., Inc. Boston, MA, USA ©1985 ISBN:0-201-08313-2.
5. Nilson, N. J., "*Principles of Artificial Intelligence*", Springer Verlag, Berlin, 1980.
6. Eugene Charniak and Drew McDermot, "*Introduction to Artificial Intelligence*", Addison Wesley Longman Inc., 1998.
7. Patterson, "*Introduction to Artificial Intelligence and Expert systems*", Prentice Hall of India, New Delhi, 1990.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 444	Micro Controller and Its Application in Robotics	TE	3	0	0	3

UNIT I: INTRODUCTION TO 8051 MICROCONTROLLERS

Data representation and Numbering system and its types are binary, decimal, hexadecimal systems, Data conversion from hexadecimal to decimal and decimal to binary, binary addition and subtraction, Introduction and history description about Microcontrollers, Specification and Internal architecture of 8051. Pin description of 8051, Various Addressing modes of 8051 are immediate, direct, indirect, indexed addressing modes, difference between microcontroller with microprocessor. selection criterion for choosing microcontroller.

UNIT II: 8051 PROGRAMMING

Introduction to Assembly language, Instruction sets with syntax, timers and its types, TCON, TMOD, Delay program with and without timer, Interrupts both hardware and software, I/O Ports and its 3 modes of operation, Serial communication and its modes, SCON.

UNIT III: PERIPHERAL INTERFACE

Introduction to External world interfacing with microcontroller, Analog signals and Digital signals, Analog to digital and Digital to Analog conversion and its types, Analog inputs are mechanical switches, relays, Digital outputs are LED, 7 segment display and LCD Interfacing. Analog outputs are DC motor, Stepper motor, Servo motor and its interfacing. Digital inputs are keypad and its interfacing.

UNIT IV: OPENSOURCE MICROCONTROLLER AND ITS PROGRAMMING

Introduction to open-source microcontroller, Arduino platform basic knowledge of its hardware and its software environments, Variables, digital inputs and outputs, print and printing with programs. Reading analog signals and PWM signal generation with programs, Conditional statements are if, else and nested if with Programs. Looping statements are for, while and Do while with programs, functions and recursive function with programs, Continuous Serial monitoring and hardware interrupt with programs.

UNIT V: MICROCONTROLLER SYSTEM DESIGN AND APPLICATION

Application of Microcontroller in various fields, Advancement in Microcontroller, Study and Design a home security system using microcontroller, Study and Design a Micro mouse using microcontroller, Study and Design a Unmanned Aerial Vehicle using microcontroller, study and design a smart card using microcontroller, study and design a soccer playing robot using microcontroller.

TEXTBOOKS

1. Mazidi, “*The 8051 micro controller and embedded system*”, Pearson education, 2007.
2. Simon Monk, “*Programming Arduino Getting Started with Sketches*”, McGraw-Hill Education, 2011.
3. K. Uma rao, Andhe Pallavi, “*The 8051 Microcontroller Architecture, Programming and Applications*”, Pearson Education India, 2010.

REFERENCES

1. Han-way Huang, “*Using the MCS-51 microcontroller*”, Oxford University Press, 2009.
2. Scott Mackenzie, Raphael C. W. Phan, “*The 8051 Microcontroller*”, Prentice Hall, 2007.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 445	Machinery Fault Diagnostics and Signal Processing	TE	3	0	0	3

UNIT I: FAILURE ANALYSIS

Failures and failure analysis, failure concepts and characteristics, fault detection sensors, data processing and signal analysis, condition-based maintenance principles, fault analysis planning and system availability, reliability/failure concepts, application of diagnostic maintenance to specific industrial machinery and plants.

UNIT II: FAULT DIAGNOSTICS AND VIBRATION

Principles of maintenance, failure modes effects and criticality analysis, fault diagnostics and prognostics, basics of machinery vibration, engineering applications of vibration, rotor dynamics.

UNIT III: SIGNAL ANALYSIS

Time domain signal analysis, frequency domain signal analysis, computer aided data acquisition, FFT analysis, modulation and sidebands, envelope analysis, cepstrum analysis, order analysis.

UNIT IV: INSTRUMENTATION AND DETECTION

Data recording and transmission, vibration transducers, vibration monitoring, basics of noise and noise monitoring, numerical problems in noise vibration and data, acquisition, unbalance detection, field balancing, misalignment detection, cracked shaft detection, looseness and rub detection, ball and journal bearings, gear fault detection.

UNIT V: EQUIPMENT TESTING AND ANALYSIS

Fans, blowers, compressors, pumps and turbines, contaminant analysis, oil analysis, fault detection in motors and transformers, motor current signature analysis, thermography and ultrasonics, acoustic emission and eddy current testing, radiography, dye penetrant test and visual inspection.

TEXTBOOKS

1. E. S. Tehrani and K. Khorasani, "*Fault diagnostics of a nonlinear system using a hybrid approach*" Springer, 2009.
2. Paresh Girdhar, Cornelius Scheffer, "*Practical machinery vibration analysis and predictive maintenance*", Elsevier, 2004.
3. Rolf Isermann, B. Freyermuth, "*Fault Detection, Supervision and Safety for Technical Processes*", Pergamon Press, 2006.
4. J Prasad, C G K Nair, "*Non-Destructive Testing and Evaluation of Materials*", Tata McGraw Hill Education Private Limited, 2008.
5. American Metals Society, "*Non-Destructive Examination and Quality Control*", Metals Handbook, Vol.17, 9th Ed, Metals Park, OH, 1989.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 446	Advanced Strength of Materials	TE	3	0	0	3

UNIT I: INTRODUCTION

Plane Stress - Plane strain relations, General equations of elasticity in Cartesian, polar and spherical co-ordinates equations of equilibrium, Representation of 3-dimensional stress of tensor, Stress at a point - inclined plane. 3D stress at a point - Principal stress, 3D Stress transformation, Generalized Hooke's law, St. Venant's principle, Compatibility and boundary conditions, Airy's stress function.

UNIT II: UNSYMMETRICAL BENDING AND SHEAR STRESS ON BEAMS

Stress and deflections in beams subjected to unsymmetrical loading – Double (I) symmetry sections. Stress and deflections in beams subjected to unsymmetrical loading – Single symmetry (T) sections. Stress and deflections in beams subjected to unsymmetrical loading – Single symmetry (C) sections. Stress and deflections in beams subjected to unsymmetrical loading – Unsymmetrical (L) sections. Kern of a section, Shear Stress Distribution on beams – Thin-walled sections, Shear Center - Location of shear center for various sections, Shear flow.

UNIT III: CURVED FLEXURAL MEMBERS

CURVED FLEXURAL MEMBERS: Circumferential and radial stresses – winklerbach theory, circumferential and radial stresses for curved beam with restrained ends, deflections in curved flexural members, closed ring subjected to concentrated loading, closed ring subjected to uniform load, chain links, crane hooks.

UNIT IV: TORSION ON NON-CIRCULAR SECTIONS

Torsion of rectangular cross section, St. Venant's theory, Elastic membrane analogy, Prandtl's stress function, Torsional stress in hollow thin-walled tubes, Stress due to Rotation: Radial and tangential stresses in solid disc of uniform and varying thickness with allowable speeds, Radial and tangential stresses in ring of uniform and varying thickness with allowable speeds.

UNIT V: STRESSES IN FLAT PLATES AND CONTACT STRESSES

Stresses in circular plates due to various types of loading and end conditions, Stresses in rectangular plates due to various types of loading and end conditions, Buckling of plates, Methods of computing contact stresses, Deflection of bodies in point contact, Deflection of bodies in line contact, Contact stress for various applications.

TEXTBOOKS

1. Arthur Boresi & Omar Sidebottom, "*Advanced Mechanics of Materials*," John Wiley & Sons, 6th Edition, 2002.
2. Seely and Smith, "*Advanced mechanics of materials*", John Wiley International Edn, 1952.
3. Rimoahwnko, "*Strength of Materials*", Van Nostrand., 1970.
4. Den Hartong, "*Advanced Strength of Materials*", McGraw Hill Book Co., New York 1952.
5. Timoshenko and Goodier, "*Theory of Elasticity*", McGraw Hill., 1994.
6. Wang, "*Applied Elasticity*", McGraw Hill., 1979.
7. Case, "*Strength of Materials*", Edward Arnold, London 1957.
8. Robert D. Cook, Warren C. Young, "*Advanced Mechanics of Materials*", Macmillian Pub. Co. 1952.
9. Durelli Phillips and Tso, "*Introduction to the Theoretical and Experimental Analysis of Stress and Strain*", McGraw-Hill, 1958.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 460	Additive Manufacturing Technology	TE	3	0	0	3

UNIT I: INTRODUCTION TO ADDITIVE MANUFACTURING SYSTEMS

History and Development of AM, Need of AM, Difference between AM and CNC, Classification of AM Processes: Based on Layering techniques, Raw materials and Energy sources. AM Process chain, Benefits of AM, Applications of AM, Representation of 3d model in STL format, Repair of STL files, RP Data formats: SLC, CLI, RPI, LEAF, IGES, CT, STEP, HP/GL.

UNIT II: POWDER BASED AM SYSTEMS

Principle and process of Selective Laser Sintering (SLS). Advantages, Limitations and Applications of SLS, Principle and Process of Laser Engineered Net Shaping (LENS), Advantages, Limitations and Applications of LENS, Principle and Process of Electron Beam Melting (EBM), Advantages, Limitations and Applications of EBM.

UNIT III: SOLID AND LIQUID BASED AM SYSTEMS

Stereolithography (SLA): principle, process, materials, advantages, limitations, applications, solid ground curing (SGC): principle, process, materials, advantages, limitations, applications. Fusion deposition modeling (FDM): principle, process, materials, advantages, limitations, applications. Laminated object manufacturing (LOM): principle, process, materials, advantages, limitations, applications.

UNIT IV: OTHER ADDITIVE MANUFACTURING SYSTEMS

Three-dimensional printing (3DP): principle, process, advantages, limitations, applications. Ballistic particle manufacturing (BPM): principle, process, advantages, limitations, applications. Shape deposition manufacturing (SDM): principle, process, advantages, limitations, applications, reverse engineering.

UNIT V: TOOLING AND PRE & POST PROCESSING TECHNIQUES IN AM SYSTEMS

Rapid tooling: Classification of Tooling, Direct, and Indirect tooling methods, Soft and Hard tooling methods. Design for AM: Part orientation, Removal of Post processing: Support material removal, Surface texture Improvements, Accuracy supports, following out parts, Interlocking features, Reduction of part count in an assembly. Improvements, Machining Strategy, Aesthetic Improvements, Property enhancements.

TEXTBOOKS

1. Ian Gibson, David Rosan, Brent Stucker, “*Additive Manufacturing Technologies*”, Springer, 2010.
2. Chua C.K., Leong K.F., and Lim C.S., “*Rapid Prototyping: Principles and Applications*”, Second Edition, World scientific Publishers, 2003.
3. Liou W. Liou, Frank W. Liou, “*Rapid Prototyping and Engineering applications: A Toolbox for Prototype development*”, CRC Press, 2007.
4. Pham D.T. and Dimov S.S., “*Rapid Manufacturing; the technologies and application of RPT and Rapid tooling*”, Springer, London 2001.
5. Gebhardt, A., “*Rapid prototyping*”, Hanser Gardener Publications, 2003.
6. Hilton, P.D. and Jacobs, P.F., “*Rapid Tooling: Technologies and Industrial Applications*”, CRC press, 2005.
7. Rafiq Noorani, “*Rapid Prototyping: Principles and Applications in Manufacturing*”, John Wiley & Sons, 2006.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 447	Computer Graphics	TE	3	0	0	3

UNIT I: INTRODUCTION

Origin of computer graphics, Interactive graphics display, Display devices, pixels, Algorithms for line and circle, 2D transformation (scaling, rotation, translation), 3D transformation (scaling, rotation, translation) Concatenation transformations.

UNIT II: SPECIAL CURVES

Curve representation, Parametric representation of Bezier curve, Parametric representation of Cubic spline curve, Parametric representation of B-Spline curve, Parametric representation of Rotational curves.

UNIT III: SURFACES

Surface modeling techniques, Mathematical representation and boundaries Coons patch, Mathematical representation of Bi-Cubic patch, Bezier and B-Spline surfaces.

UNIT IV: THREE-DIMENSIONAL COMPUTER GRAPHICS

Boundary representation (B-rep), basic elements and building operations, Constructive solid geometry (CSG), basic elements and building operations, viewing transformations, clipping operations Hidden line removal for curved surfaces, Algorithms for shading and rendering.

UNIT V: GRAPHICS AND COMMUNICATION STANDARDS

Graphical Kernel System, Bit maps and open GL (graphics library) Data exchange standards (IGES, STEP, CALLS, DXF, STL) Communication standards (LAN, WAN).

TEXTBOOKS

1. Donald Hearn and Pauline Baker M. "*Computer Graphics*", Prentice Hall, Inc., 2009.
2. Ibrahim Zeid "*CAD/Cam Theory and Practice*", McGraw Hill, International Edition, 2010.
3. Harington, Stevan, "*Computer Graphics: A Programming Approach*", McGraw Hill, 1983.
4. Plastock, Roy A., &Kally, "*Theory and Problems of Computer Graphics*", McGraw Hill, 1986.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 448	Automotive Engineering	TE	3	0	0	3

UNIT I: AUTOMOBILE ARCHITECTURE AND PERFORMANCE

Automotive components, subsystems and their positions of chassis, frame and body, front, rear and four-wheel drives, operation and performance, traction force and traction resistance, power required for automobile.

UNIT II: TRANSMISSION SYSTEMS

Clutch types, coil spring and diaphragm type clutch, single and multi-plate clutch, centrifugal clutch, Gear box types, constant mesh, sliding mesh and synchromesh gear box, layout of gear box, gear selector and shifting mechanism. Overdrive, automatic transmission, Rolling, air and gradient resistance, Propeller shaft, universal joint, slip joint Differential and real axle arrangement, hydraulic Coupling.

UNIT III: WHEEL, TYRES, AND BRAKING SYSTEM

Types of wheels, construction, wired wheels, Tyres, construction, radial, bias & belted bias, slip angle, tread patterns, tyre retreading cold & hot, tubeless tyres. Forces on vehicles, tyre grip, load transfer, braking distribution between axles, stopping distance. Types of brakes, Mechanical, Hydraulic, Air, brakes, Disc & Drum brakes, Engine brakes, anti-lock braking system.

UNIT IV: SUSPENSION AND STEERING SYSTEM

Types-front and rear suspension, conventional and independent type suspension, Leaf springs, coil springs, dampers, torsion bars, stabilizer bars, arms, air suspension systems. Types of steering systems, Ackermann principle, Davis steering gear, steering gear boxes, steering linkages. Power steering, wheel geometry, caster, camber toe in, toe out. Wheel Alignment and balancing.

UNIT V: ELECTRICAL SYSTEM AND ADVANCES IN AUTOMOTIVE ENGINEERING

Battery, general electrical circuits, dashboard instrumentation. Passenger comfort, safety and security, HVAC seat belts, air bags. Automotive Electronics, Electronic Control Unit (ECU). Variable Valve Timing (VVT), Active Suspension System (ASS), Electronic Brake Distribution (EBD) Electronic Stability Program (ESP), Traction Control System (TCS), Global Positioning System (GPS), Electric Hybrid Vehicle.

TEXTBOOKS

1. Kirpal Singh, "Automobile Engineering", Standard Publishers, Vol-I & II, 2004.
2. Ramalingam, K. K., "Automobile Engineering", Scitech Publications, 2014.
3. Rajput R K, "A Textbook of Automobile Engineering", Laxmi Publication, 2015.
4. Crouse, W.H., and Anglin, D.L., "Automotive Mechanics", Tata McGraw Hill, 2005.
5. Narang, G.B., "Automobile Engineering", Khanna Publishers, 2001.
6. Kamaraju Ramakrishna, "Automobile Engineering", PHI Learning Pvt. Ltd, 2012

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 449	Fatigue, Fracture Mechanics and Creep	TE	3	0	0	3

UNIT I: INTRODUCTION TO FATIGUE

Introduction to fatigue, stress and strain cycles, S-N curves, statistical nature of fatigue, low cycle fatigue, High cycle fatigue, basquin equation, Coffin and Manson equation, strain life equation, design for fatigue.

UNIT II: EFFECT OF VARIOUS PARAMETERS ON FATIGUE

Effect of stress concentration on fatigue, size effect, surface effects and fatigue, corrosion fatigue, effect of mean stress on fatigue, engineering analysis of fatigue strength, cumulative fatigue damage, effect of metallurgical variables on fatigue, effect of temperature on fatigue.

UNIT III: FRACTURE MECHANICS

Introduction to fracture mechanics (FM), modes of crack and types of fracture in metals, linear elastic fracture mechanics (LEFM), griffith's theory of brittle fracture, irwin's modification, determination of stress intensity factor (K and K_{Ic}). Plane strain fracture toughness.

UNIT IV: APPLICATIONS OF FRACTURE MECHANICS

Theories of elastic and plastic fracture mechanics (EPFM) crack opening displacement (COD), crack tip opening displacement (CTOD), j-integral, ductile fracture, notch effect, concept of fracture curve, fracture under combined stresses. Life prediction and design.

UNIT V: CREEP, STRESS RUPTURE AND HIGHTEMPERATURE MATERIALS

Introduction to high temperature behavior, the creep curves, the stress rupture test, mechanisms of creep and mechanism maps, presentation of engineering creep data, prediction of long-life properties, creep fractures, creep fatigue interaction and creep resistant materials.

TEXTBOOKS

1. George E. Dieter, "Mechanical Metallurgy", McGraw-Hill, 3rdSI metric edition", 1989.
2. Robert P. Wei, Fracture Mechanics, "Integration of Mechanics, Materials Science and chemistry", Cambridge University Press, 2010.
3. Richard W. Hertzberg, "Deformation and Fracture Mechanic of Engineering Materials", John Wiley & sons, 1995.
4. Prashant Kumar, "Elements of Fracture Mechanics", Tata McGraw-Hill, New Delhi, 2009.
5. Suryanarayana.A.V.K, "Testing of Metallic Materials", 2nd Edition, BS Publication, Hyderabad, 2007.
6. Davis H.E, Troxell G.E, Hauck G.E.W, "Testing of Engineering Materials", 4th Edition, McGraw Hill, Int. Students, 1982.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 452	Flexible Manufacturing Systems	TE	3	0	0	3

UNIT I: PRODUCTION SYSTEMS

Types of production system, comparison, plant layout. Functions in manufacturing, manufacturing support system. Automation in production system. Production quantity and product variety, production concepts and mathematical model, tutorial on production rate, production, capacity, utilization, availability, manufacturing lead time for all types of production. Tutorial on manufacturing lead time, work in progress for all types of production, single product scheduling.

UNIT II: GROUP TECHNOLOGY AND FMS

Introduction to GT, formation of part families, part classification and coding system, production flow analysis, machine cell design, clustering algorithm, GT benefits, introduction and evolution of FMS. FMS need and economic justification, components and classification of fms.

UNIT III: FMS PLANNING

Physical planning for FMS, objective, guideline. User-supplier responsibilities in planning, user-supplier role in site preparation, machine tool selection and layout, computer control system, datafiles, types of reports, system description and sizing, factors affecting it. Human resources for FMS, objective, staffing, supervisor role. Quantitative analysis methods for fms, bottle neck and extended bottle neck model, tutorial. FMS benefits and limitation.

UNIT IV: FLEXIBLE MANUFACTURING CELLS

Introduction to manufacturing cells, cell description and classifications, unattended machining, requirement and features, component handling and storage system, cellular versus FMS, system simulation, hardware configuration, plc and computer controllers, communication networks, lean production and agile manufacturing.

UNIT V: FMS SOFTWARE

Introduction to FMS software, general structure and requirements, functional descriptions, operational overview, FMS installation, acceptance testing, performance goals, FMS application in machining, sheet metal fabrication, prismatic component production, FMS development towards factories of the future.

TEXTBOOKS

1. William W. Luggen, "*Flexible Manufacturing Cells and Systems*", Prentice Hall, New Jersey, 1991.
2. Mikell P. Groover, "*Automation Production Systems & Computer Integrated manufacturing*", Prentice.
3. Jha.N.K, "*Handbook of Flexible Manufacturing Systems*", Academic Press Inc.,1991.

REFERENCES

1. David J. Parrish, "*Flexible Manufacturing*", Butterworth-Heinemann, Newton, MA, USA, 1990.
2. Radhakrishnan.P and Subramanyan.S, "*CAD/CAM/CIM*", Wiley Eastern Ltd.,New Age International Ltd., 1994 3.
3. Raouf.A and Ben-Daya.M, Editors, "*Flexible manufacturing systems: recent development*", Elsevier Science, 1995.
4. Kalpakjian, "*Manufacturing engineering and technology*", Addison-Wesley Publishing Co., 1995.
5. Taiichi Ohno, "*Toyota production system: beyond large-scale production*", Productivity Press (India) Pvt. Ltd. 1992.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 453	Combustion Engineering	TE	3	0	0	3

UNIT I: COMBUSTION OF FUEL

Introduction, combustion equations, theoretical air, excess air, air fuel ratio, equivalence ratio, exhaust gas composition, air fuel ratio from exhaust gas composition, heating value of fuels.

UNIT II: THERMODYNAMICS OF COMBUSTION

Thermo-chemistry, first law analysis of reacting systems, adiabatic combustion temperature, second law analysis of reacting systems, criterion for chemical equilibrium, equilibrium constant for gaseous mixtures, evaluation of equilibrium composition, chemical availability.

UNIT III: KINETICS OF COMBUSTION

Rates of reaction, reaction order and complex reactions, chain reactions, arrhenius rate equation, collision theory. Activated complex theory, explosive and general oxidative characteristics of fuels.

UNIT IV: FLAMES

Laminar and turbulent flames premixed and diffusion flames, burning velocity and its determination, factors affecting burning velocity, quenching, flammability and ignition, flame stabilization in open burners.

UNIT V: ENGINE COMBUSTION

Combustion in SI and CI engines, stages of combustion in SI and CI engines, normal combustion and abnormal combustion, emissions from premixed combustion, emission from non-premixed combustion, control of emissions.

TEXTBOOKS

1. Stephen.R.Turns, "*An Introduction to Combustion concepts and applications*", McGraw Hill BookCompany, Boston, 3rd Edition, 2011.
2. Ganesan.V, "*Internal Combustion Engines*", Tata McGraw-Hill, New Delhi, 2009.
3. Ramalingam.K.K, "*Internal Combustion Engines - Theory and practice*", SciTechPublicationsIndiaPvt. Ltd., Chennai, 2010.
4. Thipse.S.S, "*Internal Combustion Engines*", Jaico Publication House, 2010.
5. Thipse.S.S, "*Alternate Fuels*", Jaico Publication House, 2010.
6. Mathur.M.L, and Sharma.R.P, "*A course in Internal Combustion Engines*", DhanpatRai& Sons, NewDelhi, 2010.
7. Heywood.J.B, "*Internal Combustion Engine Fundamentals*", McGraw Hill International, New York,2008.
8. Domkundwar.V.M, "*A course inInternal Combustion Engines*", DhanpatRai&Sons, 2010.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 405	Mechanics of Composite Materials	TE	3	0	0	3

UNIT I: INTRODUCTION

Definition, Need, General characteristics, Applications, Fibers-Glass, Carbon, Ceramic and Aramid fibers, Polymer Matrices, Ceramic Matrices, Metal Matrices, Characteristics of fibers and matrices, Smart materials, types and characteristics.

UNIT II: MECHANICS AND PERFORMANCE

Characteristics of fiber reinforced Lamina, Laminates, Inter laminar stresses, Static Mechanical Properties, Fatigue and Impact properties, Environmental effects, Fracture Behavior and Damage Tolerance.

UNIT III: MANUFACTURING

Bag Moulding, Compression moulding, Pultrusion, Filament winding, Other Manufacturing Processes, Quality Inspection method.

UNIT IV: ANALYSIS

Analysis of an orthographic lamina, Hooke's law, stiffness and compliance matrices, Strengths of orthographic lamina, Stress analysis of laminated composite Beams, Stress analysis of laminated composite Plates, Stress analysis of laminated composite Shells, Free vibration.

UNIT V: DESIGN

Failure predictions in a Unidirectional Lamina, Failure predictions for Unnotched Laminates, Laminated Design Consideration, Bolted and Bonded Joints, Design examples.

TEXTBOOKS

1. Mallick, P.K., "*Fibre Reinforced composites: Materials*", Manufacturing and Design: Marcel DekkerInc., 1993.
2. Halpin, J.C., "*Primer on Composite Materials, Analysis*", Techomic Publishing Co., 1984.
3. Agarwal, B.D., and Broutman L.J., "*Analysis and Performance of Fibre Composites*", John Wiley andSons, New York, 1990.
4. Malick, P.K. and Newman S., (eds), "*Composite Materials Technology: Processes and Properties*",Hansen Publisher, Munich, 1990.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 454	Gas Turbine Technology	TE	3	0	0	3

UNIT I: BASICS OF GAS TURBINES

Open cycle single shaft and twin shaft multi speed arrangement, Closed cycle gas turbine operation, Aircraft propulsion, Industrial applications of gas turbines, Environmental issues and future enhancement possibilities.

UNIT II: POWER CYCLES

Ideal cycles method of accounting component losses, design point performance calculations, comparative performance of practical cycles - combined cycle - cogeneration schemes. Closed cycle gas turbine with reheat, inter-cooling and regenerator, problems.

UNIT III: AXIAL FLOW COMPRESSORS

Axial flow compressor basic operation: elementary theory, factors effecting stage pressure ratio, blockage in compressor annulus - degree of reaction - blade fixing details - sealing materials and material selection for compressor blades, stage performance - design and off design performance characteristics, problems.

UNIT IV: COMBUSTION SYSTEMS AND TURBINES

Types of combustion and combustion requirements, Factors affecting combustion process, Combustion chamber heat calculations, Turbine construction, performance, impeller blade fixing. Cooling of turbine blades, blade vibration and protective coating. Gas turbine turbo chargers and power expanders, vortex theory. Estimation of stage performance.

UNIT V: PERFORMANCE PREDICTIONS

Prediction performance of gas turbines component characteristics, Off design operation - Equilibrium running of gas generator, Methods of displacing of the equilibrium running line, Incorporation of variable pressure losses, Matching procedure for two spool engines, principle of control system.

TEXTBOOKS

1. Saravanamuttoo. H.I.H, Rogers.G.F.C, Henry Cohen, "*Gas Turbine Theory*", Pearson Prentice Hall, 2009.
2. Mattingly.J.D, "*Elements of Propulsion: Gas turbines and Rockets*", McGraw Hill, 2012.
3. Ganesan.V, "*Gas Turbines*", Tata McGraw Hill, 3rd Edition, 2010.
4. Yahya S.M, "*Turbines, Fans and Compressors*", 3rd Edition, Tata McGraw Hill Publications, 2010.
5. Gopalakrishnan.G, Prithvi Raj D, "*Treatise on Turbomachines*", 1st Edition, Chennai, SciTechPublications, 2006.
6. Horlock.J.H, "*Advanced Gas Turbine Cycles*", Elsevier Science Ltd, 2003.
7. Venkanna.B.K, "*Fundamentals of Turbomachinery*", 4th Edition, New Delhi, PHI Learning Pvt. Ltd, 2011.
8. Yahya.S.M, "*Gas Tables for compressible flow calculations*", New Age International (P) Ltd, NewDelhi, 6th Edition, 2011.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 455	Fuel Cell Technology	TE	3	0	0	3

UNIT I: INTRODUCTION TO FUEL CELLS AND FUEL CELL THERMODYNAMICS

Introduction and overview of fuel cell technology: A simple fuel cell, fuel cell advantages and disadvantages, Basic fuel cell operation, Layout of a Real Fuel Cell: The Hydrogen–Oxygen Fuel Cell with Liquid Electrolyte. Difference between fuel cell and batteries, fuel choice, Overview of types of fuel cells (with emphasis on PEMFC and DMFC technology) Fuel cell thermodynamics: Thermodynamics review, Application of first and second law to fuel cells, Heat Potential of a fuel: Enthalpy of reaction, Work potential of a fuel: Gibbs free energy, Predicting reversible voltage of a fuel cell under non-standard-state conditions, Basic Parameters of Fuel Cells. Fuel cell efficiency, Comparison with Carnot efficiency.

UNIT II: FUEL CELL ELECTROCHEMISTRY

Fuel cell reaction kinetics, Introduction to electrode kinetics, Conversion of chemical energy to electricity in a fuel cell. reaction rate, Butler -Volmer equation, fuel cell charge and mass transport, Implications and use of fuel cell polarization curve.

UNIT III: TYPES OF FUEL CELLS

Classification of fuel cells, Polymer electrolyte membrane fuel cell (PEMFC), Direct methanol fuel cells (DMFC), Alkaline fuel cell (PAFC) Molten Carbonate fuel cell (MCFC), Solid oxide fuel cell (SOFC), Comparison of fuel cell, Performance behavior.

UNIT IV: HYDROGEN PRODUCTION, STORAGE AND UTILIZATION

Hydrogen: Its merit as a fuel, Production methods: from fossil fuels, electrolysis, thermal decomposition, photochemical, photocatalytic, hybrid, Hydrogen storage methods: Onboard hydrogen storage, Chemical storage & physical storage, In metal and alloy hydrides, Carbon nanotubes, Glass capillary arrays - pipeline storage and hydrogen utilization.

UNIT V: APPLICATION OF FUEL CELLS IN POWER COGENERATION

Balance of fuel cell power plant, fuel cell power plant structure, cogeneration, fuel cell electric vehicles, motorcycles and bicycles, airplanes, fueling stations, fuel processor and fuel cell stack, safety issues and cost expectation.

TEXTBOOKS

1. O'Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, "Fuel Cell Fundamentals", Wiley, 2006.
2. Viswanathan. B, Aulice Scibioh, M, "Fuel Cells – Principles and Applications", Universities Press(India) Pvt., Ltd., 2009.
3. Bagotsky .V.S, "Fuel Cells", Wiley, 2009.
4. Detlef Stolten, "Hydrogen and Fuel Cells: Fundamentals, Technologies and Applications", 2010.
5. Larminie .J, Dicks A. "Fuel Cell Systems", 2nd Edition, Wiley, 2003.
6. Barclay .F.J. "Fuel Cells, Engines and Hydrogen", Wiley, 2009.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 412	Additive Manufacturing Process	TE	3	0	0	3

UNIT I

Introduction to layered manufacturing, Importance of Additive Manufacturing Additive Manufacturing in Product Development. Classification of additive manufacturing processes, Common additive manufacturing technologies; Fused Deposition Modeling (FDM), Selective Laser Sintering (SLS), Stereo Lithography (SLA), Selection Laser Melting (SLM), Jetting, 3DPrinting, Laser Engineering Net Shaping (LENS), Laminated Object Manufacturing (LOM), Electron Beam Melting (EBM). Capabilities, materials, costs, advantages and limitations of different systems.

UNIT II

Material science for additive manufacturing-Mechanisms of material consolidation-FDM, SLS, SLM, 3D printing and jetting technologies. Polymer's coalescence and sintering, photo polymerization, solidification rates,Meso and macro structures, Process evaluation: process-structure relationships, structure property relationships.

UNIT III

Applications: Prototyping, Industrial tooling, Aerospace, Automotive, Medical etc., Quality control and reliability: Defects in FDM, SLS and SLM, Critical process parameters: geometry, temperature, composition, phase transformation, Numerical and experimental evaluation: roles of process parameter combination, process optimization.

UNIT IV

CAD Modelling for 3D printing: , 3D Scanning and digitization, data handling &reduction Methods, AM Software: data formats and standardization, Slicing algorithms:-uniform flat layer slicing, adaptive slicing, Process-path generation: Process-path algorithms, rasterization, part Orientation and support generation.

UNIT V

Lab: CAD Modeling: Introduction to CAD environment, Sketching, Modeling and Editing features, Different file formats, Export/Import geometries, Part orientation, Layer slicing, Process path selection, Printing, Numerical and experimental evaluation.

TEXTBOOKS/REFERENCES

1. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
2. Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications" second edition, World Scientific Publishers, 2010.
3. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2011.
4. Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
5. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 434	Elements Of Mechatronics	TE	3	0	0	3

UNIT I: INTRODUCTION TO MECHATRONICS

Introduction to Mechatronics systems, Mechatronics system components and Measurement Systems, Control Systems, Open and Closed Loops Systems temperature control, Water level controller and Shaft speed control, Transfer function: Laplace transform, system in series and System with feedback loop. Sequential Controllers: Washing machine control, Sequential Controllers: Digital camera.

UNIT II: SENSORS AND TRANSDUCERS

Introduction to sensors and transducers and classifications, Principle and working of Resistive, capacitive, inductive and resonant transducers, Optical measurement systems for absolute and incremental encoders, Photo electric sensor and vision system, Fiber optic transducers, Solid state sensors and transducers for magnetic Measurements Temperature measurements, Chemical measurements, piezoelectric sensor and Accelerometers, Ultrasonic sensors and transducers for flow and distance.

UNIT III: ELECTRICAL DRIVES AND CONTROLLERS

Introduction, Electromagnetic Principles, Solenoids and Relays, Electrical drives of stepper motors, servo motors, Operational amplifier, A/D converters & D/A converters, Signal processing, Multiplexer and Introduction to Data acquisition system, Proportional, Integral, Derivative and PID controller, Introduction to Micro controller: M68HC11 and ATMEGA328.

UNIT IV: PROGRAMMABLE LOGIC CONTROLLERS

Basic structure, Programming units and Memory of Programmable logic controller, Input and Output Modules, Mnemonics for programming, Latching and Internal relays, Timers, Counters and Shift Registers, Master relay and Jump Controls, Programming the PLC using Ladder diagram for Simple applications.

UNIT V: MECHATRONICS SYSTEM DESIGN AND APPLICATION

Mechatronics in Engineering Design, Traditional and mechatronics design, Car park barriers using PLC, Pick and Place robots and Bar code reader, Wind screen wiper using stepper motor control, Car Engine management systems, Case studies for Coin counters, Robot walking machine, Boiler control using PID.

TEXTBOOKS

1. Bolton.W, "*Mechatronics*", Addison Wesley, 4th Edition, New Delhi, 2010.
2. Bradley.D.A, Dawson.DBurdN.C.and Loader A.J, "*Mechatronics*", Chapman and Hall Publications,New York, 1993.
3. Jacob Fraden, "*Handbook of Modern Sensors Physics, Designs, and Applications*", Third Edition,Springer-Verlag New York, 2004.
4. James Harter, "*Electromechanics, Principles and Concepts and Devices*", Prentice Hall, New Delhi,1995.
5. David W. Pessen, "*Industrial Automation Circuit Design and Components*", John Wiley, New York,1990.
6. Rohner.P, "*Automation with Programmable Logic Controllers*", Macmillan / McGraw Hill, New York,1996.

7. Brian Morris, "*Automatic Manufacturing Systems Actuators, Controls and Sensors*", McGraw Hill, New York, 1994.
8. Godfrey C. Onwubolu, "*Mechatronics Principles and applications*", Butterworth-Heinemann, New Delhi, 2006.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME 417	Compressible Flow	TE	3	0	0	3

UNIT I

Review of fluid Mechanics, Thermodynamics and Navier Stokes equation.

UNIT II

Wave propagation in compressible flows, Isentropic and quasi 1D flows.

UNIT III

Normal, oblique and bow shocks, Theta-Beta-M relation.

UNIT IV

Expansion fans and interaction of shock waves.

UNIT V

Compressible flows with friction.

TEXTBOOKS

1. John D. Anderson Jr (1990), Modern Compressible Flow with Historical Perspective, McGraw-Hill, Singapore.
2. E. Rathakrishnan (2012), Gas Dynamics, 4TH Edition, PHI Learning Private Limited, New Delhi.

REFERENCES

1. Gas Dynamics Volume 1, Maurice J Zucrow and Joe D Hoffman.