School of Engineering and Applied Sciences

B. Tech Mechanical Engineering

Syllabus

AY: 2021-2025

Department of Mechanical Engineering
SRM University-Andhra Pradesh.

Semester-I					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
EGL 101	Communicative English	3	0	0	3
ISES 101	Industry Specific Employability Skills-I	1	1	0	1
MAT 112	Single Variable Calculus	3	0	0	3
CHE 103	Chemistry for Engineers	2	0	0	2
CHE 103 L	Chemistry for Engineers Lab	0	0	2	1
PHY 101	Engineering Physics	3	0	0	3
PHY 101 L	Engineering Physics Lab	0	0	2	1
CSE 105	Introduction to Programming Using C	3	0	0	3
CSE 105 L	Introduction to Programming Using C Lab	0	0	2	1
ENV 111	Environmental Science	2	0	0	2
ENV 111 L	Environmental Science Lab	0	0	2	1
	TOTAL	**17**	**1**	**8**	**21**

Semester-II					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
ENG 115	Engineering Mechanics	3	1	0	4
ISES 102	Industry Specific Employability Skills-II	1	1	0	1
CSE 107	Data Structures	3	0	0	3
CSE 107 L	Data Structures Lab	0	0	2	1
ME 103 L	Mechanical Engineering Tools Lab	0	0	2	1
ENG 105	Engineering Graphics	3	0	0	3
ENG 105 L	Engineering Graphics Lab	0	0	2	1
	HS ELECTIVE	3	0	0	3
MAT 121	Multi Variable Calculus	3	0	0	3
ENG 111	Basic Electronics	3	0	0	3
ENG 111 L	Basic Electronics Lab	0	0	2	1
CSE 131	Industry Standard Coding Practice-One	0	0	4	1
	TOTAL	**19**	**2**	**12**	**25**

Semester-III					
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 211	Linear Algebra	3	0	0	3
ME 141	Thermodynamics	3	0	0	3
ME 141 L	Thermodynamics Lab	0	0	2	1
ME 121	Material Science	3	0	0	3
ME 121 L	Material Science Lab	0	0	2	1
ME 172	Kinematics and Mechanisms	3	0	0	3
ME 172 L	Kinematics and Mechanisms Lab	0	0	2	1
ME 225 L	3d Printing	0	0	2	1
ISES 201	Industry Specific Employability Skills-III	1	1	0	1
CSE 232	Industry Standard Coding Practice-Two	0	0	4	1
	TOTAL	**16**	**1**	**14**	**22**

Semester-IV					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
ME 224	Machine Design	3	0	0	3
ME 224 L	Machine Design Lab	0	0	2	1
MAT 131	Differential Equation	3	0	0	3
ME 222	Fluid Mechanics	3	0	0	3
ME 222L	Fluid Mechanics Lab	0	0	2	1
ECO 121	Principles of Economics	3	0	0	3
	ME Elective	3	0	0	3
	ME Elective	3	0	0	3
ISES 202	Industry Specific Employability Skills-IV	1	1	0	1
CSE 234	Industry Standard Coding Practice-Three	0	0	4	1
	TOTAL	**19**	**1**	**8**	**22**

Semester-V					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
ME 321	Fluid Machinery	3	0	0	3
ME 321L	Fluid Machinery Lab	0	0	2	1
ME 132	Numerical Methods	3	0	0	3
ME 132 L	Numerical Methods 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
ME ME 430 ME 410 ME 415 ME 401	**ME ELECTIVE** Mechatronics (Robotics Specialization) Thermal Power Engineering Refrigeration and Air Conditioning CAD-CAM (Additive Manufacturing Specialization)	3	0	0	3
	Open Elective	3/4	0	0	3/4
ISES 301	Industry Specific Employability Skills-V	1	1	0	0
ME 200	Internship (Optional)	0	0	6	3
	TOTAL	**16/17**	**1**	**10/16**	**20/24**

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	Advanced Manufacturing Technology	3	0	0	3
ME 322 L	Advanced 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
ME ME 427 ME 228	**ME ELECTIVE** Robotics (Robotics Specialization) Manufacturing Science (Additive Manufacturing Specialization)	3	0	0	3
	Open Elective	3/4	0	0	3/4
	Open Elective	3/4	0	0	3/4
ISES 302	Industry Specific Employability Skills-VI	1	1	0	0
	TOTAL	**19/21**	**1**	**6**	**21/23**

Semester-VII					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
ME 450	Multidisciplinary Design Project	0	0	4	2
ME ME 402 ME 412	**Me Elective** Multibody Dynamics (Robotics Specialization) Additive Manufacturing Process (Additive Manufacturing Specialization)	3	0	0	3
ME ME 411 ME 413	**ME ELECTIVE** Artificial Intelligence (Robotics Specialization) Design And Modelling Aspects of AM (Additive Manufacturing Specialization)	3	0	0	3
	Open Elective	3/4	0	0	3/4
	Open Elective	3/4	0	0	3/4
ME 451	Seminar	0	0	2	1
	TOTAL	**12/14**	**0**	**8**	**15/17**

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 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 101	Communicative English	HS	3	0	0	3

UNIT I
Course Introduction and Overview, Tenses, Principles of Sentence Structure& Paragraph Writing(*S+V+O*)

UNIT II
The Fundamentals of Speech (*Ethos, Pathos & Logos*) Verbal & Nonverbal Communication, Fundamentals of Personal, Informative, and Scientific Speech.

UNIT III
Listening Skills: Definition, Barriers, Steps to Overcome. Listening to Influence, Negotiate, Note taking & Making while Listening.

UNIT IV
Read to Skim, and Scan, Read to Comprehend (Predict, Answer Questions & Summarize). Read to Understand.

UNIT V
Write to Inform - I News, Emails. Write to Inform- II Notice, Agenda & Minutes. Write to Define (Definitions & Essays).

TEXTBOOKS/REFERENCES

1. Shoba, Lourdes. (2017). Communicative English: A Workbook. U.K: Cambridge University Press.
2. Steven, Susan, Diana. (2015). Communication: Principles for a Lifetime. U.S.A: Pearson 6th Ed.
3. Publication Manual of the American Psychological Association, (2010). 6th Ed.
4. Kosslyn, S.M. "Understanding Charts and Graphs", *Applied Cognitive Psychology*, vol. 3, pp. 185-226, 1989.

SEMESTER-I

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ISES 101	Industry Standard Employability Skills-I	HS	1	1	0	1

UNIT I: QUANTS

Speed calculations, Time and Distance, Problems on Trains, Boats and Streams, Races And Games, Escalator Problems, Time and Work, Chain Rule, Pipes and cistern, Simplification, surds and indices, Square roots and cube roots, Functions.

UNIT II: REASONING

Number Series, Alphabet series, Odd Man Out, Missing number, Wrong number, Analogies, Mathematical Operations, Calendars, Clocks, Cryptarithmetic, Identification of Cross-Variable Relation, Sudoku.

UNIT III: VERBAL

Basic sentence structure: Nouns, Pronouns, Adjectives, Parts of speech, Degree of comparison, Articles, conditionals and sentences (kinds). Verb tense, Sentence formation, Paragraph formation, change of voice, Change of speech, Synonyms, Antonyms.

UNIT IV: COMMUNICATION SKILLS

Self-Introduction, Presentations, Email Etiquette.

INSTRUCTIONAL OBJECTIVES

1. To develop interpersonal skills and be an effective goal-oriented team player.
2. To develop professionals with idealistic, practical and moral values.
3. To develop communication and problem-solving skills.
4. To re-engineer attitude and understand its influence on behavior.
5. To solve the problems requiring interpretation and comparison of complex numeric summaries.
6. To develop the ability to sole different problems.
7. To develop the skills of reasoning.
8. To develop the knowledge of solving different reasoning problems.
9. To develop the skills in basics of English.
10. To develop skills in English vocabulary.

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.
6. Arun Sharma – *How to prepare for Quantitative Aptitude*, Tata Mcgraw Hill.
7. Rs Agarwal,*A Modern Approach to Verbal and Non Verbal Reasoning,* S.Chand Publications.

8. Verbal Ability and Reading comprehension-Sharma and Upadhyay.
9. Charles Harrington Elstor, Verbal Advantage: Ten Easy Steps to a Powerful Vocabulary, Large Print, September 2000.
10. GRE Word List 3861 – GRE Words for High Verbal Score, 2016 Edition.
11. The Official Guide to the GRE-General Revised Test, 2nd Edition, Mc Graw Hill Publication.
12. English grammar and composition – S.C. Gupta.
13. R.S. Agarwal – Reasoning.
14. Reasoning for competitive exams – Agarwal.

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 103	Chemistry for Engineers	BS	2	0	0	2

UNIT I: CHEMICAL BONDING

Ionic, covalent, metallic bonds and hydrogen bonding, Theories of bonding: Hybridization: Types of hybridization, sp, 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-nuclear diatomic molecules such as H2, O2, N2.

UNIT II: PHASE RULE, THERMOCHEMISTRY, AND KINETICS

Definition of the terms used in phase rule with examples, Application of phase rule to one component system (eg Water), Application of phase rule to two component system (eg Pb-Sn), Standard terms in thermochemistry and their significance, Heat of combustion, formation and sublimation (with examples in fuels and propellants), Order and molecularity of reactions, zero order, first order rate equations, Problems associated with Zero & First order reactions.

UNIT III: CRYSTALLINE MATERIALS

Introduction to solid state materials, difference between crystalline and amorphous systems, Properties of crystalline materials, Crystal lattice, unit cells, types of crystal systems, types of unit cells (Bravais lattices), Miller indices, Bragg's law, Problems associated theoretical density of crystals and Bragg's equation, Introduction to Band theory, metals, insulators, and semiconductors with examples. Classification of semiconductors, imperfections in crystals, Frenkel and Schottky defects, doping and devices.

UNIT IV: MATERIALS CHEMISTRY

Introduction to Polymers, Classification of polymers, Thermoplastic and Thermosetting polymers with examples, Tacticity of polymers, Properties of polymers: Glass transition temperature (Tg), Properties of polymers: Molecular weight, weight average, Problems associated with Molecular weight, weight average, Degradation of polymers and biodegradable polymers, Common Polymers: Elastomer, Conducting polymer, Hardness in water, demineralization of water, Water treatment: Zeolite process.

UNIT V: ELECTROCHEMICAL DEVICES

Introduction to Electrochemical cells and classification of Electrochemical cells, Primary and secondary cells with examples, Lead-acid battery and Li+ batteries, Li+ batteries and Fuel cells.

TEXTBOOKS/REFERENCES

1. A. Bahl, B.S. Bahl, G.D. Tuli, *Essentials of Physical Chemistry*, (**2016**), S Chand Publishing Company.
2. B. R. Puri, L. R. Sharma & M. S. Pathania, *Principles of Physical Chemistry*, 46th Edition (**2013**), Vishal Publication Company.
3. D. F. Shriver, P. W. Atkins and C. H. Langford, *Inorganic Chemistry*, 3rd Ed., Oxford University Press, London, **2001.**
4. V. R. Gowariker, N. V. Viswanathan, J. Sreedhar, *Polymer Science*, New Age International, **1986.** ISBN: 0-85226-307-4.
5. Atkins, P.W.; de Paula, J. (**2006**). *Physical chemistry* (8th ed.). Oxford University Press. ISBN 0-19-870072-5.

SEMESTER-I

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
CHE 103 L	Chemistry for Engineers 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.

REFERENCES

1. G.H Jeffery, J Bassett, J Mendham, R.C Denny, *Vogel's Text Book of Quantitative Chemical Analysis*, Longmann Scientific and Technical, John Wiley, New York.
2. J.B Yadav, *Advanced Practical Physical Chemistry*, Goel Publishing House, **2001**.
3. A.I Vogel, A.R Tatchell, B.S Furnis, A.J Hannaford, P.W.G Smith, *Vogel's Text Book of Practical Organic Chemistry*, Longman and Scientific Technical, New York, **1989**.
4. J.V. McCullagh, K.A. Daggett, *J. Chem. Ed*. **2007**, *84*, 1799.

SEMESTER-I

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
PHY 101	Engineering Physics	BS	3	0	0	3

UNIT I: CLASSICAL MECHANICS

Vector calculus and Kinematics, Dynamics: Contact forces, Static friction, kinetic friction and worked examples, Free body force diagram; Applications of Newton's law. Worked examples (i.e., pulley, inclined planes). Momentum and Impulse, Conservation of linear momentum. Calculation of Centre of mass for complex systems, Work and Kinetic Energy Theorem, Motion at inclined plane, Conservation of mechanical energy: Worked out problems, Rotational motion: MoI, Torque, Angular momentum, and Conservation of Angular Momentum. Newtons Laws of Universal Gravitation. Kepler's Law & Planetary motion.

UNIT II: WAVES, OSCILLATIONS AND OPTICS

Simple harmonic motion: position, velocity, and acceleration, Circular Analogy of SHM and Simple Pendulum, Compound Pendulum and Torsional Pendulum. Damped harmonic oscillations. Forced harmonic oscillations, Quality factor, Bandwidth & Resonance. Longitudinal & Transverse Wave, Traveling and Standing Wave, Concept of Electromagnetic waves – Geometrical & Physical Optics, Conditions of Interference: Young's Double Slit Experiment, Introduction to Diffraction Patterns: Fresnel and Fraunhofer Diffraction.

UNIT III: THERMODYNAMICS

Zeroth law of thermodynamics and concept of temperature. Types of Thermometers and temperature scales: inter- relation among temperature scales, Introduction of Heat and Internal energy, Calorimetry and Concept of Specific Heat, Concept of Work and inter-relation among Heat, Work, and IE: First Law of Thermodynamics, Application of 1st law of thermodynamics & introduction of thermodynamic processes – adiabatic, isothermal etc. Second law of thermodynamics: Heat Pump and Heat Engines. Concept of Entropy: Reversible and Irreversible Process. Thermodynamic Phases and phase transitions: Concept of Latent Heat.

UNIT IV: ELECTRO-MAGNETISM - I

Describe Maxwell Equations as the foundation of electro- magnetism. Derive differential forms starting from Integral forms. Discuss Physical Significance, focus on Maxwell's Equation I: Discuss lines of force and Electrostatic flux, Introduce Gauss's law (differential and integral form). Application of Gauss Law: ES field due to infinite wire and sheet. Electrostatic field due to conducting and insulating sphere & cylinder. Discuss Coulomb's Law as an alternative & direct approach to calculate electrostatic field – superposition principle, electrostatic field due to discrete charges. Concept of Electrostatic Potential and Potential Energy. Inter-relation with electrostatic field, Capacitor and Capacitance:

Capacitance of a parallel plate capacitor. Electric dipole and dipole moment, Electric potential, and electrostatic field due to a physical dipole. Definition and inter-relation of Polarization P, Electric displacement D, Electric susceptibility, and relative permittivity.

UNIT V: ELECTRO-MAGNETISM - II

Focus on Maxwell's Equation II: Discuss absence of Magnetic monopoles! Introduce Magnetic Vector potential using vector calculus. **Focus on Maxwell's Equation IV**: Discuss Ampere's circuital law. Calculate Magnetic field due to Infinite wire and Solenoid using Ampere's Law. Introduce Biot-Savart Law as an alternative approach to calculate magnetic field. Calculate Magnetic field due to finite current element using Biot Savart Law. Derive force between parallel current - define 1 Ampere using magnetic force. Calculate magnetic field due to circular loop using Biot Savart Law. **Focus on Maxwell's Equation III:** Lenz's Law and Faraday's law: Induced EMF and Current. Definition and inter-relation between Magnetic field, magnetic moment, magnetization, magnetic induction, magnetic susceptibility, and permeability. Discuss classification of Magnetic materials, Ferromagnetic materials, Hysteresis loss, B-H curve.

TEXTBOOKS

1. University Physics with Modern Physics with Mastering Physics - D Young, Roger A Freedman and Lewis Ford, XII Edition (2018), Publisher – PEARSON.
2. Physics for Scientist and Engineers - Raymond A. Serway, John W. Jewett, XIX Edition (2017),Publisher - Cengage India Private Limited.
3. Concept of Modern Physics - Arthur Beiser, Shobhit Mahajan, S Rai, 2017 Edition, Publisher - TataMcGraw Hill.

REFERENCES

1. Introduction to Electrodynamics – David J. Griffiths. 4th Edition (2012), Publisher - PHI EasternEconomy Editions.
2. Electricity and Magnetism - A S Mahajan and A A Rangwala, Revised of 1 Edition (2001), Publisher- McGraw-Hill.
3. Advanced Engineering Mathematics - Erwin Kreyszig, X Edition (2016), Publisher – Wiley.

SEMESTER-I

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
PHY 101 L	Engineering Physics Lab	BS	0	0	2	1

LIST OF EXPERIMENTS

1. a. Revisions of Vernier caliper and Screw Gauge measurement methods.
   b. Plotting experimental data in graphs and error analysis.
2. To determine the moment of inertia of a flywheel.
3. a. Measurement of time period for a given compound pendulum with different lengths.
   b. To determine radius of gyration of a given pendulum.
4. Verification of Stefan`s Law.
5. Measurement of specific heat capacity of any given material.
6. Verify of Hooke's law and to determine spring contact for given spring combinations.
7. To determine the rigidity modulus of steel wire by torsional oscillations.
8. To calculate Young's modulus of a given material by deflection method.
9. a. To measure the capacitance as a function of area and distance between the plates.
   b. To determine the dielectric constant of different dielectric materials.
10. a. Measurement of the induced voltage impulse as a function of the velocity of the magnet.
    b. Calculation of the magnetic flux induced by a falling magnet as a function of the velocity of the magnet.
11. a. To study the magnetic field along the axis of a current carrying circular loop.
    b. To study the dependency of magnetic field on thediameter of coil.
12. a. To investigate the spatial distribution of magnetic field between coils and determine the spacing for uniform magnetic field.
    b. To demonstrate the superposition of the magnetic fields of the two individual coils.
13. Study of B-H-Curve To study permeability curve of a given material.

SEMESTER-I

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
CSE 105	Introduction to Programming using C	ES	3	0	0	3

UNIT I: INTRODUCTION

Computer systems, hardware and software. Problem solving: Algorithm / Pseudo code, flowchart, program development steps, Computer languages: Machine, symbolic and high-level languages, Creating and Running Programs: Writing, editing (any editor), compiling (gcc), linking and executing in Linux environment, Structure of a C program, identifiers, Basic data types and sizes. Constants, Variables, Arithmetic, relational and logical operators, increment and decrement operators, Conditional operator, assignment operator, expressions, Type conversions, Conditional Expressions, Precedence and order of evaluation, Sample Programs.

UNIT II: SELECTION & DECISION MAKING

If-else, null else, nested if, examples, multi-way selection: switch, else-if, examples. **ITERATION:** Loops - while, do-while and for, break, continue. Initialization and updating, event and counter controlled loops and examples. **ARRAYS:** Concepts, declaration, definition, storing and accessing elements, One dimensional, two dimensional and multidimensional arrays, Array operations and examples, Character arrays, String manipulations.

UNIT III: MODULAR PROGRAMMING

Functions – Basics, Parameter passing, Storage classes extern, auto, register, static, scope rules, User defined functions, standard library functions, Passing 1-D arrays, 2-D arrays to functions, Recursive functions - Recursive solutions for Fibonacci series, Towers of Hanoi, C Pre-processor, Header files

UNIT IV: POINTERS

Concepts, initialization of pointer variables, Pointers as function arguments, passing by address, Dangling memory, address arithmetic, Character pointers and functions, Pointers to pointers, Pointers and multi-dimensional arrays, Dynamic memory management functions, Command line arguments,

UNTI V:

Structures - Declaration, definition and initialization of structures, accessing structures, Nested structures, arrays of structures, Structures and functions, pointers to structures, self-referential structures, Unions, Typedef, bit-fields, Program applications, Bit-wise operators: logical, shift, rotation, masks, **FILE HANDLING**: Concept of a file, text files and binary files, formatted I/O, I/O operations and example programs.

TEXTBOOKS/REFERENCES

1. The C programming Language by Dennis Richie and Brian Kernighan.
2. Problem Solving and Program Design in C, Hanly, Koffman, 7th ed, PEARSON.
3. Programming in C, Second Edition Pradip Dey and Manas Ghosh, OXFORD Higher Education.
4. Programming in C, A practical approach Ajay Mittal PEARSON.
5. Programming in C, B. L. Juneja, Anith Seth, Cengage Learning.

SEMESTER-I

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
CSE 105 L	Introduction to Programming using C Lab	ES	0	0	2	1

LIST OF EXPERIMENTS

1. Basic C programs
    a. Calculation of the area of triangle.
    b. Find the largest of three numbers using ternary operator.
    c. Swap two numbers without using a temporary variable.
    d. Find the roots of a quadratic equation.
    e. Takes two integer operands and one operator form the user, performs the operation and then prints the result.

2. a. Find the sum of individual digits of a positive integer and find the reverse of the given number
    b. Generate the first n terms of Fibonacci sequence.
    c. Generate all the prime numbers between 1 and n, where n is a value supplied by the user.
    d. Print the multiplication table of a given number n up to a given value, where n is entered by the user.
    e. Decimal number to binary conversion.
    f. Check whether the given number is Armstrong number or not.

3. a. Interchange the largest and smallest numbers in the array.
    b. Sorting array elements.
    c. Addition and multiplication of 2 matrices.

4. a. Function to find both the largest and smallest number of an array of integers.
    b. Liner search.
    c. Replace a character of string either from beginning or ending or at a specified location.

5. a. Reading a complex number
    b. Writing a complex number.
    c. Addition of two complex numbers.
    d. Multiplication of two complex numbers.

6. a. Concatenate two strings.
    b. Append a string to another string.
    c. Compare two strings.
    d. Length of a string.
    e. Find whether a given string is palindrome or not.

7. a. Illustrate call by value and call by reference.
    b. Reverse a string using pointers.
    c. Compare two arrays using pointers.
8. a. To find the factorial of a given integer.

b. To find the GCD (greatest common divisor) of two given integers.
c. Towers of Hanoi.

9. File Operations (File copy, Word, line and character count in a file).
10. Command line arguments (Merge two files using command line arguments).

SEMESTER-I

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-I

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-II

SEMESTER-II

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ENG 115	Engineering Mechanics	ES	3	1	0	4

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-II

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ISES 102	Industry Specific Employability Skills-II	HS	1	1	0	1

UNIT I: QUANTS

Average, Allegation or Mixture, Ratio and Proportion, Percentage, Profit and Loss, True discount, Partnership, Height and distance.

UNIT II: REASONING

Logical deductions, Syllogism, Image based problems, Coding and Decoding, Cubes and Cuboids, Inequalities, Input output tracing.

UNIT III: VERBAL

Ordering of sentences, Comprehension, Verbal Analogies, Essential parts of a sentence, One-word substitutes, Cause and effect, Syllogism.

UNIT IV: COMMUNICATION SKILLS

Sentence formation (Practical), Word group categorization, Casual conversation (Practical), Formal conversation (interpersonal).

INSTRUCTIONAL OBJECTIVES

1. To develop interpersonal skills and be an effective goal-oriented team player.
2. To develop professionals with idealistic, practical and moral values.
3. To develop communication and problem-solving skills.
4. To re-engineer attitude and understand its influence on behavior.
5. To solve the problems requiring interpretation and comparison of complex numeric summaries.
6. To develop the ability to sole different problems.
7. To develop the skills of reasoning.
8. To develop the knowledge of solving different reasoning problems.
9. To develop the skills in basics of English.
10. To develop skills in English vocabulary.

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.
6. Arun Sharma – *How to prepare for Quantitative Aptitude,* Tata Mcgraw Hill.
7. Rs Agarwal,*A Modern Approach to Verbal and Non Verbal Reasoning,* S.Chand Publications.
8. Verbal Ability and Reading comprehension-Sharma and Upadhyay.
9. Charles Harrington Elstor, Verbal Advantage: Ten Easy Steps to a Powerful

Vocabulary, Large Print, September 2000.
10. GRE Word List 3861 – GRE Words for High Verbal Score, 2016 Edition.
11. The Official Guide to the GRE-General Revised Test, 2nd Edition, Mc Graw Hill Publication.
12. English grammar and composition – S.C. Gupta.
13. R.S. Agarwal – Reasoning.
14. Reasoning for competitive exams – Agarwal.

SEMESTER-II

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
CSE 107	Data Structures	ES	3	0	0	3

UNIT I: INTRODUCTION TO C PROGRAMMING

Identifiers, basic data types, constants, variables, keywords, operators: arithmetic, relational and logical, increment and decrement operators, conditional operator, assignment operators, Instruction: type declaration, Input-output, conditional, loop control, Arrays, Functions, pointers, dynamic memory management functions Derived types- structures- declaration, definition and initialization of structures, accessing member of structure, arrays of structures, structures and functions, pointers to structures, self-referential structures.

UNIT II: INTRODUCTION TO DATA STRUCTURES

Stacks and Queues: representation and application, implementation of stack and queue operations using C. Linked lists: Single linked lists, implementation of link list and various operation using C, Double linked list, circular list.

UNIT III: TREES

Tree terminology, Binary tree, Binary search tree, infix to post fix conversion, postfix expression evaluation. General tree, AVL Tree, Complete Binary Tree representation.

UNIT IV: GRAPHS

Graph terminology, Representation of graphs, Path matrix, BFS (breadth first search), DFS (depth first search), topological sorting, shortest path algorithms. Implementation of shortest path algorithm using C.

UNIT V: SORTING AND SEARCHING TECHNIQUES

Bubble sort and its algorithm analysis, Selection sort and its algorithm analysis, Insertion sort and its algorithm analysis, Quick sort and its algorithm analysis, Merge sort and its algorithm analysis, Heap sort and its algorithm analysis, Radix sort and its algorithm analysis, Linear and binary search methods and its algorithm analysis, Hashing techniques and hash functions.

TEXTBOOKS

1. Data structure using C, Aaron M. Tenenbaum, Y Langsam and Mosche J. Augenstein, Pearson publication.
2. Data structures and Algorithm Analysis in C , Mark Allen Weiss, Pearson publications, Second Edition Programming in C. P. Dey and M Ghosh , Second Edition, Oxford University Press.
3. Programming with C, Byron Gottfried, McGraw hill Education, Fourteenth reprint,2016.

REFERENCES

1. Fundamentals of data structure in C - Horowitz, Sahani & Anderson Freed, Computer Science Press.
2. Fundamental of Data Structures - (Schaums Series) Tata-McGraw-Hill.
3. G. A. V. Pai: “Data Structures & Algorithms; Concepts, Techniques &Algorithms” Tata McGraw Hill.

SEMESTER-II

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
CSE 107 L	Data Structures Lab	ES	0	0	2	1

LIST OF EXPERIMENTS

1. Write a C program to find the factorial of the given number (Example: 5! = 5*4*3*2*1 =120).
2. Write a C 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.
3. Write a C program for implementation of Stack operations using arrays.
4. Write a C program for implementation of Queue operations using arrays.
5. Write a C program for Linked list implementations and problems related to linked list such as inverting list, concatenation, etc.
6. Write a C program for Linked list-based implementation of stack and queue operations.
7. Write a C program for Evaluation of expressions.
8. Write a C program for implementation of Binary tree traversals techniques.
9. Write a C program for implementation of Graph traversals techniques (BFS and DFS).
10. Write a C program for Linear search and Binary search algorithms. What is the best case and worst-case time complexity of those searching algorithms?
11. Write a C program for bubble sort algorithm. What is the best case and worst-case time complexity of Bubble sort algorithm?
12. Write a C program for Selection sort algorithm. What is the worst case or average case time complexity of selection sort algorithm?
13. Write a C program for Insertion sort algorithm. What is the worst case or average case time complexity of Insertion sort algorithm?
14. Write a C program for Quick sort algorithm. What is the worst case or average case time complexity of Quick sort algorithm?
15. Write a C program for Merge sort algorithm. What is the worst case or average case time complexity of Merge sort algorithm?

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	3	0	0	3

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
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-II

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-II

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
CSE 131	Industry Standard Coding Practice-One	ES	0	0	4	1

UNIT I

Problem solving approaches using Expression evaluations, coding on expressions, control statements, if-else statements, switch case statements, loops, Examples, Practice Problems, Problem Solving through code complexity analysis, Linear/Logarithmic/Super linear/ Polynomial/Exponential Algorithms, Factorial Algorithms, Problem Solving Examples, Problem solving on Linear List data, rotations of data, Problem solving on Order statistic problems, Problem Solving, Examples, Practice problems.

UNIT II

Introduction to 2D Array, 2D Array Subscript, problem solving on Matrix data, representation of matrix data in Row Major Order & Column Major Order, Coding Examples, Practice Problems, Problem solving implementing Memory manipulation techniques using pointers. Memory Arithmetic, Problem solving implementing pointer to an array, Memory Layout, overcoming the segmentation faults, Runtime memory allocation, Coding comparisons of Linear list data structure and Pointer, Examples, Practice problems.

UNIT III

Problem solving on string data, Problem solving on String manipulations, coding problems using string handling functions, Problem solving on Multi-String Problems, Problem Solving for long strings, Examples, Practice problems.

UNIT IV

Problem solving using modular programming, Inter module communications, Memory references as parameters, Coding on various scopes of data in the code, Examples, Practice problems. Problem solving approaches implementing recursions, Evaluation of Recursive algorithms, Significance of mathematical Recurrence Relations, Evaluation of recurrence relations, Time Analysis, Examples, Practice problems.

UNIT V

Problem solving through testing, implementing various testing approaches: Test strategy, Test development, Test execution, Bug fixing, Examples, Practice problems Version control systems, Git repositories and working trees, adding new version of the files to a Git repository, Examples.

SEMESTER-III

SEMESTER-III

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. Lame'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 KoyakushaLimited, 2000.

SEMESTER-III

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 springwsws.
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-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 f actor 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 f our 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,3rdEdition, 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	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 harening, 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 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 172	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, Kutzback's and Gruebler'scriterion, 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(□E), coefficient of fluctuation of energy, Tutorial on calculation of □E 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, processional 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, 4thEdition, 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 172 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 vibratio1n 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
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.

UNITII: 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.

UNITIII: 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 andKah 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-III

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ISES 201	Industry Specific Employability Skills-III	HS	1	1	0	1

UNIT I: QUANTS

Numbers, Problems on numbers (Divisibility, power cycle, reminder cycle), Problems on ages, Problems on HCF and LCM, Simple interest, compound interest, Data interpretation (Charts, tables, pie charts, lines).

UNIT II: REASONING

Direction sense, Blood relations, Logical order, Analytical reasoning, Passage and inference, Selection decision table, Attention to details, Seating arrangements.

UNIT III: VERBAL

Spellings, selecting words, spotting errors, Ordering of words, Sentence correction, Sentence improvement, Synonyms, Antonyms.

UNIT IV: COMMUNICATION SKILLS

Topic wise discussion, Group discussion, Debate, Presentations.

INSTRUCTIONAL OBJECTIVES

1. To develop interpersonal skills and be an effective goal-oriented team player.
2. To develop professionals with idealistic, practical and moral values.
3. To develop communication and problem-solving skills.
4. To re-engineer attitude and understand its influence on behavior.
5. To solve the problems requiring interpretation and comparison of complex numeric summaries.
6. To develop the ability to sole different problems.
7. To develop the skills of reasoning.
8. To develop the knowledge of solving different reasoning problems.
9. To develop the skills in basics of English.
10. To develop skills in English vocabulary.

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.
6. Arun Sharma – *How to prepare for Quantitative Aptitude*, Tata Mcgraw Hill.
7. Rs Agarwal,*A Modern Approach to Verbal and Non Verbal Reasoning,* S.Chand Publications.
8. Verbal Ability and Reading comprehension-Sharma and Upadhyay.

9. Charles Harrington Elstor, Verbal Advantage: Ten Easy Steps to a Powerful Vocabulary, Large Print, September 2000.
10. GRE Word List 3861 – GRE Words for High Verbal Score, 2016 Edition.
11. The Official Guide to the GRE-General Revised Test, 2nd Edition, Mc Graw Hill Publication.
12. English grammar and composition – S.C. Gupta.
13. R.S. Agarwal – Reasoning.
14. Reasoning for competitive exams – Agarwal.

SEMESTER-III

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
CSE 232	Industry Standard Coding Practice-Two	ES	0	0	4	1

UNIT I

Requirement of User-Defined data, Problem solving implementing structures, Nested Structures, Unions, Enumeration, Usage of Preprocess statements in coding problems, Problem Solving on primes, sieve, series, factorization, divisors, Catalan numbers, modular arithmetic, Set theory, Examples, Practice Problems.

UNIT II

Structure member reference, member pointer reference, Coding to form links, Example codes, Problem solving on operational and traversal logics on linked lists, Problem solving to compare linked lists, detection of a cycle/merge point, Merging sorted linked lists, coding problems on circular linked lists/Double linked lists, examples, Practice problems.

UNIT III

Search operations implementing linear/ binary search, Bubble Sort, Selection Sort, Insertion Sort, Evaluation of sorting Algorithms. Problem solving using Quick Sort, Merge Sort, O(n log n) algorithms, Examples, Practice problems.

UNIT IV

Industry Standards of leveraging DBMS concepts: SQL Queries, Entity Relationship Models, Query Optimization, Transactions & Concurrency, Normalization, case studies, Question, and answers.

UNIT V

Problem solving Methods and techniques: Encoding methods, Handling faults within the code, Examples, Practice Questions Push a branch to GitHub, creating a pull request, merging a pull request, Get back the changes from Github, Examples.

SEMESTER-IV

SEMESTER-IV

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, Guests theory, St.Venants 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 work 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-IV

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-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.
1. 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, 20**th** 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-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-IV

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ISES 202	Industry Specific Employability Skills-IV	HS	1	1	0	1

UNIT I: QUANTS
Logarithms, Permutations and combinations, Probability, Progressions, Geometry and Mensuration, Data sufficiency.

UNIT II: REASONING
Statement and conclusions, most logical choice, inferred meaning, Data arrangements, Venn diagram, Flow charts and logical gates, Puzzles, Case lets, Ordering, Ranking, Grouping.

UNIT III: VERBAL
Classification of sentences, Logical sequence of words, Verbal reasoning, Analyzing arguments, Verification of truth, Matching definitions, Theme detection, Idioms and phrases, Antonyms, Synonyms.

UNIT IV: COMMUNCIATION SKILLS
Extempore, JAM, Active listening, Email Etiquette, Self-image and self-presentation, FAQ's, Resume.

INSTRUCTIONAL OBJECTIVES
1. To develop interpersonal skills and be an effective goal-oriented team player.
2. To develop professionals with idealistic, practical and moral values.
3. To develop communication and problem-solving skills.
4. To re-engineer attitude and understand its influence on behavior.
5. To solve the problems requiring interpretation and comparison of complex numeric summaries.
6. To develop the ability to sole different problems.
7. To develop the skills of reasoning.
8. To develop the knowledge of solving different reasoning problems.
9. To develop the skills in basics of English.
10. To develop skills in English vocabulary.

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.
6. Arun Sharma – *How to prepare for Quantitative Aptitude,* Tata Mcgraw Hill.
7. Rs Agarwal,*A Modern Approach to Verbal and Non Verbal Reasoning,* S.Chand Publications.
8. Verbal Ability and Reading comprehension-Sharma and Upadhyay.

9. Charles Harrington Elstor, Verbal Advantage: Ten Easy Steps to a Powerful Vocabulary, Large Print, September 2000.
10. GRE Word List 3861 – GRE Words for High Verbal Score, 2016 Edition.
11. The Official Guide to the GRE-General Revised Test, 2nd Edition, Mc Graw Hill Publication.
12. English grammar and composition – S.C. Gupta.
13. R.S. Agarwal – Reasoning.
14. Reasoning for competitive exams – Agarwal.

SEMESTER-IV

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
CSE 234	Industry Standard Coding Practice-Three	ES	0	0	4	1

UNIT I

Introduction to Python, Basic syntax, variables and data types, operators, Input and Output, conditional statements and loops, Problem solving on accessing strings, string operations, string slices, functions and methods, Introduction to lists, accessing list, working on Lists, Matrix data, Practice Problems.

UNIT II

Introduction to tuple, accessing tuples, tuple operations, introduction to dictionaries, accessing values in dictionaries, properties and functions, importing modules, math module, random module, packages and composition, Problem solving through user defined functions and methods, implementing exception handling, except clause, try? finally clause, user defined exceptions, Advanced data types, examples, Practice problems.

UNIT III

Problem Solving through Class and Instance Attributes - Properties vs. getters and setters - Implementing a Property Decorator, Descriptors, Inheritance, Multiple Inheritance, Multiple Inheritance Example, Magic Methods and Operator Overloading, Callable and Callable Instances, Inheritance, Python Class for Polynomial Functions, Problem solving Methods and techniques: Defining the and analyzing the problem, High level strategy for a solution, Arriving at an Algorithm, Encoding, Version control systems, Adding new files to the repository, Staging the environment, Commit Examples, Examples, Practice problems.

UNIT IV

Industry Standards of leveraging DBMS concepts: Implementing stored procedures, implementing functions, implementing triggers, implementing transactions, case studies, Question and answers.

UNIT V

Industry Standards of leveraging DBMS concepts: Understanding Managed code, creating managed database objects, HTTP Endpoints and Implementation, case studies, Question and answers.

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 impacton 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 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-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 langaragian 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)	A short presentation to be delivered on: • A brief, descriptive project title (2-4 words). This iscritical! • 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	Viability / feasibility of the project Extent of preliminary work done.	**0**
Review II	• Mission Statement /Techniques • Concept Sketches, Design	Panel of reviewers	Originality, Multi-disciplinary	**20**
	Specifications / Modules & Techniques along with System architecture		component, clarity of idea	

	• Coding		and presentation, team work, handling Q&A.	
Review III	• 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
ME 430	Mechatronics	TE	3	0	0	3

UNIT I

Definition of mechatronics, History of mechatronics, evolution of mechatronics, applications of mechatronics, Objectives of mechatronics, advantages and disadvantages of mechatronics, philosophy of a mechatronic system, practical examples of various mechatronic systems, mechatronics design process, mechatronics key elements, measurement systems, design issues in mechatronics.

UNIT II

Sensors and transducers, Performance terminology, Displacement, position and proximity measurement devices, velocity and motion measurement devices, Force measurement, fluid pressure measurement, liquid flow measurement, liquid level measurement, temperature measurement, light sensors, selection of sensors.

UNIT III

Actuators: Hydraulic and pneumatic actuation systems, directional control valves, pressure control valves, mechanical actuation systems, kinematic chains, cams, gears, rachet and pawl, belt and chain drives, bearings, electrical actuation systems, mechanical switches, solid state switches, solenoid valves, DC motors, AC motors, servo motors, motor selection.

UNIT IV

Microprocessors, Micro controllers, applications of microprocessors and micro controllers, Programmable Logic controllers, timers, Ladder programming, timers, counters, latching and internal relays, shift registers, data handling, Analog to digital and digital to analog conversion.

UNIT V

Data acquisition fundamentals, sampling and aliasing, elements of a data acquisition and control systems, devices for data acquisition, data acquisition process. Case studies of designing a mechatronics system.

TEXTBOOKS/REFERENCES

1. William Bolton, "*Mechatronics*", Pearson Publishers, 7th edition.
2. Jouaneh M, "*Fundamentals of Mechatronics*", CENGAGE Learning publishers.
3. Godfrey Onwubolu, "*Mechatronics Principles and Applications*", Elsevier publishers.
4. Devdas Shetty and Richard A. Kolk, "*Mechatronics system design*", CENGAGE Learning publishers.
5. David G. Alciatore, "*Introduction to Mechatronics*", 5th edition, McGraw-Hill Education.

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 it 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) NewYork: 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
ISES 301	Industry Specific Employability Skills-V	HS	1	1	0	0

UNIT I: QUANTS

Advanced Algebra, Advanced P & C and Probability, Advanced Time, Speed and Distance, Advanced Time and Work, Advanced Geometry and Mensuration.

UNIT II: COMMUNCIATION SKILLS

Group discussion. Tell about yourself, Extempore, Mock interview, Video interview & Presentations.

UNIT III: REASONING

Puzzle and Reasoning.

INSTRUCTIONAL OBJECTIVES

1. To develop interpersonal skills and be an effective goal-oriented team player.
2. To develop professionals with idealistic, practical and moral values.
3. To develop communication and problem-solving skills.
4. To re-engineer attitude and understand its influence on behavior.
5. To solve the problems requiring interpretation and comparison of complex numeric summaries.
6. To develop the ability to sole different problems.
7. To develop the skills of reasoning.
8. To develop the knowledge of solving different reasoning problems.
9. To develop the skills in basics of English.
10. To develop skills in English vocabulary.

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.
6. Arun Sharma – *How to prepare for Quantitative Aptitude*, Tata Mcgraw Hill.
7. Rs Agarwal,*A Modern Approach to Verbal and Non Verbal Reasoning,* S.Chand Publications.
8. Verbal Ability and Reading comprehension-Sharma and Upadhyay.
9. Charles Harrington Elstor, Verbal Advantage: Ten Easy Steps to a Powerful Vocabulary, Large Print, September 2000.
10. GRE Word List 3861 – GRE Words for High Verbal Score, 2016 Edition.
11. The Official Guide to the GRE-General Revised Test, 2nd Edition, Mc Graw Hill Publication.
12. English grammar and composition – S.C. Gupta.
13. R.S. Agarwal – Reasoning.
14. Reasoning for competitive exams – Agarwal.

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, Reynolds 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.

UNITV: 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 counter flow, 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. Incorporeal, 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	Advanced 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.PaulDeGarmo, 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. SeropeKalpakjian ,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	Advanced 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.
    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: COORDINATEANDMACHINETOOLMETROLOGY

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 - X bar andR 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 (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
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. Klafter 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), 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.

SEMESTER-VI

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ISES 302	Industry Specific Employability Skills-VI	HS	1	1	0	0

UNIT I: QUANTS
Advanced LR & DJ

UNIT II: COMMUNCIATION SKILLS
Group discussion, Tell about yourself, Extempore, Mock interview, Video interview & Presentations

UNIT III: REASONING
Puzzle and Reasoning.

INSTRUCTIONAL OBJECTIVES

1. To develop interpersonal skills and be an effective goal-oriented team player.
2. To develop professionals with idealistic, practical and moral values.
3. To develop communication and problem-solving skills.
4. To re-engineer attitude and understand its influence on behavior.
5. To solve the problems requiring interpretation and comparison of complex numeric summaries.
6. To develop the ability to sole different problems.
7. To develop the skills of reasoning.
8. To develop the knowledge of solving different reasoning problems.
9. To develop the skills in basics of English.
10. To develop skills in English vocabulary.

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.
6. Arun Sharma – *How to prepare for Quantitative Aptitude,* Tata Mcgraw Hill.
7. Rs Agarwal,*A Modern Approach to Verbal and Non Verbal Reasoning,* S.Chand Publications.
8. Verbal Ability and Reading comprehension-Sharma and Upadhyay.
9. Charles Harrington Elstor, Verbal Advantage: Ten Easy Steps to a Powerful Vocabulary, Large Print, September 2000.
10. GRE Word List 3861 – GRE Words for High Verbal Score, 2016 Edition.
11. The Official Guide to the GRE-General Revised Test, 2nd Edition, Mc Graw Hill Publication.
12. English grammar and composition – S.C. Gupta.
13. R.S. Agarwal – Reasoning.
14. Reasoning for competitive exams – Agarwal.

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

INTROUCTION: 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 Analyis 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, 3D Printing, 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, Auto mobive, 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, rasterisation, 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, NewJersey, 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 WesleyLongman Inc., 1998.
7. Patterson, "*Introduction to Artificial Intelligence and Expert systems"*, Prentice Hall of India, NewDelhi, 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 / Organisation 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 maximum100.
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.

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 VI: 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

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 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

4. Yunus A. Çengel, Afshin J. Ghajar, “Heat and mass transfer: fundamentals and applications”, McGraw-Hill Education, 2015
5. Ho Sung Lee, “Thermal Design: Heat Sinks, Thermo-electrics, Heat Pipes, Compact Heat Exchangers, and Solar Cells”, John Wiley and Sons,2010
6. Adrian Bejan, Allan D. Kraus, “Heat Tranfer Handbook”, Wiley-Interscience, 2003
7. Ralph Remsburg, “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, Mircobial, 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. Hand book, 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 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
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 (_nite di_erences),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

3. 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.
4. K. Hwang, Advanced Computer Architecture: Parallelism, Scalability, Programmability, McGraw-Hill, 1993.

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 COMBUSTIONENGINES

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.

UNITV: PSYCHROMETRY ANDAIRCONDITIONING

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,"*MechanicalVibrations*",5thEdition,PearsonEducationInc.Delhi2009.
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, Stagnationstate 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 AREADUCTS

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 andAerospace 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 AgeInternational (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 ANDBRAKES

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 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, NewDelhi, 2006.

COURSE CODE	COURSE NAME	COURSE CATEGORY	CREDITS			
			L	T	P	C
ME	Major Project	TE	0	0	22	11

DESCRIPTION OF TOPIC

1. The Major project is a major component of our engineering curriculum: it is the culmination of the program of study enabling the students to showcase the knowledge and the skills they have acquired during the previous four years, design a product/service of significance, and solve an open-ended problem in engineering.
2. Each student must register to the project course related to his or her program.
3. Major Project course consists of one semester and would be allowed to register only during the final year of study.
4. The Major Project may be initiated during the pre-final semester but will be assessed and credits transferred only during the last semester of study, upon completion of all other degree requirements. Generally, the undergraduate major project is a team base done.
5. Each team in the major project course will consist of maximum of 5students.
6. Each project will be assigned a faculty, who will act as the supervisor.
7. The project shall be driven by realistic constraints like that related to economic, environmental, social, political, ethical, health & safety, manufacturability and sustainability.
8. Each group must document and implement a management structure. Group leadership roles must be clearly identified including who has responsibility for monitoring project deliverables and group coordination.
9. A group project may be interdisciplinary, with students enrolled in different engineering degrees, or in Engineering plus other faculties such as Management, Medical and Health Sciences, Science and Humanities.
10. Each student team is expected to maintain a logbook that would normally be used to serve as a record of the way in which the project progressed during the session.
11. Salient points discussed at meetings with the supervisor (i.e., suggestions for further meetings, changes to experimental procedures) should be recorded by the student in order to provide a basis for subsequent work.
12. The logbook may be formally assessed.
13. The contribution of each individual team member will be clearly identified, and the weightage of this component will be explicitly considered while assessing the work done.
14. A project report is to be submitted on the topic which will be evaluated during the final review.
15. Assessment components will be as spelt out in the regulations.
16. The department will announce a marking scheme for awarding marks for the different sections of the report.
17. The project report must possess substantial technical, depth and require the students to exercise analytical, evaluation and design skills at the appropriate level.

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 cactuators. Introduction to fluidic devices, working of Bi-stable, mono-stable devices. Fluidic logic application circuits. Pneumatic Sensors 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 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 in depreciation 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 TIMESAND 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, coolantand 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 inInternal 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 223	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

1. Tiwari.G.N, Ghosal.M.K, "*Fundamentals of renewable energy sources"*,1st Edition, UK, Alpha ScienceInternational 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
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 ERGONIMICS, 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, Objectives 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- bénard 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: TRANSPORTATIONMODELSAND REPLACEMENTMODEL

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'sRule, 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 (2xn) and (mx2) games, Solution of (mxn) 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: DISCRITIZATION 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: SOLUTUION 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, Metrices 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 Fl*ow", 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. Ghoshdasdidar.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 cp and clausiusclapeyron 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 ANDEQUILIBRIUM

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–boltzman, fermi–diarc and bose–einstein statistics 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 WarkJt.m, "*Advanced Thermodynamics for Engineers*", McGrew – Hill Inc., 1995.
2. M.J. Moran and H.N. Shapiro, "*Fundamentals of Engineering Thermodynamics*", John Wiley and Sons, 2003.
3. Yunuscengel, "*Thermodynamics an engineering approach*", McGrew – Hill Inc, 8th Edition, 2015.
4. Bejan, A., "*Advanced Engineering Thermodynamics*", John Wiley and Cons, 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 Themodynamics*", 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: STEADYANALYSIS STATE HEAT TRANSFER

Introduction, straight uniform fin analysis, Derivation 1D Element matrices, Example Problems, straight uniform fin analysis, Example Problems, Taper fin analysis, Heat Flex 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 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 andits 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*", Pearsoneducation, 2007.
2. Simon Monk, "*Programming Arduino Getting Started with Sketches*", McGraw-Hill Education, 2011.
3. K. Uma rao, Andhe Pallavi, "*The8051 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. PareshGirdhar, 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-dimentinal 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: UN SYMMETRICAL 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-CIRCULARSECTIONS

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 modelin 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. Ballastic 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. LiouW. 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 technologiesand 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. RafiqNoorani, "*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 Kic). 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.

UNITIII: KINETICS OF COMBUSTION

Rates of reaction, reaction order and complex reactions, chain reactions, arrhenius rate equation, collection 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	Composite Materials and 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 -cognation 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, STORAGEAND UTILIZATION

Hydrogen: Its merit as a fuel, Production methods: from fossil fuels, electrolysis, thermal decomposition, photochemical, photo catalytic, hybrid, Hydrogen storage methods: Onboard hydrogen storage, Chemical storage & physical storage, In metal and alloy hydrides, Carbon nano tubes, Glass capillary arrays - pipeline storage and hydrogen utilization.

UNIT V: APPLICATION OF FUEL CELLS INPOWER 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, AuliceScibioh, M*, "Fuel Cells – Principles and Applications",* Universities Press(India) Pvt., Ltd., 2009.
3. Bagotsky .V.S, *"Fuel Cells",*Wiley, 2009.
4. DetlefStolten, *"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, 3D Printing, 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, Auto mobive, 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, rasterisation, 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 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.