DEPARTMENT OF MECHANICAL ENGINEERING

Institute Vision:

To develop highly skilled professionals with strong ethical and human values.

Institute Mission:

M1: To impart quality education through effective teaching–learning practices, industrial exposure, and professional training.

M2: To produce competent and highly knowledgeable graduates with a positive attitude and problem-solving ability.

M3: To instill self-confidence, leadership qualities, and social responsibility to face professional and societal challenges.

Department Vision

To be a recognized center for quality education and applied research in Mechanical Engineering, Producing skilled professionals with an innovation mindset and ethical values.

Department Mission

M1: To impart strong foundational and advanced knowledge in Mechanical Engineering through effective and learner-centric teaching–learning practices.

M2: To develop analytical, design, and problem-solving abilities by providing hands-on laboratory experience, project-based learning, and industry exposure.

M3: To foster innovation, research aptitude, and the effective use of modern engineering tools to address real-world engineering challenges.

M4: To inculcate professional ethics, teamwork, leadership qualities, and concern for sustainable development and societal needs.

Program Educational Objectives (PEOs)

PEO1: Graduates will establish successful careers in mechanical engineering and allied industries or pursue higher studies and research.

PEO2: Graduates will apply fundamental and advanced mechanical engineering principles to analyze, design, and solve complex engineering problems.

PEO3: Graduates will demonstrate proficiency in modern engineering tools, effective

communication, teamwork, and project management skills.

PEO4: Graduates will exhibit professional ethics, leadership qualities, social responsibility, and commitment to lifelong learning.

Program Specific Outcomes (PSOs):

PSO1: Ability to design, analyze, and optimize mechanical components and systems using modern CAD/CAM and engineering analysis tools.

PSO2: Ability to apply principles of manufacturing, thermal, and fluid engineering to develop efficient, sustainable, and practical engineering solutions.

Program Outcomes (POs):

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF MECHANICAL ENGINEERING

COURSE STRUCTURE AND SYLLABUS

For

B. TECH MECHANICAL ENGINEERING

(Applicable for batches admitted from 2019-2020)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA

KAKINADA - 533 003, Andhra Pradesh, India

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF MECHANICAL ENGINEERING

I Year – I SEMESTER

Sl. No	Course Code	Subjects	L	T	P	Credits
1	BS1101	Mathematics – I	3	0	0	3
2	BS1102	Mathematics – II	3	0	0	3
3	BS1108	Engineering Physics	3	0	0	3
4	ES1101	Programming for Problem Solving Using C	3	0	0	3
5	ES1103	Engineering Drawing	1	0	3	2.5
6	HS1102	English Lab	0	0	3	1.5
7	BS1109	Engineering Physics Lab	0	0	3	1.5
8	ES1102	Programming for Problem Solving Using C Lab	0	0	3	1.5
9	MC1104	Constitution of India	2	0	0	0
Total Credits			**15**	**0**	**12**	**19**

I Year – II SEMESTER

Sl. No	Course Code	Subjects	L	T	P	Credits
1	HS1201	English	3	0	0	3
2	BS1210	Engineering Chemistry	3	0	0	3
3	ES1204	Engineering Mechanics	3	0	0	3
4	ES1206	Basic Electrical & Electronics Engineering	3	0	0	3
5	ES1207	Computer Aided Engineering Drawing	1	0	3	2.5
6	HS1203	Communication Skills Lab	0	0	2	1
7	BS1211	Engineering Chemistry Lab	0	0	2	1.5
8	ES1208	Basic Electrical & Electronics Engineering Lab	0	0	3	1.5
9	ES1219	Workshop Practice Lab	0	0	3	1.5
10	PR1201	Engineering Exploration Project	0	0	2	1
Total Credits			**13**	**0**	**15**	**21**

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DEPARTMENT OF MECHANICAL ENGINEERING

II YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1	BSC	Vector Calculus & Fourier Transforms	3	--	--	3
2	PCC-ME	Mechanics of Solids	3	--	--	3
3	PCC-ME	Material Science & Metallurgy	3	--	--	3
4	PCC-ME	Production Technology	3	--	--	3
5	PCC-ME	Thermodynamics	3	--	--	3
6	PCC-ME	Machine Drawing	1	--	3	2.5
7	PCC-Lab1	Metallurgy & Mechanics of Solids Lab	--	--	3	1.5
8	PCC-Lab2	Production Technology Lab	--	--	3	1.5
9	MC2101	Environmental Science	3	--	--	--
10	PROJ-2101	Socially Relevant Project				0.5
		Total Credits	**19**	--	**9**	**21**

II YEAR II SEMESTER

S.No	Course Code	Course Title	L	T	P	Credits
1	BSC	Complex Variables & Statistical Methods	3	--	--	3
2	PCC-ME	Kinematics of Machinery	3	--	--	3
3	PCC-ME	Applied Thermodynamics	3	--	--	3
4	PCC-ME	Fluid Mechanics & Hydraulic Machines	3	--	--	3
5	PCC-ME	Metal Cutting & Machine Tools	3	--	--	3
6	PCC-ME	Design of Machine Members-I	3	--	--	3
7	PCC-Lab5	Fluid Mechanics & Hydraulic Machines Lab	--	--	3	1.5
8	PCC-Lab6	Machine Tools Lab	--	--	3	1.5
9	MC2201	Essence of Indian Traditional Knowledge	2	--	--	--
		Total Credits	**20**	--	**6**	**21**

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III YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1	PCC-ME	Dynamics of Machinery	3	--	--	3
2	PCC-ME	Design of Machine Members-II	3	--	--	3
3	PCC-ME	Mechanical Measurements & Metrology	3	--	--	3
4	HSIMS	Managerial Economics and Financial Accountancy	3	--	--	3
5	PCC-ME	IC Engines & Gas turbines	3	--	--	3
6	PCC-Lab	Thermal Engineering Lab	--	--	3	1.5
7	PCC-Lab	Theory of Machines Lab	--	--	3	1.5
8	PCC-Lab	Mechanical Measurements & Metrology Lab	--	--	3	1.5
9	PROJ-3101	Socially Relevant Project				0.5
		Total Credits	**15**	--	**9**	**20**

III YEAR II SEMESTER

S. No	Course Code	Course Title	L	T	P	Credits
1	PCC-ME	Operations Research	3	--	--	3
2	PCC-ME	Heat Transfer	3	--	--	3
3	PCC-ME	CAD/CAM	3	--	--	3
4	PEC-ME1	1.Composite Materials 2.Refrigeration & Air Conditioning 3. Unconventional Machining Processes 4. Advanced Mechanics of Solids 5.MOOCS(NPTEL/Swayam)	3	--	--	3
5	PEC-ME2	1. Material Characterization 2. Tribology 3. Automobile Engineering 4.Mechatronics 5.MOOCS(NPTEL/Swayam)	3	--	--	3
6	PCC-Lab	Simulation of Mechanical Systems Lab	--	--	2	1
7	PCC-Lab	Heat Transfer Lab	--	--	3	1.5
8	PCC-Lab	CAD /CAM Lab	--	--	3	1.5
9	PROJ- ME	Summer Internship*	--	--		1
		Total Credits	**15**	--	**9**	**20**

***The students have to undergo a summer internship for minimum of Four weeks duration from Industries/R&D/ Govt. Organizations after B.Tech III year II-Semester and credits will be awarded in B.Tech IV year I-Semester after evaluation.**

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DEPARTMENT OF MECHANICAL ENGINEERING

IV YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1	HSIMS	Industrial Management	3	--	--	3
2	PCC-ME	Finite Element Methods	3	--	--	3
3	PEC-3	1.Mechanical Vibrations 2. Renewable Energy Sources 3.Production Planning & Control 4. Machine Tool Design 5. MOOCs (NPTEL/Swayam)	3	--	--	3
4	PEC-4	1.Industrial Automation and Robotics 2. Micro and Nano manufacturing 3. Power Plant Engineering 4.Optimization Techniques 5. MOOCs (NPTEL/Swayam)	3	--	--	3
5	OEC-1	**OPEN ELECTIVE -I**	3	--	--	3
6	PCC-ME Lab	Finite Element Simulation Lab	--	--	2	1
7	PROJ-I	Project-I	--	--	4	2
		Total Credits	**15**	--	**6**	**18**

OPEN ELECTIVE -I:

1. MEMS
2. Optimization Methods
3. Operations Management
4. Nano Technology
5. Finite Element Analysis

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IV YEAR II SEMESTER (VIII SEMESTER)

S. No.	Course Code	Course Title	L	T	P	Credits
1	PEC-5	1.Additive Manufacturing 2.Gas Dynamics and Jet Propulsion 3. Product design and development 4. Reliability Engineering 5. MOOCs (NPTEL/Swayam)	3	--	--	3
2	PEC-6	1.Condition Monitoring 2.Computational Fluid Dynamics 3.Non Destructive Evaluation 4. Control Systems 5. Entrepreneurship Development	3	--	--	3
3	OEC-2	OPEN ELECTIVE -II	3	--	--	3
4	OEC-3	OPEN ELECTIVE -III	3	--	--	3
5	PROJ-II	Project-II	--	--	16	8
		Total Credits	**12**	**--**	**16**	**20**

OPEN ELECTIVE-II:	**OPEN ELECTIVE-III:**
1. Green Energy Systems	1. Total Quality Management
2. Robotics	2. Supply Chain Management
3. Energy Consumption and Management	3. Product Design & Development
4. 3D Printing Technologies	4. Entrepreneurship
5. Mechatronics	5. Advanced Materials

Note:

1) Professional Elective course (PEC) /Open Elective course (OEC) can also be completed via MOOCs (NPTEL/Swayam) Course (12 Week duration)
2) The list of MOOCs courses shall be approved by the chairperson of BOS.

3) The tutorial class can be of one hour duration as per requirements of a particular subject.

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DEPARTMENT OF MECHANICAL ENGINEERING

I Year - I Semester		L	T	P	C
		3	0	0	3
Mathematics-I (BS1101) **(Common to all Branch's for I Year B. Tech)**					

Course Objectives:

- This course will illuminate the students in the concepts of calculus.
- To enlighten the learners in the concept of differential equations and multivariable calculus.
- To equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various real world problems and their applications.

Course Outcomes: At the end of the course, the student will be able to

- utilize mean value theorems to real life problems (L3)
- solve the differential equations related to various engineering fields (L3)
- familiarize with functions of several variables which is useful in optimization (L3)
- Apply double integration techniques in evaluating areas bounded by region (L3)
- students will also learn important tools of calculus in higher dimensions. Students will become familiar with 2- dimensional and 3-dimensional coordinate systems (L5)

UNIT I: Sequences, Series and Mean value theorems: (10 hrs)
Sequences and Series: Convergences and divergence – Ratio test – Comparison tests – Integral test – Cauchy's root test – Alternate series – Leibnitz's rule.

Mean Value Theorems (without proofs): Rolle's Theorem – Lagrange's mean value theorem – Cauchy's mean value theorem – Taylor's and Maclaurin's theorems with remainders.

UNIT II: Differential equations of first order and first degree: (10 hrs)
Linear differential equations – Bernoulli's equations – Exact equations and equations reducible to exact form.
Applications: Newton's Law of cooling – Law of natural growth and decay – Orthogonal trajectories – Electrical circuits.

UNIT III: Linear differential equations of higher order: (10 hrs)

Non-homogeneous equations of higher order with constant coefficients – with non-homogeneous term of the type e^{ax}, sin ax, cos ax, polynomials in x^n, e^{ax} V(x) and x^nV(x) – Method of Variation of parameters.

Applications: LCR circuit, Simple Harmonic motion.

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UNIT IV: Partial differentiation: (10 hrs)

Introduction – Homogeneous function – Euler's theorem – Total derivative – Chain rule – Jacobian – Functional dependence – Taylor's and Mc Laurent's series expansion of functions of two variables.
Applications: Maxima and Minima of functions of two variables without constraints and Lagrange's method (with constraints).

UNIT V: Multiple integrals: (8 hrs)

Double and Triple integrals – Change of order of integration – Change of variables.
Applications: Finding Areas and Volumes.

Text Books:

1. **B. S. Grewal,** Higher Engineering Mathematics, 43rd Edition, Khanna Publishers.
2. **B. V. Ramana,** Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

Reference Books:

1. **Erwin Kreyszig,** Advanced Engineering Mathematics, 10th Edition, Wiley-India.
2. **Joel Hass, Christopher Heil and Maurice D. Weir,** Thomas calculus, 14th Edition, Pearson.
3. **Lawrence Turyn,** Advanced Engineering Mathematics, CRC Press, 2013.
4. **Srimantha Pal, S C Bhunia,** Engineering Mathematics, Oxford University Press.

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I Year - I Semester		L	T	P	C
		3	0	0	3
MATHEMATICS - II (BS1102) **(Common to all Branch's for I Year B. Tech)**					

Course Objectives:

- To instruct the concept of Matrices in solving linear algebraic equations
- To elucidate the different numerical methods to solve nonlinear algebraic equations
- To disseminate the use of different numerical techniques for carrying out numerical integration.
- To equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various real world problems and their applications.

Course Outcomes: At the end of the course, the student will be able to

- develop the use of matrix algebra techniques that is needed by engineers for practical applications (L6)
- solve system of linear algebraic equations using Gauss elimination, Gauss Jordan, Gauss Seidel (L3)
- evaluate approximating the roots of polynomial and transcendental equations by different algorithms (L5)
- apply Newton's forward & backward interpolation and Lagrange's formulae for equal and unequal intervals (L3)
- apply different algorithms for approximating the solutions of ordinary differential equations to its analytical computations (L3)

Unit I: Solving systems of linear equations, Eigen values and Eigen vectors: (10 hrs)

Rank of a matrix by echelon form and normal form – Solving system of homogeneous and non-homogeneous equations linear equations – Gauss Elimination for solving system of equations – Eigen values and Eigen vectors and their properties.

Unit-II: Cayley-Hamilton theorem and Quadratic forms: (10 hrs)

Cayley-Hamilton theorem (without proof) – Finding inverse and power of a matrix by Cayley-Hamilton theorem – Reduction to Diagonal form – Quadratic forms and nature of the quadratic forms – Reduction of quadratic form to canonical forms by orthogonal transformation.

Singular values of a matrix, singular value decomposition (Ref. Book – 1).

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UNIT III: Iterative methods: (8 hrs)

Introduction – Bisection method – Secant method – Method of false position – Iteration method – Newton-Raphson method (One variable and simultaneous Equations) – Jacobi and Gauss-Seidel methods for solving system of equations.

UNIT IV: Interpolation: (10 hrs)

Introduction – Errors in polynomial interpolation – Finite differences – Forward differences – Backward differences – Central differences – Relations between operators – Newton's forward and backward formulae for interpolation – Interpolation with unequal intervals – Lagrange's interpolation formula – Newton's divide difference formula.

UNIT V: Numerical integration and solution of ordinary differential equations: (10 hrs)

Trapezoidal rule – Simpson's $1/3^{rd}$ and $3/8^{th}$ rule – Solution of ordinary differential equations by Taylor's series – Picard's method of successive approximations – Euler's method – Runge-Kutta method (second and fourth order).

Text Books:

1. **B. S. Grewal,** Higher Engineering Mathematics, 43^{rd} Edition, Khanna Publishers.
2. **B. V. Ramana,** Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

Reference Books:

1. **David Poole,** Linear Algebra- A modern introduction, 4^{th} Edition, Cengage.
2. **Steven C. Chapra,** Applied Numerical Methods with MATLAB for Engineering and Science, Tata Mc. Graw Hill Education.
3. **M. K. Jain, S. R. K. Iyengar and R. K. Jain,** Numerical Methods for Scientific and Engineering Computation, New Age International Publications.
4. **Lawrence Turyn,** Advanced Engineering Mathematics, CRC Press.

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DEPARTMENT OF MECHANICAL ENGINEERING

I Year - I Semester		L	T	P	C
		3	0	0	3
ENGINEERING PHYSICS (BS1108)					

Course Objectives:

Physics curriculum which is re-oriented to the needs of non-circuital branches of graduate engineering courses offered by JNT University Kakinada that serves as a transit to understand the branch specific advanced topics. The course is designed to:

- Impart concepts of mechanics required to identify forces and moments in mechanical systems by vector representation-extend Newton's second law for inertial and non-inertial frames of reference- study different types of harmonic oscillatory motions.
- Tap the Simple harmonic motion and its adaptability for improved acoustic quality of concert halls- impart concepts of flaw detection techniques using ultrasonics.
- Study the structure- property relationship exhibited by solid materials within the elastic limit.
- Impart knowledge in basic concepts of LASERs along with its Engineering applications- Familiarize types of sensors for various engineering applications
- Explore the knowledge of magnetic and dielectric materials and their utility in appliances.

UNIT-I **(10hrs)**

MECHANICS: Basic laws of vectors and scalars, rotational frames-conservative and non – conservative forces , F = - grad V, Newton's laws in inertial and linear accelerating non-inertial frames of reference, rotating frame of reference with constant angular velocity, Harmonic oscillator ; damped harmonic motion ; Forced oscillations and resonance.

Outcome:

The students will be able to

- Identify forces and moments in mechanical systems using scalar and vector techniques
- extend Newton's second law for inertial and non-inertial frame of reference
- explain simple harmonic motion and damped harmonic motions

UNIT-II **(10hrs)**

ACOUSTICS & ULTRASONICS: Introduction – Reverberation - Reverberation time - Sabine's formula (Derivation using growth and decay method)–absorption coefficient and its determination-factors affecting acoustics of buildings and their remedies.

Production of ultrasonics by Magnetostriction and piezoelectric methods – Detection of ultrasonics - acoustic grating - Non-Destructive Testing- pulse echo system through transmission and reflection modes - Applications.

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Outcome:

The students will be able to

- explain how sound is propagated in buildings
- analyze acoustic properties of typically used materials in buildings
- recognize sound level disruptors and their use in architectural acoustics
- Use of ultrasonics in flaw detection using NDT technique

UNIT-III **(9hrs)**

ELASTICITY:, stress, strain, Hooke's law, stress-strain curve, generalized Hooke's law with and without thermal strains for isotropic materials, different types of moduli and their relations, bending of beams – Bending moment of a beam – Depression of cantilever.

Outcome:

The students will be able to

- Understand the elasticity and plasticity concepts
- Study different types of moduli and their relation
- Analyze the concepts of shearing force and moment of inertia

UNIT-IV **(9hrs)**

LASERS & SENSORS: Characteristics–Spontaneous and Stimulated emission of radiation – population inversion - Einstein's coefficients & Relation between them and their significance - Pumping Mechanisms - Ruby laser – Helium Neon laser – Applications.

SENSORS (qualitative description only): Different types of sensors and applications; Strain and Pressure sensors- Piezoelectric, magnetostrictive sensors, Temperature sensor - bimetallic strip, pyroelectric detectors.

Outcome:

The students will be able to

- **Understand** the basic concepts of LASER light Sources
- Study Different types of laser systems
- Identify different types of sensors and their working principles

UNIT-V **(10hrs)**

MAGNETISM & DIELECTRICS: Introduction – Magnetic dipole moment – Magnetization-Magnetic susceptibility and permeability – Origin of permanent magnetic moment – Bohr Magneton - Classification of magnetic materials (Dia, Para and Ferro) – Domain concept of Ferromagnetism - Hysteresis – soft and hard magnetic materials – Applications of Ferromagnetic materials.

Introduction - Dielectric polarization – Dielectric polarizability, Susceptibility and Dielectric constant-types of polarizations: Electronic and Ionic (Quantitative), Orientational polarizations (qualitative)-Lorentz internal field – Claussius_Mossoti equation- Frequency dependence of polarization - Applications of dielectrics.

Outcome:

The students will be able to

- **explain** the concept of dielectric constant and polarization in dielectric materials.
- **summarize** various types of polarization of dielectrics .

- **interpret** Lorentz field and Claussius_Mosotti relation in dielectrics.
- **classify** the magnetic materials based on susceptibility and their temperature dependence.
- **explain** the applications of dielectric and magnetic materials .
- **Apply** the concept of magnetism to magnetic devices.

Text Books:

1. "Engineering Mechanics" by Manoj K Harbola, Cengage Publications 2nd Eds.
2. "A text book of Engineering Physics" by P G Kshirsagar & M N Avadhanulu, S Chand & Company Ltd.
3. "Engineering Physics" by R K Gaur and S L Gupta, Dhanpat Rai Publications.
4. "Sensor and Transducers" by Ian R Sinclair, Elsevier (Newnes) 3rd Eds.

Reference Books:

1. "Engineering Physics" by M R Srinivasan, New Age International Publishers.
2. "Lectures on Physics" by Richard P Feynman, Pearson Publishers, New Millennium Eds.
3. "Lasers and Non-linear Optics" by B B Laud, New Age International Publishers (3rd Eds.).

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I Year - I Semester		L	T	P	C
		3	0	0	3
PROGRAMMING FOR PROBLEM SOLVING USING C (ES1101)					

COURSE OBJECTIVES:

The objectives of Programming for Problem Solving Using C are

1) To learn about the computer systems, computing environments, developing of a computer program and Structure of a C Program
2) To gain knowledge of the operators, selection, control statements and repetition in C
3) To learn about the design concepts of arrays, strings, enumerated structure and union types. To learn about their usage.
4) To assimilate about pointers, dynamic memory allocation and know the significance of Preprocessor.
5) To assimilate about File I/O and significance of functions

UNIT I

Introduction to Computers: Creating and running Programs, Computer Numbering System, Storing Integers, Storing Real Numbers

Introduction to the C Language: Background, C Programs, Identifiers, Types, Variable, Constants, Input/output, Programming Examples, Scope, Storage Classes and Type Qualifiers.

Structure of a C Program: Expressions Precedence and Associativity, Side Effects, Evaluating Expressions, Type Conversion Statements, Simple Programs, Command Line Arguments.

UNIT II

Bitwise Operators: Exact Size Integer Types, Logical Bitwise Operators, Shift Operators.

Selection & Making Decisions: Logical Data and Operators, Two Way Selection, Multiway Selection, More Standard Functions

Repetition: Concept of Loop, Pretest and Post-test Loops, Initialization and Updating, Event and Counter Controlled Loops, Loops in C, Other Statements Related to Looping, Looping Applications, Programming Examples

UNIT III

Arrays: Concepts, Using Array in C, Array Application, Two Dimensional Arrays, Multidimensional Arrays, Programming Example – Calculate Averages

Strings: String Concepts, C String, String Input / Output Functions, Arrays of Strings, String Manipulation Functions String/ Data Conversion, A Programming Example – Morse Code

Enumerated, Structure, and Union: The Type Definition (Type def), Enumerated Types, Structure, Unions, and Programming Application

UNIT IV

Pointers: Introduction, Pointers to pointers, Compatibility, L value and R value

Pointer Applications: Arrays, and Pointers, Pointer Arithmetic and Arrays, Memory Allocation Function, Array of Pointers, Programming Application

Processor Commands: Processor Commands

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UNIT V

Functions: Designing, Structured Programs, Function in C, User Defined Functions, Inter-Function Communication, Standard Functions, Passing Array to Functions, Passing Pointers to Functions, Recursion

Text Input / Output: Files, Streams, Standard Library Input / Output Functions, Formatting Input / Output Functions, Character Input / Output Functions

Binary Input / Output: Text versus Binary Streams, Standard Library, Functions for Files, Converting File Type.

TEXT BOOKS:

1. Programming for Problem Solving, Behrouz A. Forouzan, Richard F.Gilberg, CENGAGE
2. The C Programming Language, Brian W.Kernighan, Dennis M. Ritchie, 2e, Pearson

REFERENCES:

1. Computer Fundamentals and Programming, Sumithabha Das, Mc Graw Hill
2. Programming in C, Ashok N. Kamthane, Amit Kamthane, Pearson
3. Computer Fundamentals and Programming in C, Pradip Dey, Manas Ghosh, OXFORD

COURSE OUTCOMES:

Upon the completion of the course the student will learn

1) To write algorithms and to draw flowcharts for solving problems
2) To convert flowcharts/algorithms to C Programs, compile and debug programs
3) To use different operators, data types and write programs that use two-way/ multi-way selection
4) To select the best loop construct for a given problem
5) To design and implement programs to analyze the different pointer applications
6) To decompose a problem into functions and to develop modular reusable code
7) To apply File I/O operations

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I Year - I Semester		L	T	P	C
		1	0	3	2.5
ENGINEERING DRAWING (ES1103)					

Course Objective: Engineering drawing being the principal method of communication for engineers, the objective is to introduce the students, the techniques of constructing the various types of polygons, curves and scales. The objective is also to visualize and represent the 3D objects in 2D planes with proper dimensioning, scaling etc.

Unit I

Objective: To introduce the students to use drawing instruments and to draw polygons, Engg. Curves.

Polygons: Constructing regular polygons by general methods, inscribing and describing polygons on circles.

Curves: Parabola, Ellipse and Hyperbola by general and special methods, cycloids, involutes, tangents & normals for the curves.

Scales: Plain scales, diagonal scales and vernier scales

Unit II

Objective: To introduce the students to use orthographic projections, projections of points & simple lines. To make the students draw the projections of the lines inclined to both the planes.

Orthographic Projections: Reference plane, importance of reference lines, projections of points in various quadrants, projections of lines, line parallel to both the planes, line parallel to one plane and inclined to other plane.

Projections of straight lines inclined to both the planes, determination of true lengths, angle of inclination and traces.

Unit III

Objective: The objective is to make the students draw the projections of the plane inclined to both the planes.

Projections of planes: regular planes perpendicular/parallel to one reference plane and inclined to the other reference plane; inclined to both the reference planes.

Unit IV

Objective: The objective is to make the students draw the projections of the various types of solids in different positions inclined to one of the planes.

Projections of Solids – Prisms, Pyramids, Cones and Cylinders with the axis inclined to both the planes.

Unit V

Objective: The objective is to represent the object in 3D view through isometric views. The student will be able to represent and convert the isometric view to orthographic view and vice versa.

Conversion of isometric views to orthographic views; Conversion of orthographic views to isometric views.

Computer Aided Design, Drawing practice using Auto CAD, Creating 2D&3D drawings of objects using Auto CAD

Note: In the End Examination there will be no question from CAD.

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TEXT BOOKS:

1. Engineering Drawing by N.D. Butt, Chariot Publications
2. Engineering Drawing by Agarwal & Agarwal, Tata McGraw Hill Publishers

REFERENCE BOOKS:

1. Engineering Drawing by K.L.Narayana & P. Kannaiah, Scitech Publishers
2. Engineering Graphics for Degree by K.C. John, PHI Publishers
3. Engineering Graphics by PI Varghese, McGrawHill Publishers
4. Engineering Drawing + AutoCad – K Venugopal, V. Prabhu Raja, New Age

Course Outcome: The student will learn how to visualize 2D & 3D objects.

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I Year - I Semester		L	T	P	C
		0	0	3	1.5
ENGLISH LAB (HS1102)					

UNIT I:
Vowels, Consonants, Pronunciation, Phonetic Transcription

UNIT II:

Past tense markers, word stress-di-syllabic words, Poly-Syllabic words

UNIT III:

Rhythm & Intonation

UNIT IV:

Contrastive Stress (Homographs)

UNIT V:

Word Stress: Weak and Strong forms
Stress in compound words

References books:

1. Infotech English, Maruthi Publications (with Compact Disc).
2. Exercises in Spoken English Part 1,2,3,4, OUP and CIEFL.
3. English Pronunciation in use- Mark Hancock, Cambridge University Press.
4. English Phonetics and Phonology-Peter Roach, Cambridge University Press.
5. English Pronunciation in use- Mark Hewings, Cambridge University Press.
6. English Pronunciation Dictionary- Daniel Jones, Cambridge University Press.
7. English Phonetics for Indian Students- P. Bala Subramanian, Mac Millan Publications.

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I Year - I Semester		L	T	P	C
		0	0	3	1.5
ENGINEERING PHYSICS LAB (BS1109)					

(Any 10 of the following listed 15 experiments)

LIST OF EXPERIMENTS:

1. Determination of Rigidity modulus of a material- Torsional Pendulum.
2. Determination of Young's modulus by method of single cantilever oscillations.
3. Determination of Acceleration due to Gravity and Radius of Gyration - Compound Pendulum.
4. Verification of laws of vibrations in stretched strings – Sonometer.
5. Determination of spring constant of springs using coupled oscillators.
6. Magnetic field along the axis of a current carrying coil – Stewart and Gee's apparatus
7. Study the variation of B versus H by magnetizing the magnetic material (B-H curve).
8. Measurement of magnetic susceptibility by Gouy's method.
9. Determination of ultrasonic velocity in liquid (Acoustic Grating)
10. Determination of dielectric constant by charging and discharging method
11. Determination of wavelength of Laser by diffraction grating
12. Determination of particle size using Laser.
13. Determeination of Pressure variation using strain Gauge sensor.
14. Determination of Moment of Inertia of a Fly Wheel.
15. Determination of Velocity of sound –Volume Resoantor.

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I Year - I Semester		L	T	P	C
		0	0	3	1.5
PROGRAMMING FOR PROBLEM SOLVING USING C LAB (ES1102)					

Course Objectives:

1) Apply the principles of C language in problem solving.
2) To design flowcharts, algorithms and knowing how to debug programs.
3) To design & develop of C programs using arrays, strings pointers & functions.
4) To review the file operations, preprocessor commands.

Exercise 1:

1. Write a C program to print a block F using hash (#), where the F has a height of six characters and width of five and four characters.
2. Write a C program to compute the perimeter and area of a rectangle with a height of 7 inches and width of 5 inches.
3. Write a C program to display multiple variables.

Exercise 2:

1. Write a C program to calculate the distance between the two points.
2. Write a C program that accepts 4 integers p, q, r, s from the user where r and s are positive and p is even. If q is greater than r and s is greater than p and if the sum of r and s is greater than the sum of p and q print "Correct values", otherwise print "Wrong values".

Exercise 3:

1. Write a C program to convert a string to a long integer.
2. Write a program in C which is a Menu-Driven Program to compute the area of the various geometrical shape.
3. Write a C program to calculate the factorial of a given number.

Exercise 4:

1. Write a program in C to display the n terms of even natural number and their sum.
2. Write a program in C to display the n terms of harmonic series and their sum. 1 + 1/2 + 1/3 + 1/4 + 1/5 ... 1/n terms.
3. Write a C program to check whether a given number is an Armstrong number or not.

Exercise 5:

1. Write a program in C to print all unique elements in an array.
2. Write a program in C to separate odd and even integers in separate arrays.
3. Write a program in C to sort elements of array in ascending order.

Exercise 6:

1. Write a program in C for multiplication of two square Matrices.
2. Write a program in C to find transpose of a given matrix.

Exercise 7:

1. Write a program in C to search an element in a row wise and column wise sorted matrix.
2. Write a program in C to print individual characters of string in reverse order.

Exercise 8:

1. Write a program in C to compare two strings without using string library functions.
2. Write a program in C to copy one string to another string.

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Exercise 9:

1. Write a C Program to Store Information Using Structures with Dynamically Memory Allocation
2. Write a program in C to demonstrate how to handle the pointers in the program.

Exercise 10:

1. Write a program in C to demonstrate the use of & (address of) and *(value at address) operator.
2. Write a program in C to add two numbers using pointers.

Exercise 11:

1. Write a program in C to add numbers using call by reference.
2. Write a program in C to find the largest element using Dynamic Memory Allocation.

Exercise 12:

1. Write a program in C to swap elements using call by reference.
2. Write a program in C to count the number of vowels and consonants in a string using a pointer.

Exercise 13:

1. Write a program in C to show how a function returning pointer.
2. Write a C program to find sum of n elements entered by user. To perform this program, allocate memory dynamically using malloc( ) function.

Exercise 14:

1. Write a C program to find sum of n elements entered by user. To perform this program, allocate memory dynamically using calloc( ) function. Understand the difference between the above two programs
2. Write a program in C to convert decimal number to binary number using the function.

Exercise 15:

1. Write a program in C to check whether a number is a prime number or not using the function.
2. Write a program in C to get the largest element of an array using the function.

Exercise 16:

1. Write a program in C to append multiple lines at the end of a text file.
2. Write a program in C to copy a file in another name.
3. Write a program in C to remove a file from the disk.

Course Outcomes:

By the end of the Lab, the student

1) Gains Knowledge on various concepts of a C language.
2) Able to draw flowcharts and write algorithms.
3) Able design and development of C problem solving skills.
4) Able to design and develop modular programming skills.
5) Able to trace and debug a program

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I Year - I Semester		L	T	P	C
		2	0	0	0
CONSTITUTION OF INDIA (MC1104)					

Course Objectives:

- To Enable the student to understand the importance of constitution
- To understand the structure of executive, legislature and judiciary
- To understand philosophy of fundamental rights and duties
- To understand the autonomous nature of constitutional bodies like Supreme Court and high court controller and auditor general of India and election commission of India.
- To understand the central and state relation financial and administrative.

UNIT-I

Introduction to Indian Constitution: Constitution meaning of the term, Indian Constitution - Sources and constitutional history, Features - Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.

Learning outcomes:

After completion of this unit student will

- Understand the concept of Indian constitution
- Apply the knowledge on directive principle of state policy
- Analyze the History, features of Indian constitution
- Evaluate Preamble Fundamental Rights and Duties

UNIT-II

Union Government and its Administration Structure of the Indian Union: Federalism, Centre- State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, LokSabha, RajyaSabha, The Supreme Court and High Court: Powers and Functions;

Learning outcomes:-After completion of this unit student will

- Understand the structure of Indian government
- Differentiate between the state and central government
- Explain the role of President and Prime Minister
- Know the Structure of supreme court and High court

UNIT-III

State Government and its Administration Governor - Role and Position - CM and Council of ministers, State Secretariat: Organisation, Structure and Functions

Learning outcomes:-After completion of this unit student will

- Understand the structure of state government
- Analyze the role Governor and Chief Minister
- Explain the role of state Secretariat
- Differentiate between structure and functions of state secretariat

UNIT-IV

A.Local Administration - District's Administration Head - Role and Importance, Municipalities - Mayor and role of Elected Representative - CEO of Municipal Corporation PachayatiRaj: Functions PRI: ZilaPanchayat, Elected officials and their roles, CEO ZilaPanchayat: Block level Organizational Hierarchy - (Different departments), Village level - Role of Elected and Appointed officials - Importance of grass root democracy

Learning outcomes:-After completion of this unit student will

- Understand the local Administration

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- Compare and contrast district administration role and importance
- Analyze the role of Myer and elected representatives of Municipalities
- Evaluate Zillapanchayat block level organisation

UNIT-V

Election Commission: Election Commission- Role of Chief Election Commissioner and Election Commissionerate State Election Commission:, Functions of Commissions for the welfare of SC/ST/OBC and women

Learning outcomes:-After completion of this unit student will

- Know the role of Election Commission apply knowledge
- Contrast and compare the role of Chief Election commissioner and Commissiononerate
- Analyze role of state election commission
- Evaluate various commissions of viz SC/ST/OBC and women

References:

1. Durga Das Basu, Introduction to the Constitution of India, Prentice – Hall of India Pvt. Ltd.. New Delhi
2. SubashKashyap, Indian Constitution, National Book Trust
3. J.A. Siwach, Dynamics of Indian Government & Politics
4. D.C. Gupta, Indian Government and Politics
5. H.M.Sreevai, Constitutional Law of India, 4th edition in 3 volumes (Universal Law Publication)
6. J.C. Johari, Indian Government andPolitics Hans
7. J. Raj IndianGovernment and Politics
8. M.V. Pylee, Indian Constitution Durga Das Basu, Human Rights in Constitutional Law, Prentice – Hall of India Pvt. Ltd.. New Delhi
9. Noorani, A.G., (South Asia Human Rights Documentation Centre), Challenges to Civil Right), Challenges to Civil Rights Guarantees in India, Oxford University Press 2012

E-resources:

1. nptel.ac.in/courses/109104074/8
2. nptel.ac.in/courses/109104045/
3. nptel.ac.in/courses/101104065/
4. www.hss.iitb.ac.in/en/lecture-details
5. www.iitb.ac.in/en/event/2nd-lecture-institute-lecture-series-indian-constitution

Course Outcomes:

At the end of the semester/course, the student will be able to have a clear knowledge on the following:

- Understand historical background of the constitution making and its importance for building a democratic India.
- Understand the functioning of three wings of the government ie., executive, legislative and judiciary.
- Understand the value of the fundamental rights and duties for becoming good citizen of India.
- Analyze the decentralization of power between central, state and local self-government.
- Apply the knowledge in strengthening of the constitutional institutions like CAG, Election Commission and UPSC for sustaining democracy.
    1. Know the sources, features and principles of Indian Constitution.
    2. Learn about Union Government, State government and its administration.
    3. Get acquainted with Local administration and Pachayati Raj.
    4. Be aware of basic concepts and developments of Human Rights.
    5. Gain knowledge on roles and functioning of Election Commission

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I Year - II Semester		L	T	P	C
		3	0	0	3
ENGLISH (HS1201)					

Introduction

The course is designed to train students in receptive (listening and reading) as well as productive and interactive (speaking and writing) skills by incorporating a comprehensive, coherent and integrated approach that improves the learners' ability to effectively use English language in academic/ workplace contexts. The shift is from *learning about the language* to *using the language*. On successful completion of the compulsory English language course/s in B.Tech., learners would be confident of appearing for international language qualification/proficiency tests such as IELTS, TOEFL, or BEC, besides being able to express themselves clearly in speech and competently handle the writing tasks and verbal ability component of campus placement tests. Activity based teaching-learning methods would be adopted to ensure that learners would engage in actual use of language both in the classroom and laboratory sessions.

Course Objectives

- Facilitate effective listening skills for better comprehension of academic lectures and English spoken by native speakers
- Focus on appropriate reading strategies for comprehension of various academic texts and authentic materials
- Help improve speaking skills through participation in activities such as role plays, discussions and structured talks/oral presentations
- Impart effective strategies for good writing and demonstrate the same in summarizing, writing well organized essays, record and report useful information
- Provide knowledge of grammatical structures and vocabulary and encourage their appropriate use in speech and writing

Learning Outcomes

At the end of the module, the learners will be able to

- understand social or transactional dialogues spoken by native speakers of English and identify the context, topic, and pieces of specific information
- ask and answer general questions on familiar topics and introduce oneself/others
- employ suitable strategies for skimming and scanning to get the general idea of a text and locate specific information
- recognize paragraph structure and be able to match beginnings/endings/headings with paragraphs
- form sentences using proper grammatical structures and correct word forms

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Unit 1:

Lesson-1: A Drawer full of happiness from "**Infotech English**", Maruthi Publications
Lesson-2: Deliverance by Premchand from "**The Individual Society",** Pearson Publications. (Non-detailed)

Listening: Listening to short audio texts and identifying the topic. Listening to short audio texts and identifying the context and specific pieces of information to answer a series of questions both in speaking and writing.

Speaking: Asking and answering general questions on familiar topics such as home, family, work, studies and interests. Self introductions and introducing others.

Reading: Skimming text to get the main idea. Scanning to look for specific pieces of information.

Reading for Writing: Paragraph writing (specific topics) using suitable cohesive devices; linkers, sign posts and transition signals; mechanics of writing - punctuation, capital letters.

Vocabulary: Technical vocabulary from across technical branches (20) GRE Vocabulary (20) (Antonyms and Synonyms, Word applications) Verbal reasoning and sequencing of words.

Grammar: Content words and function words; word forms: verbs, nouns, adjectives and adverbs; nouns: countables and uncountables; singular and plural basic sentence structures; simple question form - wh-questions; word order in sentences.
Pronunciation: Vowels, Consonants, Plural markers and their realizations

Unit 2:

Lesson-1: Nehru's letter to his daughter Indira on her birthday from "**Infotech English**", Maruthi Publications

Lesson-2: Bosom Friend by Hira Bansode from "**The Individual Society",** Pearson Publications. (Non-detailed)

Listening: Answering a series of questions about main idea and supporting ideas after listening to audio texts, both in speaking and writing.

Speaking: Discussion in pairs/ small groups on specific topics followed by short structured talks. Functional English: Greetings and leave takings.

Reading: Identifying sequence of ideas; recognizing verbal techniques that help to link the ideas in a paragraph together.

Reading for Writing: Summarizing - identifying main idea/s and rephrasing what is read; avoiding redundancies and repetitions.

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Vocabulary: Technical vocabulary from across technical branches (20 words). GRE Vocabulary Analogies (20 words) (Antonyms and Synonyms, Word applications)

Grammar: Use of articles and zero article; prepositions.

Pronunciation: Past tense markers, word stress-di-syllabic words

Unit 3:

Lesson-1: Stephen Hawking-Positivity 'Benchmark' from "**Infotech English**", Maruthi Publications

Lesson-2: Shakespeare's Sister by Virginia Woolf from "**The Individual Society",** Pearson Publications. (Non-detailed**)**

Listening: Listening for global comprehension and summarizing what is listened to, both in speaking and writing.
Speaking: Discussing specific topics in pairs or small groups and reporting what is discussed. Functional English: Complaining and Apologizing.
Reading: Reading a text in detail by making basic inferences - recognizing and interpreting specific context clues; strategies to use text clues for comprehension. Critical reading.

Reading for Writing: Summarizing - identifying main idea/s and rephrasing what is read; avoiding redundancies and repetitions. Letter writing-types, format and principles of letter writing. E-mail etiquette, Writing CV's.

Vocabulary: Technical vocabulary from across technical branches (20 words). GRE Vocabulary (20 words) (Antonyms and Synonyms, Word applications) Association, sequencing of words

Grammar: Verbs - tenses; subject-verb agreement; direct and indirect speech, reporting verbs for academic purposes.

Pronunciation: word stress-poly-syllabic words

Unit 4:

Lesson-1: Liking a Tree, Unbowed: Wangari Maathai-biography from "**Infotech English**", Maruthi Publications

Lesson-2: Telephone Conversation-Wole Soyinka from "**The Individual Society",** Pearson Publications**.** (Non-detailed)

Listening: Making predictions while listening to conversations/ transactional dialogues without video (only audio); listening to audio-visual texts.

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Speaking: Role plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions. Functional English: Permissions, Requesting, Inviting.
Reading: Studying the use of graphic elements in texts to convey information, reveal trends/patterns/relationships, communicative process or display complicated data.
Reading for Writing: Information transfer; describe, compare, contrast, identify significance/trends based on information provided in figures/charts/graphs/tables. Writing SOP, writing for media.
Vocabulary: Technical vocabulary from across technical branches (20 words) GRE Vocabulary (20 words) (Antonyms and Synonyms, Word applications) Cloze Encounters.
Grammar: Quantifying expressions - adjectives and adverbs; comparing and contrasting; degrees of comparison; use of antonyms

Pronunciation: Contrastive Stress
Unit 5:

Lesson-1: Stay Hungry-Stay foolish from "**Infotech English**", Maruthi Publications

Lesson-2: Still I Rise by Maya Angelou from "**The Individual Society",** Pearson Publications. (Non-detailed)

Listening: Identifying key terms, understanding concepts and interpreting the concepts both in speaking and writing.

Speaking: Formal oral presentations on topics from academic contexts - without the use of PPT slides. Functional English: Suggesting/Opinion giving.
Reading: Reading for comprehension. RAP Strategy Intensive reading and Extensive reading techniques.
Reading for Writing: Writing academic proposals- writing research articles: format and style.
Vocabulary: Technical vocabulary from across technical branches (20 words) GRE Vocabulary (20 words) (Antonyms and Synonyms, Word applications) Coherence, matching emotions.

Grammar: Editing short texts – identifying and correcting common errors in grammar and usage (articles, prepositions, tenses, subject verb agreement)

Pronunciation: Stress in compound words

Prescribed text books for theory:

1. "**Infotech English**", Maruthi Publications. (Detailed)
2. "**The Individual Society",** Pearson Publications. (Non-detailed)

Reference books:

1. Bailey, Stephen. Academic writing: A handbook for international students. Routledge, 2014.
2. Chase, Becky Tarver. Pathways: Listening, Speaking and Critical Thinking. Heinley ELT; 2nd Edition, 2018.
3. Skillful Level 2 Reading & Writing Student's Book Pack (B1) Macmillan Educational.
4. Hewings, Martin. Cambridge Academic English (B2). CUP, 2012.

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I Year - II Semester		L	T	P	C
		3	0	0	3
ENGINEERING CHEMISTRY (BS1210)					

Knowledge of basic concepts of Chemistry for Engineering students will help them as professional engineers later in design and material selection, as well as utilizing the available resources.

Learning Objectives:

- **Importance** of usage of plastics in household appliances and composites (FRP) in aerospace and automotive industries.
- **Outline** the basics for the construction of electrochemical cells, batteries and fuel cells. Understand the mechanism of corrosion and how it can be prevented.
  Express the increase in demand as wide variety of advanced materials are introduced; which have excellent engineering properties.
  Classify and discuss the materials used in major industries like steel industry, metallurgical industries and construction industries and electrical equipment manufacturing industries. Lubrication is also **summarized**.
- **Relate** the need of fuels as a source of energy to any industry, particularly industries like thermal power stations, steel industry, fertilizer industry etc., and hence introduced.
- **Explain** the importance and usage of water as basic material in almost all the industries; **interpret** drawbacks of steam boilers and also how portable water is supplied for drinking purposes.

UNIT I: POLYMER TECHNOLOGY

Polymerisation:- Introduction-methods of polymerization (emulsion and suspension)-physical and mechanical properties.

Plastics: Compounding-fabrication (compression, injection, blown film, extrusion) - preparation, properties and applications of PVC, polycarbonates and Bakelite-mention some examples of plastic materials used in electronic gadgets, recycling of e-plastic waste.

Elastomers:- Natural rubber-drawbacks-vulcanization-preparation, properties and applications of synthetic rubbers (Buna S, thiokol and polyurethanes).

Composite materials: Fiber reinforced plastics-conducting polymers-biodegradable polymers-biopolymers-biomedical polymers.

Learning Outcomes: At the end of this unit, the students will be able to

- **Outline** the properties of polymers and various additives added and different methods of forming plastic materials.
- **Explain** the preparation, properties and applications of some plastic materials.
- **Interpret** the mechanism of conduction in conducting polymers .
- **Discuss** natural and synthetic rubbers and their applications.

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UNIT II: ELECTROCHEMICAL CELLS AND CORROSION

Single electrode potential-Electrochemical series and uses of series-standard hydrogen electrode, calomel electrode-concentration cell-construction of glass electrode-Batteries: Dry cell, Ni-Cd cells, Ni-Metal hydride cells, Li ion battery, zinc air cells–Fuel cells: H_2-O_2, CH_3OH-O_2, phosphoric acid, molten carbonate.

Corrosion:-Definition-theories of corrosion (chemical and electrochemical)-galvanic corrosion, differential aeration corrosion, stress corrosion, waterline corrosion-passivity of metals-galvanic series-factors influencing rate of corrosion-corrosion control (proper designing, cathodic protection)-Protective coatings: Surface preparation, cathodic and anodic coatings, electroplating, electroless plating (nickel). Paints (constituents, functions, special paints).

Learning Outcomes: At the end of this unit, the students will be able to

- **Explain** the theory of construction of battery and fuel cells.
- **Categorize** the reasons for corrosion and study some methods of corrosion control.

UNIT III: CHEMISTRY OF MATERIALS

Part- A:

Nano materials:- Introduction-sol-gel method-characterization by BET, SEM and TEM methods-applications of graphene-carbon nanotubes and fullerenes:Types, preparation and applications

Thermal analysis techniques: Instrumentation and applications of thermogravimetric analysis (TGA), differential thermal analysis (DTA), differential scanning calorimetry (DSC).

Part-B:

Refractories: - Definition, classification, properties (refractoriness, refractoriness under load, porosity and thermal spalling), failure of refractories.

Lubricants: - Definition, mechanism of lubricants and properties (definition and importance).

Cement: - Constituents, manufacturing, parameters to characterize the clinker formation: lime saturation factor (LSF), silica ratio (SR) and alumina ratio (AR), chemistry of setting and hardening, deterioration of cement.

Learning Outcomes: At the end of this unit, the students will be able to

- **Outline** the awareness of materials like nanomaterials and fullerenes and their uses.
- **Explain** the techniques that detect and measure changes of state of reaction.
- **Illustrate** the commonly used industrial materials.

UNIT IV: FUELS

Introduction-calorific value-HCV and LCV-problems using Dulong's formula-proximate and ultimate analysis of coal sample-significance of these analyses-problems-Petroleum (refining-cracking)-Synthetic petrol (Fischer Tropsch and Bergius)-petrol knocking-diesel knocking-octane and cetane ratings-anti-knock agents-Introduction to alternative fuels (Bio-diesel, ethanol, methanol, Natural gas, LPG, CNG)-Flue gas analysis by Orsat apparatus-Rocket fuels.

Learning Outcomes: At the end of this unit, the students will be able to

- **Differentiate** petroleum, petrol, synthetic petrol and have knowledge how they are produced.
- **Study** alternate fuels.

- **Analyse** flue gases.

UNIT V: WATER TECHNOLOGY

Hardness of water-determination of hardness by complexometric method-boiler troubles (priming and foaming, scale formation, boiler corrosion, caustic embrittlement)-internal treatments-softening of hard water (zeolite processs and related sums, ion exchange process)-treatment of industrial waste water
Portable water and its specifications-steps involved in purification of water-chlorination, break point chlorination-reverse osmosis and electro dialysis.

Learning Outcomes: At the end of this unit, the students will be able to

- **Explain** the impurities present in raw water, problems associated with them and how to avoid them are understood.

Standard Books:

1. Engineering Chemistry by Jain and Jain; Dhanpat Rai Publicating Co. Latest edition
2. Engineering Chemistry by Shikha Agarwal; Cambridge University Press, 2019 edition.
3. A text book of engineering Chemistry by S. S. Dara; S. Chand & Co Ltd., Latest Edition
4. Engineering Chemistry by Shashi Chawla; Dhanpat Rai Publicating Co. Latest edition

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I Year - II Semester		L	T	P	C
		3	0	0	3
ENIGINEERING MECHANICS (BS1204)					

Objectives: The students completing this course are expected to understand the concepts of forces and its resolution in different planes, resultant of force system, Forces acting on a body, their free body diagrams using graphical methods. They are required to understand the concepts of centre of gravity and moments of inertia and their application, Analysis of frames and trusses, different types of motion, friction and application of work - energy method.

UNIT – I
Objectives: The students are to be exposed to the concepts of force and friction, direction and its application.
Introduction to Engg. Mechanics – Basic Concepts.
Systems of Forces: Coplanar Concurrent Forces – Components in Space – Resultant – Moment of Force and its Application – Couples and Resultant of Force Systems.
Friction: Introduction**,** limiting friction and impending motion, coulomb's laws of dry friction, coefficient of friction, cone of friction

UNIT II
Objectives: The students are to be exposed to application of free body diagrams. Solution to problems using graphical methods and law of triangle of forces.
Equilibrium of Systems of Forces: Free Body Diagrams, , Lami's Theorm, Equations of Equilibrium of Coplanar Systems, Graphical method for the equilibrium, Triangle law of forces, converse of the law of polygon of forces condition of equilibrium, Equations of Equilibrium for Spatial System of forces, Numerical examples on spatial system of forces using vector approach, Analysis of plane trusses.

UNIT – III
Objectives : The students are to be exposed to concepts of centre of gravity. The students are to be exposed to concepts of moment of inertia and polar moment of inertia including transfer methods and their applications.
Centroid: Centroids of simple figures (from basic principles) – Centroids of Composite Figures
Centre of Gravity: Centre of gravity of simple body (from basic principles), centre of gravity of composite bodies, Pappus theorems.
Area moments of Inertia: Definition – Polar Moment of Inertia, Transfer Theorem, Moments of Inertia of Composite Figures, Products of Inertia, Transfer Formula for Product of Inertia. **Mass Moment of Inertia:** Moment of Inertia of Masses, Transfer Formula for Mass Moments of Inertia, mass moment of inertia of composite bodies.

UNIT – IV
Objectives: The students are to be exposed to motion in straight line and in curvilinear paths, its velocity and acceleration computation and methods of representing plane motion.
Rectilinear and Curvilinear motion of a particle: Kinematics and Kinetics- Work Energy method and applications to particle motion- Impulse momentum method.

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UNIT – V
Objectives: The students are to be exposed to rigid motion kinematics and kinetics
Rigid body Motion: Kinematics and kinetics of translation, Rotation about fixed axis and plane motion, Work Energy method and Impulse momentum method.

TEXT BOOK:

1. Engg. Mechanics - S.Timoshenko & D.H.Young., 4th Edn - , Mc Graw Hill publications.

Course outcomes:

1. The student should be able to draw free body diagrams for FBDs for particles and rigid bodies in plane and space and problems to solve the unknown forces, orientations and geometric parameters.
2. He should be able to determine centroid for lines, areas and center of gravity for volumes and their composites.
3. He should be able to determine area and mass movement of inertia for composite sections
4. He should be able to analyze motion of particles and rigid bodies and apply the principles of motion, work energy and impulse – momentum.

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I Year - II Semester		L	T	P	C
		3	0	0	3
BASIC ELECTRICAL & ELECTRONICS ENGINEERING (ES1206)					

Preamble:
This course covers the topics related to analysis of various electrical circuits, operation of various electrical machines and electronic components to perform well in their respective fields.

Learning Objectives:

- To learn the basic principles of electrical circuital law's and analysis of networks.
- To understand principle of operation and construction details of DC machines.
- To understand principle of operation and construction details of transformers, alternator and 3-Phase induction motor.
- To study operation of PN junction diode, half wave, full wave rectifiers and OP-AMPs.
- To learn operation of PNP and NPN transistors and various amplifiers.

Unit - I
Electrical Circuits
Basic definitions – types of network elements – Ohm's Law – Kirchhoff's Laws – inductive networks – capacitive networks – series – parallel circuits – star-delta and delta-star transformations.-Numerical Problems.

Unit - II
DC Machines
Principle of operation of DC generator – EMF equation – types of DC machines – torque equation characteristics of DC motors – applications – three point starter – speed control methods of DC motor – Swinburne's Test-Brake test on DC shunt motor-Numerical problems.

Unit - III
AC Machines:
Transformers
Principle of operation and construction of single phase transformers – EMF equation – Losses – OC & SC tests – efficiency and regulation-Numerical Problems.

AC Rotating Machines
Principle of operation and construction of alternators – types of alternators Regulation of alternator by synchronous impedance method – principle of operation of synchronous motor – principle of operation of 3-Phase induction motor – slip-torque characteristics – efficiency – applications- Numerical Problems.

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Unit IV
Rectifiers & Linear ICs
PN junction diodes – diode applications (half wave and bridge rectifiers). Characteristics of operation amplifiers (OP-AMP) – application of OP-AMPs (inverting, non-inverting, integrator and differentiator)-Numerical Problems.

Unit V
Transistors
PNP and NPN junction transistor, transistor as an amplifier– frequency response of CE amplifier – Basic concepts of feedback amplifier-Numerical problems.

Learning Outcomes:
The student should be able to:
- Analyse various electrical networks.
- Understand operation of DC generators,3-point starter and DC machine testing by Swinburne's Test and Brake test.
- Analyse performance of single-phase transformer and acquire proper knowledge and working of 3-phase alternator and 3-phase induction motors.
- Analyse operation of half wave, full wave bridge rectifiers and OP-AMPs.
- Understanding operations of CE amplifier and basic concept of feedback amplifier.

Text Books:

1. Electrical Technology by Surinder Pal Bali, Pearson Publications.
2. Electronic Devices and Circuits by R.L. Boylestad and Louis Nashelsky, 9th edition, PEI/PHI 2006.

Reference Books:

1. Electrical Circuit Theory and Technology by John Bird, Routledge Taylor &Francis Group
2. Basic Electrical Engineering by M.S.Naidu and S.Kamakshiah, TMH Publications
3. Fundamentals of Electrical Engineering by Rajendra Prasad, PHI Publications,2nd edition
4. Basic Electrical Engineering by Nagsarkar, Sukhija, Oxford Publications,2nd edition
5. Industrial Electronics by G.K. Mittal, PHI

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DEPARTMENT OF MECHANICAL ENGINEERING

I Year - II Semester		L	T	P	C
		1	0	3	2.5
COMPUTER AIDED ENGINEERING DRAWING (ES1207)					

Course Objective: To enhance the student's knowledge and skills in engineering drawing and to introduce drafting packages and commands for computer aided drawing and modeling.

UNIT-I:
Objective: The knowledge of projections of solids is essential in 3D modeling and animation. The student will be able to draw projections of solids. The objective is to enhance the skills they already acquired in their earlier course in drawing of projection.
PROJECTIONS OF SOLIDS: Projections of Regular Solids inclined to both planes – Auxiliary Views.

UNIT-II:
The knowledge of sections of solids and development of surfaces is required in designing and manufacturing of the objects. Whenever two or more solids combine, a definite curve is seen at their intersection.
SECTIONS OF SOLIDS: Sections and Sectional views of Right Regular Solids – Prism, Cylinder, Pyramid, Cone – Auxiliary views.
DEVELOPMENT AND INTERPENETRATION OF SOLIDS: Development of Surfaces of Right Regular Solids – Prism, Cylinder, Pyramid, Cone and their parts.

UNIT-III:
The intersection of solids also plays an important role in designing and manufacturing. The objective is to impart this knowledge through this topic. A perspective view provides a realistic 3D View of an object. The objective is to make the students learn the methods of Iso and Perspective views.
INTERPENETRATION OF RIGHT REGULAR SOLIDS: Intersection of Cylinder Vs Cylinder, Cylinder Vs Prism, Cylinder Vs Cone, Prism Vs Cone.
PERSPECTIVE PROJECTIONS: Perspective View: Points, Lines, Plane Figures and Simple Solids, Vanishing Point Methods (General Method only).
In part B computer aided drafting is introduced.

UNIT IV:
The objective is to introduce various commands in AutoCAD to draw the geometric entities and to create 2D and 3D wire frame models.
INTRODUCTION TO COMPUTER AIDED DRAFTING: Generation of points, lines, curves, polygons, dimensioning. Types of modeling : object selection commands – edit, zoom, cross hatching, pattern filling, utility commands, 2D wire frame modeling, 3D wire frame modeling,.

UNIT V:
By going through this topic the student will be able to understand the paper-space environment thoroughly.
VIEW POINTS AND VIEW PORTS: view point coordinates and view(s) displayed, examples to exercise different options like save, restore, delete , joint , single option.

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UNIT VI:
The objective is to make the students create geometrical model of simple solids and machine parts and display the same as an Isometric, Orthographic or Perspective projection.
COMPUTER AIDED SOLID MODELING: Isometric projections, orthographic projections of isometric projections, Modeling of simple solids, Modeling of Machines & Machine Parts.

TEXT BOOKS :

1. Engineering drawing by N.D Bhatt , Charotar publications.
2. Engineering Graphics, K.C. john, PHI Publications

REFERENCES:

1. Mastering Auto CAD 2013 and Auto CAD LT 2013 – George Omura, Sybex
2. Auto CAD 2013 fundamentals- Elisemoss, SDC Publ.
3. Engineering Drawing and Graphics using Auto Cad – T Jeyapoovan, vikas
4. Engineering Drawing + AutoCAD – K Venugopal, V. Prabhu Raja, New Age
5. Engineering Drawing – RK Dhawan, S Chand
6. Engineering Drawing – MB Shaw, BC Rana, Pearson
7. Engineering Drawing – KL Narayana, P Kannaiah, Scitech
8. Engineering Drawing – Agarwal and Agarwal, Mc Graw Hill
9. Engineering Graphics – PI Varghese, Mc Graw Hill
10. Text book of Engineering Drawing with auto-CAD , K.venkata reddy/B.S . publications.
11. Engineering Drawing with Auto CAD/ James D Bethune/Pearson Publications
12. Engineering Graphics with Auto CAD/Kulkarni D.M, Rastogi A.P, Sarkar A.K/PHI Publications

End Semester examination shall be conducted for **Four** hours with the following pattern:

a) Two hours-Conventional drawing
b) Two hours – Computer Aided Drawing

Course outcomes:
1. Student get exposed on working of sheet metal with help of development of surfaces.
2. Student understands how to know the hidden details of machine components with the help of sections and interpenetrations of solids.
3. Student shall exposed to modeling commands for generating 2D and 3D objects using computer aided drafting tools which are useful to create machine elements for computer aided analysis.

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I Year - II Semester		L	T	P	C
		0	0	2	1
COMMUNICATION SKILLS LAB (HS1203)					

UNIT I:
Oral Activity: JAM, Hypothetical Situations, Self/Peer Profile
Common Errors in Pronunciation, Neutralising Accent

UNIT II:
Oral Activity: Telephonic Etiquette, Role Plays
Poster Presentations

UNIT III:
Oral Activity: Oral Presentation skills, Public speaking
Data Interpretation

UNIT IV:
Oral Activity: Group Discussions: Do's and Don'ts- Types, Modalities

UNIT V:
Oral Activity: Interview Skills: Preparatory Techniques, Frequently asked questions, Mock Interviews.
Pronunciation: Connected speech (Pausing, Tempo, Tone, Fluency etc.,)

References:

1. Infotech English, Maruthi Publications (with Compact Disc).
2. Exercises in Spoken English Part 1,2,3,4, OUP and CIEFL.
3. English Pronunciation in use- Mark Hancock, Cambridge University Press.
4. English Phonetics and Phonology-Peter Roach, Cambridge University Press.
5. English Pronunciation in use- Mark Hewings, Cambridge University Press.
6. English Pronunciation Dictionary- Daniel Jones, Cambridge University Press.
7. English Phonetics for Indian Students- P. Bala Subramanian, Mac Millan Publications.
8. Technical Communication- Meenakshi Raman, Sangeeta Sharma, Oxford University Press.
9. Technical Communication- Gajendrea Singh Chauhan, Smita Kashiramka, Cengage Publications.

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DEPARTMENT OF MECHANICAL ENGINEERING

I Year - II Semester		L	T	P	C
		0	0	2	1.5
ENGINEERING CHEMISTRY LAB (BS1211)					

Introduction to Chemistry laboratory – Molarity, normality, primary, secondary standard solutions, volumetric titrations, quantitative analysis

1. Determination of HCl using standard Na_2CO_3 solution.
2. Determination of alkalinity of a sample containing Na_2CO_3 and NaOH.
3. Determination of Mn (II) using standard oxalic acid solution.
4. Determination of ferrous iron using standard $K_2Cr_2O_7$ solution.
5. Determination of copper (II) using standard hypo solution.
6. Determination of temporary and permanent hardness of water using standard EDTA solution.
7. Determination of iron (III) by a colorimetric method.
8. Determination of the concentration of acetic acid using sodium hydroxide (pH-metry method).
9. Determination of the concentration of strong acid vs strong base (by conductometric method).
10. Determination of strong acid vs strong base (by potentiometric method).
11. Determination of Mg^{+2} present in an antacid.
12. Determination of $CaCO_3$ present in an egg shell.
13. Estimation of Vitamin C.
14. Determination of phosphoric content in soft drinks.
15. Adsorption of acetic acid by charcoal.
16. Preparation of nylon-6, 6 and Bakelite (demonstration only).

Of the above experiments at-least 10 assessment experiments should be completed in a semester.
Outcomes: The students entering into the professional course have practically very little exposure to lab classes. The experiments introduce volumetric analysis; redox titrations with different indicators; EDTA titrations; then they are exposed to a few instrumental methods of chemical analysis. Thus at the end of the lab course, the student is exposed to different methods of chemical analysis and use of some commonly employed instruments. They thus acquire some experimental skills.

Reference Books

1. A Textbook of Quantitative Analysis, Arthur J. Vogel.

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I Year - II Semester		L	T	P	C
		0	0	3	1.5
BASIC ELECTRICAL & ELECTRONICS ENGINEERING LAB (ES1208)					

Learning Objectives:

- To predetermine the efficiency of dc shunt machine using Swinburne's test.
- To predetermine the efficiency and regulation of 1-phase transformer with O.C and S.C tests.
- To obtain performance characteristics of DC shunt motor &3-phase induction motor.
- To find out regulation of an alternator with synchronous impedance method.
- To control speed of dc shunt motor using Armature voltage and Field flux control methods.
- To find out the characteristics of PN junction diode & transistor
- To determine the ripple factor of half wave & full wave rectifiers.

Section A: Electrical Engineering:

The following experiments are required to be conducted as compulsory experiments:

1. Swinburne's test on D.C. Shunt machine (predetermination of efficiency of a given D.C. shunt machine working as motor and generator).
2. OC and SC tests on single phase transformer (predetermination of efficiency and regulation at given power factors).
3. Brake test on 3-phase Induction motor (determination of performance characteristics)
4. Regulation of alternator by Synchronous impedance method.
5. Speed control of D.C. Shunt motor by
   a) Armature Voltage control b) Field flux control method
6. Brake test on D.C. Shunt Motor.

Section B: Electronics Engineering:

The following experiments are required to be conducted as compulsory experiments:

1. PN junction diode characteristics a) Forward bias b) Reverse bias (Cut in voltage and resistance calculations)
2. Transistor CE characteristics (input and output)
3. Half wave rectifier with and without filters.
4. Full wave rectifier with and without filters.
5. CE amplifiers.
6. OP- amp applications (inverting, non inverting, integrator and differentiator)

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Learning Outcomes:

The student should be able to:

- Compute the efficiency of DC shunt machine without actual loading of the machine.
- Estimate the efficiency and regulation at different load conditions and power factors for single phase transformer with OC and SC tests.
- Analyse the performance characteristics and to determine efficiency of DC shunt motor &3-Phase induction motor.
- Pre-determine the regulation of an alternator by synchronous impedance method.
- Control the speed of dc shunt motor using Armature voltage and Field flux control methods.
- Draw the characteristics of PN junction diode & transistor
- Determine the ripple factor of half wave & full wave rectifiers.

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I Year - II Semester		L	T	P	C
		0	0	3	1.5
WORKSHOP PRACTICE LAB (ES1219)					

Course Objective: To impart hands-on practice on basic engineering trades and skills.
Note: At least two exercises to be done from each trade.
Trade:

1.Carpentry	1. T-Lap Joint
	2. Cross Lap Joint
	3. Dovetail Joint
	4. Mortise and Tenon Joint
2.Fitting	1. Vee Fit
	2. Square Fit
	3. Half Round Fit
	4. Dovetail Fit
3.Black Smithy	1. Round rod to Square
	2. S-Hook
	3. Round Rod to Flat Ring
	4. Round Rod to Square headed bolt
4.House Wiring	1. Parallel / Series Connection of three bulbs
	2. Stair Case wiring
	3. Florescent Lamp Fitting
	4. Measurement of Earth Resistance
5.Tin Smithy	1. Taper Tray
	2. Square Box without lid
	3. Open Scoop
	4. Funnel
6.IT Workshop	1.Assembly & Disassembly of Computer

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I Year - II Semester		L	T	P	C
		0	0	2	1
ENGINEERING EXPLORATION PROJECT (PR1201)					

COURSE OBJECTIVES:

- Build mindsets & foundations essential for designers
- Learn about the Human-Centered Design methodology and understand their real-world applications
- Use Design Thinking for problem solving methodology for investigating illdefined problems.
- Undergo several design challenges and work towards the final design challenge

Apply Design Thinking on the following Streams to

- Project Stream 1: Electronics, Robotics, IOT and Sensors
- Project Stream 2: Computer Science and IT Applications
- Project Stream 3: Mechanical and Electrical tools
- Project Stream4: Eco-friendly solutions for waste management, infrastructure, safety, alternative energy sources, Agriculture, Environmental science and other fields of engineering.

HOW TO PURSUE THE PROJECT WORK?

- The first part will be learning-based-masking students to embrace the methodology by exploring all the phases of design thinking through the wallet/ bag challenge and podcasts.
- The second part will be more discussion-based and will focus on building some necessary skills as designers and learning about complementary material for human- centered design.
- The class will then divide into teams and they will be working with one another for about 2 – 3 weeks. These teams and design challenges will be the basis for the final project and final presentation to be presented.
- The teams start with **Design Challenge** and go through all the phases more in depth from coming up with the right question to empathizing to ideating to prototyping and to testing.
- Outside of class, students will also be gathering the requirements, identifying the challenges, usability, importance etc
- At the end, Students are required to submit the final reports, and will be evaluated by the faculty.

TASKS TO BE DONE:

Task 1: Everyone is a Designer

- Understand class objectives & harness the designer mindset

Task 2: The Wallet/Bag Challenge and Podcast

- Gain a quick introduction to the design thinking methodology
- Go through all stages of the methodology through a simple design challenge
- Podcast: Observe, Listen and Engage with the surrounding environment and identify a design challenge.

Task 3: Teams & Problems

- Start Design Challenge and learn about teams & problems through this
- Foster team collaboration, find inspiration from the environment and learn how to identify problems

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Task 4: Empathizing
- Continue Design Challenge and learn empathy
- Learn techniques on how to empathize with users
- Go to the field and interview people in their environments
- Submit Activity Card

Task 5: Ideating
- Continue Design Challenge and learn how to brainstorm effectively
- Encourage exploration and foster spaces for brainstorming
- Submit Activity Card

Task 6: Prototyping
- Continue Design Challenge and learn how to create effective prototypes
- Build tangible models and use them as communication tools
- Start giving constructive feedback to classmates and teammates
- Submit Activity Card

Task 7: Testing
- Finish Design Challenge and iterate prototypes and ideas through user feedback
- Evolve ideas and prototypes through user feedback and constructive criticism
- Get peer feedback on individual and group performance
- Submit Activity Card

Task 8:
- Final Report Submission and Presentation

Note: The colleges may arrange for Guest Speakers from Various Design Fields: Graphic Design, Industrial Design, Architecture, Product Design, Organizational Design, etc to enrich the students with Design Thinking Concept.

REFERENCES:

1. Tom Kelly, *The Art of Innovation: Lessons in Creativity From IDEO, America's Leading Design Firm* (Profile Books, 2002)
2. Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation (HarperBusiness, 2009)
3. Jeanne Liedtka, Randy Salzman, and Daisy Azer, Design Thinking for the Greater Good: Innovation in the Social Sector (Columbia Business School Publishing, 2017)

OTHER USEFUL DESIGN THINKING FRAMEWORKS AND METHODOLOGIES:

- Human-Centered Design Toolkit (IDEO); https://www.ideo.com/post/design-kit
- Design Thinking Boot Camp Bootleg (Stanford D-School); https://dschool.stanford.edu/resources/the-bootcamp-bootleg
- Collective Action Toolkit (frogdesign); https://www.frogdesign.com/wpcontent/uploads/2016/03/CAT_2.0_English.pdf
- Design Thinking for Educators (IDEO); https://designthinkingforeducators.com/

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II Year - I Semester		L	T	P	C
		3	0	0	3
VECTOR CALCULAUS & FOURIER TRANSFORMS					

Course Objectives:

- To familiarize the techniques in partial differential equations.
- To furnish the learners with basic concepts and techniques at plus two level to lead them into advanced level by handling various real world applications.

Course Objectives: At the end of the course, the student will be able to

- Interpret the physical meaning of different operators such as gradient, curl and divergence (L5)
- Estimate the work done against a field, circulation and flux using vector calculus (L5)
- Apply the Laplace transform for solving differential equations (L3).
- Find or compute the Fourier series of periodic signals (L3)
- Know and be able to apply integral expressions for the forwards and inverse Fourier transform to a range of non-periodic waveforms (L3)
- Identify solution methods for partial differential equations that model physical processes (L3)

UNIT I: Vector calculus: (10 hrs)

Vector Differentiation: Gradient — Directional derivative — Divergence — Curl — Scalar Potential. Vector Integration: Line integral — Work done — Area — Surface and volume integrals — Vector integral theorems: Greens, Stokes and Gauss Divergence theorems (without proof).

UNIT II:Laplace Transforms: (10 hrs)

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).

Applications: Solving ordinary differential equations (initial value problems) using Laplace transforms.

UNIT III:Fourier series and Fourier Transforms: (10 hrs)

Fourier Series: Introduction — Periodic functions — Fourier series of periodic function — Dirichlet's conditions — Even and odd functions — Change of interval — Half-range sine and cosine series.

Fourier Transforms: Fourier integral theorem (without proof) — Fourier sine and cosine integrals — Sine and cosine transforms — Properties — inverse transforms — Finite Fourier transforms.

UNIT IV:PDE of first order: (8 hrs)

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions — Solutions of first order linear (Lagrange) equation and nonlinear (standard types) equations.

UNIT V: Second order PDE and Applications: (10 hrs)

Second order PDE: Solutions of linear partial differential equations with constant coefficients — RHS term of the type e^{ax+by} ,sin(ax + by), cos(ax + by), $x^m y^n$

Applications of PDE: Method of separation of Variables — Solution of One dimensional Wave, Heat and two-dimensional Laplace equation.

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Text Books:

1. **B.S. Grewal,** Higher Engineering Mathematics, 43rd Edition, Khanna Publishers.
2. **B. V. Ramana**, Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

Reference Books:

1. **Erwin Kreyszig**, Advanced Engineering Mathematics, 10thEdition, Wiley-India.
2. **Dean. G. Duffy**, Advanced Engineering Mathematics with MATLAB, 3rd Edition, CRC Press.
3. **Peter O' Neil**, Advanced Engineering Mathematics, Cengage.
4. **Srimantha Pal, S C Bhunia,** Engineering Mathematics, Oxford University Press.

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DEPARTMENT OF MECHANICAL ENGINEERING

II Year - I Semester		L	T	P	C
		3	0	0	3
MECHANICS OF SOLIDS					

Objective: The students completing this course are expected to understand the basic terms like stress, strain, poissons ratio…etc and different stresses and deflections induced in beams, thin cylinders, thick cylinders, and columns. Further, the student shall be able to understand the shear stresses due to torsion in circular shafts.

UNIT – I
SIMPLE STRESSES & STRAINS : Elasticity and plasticity – Types of stresses & strains–Hooke's law – stress – strain diagram for mild steel – Working stress – Factor of safety – Lateral strain, Poisson's ratio & volumetric strain – Bars of varying section – composite bars – Temperature stresses- Complex Stresses - Stresses on an inclined plane under different uniaxial and biaxial stress conditions - Principal planes and principal stresses - Mohr's circle - Relation between elastic constants, Strain energy – Resilience – Gradual, sudden, impact and shock loadings.

UNIT – II
SHEAR FORCE AND BENDING MOMENT : Definition of beam – Types of beams – Concept of shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, u.d.l, uniformly varying loads and combination of these loads – Point of contra flexure – Relation between S.F., B.M and rate of loading at a section of a beam.

UNIT – III
FLEXURAL STRESSES : Theory of simple bending – Assumptions – Derivation of bending equation: M/ I = f/y = E/R Neutral axis – Determination bending stresses – section modulus of rectangular and circular sections (Solid and Hollow), I,T, Angle and Channel sections – Design of simple beam sections.
SHEAR STRESSES: Derivation of formula – Shear stress distribution across various beams sections like rectangular, circular, triangular, I, T angle sections.

UNIT – IV
DEFLECTION OF BEAMS : Bending into a circular arc – slope, deflection and radius of curvature – Differential equation for the elastic line of a beam – Double integration and Macaulay's methods – Determination of slope and deflection for cantilever and simply supported beams subjected to point loads, - U.D.L uniformly varying load. Mohr's theorems – Moment area method – application to simple cases including overhanging beams, Statically indeterminate Beams and solution methods.
TORSION: Introduction-Derivation- Torsion of Circular shafts- Pure Shear-Transmission of power by circular shafts, Shafts in series, Shafts in parallel.
UNIT – V
THIN AND THICK CYLINDERS: Thin seamless cylindrical shells – Derivation of formula for longitudinal and circumferential stresses – hoop, longitudinal and Volumetric strains – changes in dia, and volume of thin cylinders – Riveted boiler shells – Thin spherical shells. Wire wound thin cylinders. Lame's equation – cylinders subjected to inside & outside pressures –compound cylinders.
COLUMNS:

Buckling and Stability, Columns with Pinned ends, Columns with other support Conditions, Limitations of Euler's Formula, Rankine's Formula,

TEXT BOOK:

1. Strength of materials /GH Ryder/ Mc Millan publishers India Ltd.
2. Strength of materials by B.C. Punmia-lakshmi publications pvt.Ltd, New Delhi.

REFERENCES :

1. Mechanics of Materials by Gere & Timeshenko
2. Strength of Materials -By Jindal, Umesh Publications.
3. Strength of Materials by S.Timshenko- D. VAN NOSTRAND Company- PHI Publishers
4. Strength of Materials by Andrew Pytel and Ferdinond L. Singer Longman- Harpercollins College Division
5. Solid Mechanics, by Popov-
6. Mechanics of Materials/Gere and Timoshenko, CBS Publishers

Course outcomes:

On the completion of the course the student will able to

CO1: Model & Analyze the behavior of basic structural members subjected to various loading and support conditions based on principles of equilibrium.
CO2: Understand the apply the concept of stress and strain to analyze and design structural members and machine parts under axial, shear and bending loads, moment and torsional moment.
CO3: Students will learn all the methods to analyze beams, columns, frames for normal, shear, and torsion stresses and to solve deflection problems in preparation for the design of such structural components. Students are able to analyse beams and draw correct and complete shear and bending moment diagrams for beams.
CO4: Students attain a deeper understanding of the loads, stresses, and strains acting on a structure and their relations in the elastic behavior
CO5: Design and analysis of Industrial components like pressure vessels.

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DEPARTMENT OF MECHANICAL ENGINEERING

II Year - I Semester		L	T	P	C
		3	0	0	3
MATERIALS SCIENCE & METALLURGY					

***Course Objective**: To understand the basic fundamentals of Material science and Physical metallurgy. The basic concepts to be taught will help for the improvement, proper selection and effective utilization of materials which is essential to satisfy the ever increasing demands of the society.*

UNIT – I

Structure of Metals and Constitution of alloys: Bonds in Solids, Metallic bond, crystallization of metals, Packing Factor - SC, BCC, FCC& HCP-line density, plane density. Grain and grain boundaries, effect of grain boundaries on the Properties of metal / alloys – determination of grain size. Imperfections – point, line, surface and volume- Slip and Twinning.

Necessity of alloying, types of solid solutions, Hume Rotherys rules, intermediate alloy phases, and electron compounds

Equilibrium Diagrams : Experimental methods of construction of equilibrium diagrams, Isomorphous alloy systems, equilibrium cooling and heating of alloys, Lever rule, coring miscibility gaps, eutectic systems, congruent melting intermediate phases, peritectic reaction. Transformations in the solid state – allotropy, eutectoid, peritectoid reactions, phase rule, relationship between equilibrium diagrams and properties of alloys. Study of binary phase diagrams such as Cu-Ni and Fe-Fe_3C.

UNIT –II

Ferrous metals and alloys: Structure and properties of White Cast iron, Malleable Cast iron, grey cast iron, Spheriodal graphite cast iron, Alloy cast irons. Classification of steels, structure and properties of plain carbon steels, Low alloy steels, Hadfield manganese steels, tool and die steels.

Non-ferrous Metals and Alloys: Structure and properties of Copper and its alloys, Aluminium and its alloys, Titanium and its alloys, Magnesium and its alloys, Super alloys.

UNIT – III

Heat treatment of Alloys: Effect of alloying elements on Fe-Fe_3C system, Annealing, normalizing, hardening, TTT diagrams, tempering, hardenability, surface - hardening methods, Age hardening treatment, Cryogenic treatment of alloys.

UNIT – IV

Powder Metallurgy: Basic processes- Methods of producing metal powders- milling atomization-Granulation-Reduction-Electrolytic Deposition. Compacting methods – Sintering - Methods of manufacturing sintered parts. Sintering Secondary operations-Sizing, coining, machining -Factors determining the use of powder metallurgy-Application of this process.

UNIT – V

Ceramic and composite materials: Crystalline ceramics, glasses, cermets, abrasive materials,

Classification of composites, various methods of component manufacture of composites, particle – reinforced materials, fiber reinforced materials, metal ceramic mixtures, metal – matrix composites and C – C composites. Nanomaterials – definition, properties and applications.

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TEXT BOOKS:

1. Introduction to Physical Metallurgy - Sidney H. Avener - McGrawHill
2. Essential of Materials science and engineering - Donald R.Askeland - Cengage.

REFERENCES :

1. Material Science and Metallurgy – Dr. V.D.kodgire- Everest Publishing House
2. Materials Science and engineering - Callister & Baalasubrahmanyam- Wiley Publications
3. Material Science for Engineering students – Fischer – Elsevier Publishers
4. Material science and Engineering - V. Rahghavan-PHI Publishers
5. Introduction to Material Science and Engineering – Yip-Wah Chung CRC Press
6. Material Science and Metallurgy – A V K Suryanarayana – B S Publications
7. Material Science and Metallurgy – U. C. Jindal – Pearson Publications

Course Outcomes:

CO1: Understand the crystalline structure of different metals and study the stability of phases in different alloy systems.
CO2: Study the behavior of ferrous and non ferrous metals and alloys and their application in different domains
CO3: Able to understand the effect of heat treatment, addition of alloying elements on properties of ferrous metals.
CO4: Grasp the methods of making of metal powders and applications of powder metallurgy
CO5: Comprehend the properties and applications of ceramic, composites and other advanced methods.

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II Year - I Semester		L	T	P	C
		3	0	0	3
PRODUCTION TECHNOLOGY					

Course Objective:

To impart basic knowledge and understanding about the primary manufacturing processes such as casting, joining, bulk forming, sheet metal forming and powder metallurgy and their relevance in current manufacturing industry.

UNIT – I

CASTING : Steps involved in making a casting – Advantage of casting and its applications. Patterns and Pattern making – Types of patterns – Materials used for patterns, pattern allowances and their construction, Molding – molding methods - ingredients of molding sand –. Molding materials, Properties of molding sand, Testing of molding sand. Types of molding – Hand molding – Machine molding. Core – different types of cores – materials – properties of core sand – core manufacturing.

UNIT – II

Principles of Gating, Gating ratio and design of Gating systems. Risers – Types, function and design, casting design considerations. Methods of melting and types of furnaces - cupola, electric arc, resistance and induction furnace. Solidification of castings-Solidification of pure metals and alloys-Short & long freezing range alloys. Fettling. Casting defects. Basic principles and applications of special casting processes - Centrifugal casting – True, semi and centrifuging, Die casting, Investment casting and shell molding.

UNIT – III

Welding : Classification of welding processes, types of welded joints and their characteristics, Gas welding, Different types of flames and uses, Oxy – Acetylene Gas cutting. Basic principles of Arc welding, power characteristics, Manual metal arc welding, Submerged arc welding, TIG & MIG welding. Electro – slag welding.

Resistance welding, Friction welding, Friction stir welding, Forge welding, Explosive welding; Thermit welding, Plasma Arc welding, Laser welding, electron beam welding, Soldering & Brazing.

Heat affected zones in welding; pre & post heating, Weldability of metals, welding defects – causes and remedies – destructive and nondestructive testing of welds.

UNIT – IV

Plastic deformation in metals and alloys-recovery, recrystallization and grain growth. Hot working and Cold working-Strain hardening and Annealing. Bulk forming processes: Forging - Types of Forging, Smith forging, Drop Forging, Roll forging, Forging hammers, Rotary forging, forging defects; Rolling – fundamentals, types of rolling mills and products, Forces in rolling and power requirements. Extrusion and its characteristics. Types of extrusion, Impact extrusion, Hydrostatic extrusion; Wire drawing and Tube drawing.

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UNIT – V

Sheet metal forming - Blanking and piercing, Forces and power requirement in these operations, Deep drawing, Stretch forming, Bending, Spring back and its remedies, Coining, Spinning, Types of presses and press tools.

High energy rate forming processes: Principles of explosive forming, electromagnetic forming, Electro hydraulic forming, rubber pad forming, advantages and limitations.

TEXT BOOKS:

1. Manufacturing Processes for Engineering Materials – Kalpakjian S and Steven R Schmid- Pearson Publ , 5th Edn.
2. Manufacturing Technology -Vol I- P.N. Rao- TMH

REFERENCES :

1. Manufacturing Science – A.Ghosh & A.K.Malik – East West Press Pvt. Ltd
2. Process and materials of manufacture- Lindberg- PHI
3. Production Technology- R.K. Jain- Khanna
4. Production Technology-P C Sharma-S. Chand
5. Manufacturing Processes- H.S. Shaun- Pearson
6. Manufacturing Processes- J.P. Kaushish- PHI
7. Workshop Technology -WAJ Chapman/CBS Publishers&Distributors Pvt.Ltd.
8. Production Technology-HMT- Tata McGrawHill

Course Outcomes:

CO1: Able to design the patterns and core boxes for metal casting processes
CO2: Able to design the gating system for different metallic components
CO3: Know the different types of manufacturing processes
CO4: Be able to use forging, extrusion processes
CO5: Learn about the different types of welding processes used for special fabrication.

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II Year - I Semester		L	T	P	C
		3	0	0	3
THERMODYNAMICS					

Course Objectives:
To impart the knowledge of the thermodynamic laws and principles so as to enable the student to prepare an energy audit of any mechanical system that exchange heat and work with the surroundings.

UNIT – I

Introduction: Basic Concepts : System, boundary, Surrounding, Universe, control volume, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process - Reversible, Quasi static & Irreversible Processes, cycle, Causes of Irreversibility. Energy in State and in Transition - Types, Work and Heat, Point and Path function.
Zeroth Law of Thermodynamics – Concept of Temperature – Principles of Thermometry –Reference Points – Const. Volume gas Thermometer – Scales of Temperature.

UNIT – II

Joule's Experiments – First law of Thermodynamics – Corollaries – First law applied to a Process – applied to a flow system –Energy balance for closed systems-Specific heats- Internal energy, Enthalpy and Specific heats of Solids, liquids and Ideal gases, Some steady flow energy equation applied to Nozzle, Turbine, Compressor and heat exchanger devices, PMM-I.

UNIT III

Limitations of the First Law – Thermal Reservoir, Heat Engine, Heat pump, Parameters of performance, Second Law of Thermodynamics, Kelvin-Planck and Clausius Statements and their Equivalence, Corollaries, PMM of Second kind, Carnot cycle and its specialties, Carnot's theorem, Thermodynamic scale of Temperature.
Clausius Inequality, Entropy, Principle of Entropy Increase, Availability and Irreversibility (Basic definitions) – Thermodynamic Potentials, Gibbs and Helmholtz Functions, Maxwell Relations – Elementary Treatment of the Third Law of Thermodynamics.

UNIT IV

Pure Substances, P-V-T- surfaces, T-S and h-s diagrams, Mollier Charts, Phase Transformations – Triple point and critical point, properties during change of phase, Dryness Fraction – Clausius – Clapeyron Equation, Property tables. Various Thermodynamic processes and energy Transfer – Steam Calorimetry.

UNIT – V

Ideal Gas equation of state- Compressibility factor- Van der Waals equation of state- Beattie-Bridgeman equation of state- Benedict-Webb-Rubin equation of state- Viral equation of state- compressibility charts – variable specific heats .
Mixtures of perfect Gases – Dalton's Law of partial pressure, Avogadro's Laws of additive volumes-Equivalent Gas constant and Molecular Internal Energy, Enthalpy, Specific Heat and Entropy of Mixture of Perfect Gases and Vapour.

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Psychrometric Properties – Dry bulb Temperature, Wet Bulb Temperature, Dew point Temperature, Thermodynamic Wet Bulb Temperature, Specific Humidity, Relative Humidity, Saturated Air, Vapour pressure, Degree of saturation – Adiabatic Saturation , Carrier's Equation – Psychrometric chart.

TEXT BOOKS:

1. Engineering Thermodynamics, PK Nag 6th Edn , McGraw Hill.
2. Fundamentals of Thermodynamics – Sonntag, Borgnakke, Van Wylen, 6th Edn, Wiley

REFERENCES:

1. Thermodynamics by Prasanna Kumar, Pearson Publishers
2. Engineering Thermodynamics – Jones & Dugan PHI
3. Thermodynamics, an Engineering Approach, Yunus A Cenegel, Michael A Boles, 8th Edn in SI Units, McGraw Hill.
4. Thermodynamics – J.P.Holman , McGrawHill
5. An Introduction to Thermodynamics - Y.V.C.Rao – Universities press.
6. Thermodynamics – W.Z.Black & J.G.Hartley, 3rd Edn Pearson Publ.
7. Engineering Thermodynamics – D.P.Misra, Cengage Publ.
8. Engineering Thermodynamics – P.Chattopadhyay – Oxford Higher Edn Publ.

COURSE OUTCOMES:

After undergoing the course the student is expected to learn
CO1: Basic concepts of thermodynamics
CO2: Laws of thermodynamics
CO3: Concept of entropy
CO4: Property evaluation of vapors and their depiction in tables and charts
CO5: Evaluation of properties of perfect gas mixtures.

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II Year - I Semester		L	T	P	C
		1	0	3	2.5
MACHINE DRAWING					

Course Objective: *The student will acquire knowledge in national and International standards while drawing machine components students will also familiarize in drawing assembly, orthographic and sectional views of various machine components.*

Machine Drawing Conventions:

Need for drawing conventions – introduction to IS conventions-Standardization-Interchangeability-Selective assembly-Tolerance

a) Conventional representation of materials, common machine elements and parts such as screws, nuts, bolts, keys, gears, webs, ribs.
b) Types of sections – selection of section planes and drawing of sections and auxiliary sectional views. Parts not usually sectioned.
c) Methods of dimensioning, general rules for sizes and placement of dimensions for holes, centers, curved tapered features and surface finish indication
d) Title boxes, their size, location and details - common abbreviations & their liberal usage
e) Types of Drawings – working drawings for machine parts.

PART-A

I. Drawing of Machine Elements and simple parts

Objective: To provide basic understanding and drawing practice of various joint, simple mechanical parts

Selection of Views, additional views for the following machine elements and parts with every drawing proportions.

a) Popular forms of Screw threads, bolts, nuts, stud bolts, tap bolts, set screws.
b) Keys, cotter joints, knuckle joint, Hook's joint
c) Riveted joints for plates
d) Shaft couplings.
e) Journal, pivot and collar and foot step bearings.

PART-B

II. Assembly Drawings:

Objective: The student will be able to draw the assembly from the individual part drawing.

Drawings of assembled views for the part drawings of the following using conventions and easy drawing proportions.

a) Engine parts –Gear pump, Fuel pump, petrol Engine connecting rod, piston, stuffing box and eccentric assembly.
b) Other machine parts - Screws jack, Machine swivel vice, Plummer block, Tailstock and Tool post.

III. Manufacturing Drawing

Introduction of Limits and fits, fundamental deviations for Hole based and Shaft based systems, alpha numeric designation of limits & fits. Types of Fits. Form and positional tolerances.

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Conventional practices of indicating limits and fits, geometrical form and position tolerances, surface finish and surface treatments requirements. Study of Examples involving selection of fits and calculation of limits. Suggestion of suitable fits for mating parts.
Representation of limits fits and tolerances for mating parts. Use any four parts of above assembly drawings and prepare manufacturing drawing with dimensional and geometric tolerances.

TEXT BOOKS:
1. Machine Drawing – N.Siddeswar, K.Kannaiah & V.V.S.Sastry - TMH
2. Machine Drawing –K.L.Narayana, P.Kannaiah & K. Venkata Reddy / New Age/ Publishers
3. Production Drawing- K.L.Narayana, P.Kannaiah & K. Venkata Reddy / New Age/ Publishers

REFERENCES:
1. Machine Drawing – P.S.Gill,
2. Machine Drawing – Luzzader
3. Machine Drawing – Rajput
4. Machine Drawing – N.D. Junnarkar, Pearson
5. Machine Drawing – Ajeeth Singh, McGraw Hill
6. Machine Drawing – KC John, PHI
7. Machine Drawing – B Battacharya, Oxford
8. Machine Drawing – Gowtham and Gowtham, Pearson
9. Machine Drawing- Dhawan R K- S.chand&Company

Course Outcome:
CO1. Draw and represent standard dimensions of different mechanical fasteners and joints and Couplings.
CO2. Draw different types of bearings showing different components.
CO3. Assemble components of a machine part and draw the sectional assembly drawing showing the dimensions of all the components of the assembly as per bill of materials
CO4. Select and represent fits and geometrical form of different mating parts in assembly drawings.
CO5: To prepare manufacturing drawings indicating fits, tolerances, surface finish and surface treatment requirements.

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II Year - I Semester		**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**
METALLURGY& MECHANICS OF SOLIDS LAB					

Course Objective: To impart practical exposure on the microstructures of various materials and their hardness evaluation. Also to impart practical knowledge on the evaluation of material properties through various destructive testing procedures.

NOTE: Any 6 experiments from each section A and B.

(A) MECHNICS OF SOLIDS LAB:

1. Direct tension test
2. Bending test on
a) Simple supported
b) Cantilever beam
3. Torsion test
4. Hardness test
a) Brinells hardness test
b) Rockwell hardness test
5. Test on springs
6. Compression test on cube
7. Impact test
8. Punch shear test

(B) METALLURGY LAB:

1. Preparation and study of the Microstructure of pure metals like Iron, Cu and Al.
2. Preparation and study of the Microstructure of Mild steel, Medium carbon steels, High carbon steels.
3. Study of the Micro Structures of Cast Irons.
4. Study of the Micro Structures of Non-Ferrous alloys.
5. Study of the Micro structures of Heat treated steels.
6. Hardeneability of steels by Jominy End Quench Test.
7. To find out the hardness of various treated and untreated steels.

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II Year - I Semester		**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**
PRODUCTION TECHNOLOGY LAB					

Course Objective: To impart hands-on practical exposure on manufacturing processes and equipment.

1. Design and making of pattern
   i. Single piece pattern
   ii. Split pattern
2. Sand properties testing
   i. Sieve analysis (dry sand)
   ii. Clay content test
   iii. Moisture content test
   iv. Strength test (Compression test & Shear test)
   v. Permeability test
3. Mould preparation
   i. Straight pipe
   ii. Bent pipe
   iii. Dumble
   iv.Gear blank
4. Gas cutting and welding
5. Manual metal arc welding
   i. Lap joint
   ii. Butt joint
6. Injection Molding
7. Blow Molding
8. Simple models using sheet metal operations
9. Study of deep drawing and extrusion operations
10. Study of Basic powder compaction and sintering
11. Study of TIG/MIG Welding
12. Study of Resistance Spot Welding
13. Study of Brazing and soldering
14. Study of Plastic Moulding Process.

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II Year - I Semester		L	T	P	C
		3	0	0	0
ENVIRONMENTAL SCIENCE					

Learning Objectives:
The objectives of the course are to impart:

- Overall understanding of the natural resources.
- Basic understanding of the ecosystem and its diversity.
- Acquaintance on various environmental challenges induced due to unplanned anthropogenic activities.
- An understanding of the environmental impact of developmental activities.
- Awareness on the social issues, environmental legislation and global treaties.

UNIT-I:
Multidisciplinary nature of Environmental Studies: Definition, Scope and Importance –Sustainability: Stockholm and Rio Summit–Global Environmental Challenges: Global warming and climate change, acid rains, ozone layer depletion, population growth and explosion, effects;. Role of information technology in environment and human health.
Ecosystems: Concept of an ecosystem. - Structure and function of an ecosystem; Producers, consumers and decomposers. - Energy flow in the ecosystem - Ecological succession. - Food chains, food webs and ecological pyramids; Introduction, types, characteristic features, structure and function of Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems.

UNIT-II:
Natural Resources: Natural resources and associated problems.
Forest resources: Use and over – exploitation, deforestation – Timber extraction – Mining, dams and other effects on forest and tribal people.
Water resources: Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems.
Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources.
Food resources: World food problems, changes caused by non-agriculture activities-effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity.
Energy resources: Growing energy needs, renewable and non-renewable energy sources use of alternate energy sources.
Land resources: Land as a resource, land degradation, Wasteland reclamation, man induced landslides, soil erosion and desertification; Role of an individual in conservation of natural resources; Equitable use of resources for sustainable lifestyles.

UNIT-III:
Biodiversity and its conservation: Definition: genetic, species and ecosystem diversity-classification - Value of biodiversity: consumptive use, productive use, social-Biodiversity at national and local levels. India as a mega-diversity nation - Hot-sports of biodiversity - Threats to biodiversity: habitat loss, man-wildlife conflicts. - Endangered and endemic species of India – Conservation of biodiversity: conservation of biodiversity.

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UNIT – IV Environmental Pollution: Definition, Cause, effects and control measures of Air pollution, Water pollution, Soil pollution, Noise pollution, Nuclear hazards. Role of an individual in prevention of pollution. - Pollution case studies, Sustainable Life Studies. Impact of Fire Crackers on Men and his well being.
Solid Waste Management: Sources, Classification, effects and control measures of urban and industrial solid wastes. Consumerism and waste products, Biomedical, Hazardous and e – waste management.
UNIT – V Social Issues and the Environment: Urban problems related to energy -Water conservation, rain water harvesting-Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Environmental Protection Act -Air (Prevention and Control of Pollution) Act. –Water (Prevention and control of Pollution) Act -Wildlife Protection Act - Forest Conservation Act-Issues involved in enforcement of environmental legislation. -Public awareness.
Environmental Management: Impact Assessment and its significance various stages of EIA, preparation of EMP and EIS, Environmental audit. Ecotourism, Green Campus – Green business and Green politics.
The student should Visit an Industry / Ecosystem and submit a report individually on any issues related to Environmental Studies course and make a power point presentation.

Text Books:
1. Environmental Studies, K. V. S. G. Murali Krishna, VGS Publishers, Vijayawada
2. Environmental Studies, R. Rajagopalan, 2nd Edition, 2011, Oxford University Press.
3. Environmental Studies, P. N. Palanisamy, P. Manikandan, A. Geetha, and K. Manjula Rani; Pearson Education, Chennai

Reference:
1. Text Book of Environmental Studies, Deeshita Dave & P. Udaya Bhaskar, Cengage Learning.
2. A Textbook of Environmental Studies, Shaashi Chawla, TMH, New Delhi
3. Environmental Studies, Benny Joseph, Tata McGraw Hill Co, New Delhi
4. Perspectives in Environment Studies, Anubha Kaushik, C P Kaushik, New Age International Publishers, 2014

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II Year - I Semester		**L**	**T**	**P**	**C**
		0	**0**	**0**	**0.5**
SOCIALLY RELEVANT PROJECT					

Student can choose any one of the given below / any other socially relevant problem and work on it to produce a project document.

1. Water Conservation Related Works
2. Swatch Bharath (Internal External)
3. Helping police
4. Traffic monitoring
5. Teaching Rural Kids (Sarva siksha Abhiyan)
6. Street light monitoring
7. Electricity Conservation
8. Solar panel utilization
9. E- policing & cyber solution
10. Pollution
11. Any social related

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II Year - II Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
COMPLEX VARIABLES & STATISTICAL METHODS					

Course Objectives:

- To familiarize the complex variables.
- To familiarize the students with the foundations of probability and statistical methods.
- To equip the students to solve application problems in their disciplines.

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

- apply Cauchy-Riemann equations to complex functions in order to determine whether a given continuous function is analytic (L3)
- find the differentiation and integration of complex functions used in engineering problems (L5)
- make use of the Cauchy residue theorem to evaluate certain integrals (L3)
- apply discrete and continuous probability distributions (L3)
- design the components of a classical hypothesis test (L6)
- infer the statistical inferential methods based on small and large sampling tests (L4)

UNIT – I: Functions of a complex variable and Complex integration:

Introduction – Continuity – Differentiability – Analyticity – Properties – Cauchy-Riemann equations in Cartesian and polar coordinates – Harmonic and conjugate harmonic functions – Milne – Thompson method.
Complex integration: Line integral – Cauchy's integral theorem – Cauchy's integral formula – Generalized integral formula (all without proofs).

UNIT – II: Series expansions and Residue Theorem:

Radius of convergence – Expansion in Taylor's series, Maclaurin's series and Laurent series.
Types of Singularities: Isolated – pole of order m – Essential – Residues – Residue theorem (without proof) – Evaluation of real integral of the type $\int_{-\infty}^{\infty} f(x)dx$

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UNIT – III: Probability and Distributions:
Review of probability and Baye's theorem – Random variables – Discrete and Continuous random variables – Distribution function – Mathematical Expectation and Variance – Binomial, Poisson, Uniform and Normal distributions.

UNIT – IV: Sampling Theory:
Introduction – Population and samples – Sampling distribution of Means and Variance (definition only) – Central limit theorem (without proof) – Introduction to t, χ^2 and F-distributions – Point and Interval estimations – Maximum error of estimate.

UNIT – V: Tests of Hypothesis:
Introduction – Hypothesis – Null and Alternative Hypothesis – Type I and Type II errors – Level of significance – One tail and two-tail tests – Tests concerning one mean and two means (Large and Small samples) – Tests on proportions.

Text Books:

1. **B. S. Grewal,** Higher Engineering Mathematics, 43rd Edition, Khanna Publishers.
2. **Miller and Freund's,** Probability and Statistics for Engineers, 7/e, Pearson, 2008.

Reference Books:

1. **S. C. Gupta and V. K. Kapoor**, Fundamentals of Mathematical Statistics, 11/e, Sultan Chand & Sons Publications, 2012.
2. **Jay l. Devore,** Probability and Statistics for Engineering and the Sciences, 8th Edition, Cengage.
3. **Shron L. Myers, Keying Ye, Ronald E Walpole,** Probability and Statistics Engineers and the Scientists, 8th Edition, Pearson 2007.
4. **Sheldon, M. Ross**, Introduction to probability and statistics Engineers and the Scientists, 4th Edition, Academic Foundation, 2011

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II Year - II Semester		L	T	P	C
		3	0	0	3
KINEMATICS OF MACHINERY					

Course objective: The students completing this course are expected to understand the nature and role of the kinematics of machinery, mechanisms and machines. The course includes velocity and acceleration diagrams,analysis of mechanisms joints, Cams and their applications. It exposes the students to various kinds of power transmission devices like belt,rope , chain and gear drives and their working principles and their merits and demerits**.**

UNIT – I

MECHANISMS : Elements or Links – Classification – Rigid Link, flexible and fluid link – Types of kinematic pairs – sliding, turning, rolling, screw and spherical pairs – lower and higher pairs – closed and open pairs – constrained motion – completely, partially or successfully constrained and incompletely constrained.

Grashoff's law , Degrees of freedom ,Kutzbach criterian for planar mechanisms, Mechanism and machines – classification of machines – kinematic chain – inversion of mechanism – inversions of quadric cycle chain – single and double slider crank chains.

UNIT – II

LOWER PAIR MECHANISM: Exact and approximate copiers and generated types – Peaucellier, Hart and Scott Russul – Grasshopper – Watt T. Chebicheff and Robert Mechanisms and straight line motion, Pantograph.

Conditions for correct steering – Davis Steering gear, Ackermans steering gear – velocity ratio; Hooke's Joint: Single and double – Universal coupling–application–problems.

UNIT – III

KINEMATICS: Velocity and acceleration – Motion of a link in machine – Determination of Velocity and acceleration diagrams – Graphical method – Application of relative velocity method four bar chain. Velocity and acceleration analysis of for a given mechanism, Klein's construction, determination of Coriolis component of acceleration.

PLANE MOTION OF BODY: Instantaneous center of rotation, centroids and axodes – relative motion between two bodies – Three centres in line theorem – Graphical determination of instantaneous centre, diagrams for simple mechanisms and determination of angular velocity of points and links.

UNIT – IV

CAMS: Definitions of cam and followers – their uses – Types of followers and cams – Terminology – Types of follower motion: Uniform velocity, Simple harmonic motion and uniform acceleration and retardation. Maximum velocity and maximum acceleration during outward and return strokes in the above 3 cases.

Analysis of motion of followers: Roller follower – circular cam with straight, concave and convex flanks.

BELT DRIVES: Introduction, Belt and rope drives, selection of belt drive- types of belt drives,V-belts, materials used for belt and rope drives, velocity ratio of belt drives, slip of belt, creep of belt, tensions for

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flat belt drive, angle of contact, centrifugal tension, maximum tension of belt, Chains- length, angular speed ratio, classification of chains.

UNIT – V
GEARS
Higher pairs, friction wheels and toothed gears–types – law of gearing, condition for constant velocity ratio for transmission of motion, Form of teeth: cycloidal and involute profiles. Velocity of sliding – phenomena of interferences – Methods of interference. Condition for minimum number of teeth to avoid interference, expressions for arc of contact and path of contact – Introduction to Helical, Bevel and worm gearing.
GEAR TRAINS : Introduction to gear Trains, Train value, Types – Simple and reverted wheel train – Epicyclic gear Train. Methods of finding train value or velocity ratio – Epicyclic gear trains. Selection of gear box-Differential gear for an automobile.

TEXT BOOKS:
1. Theory of Mechanisms & Machines by Jagadeesh lal, Metropolitan Pvt.Ltd.
2. Theory of Machines by Thomas Bevan/ CBS Publishers

REFERENCES:
1. Theory of Machines – S. S Rattan- TMH Publishers
2. Theory of machines and Machinery-Vickers - Oxford .
3. Theory of Mechanisms and machines – A.Ghosh & A.K.Malik – East West Press Pvt. Ltd.
4. Kinematics and dynamics of Machinery- R.L Norton- TATA McGraw-Hill

Course outcomes:
The student should be able to
CO1: Contrive a mechanism for a given plane motion with single degree of freedom.
CO2: Suggest and analyze a mechanism for a given straight line motion and automobile steering motion.
CO3: Analyze the motion (velocity and acceleration) of a plane mechanism.
CO4: Suggest and analyze mechanisms for a prescribed intermittent motion like opening and closing of IC engine valves etc.
CO5: Select a power transmission system for a given application and analyze motion of different transmission systems

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II Year - II Semester		L	T	P	C
		3	0	0	3

APPLIED THERMODYNAMICS

Course objectives:
This course is intended to study the thermodynamic analysis of major components of Rankine cycle, refrigeration cycles and compressible fluids and to analyze the energy transfers and transformations in these components including individual performance evaluation.

UNIT – I
VAPOUR POWER CYCLES: Carnot, Rankine cycle - schematic layout, thermodynamic analysis, concept of mean temperature of heat addition, methods to improve cycle performance – regeneration & reheating.
COMBUSTION: Fuels and combustion, concepts of heat of reaction, adiabatic flame temperature, Stoichiometry, flue gas analysis.

UNIT II
BOILERS : Classification – working principles of L.P & H.P boilers with sketches – mountings and accessories – working principles, boiler horse power, equivalent evaporation, efficiency and heat balance – Draught: classification – height of chimney for given draught and discharge, condition for maximum discharge, efficiency of chimney – artificial draught, induced and forced.
UNIT – III
STEAM NOZZLES: Function of a nozzle – applications - types, flow through nozzles, thermodynamic analysis – assumptions -velocity of fluid at nozzle exit-Ideal and actual expansion in a nozzle, velocity coefficient, condition for maximum discharge, critical pressure ratio, criteria to decide nozzle shape: Super saturated flow - its effects, degree of super saturation and degree of under cooling, Wilson line.
STEAM TURBINES: Classification – impulse turbine; mechanical details – velocity diagram – effect of friction – power developed, axial thrust, blade or diagram efficiency – condition for maximum efficiency. De-laval turbine - methods to reduce rotor speed-velocity compounding, pressure compounding and velocity & pressure compounding, velocity and pressure variation along the flow – combined velocity diagram for a velocity compounded impulse turbine, condition for maximum efficiency
UNIT IV
REACTION TURBINE: Mechanical details – principle of operation, thermodynamic analysis of a stage, degree of reaction –velocity diagram – Parson's reaction turbine – condition for maximum efficiency – calculation of blade height.
STEAM CONDENSERS: Requirements of steam condensing plant – classification of condensers – working principle of different types – vacuum efficiency and condenser efficiency – air leakage, sources and its affects, air pump, cooling water requirement.
UNIT – V
COMPRESSORS – Classification –Reciprocating type, Principle of operation, work required, Isothermal efficiency, volumetric efficiency and effect of clearance, multi stage compression, saving of work, minimum work condition for two stage compression.

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Rotary (Positive displacement type)
Roots Blower, vane sealed compressor, Lysholm compressor – mechanical details and principle of working – efficiency considerations.
Rotary (non positive displacement type)
Centrifugal compressors: Mechanical details and principle of operation – velocity and pressure variation. Energy transfer-impeller blade shape-losses, velocity diagrams.
Axial Flow Compressors: Mechanical details and principle of operation, velocity diagrams.

TEXT BOOKS:
1. Basics & Applied Thermodynamics- P.K.Nag – 4th edition- McGraw Hill
2. Applied Thermodynamics - R Yadhav

REFERENCES:
1. Thermal Engineering- Mahesh Rathore - TataMcGrawHill
2. Heat Engineering (MKS and SI units) - VP Vasandani& DS Kumar - Metropolitan books
3. Thermal Engineering - Sadhu Singh- Pearson Publishers
4. Applied Thermodynamics - Eastop & McConkey- Pearson 5th Edn
5. Fluid Mechanics Fundementals and Applications - Y.A.Cengel, J.M.Cimbala- McGrawHill
6. Thermal Engineering-M.L.Marthur & Mehta- Jain bros. Publishers
7. Thermal Engineering - RK Rajput- Lakshmi Publications

Course outcomes:
CO1**:** Expected to learn the working of steam power cycles and also should be able to analyze and evaluate the performance of individual components
CO2: Student is able to learn the principles of combustion , stochiometry and flue gas analysis
CO3: Students will be able to design the components and calculate the losses and efficiency of the boilers, nozzles and impulse turbines**.**
CO4: Students will be able to design the components and calculate the losses and efficiency of reactions turbines and condensers.
CO5: Student is able to learn various types of compressors, principles of working and their performance evaluation.

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II Year - II Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
FLUID MECHANICS & HYDRAULIC MACHINES					

Course Objectives: The students completing this course are expected to understand the properties of fluids, its kinematic and dynamic behavior through various laws of fluids like continuity, Euler's, Bernoulli's equations, energy and momentum equations. Further, the student shall be able to understand the theory of boundary layer, working and performance characteristics of various hydraulic machines like pumps and turbines.

UNIT I

Objective: After studying this unit student will know the concept of fluid and its properties, manometry, hydrostatic forces acting on different surfaces and also problem solving techniques.

Fluid statics: Dimensions and units: physical properties of fluids - specific gravity, viscosity and its significance, surface tension, capillarity, vapor pressure. Atmospheric, gauge and vacuum pressure, Measurement of pressure – Manometers - Piezometer, U-tube, inverted and differential manometers. Pascal's & hydrostatic laws.

Buoyancy and floatation: Meta center, stability of floating body. Submerged bodies. Calculation of metacenter height. Stability analysis and applications.

UNIT II

Objective: In this unit student will be exposed to the basic laws of fluids, flow patterns, viscous flow through ducts and their corresponding problems.

Fluid kinematics: Introduction, flow types. Equation of continuity for one dimensional flow, circulation and vorticity, Stream line, path line and streak lines and stream tube. Stream function and velocity potential function, differences and relation between them. Condition for irrotational flow, flow net, source and sink, doublet and vortex flow.

Fluid dynamics: surface and body forces –Euler's and Bernoulli's equations for flow along a stream line, momentum equation and its applications, force on pipe bend.

Closed conduit flow: Reynold's experiment- Darcy Weisbach equation- Minor losses in pipes- pipes in series and pipes in parallel- total energy line-hydraulic gradient line.

UNIT III

Objective: At the end of this unit student will be aware of the concepts related to boundary layer theory, flow separation, basic concepts of velocity profiles, dimensionless numbers and dimensional analysis.

Boundary Layer Theory: Introduction, momentum integral equation, displacement, momentum and energy thickness, separation of boundary layer, control of flow separation, Stream lined body, Bluff body and its applications, basic concepts of velocity profiles.

Dimensional Analysis: Dimensions and Units, Dimensional Homogeneity, Non dimensionalization of equations, Method of repeating variables and Buckingham Pi Theorem.

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UNIT IV

Objective: In this unit student will know the hydrodynamic forces acting on vanes and performance evaluation of hydraulic turbines.

Basics of turbo machinery: hydrodynamic force of jets on stationary and moving flat, inclined, and curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency, flow over radial vanes.

Hydraulic Turbines: classification of turbines, impulse and reaction turbines, Pelton wheel, Francis turbine and Kaplan turbine-working proportions, work done, efficiencies, hydraulic design – draft tube- theory- functions and efficiency.

UNIT V

Objective: After studying this unit student will be in a position to understand the* characteristic curves of hydraulic turbines and also *evaluate the performance characteristics of hydraulic pumps.

Performance of hydraulic turbines: Geometric similarity, Unit and specific quantities, characteristic curves, governing of turbines, selection of type of turbine, cavitation, surge tank, water hammer. Hydraulic systems- hydraulic ram, hydraulic lift, hydraulic coupling. Fluidics – amplifiers, sensors and oscillators. Advantages, limitations and applications.

Centrifugal pumps: classification, working, work done – manometric head- losses and efficiencies- specific speed- pumps in series and parallel-performance characteristic curves, cavitation & NPSH.

Reciprocating pumps: Working, Discharge, slip, indicator diagrams.

TEXT BOOKS:

1. Fluid Mechanics- Fundementals and Applications by Y.A. Cengel, J.M.Cimbala, 6th Edn, McGrawHill
2. Fluid Mechanics - Dixon, 7th Edn, Elesvier

REFERENCE BOOKS:

1. Hydraulics, fluid mechanics and Hydraulic machinery- Modi and Seth
2. Fluid Mechanics and Hydraulic Machines - RK Bansal- Laxmi Publications (P) Ltd.
3. Fluid Mechanics and Hydraulic Machines - Rajput
4. Fluid Mechanics and Fluid Power Engineering - D.S. Kumar, Kotaria & Sons.
5. Fluid Mechanics and Machinery - D. Rama Durgaiah, New Age International.

COURSE OUTCOMES:

From this course the student is expected to learn
CO1: The basic concepts of fluid properties.
CO2: The mechanics of fluids in static and dynamic conditions.
CO3: Boundary layer theory, flow separation and dimensional analysis.
CO4: Hydrodynamic forces of jet on vanes in different positions.
CO5: Working Principles and performance evaluation of hydraulic pump and turbines.

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II Year - II Semester		L	T	P	C
		3	0	0	3
METAL CUTTING & MACHINE TOOLS					

Course objectives:
1. The course provides students with fundamental knowledge and principles in material removal processes.
2.In this course, the students apply the fundamentals and principles of metal cutting to practical applications through multiple labs using lathes, milling machines, grinding machines, and drill presses, Computer Numerical Control etc
3. To demonstrate the fundamentals of machining processes and machine tools.
4. To develop knowledge and importance of metal cutting parameters.
5. To develop fundamental knowledge on tool materials, cutting fluids and tool wear mechanisms.
6. To apply knowledge of basic mathematics to calculate the machining parameters for different machining processes.

UNIT – I
FUNDAMENTAL OF MACHINING:
Elementary treatment of metal cutting theory – element of cutting process – Single point cutting tools, nomenclature of single point cutting tool, tool signature, tool angles, mechanism of metal cutting, types of chips and chip formation – built up edge and its effects, chip breakers, mechanics of orthogonal and oblique cutting –Merchant's force diagram, cutting forces, velocity ratio, cutting speeds, feed, depth of cut, tool life, Taylor's tool life equation, simple problems - Tool wear, tool wear mechanisms, heat generation in metal cutting, coolants, machinability, economics of machining, tool materials and properties.

UNIT – II
LATHE MACHINES:
Introduction- types of lathe - Engine lathe – principle of working - construction - specification of lathe - work holders and tool holders – accessories and attachments – lathe operations – taper turning methods and thread cutting – drilling on lathes – cutting speed and feed - constructional features of speed gear box and feed gear box - turret and capstan lathes – collet chucks – other work holders – tool holding devices – box and tool layout- principal features of automatic lathes – classification – single spindle and multi-spindle automatic lathes – tool layout and cam design for automats.

UNIT – III
SHAPING, SLOTTING AND PLANNING MACHINES: Introduction - principle of working – principle parts – specifications - operations performed - slider crank mechanism - machining time calculations.
DRILLING & BORING MACHINES: Introduction – construction of drilling machines – types of drilling machines - principles of working – specifications- types of drills – geometry of twist drill - tool holding devices - operations performed – tool holding devices – cutting speed and feed – machining time calculations - Boring Machines – fine Boring Machines – jig boring machines - deep hole Drilling Machines.

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UNIT – IV

MILLING MACHINES: Introduction - principle of working – specifications – milling methods - classification of Milling Machines – principle features of horizontal, vertical and universal Milling Machine, machining operations, types of cutters - geometry of milling cutters – methods of indexing, accessories to milling machines - cutting speed and feed – machining time calculations.

UNIT –V

FINISHING PROCESSES: Introduction - theory of grinding – classification of grinding machines- cylindrical and surface grinding machines- tool and cutter grinding machines- different types of abrasives- bonds, specification and selection of a grinding wheel-lapping, Honing & Broaching operations- comparison to grinding.

TEXT BOOKS:

1. Manufacturing Engineering and Technology -Kalpakjian S & Steven R Schmid/Pearson Publications 7th Edition
2. Manufacturing Technology Vol-II/P.N Rao/Tata McGraw Hill

REFERENCES:

1. Metal cutting and machine tools /Geoffrey Boothroyd, Winston A.Knight/ Taylor & Francis
2. Production Engineering/K.C Jain & A.K Chitaley/PHI Publishers
3. Technology of machine tools/S.F.Krar, A.R. Gill, Peter SMID/ TMH
4. Fundamentals of modern manufacturing – Mikell P Groover – John Wiley & sons -5th edition

Course Outcomes:

CO1: Learned the fundamental knowledge and principals in material removal process.
CO2: Acquire the knowledge on operations in conventional, automatic, Capstan and turret lathes
CO3: capable of understanding the working principles and operations of shaping, slotting, planning , drilling and boring machines.
CO4: able to make gear and keyway in milling machines and understand the indexing mechanisms
CO5: Understand the different types of unconventional machining methods and principles of finishing processes.

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II Year - II Semester		L	T	P	C
		3	0	0	3
DESIGN OF MACHINE MEMBERS – I					

Course Objectives:

1. The student shall gain appreciation and understanding of the design function in mechanical engineering, the steps involved in designing and the relation of design activity with manufacturing activity
2. Able to select proper materials to different machine elements based on their physical and mechanical properties.
3. Learn and understand of the different types of failure modes and criteria.
4. Procedure for the different machine elements such as fasteners, shafts, couplings, keys, axially know loaded joints etc.
5. To be able to know standards in design.

UNIT – I

INTRODUCTION: General considerations in the design of Engineering Materials and their properties – selection –Manufacturing consideration in design–BIS codes of steels.

STRESSES IN MACHINE MEMBERS: Simple stresses – combined stresses – torsional and bending stresses – impact stresses – stress strain relation – various theories of failure – factor of safety – design for strength and rigidity – preferred numbers. the concept of stiffness in tension, bending, torsion and combined situations – static strength design based on fracture toughness.

UNIT – II

STRENGTH OF MACHINE ELEMENTS: Stress concentration – theoretical stress concentration factor – fatigue stress concentration factor notch sensitivity – design for fluctuating stresses – endurance limit – estimation of endurance strength – goodman's line – soderberg's line – modified goodman's line, Gerber's parabola.

UNIT – III

RIVETED AND WELDED JOINTS – design of joints with initial stresses – eccentric loading.

Bolted joints – design of bolts with pre-stresses – design of joints under eccentric loading – locking devices – bolts of uniform strength.

KEYS, COTTERS AND KNUCKLE JOINTS: Design of keys-stresses in keys-cotter joints-spigot and socket, sleeve and cotter, jib and cotter joints- knuckle joints.

UNIT – IV

SHAFTS: Design of solid and hollow shafts for strength and rigidity – design of shafts for combined bending and axial loads – shaft sizes – BIS code. Use of internal and external circlips, gaskets and seals (stationary & rotary).

SHAFT COUPLING: Rigid couplings – muff, split muff and flange couplings: rigid flanged coupling, protected rigid flanged coupling, Bushed pin type flexible coupling.

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UNIT – V
MECHANICAL SPRINGS:
Stresses and deflections of helical springs – extension -compression springs – springs for fatigue loading, energy storage capacity – helical torsion springs – co-axial springs, leaf springs.
Note: Design data book is NOT Permitted for examination

TEXT BOOKS:
1. Machine Design/ Shigley, J.E/McGraw Hill
2. Machine Design/V.B.Bhandari/ McGrawHill Education

REFERENCES:
1. Machine design / Schaum Series/McGrawHill Professional
2. Machine Design / Norton/ Pearson publishers
3. Machine design / NC Pandya & CS Shah/Charotar Publishing House Pvt. Limited

COURSE OUTCOMES:
Students must be able to
1. Calculate different stresses in the machine components subjected to various static loads, failures and suitability of a material for an engineering application.
2. Calculate dynamic stresses in the machine components subjected to variable loads.
3. Design riveted, welded, bolted joints, keys, cotters and knuckle joints subjected to static loads and their failure modes
4. Design the machine shafts and suggest suitable coupling for a given application.
5. Calculate stresses in different types of springs subjected to static loads and dynamic loads.

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II Year - II Semester		**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**
FLUID MECHANICS & HYDRAULIC MACHINERY LAB					

Course Objective: To impart practical exposure on the performance evaluation methods of various flow measuring equipment and hydraulic turbines and pumps.

1. Impact of jets on Vanes.
2. Performance Test on Pelton Wheel.
3. Performance Test on Francis Turbine.
4. Performance Test on Kaplan Turbine.
5. Performance Test on Single Stage Centrifugal Pump.
6. Performance Test on Multi Stage Centrifugal Pump.
7. Performance Test on Reciprocating Pump.
8. Calibration of Venturimeter.
9. Calibration of Orifice meter.
10. Determination of friction factor for a given pipe line.
11. Determination of loss of head due to sudden contraction in a pipeline.
12. Turbine flow meter.

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II Year - II Semester		**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**
MACHINE TOOLS LAB					

Course objectives:
The students are required to understand the parts of various machine tools and operate them. They are required to understand the different shapes of products that can be produced on these machine tools.

1. Introduction of general purpose machines -Lathe, Drilling machine, Milling machine, Shaper, Planing machine, Slotting machine, Cylindrical grinder, Surface grinder and Tool and cutter grinder.
2. Operations on Lathe machines
   (i) Step turning and Knurling
   (ii) Taper turning and Knurling
   (iii) Thread cutting and knurling
   (iv) Drilling and tapping
3. Operations on Drilling machine
   (i) Drilling, reaming and tapping
   (ii) Rectangular drilling
   (iii) Circumferential drilling
4. Operations on Shaping machine
   (i) Round to square
   (ii) Round to Hexagonal
5. Operations on Slotter
   (i) Keyway (T –slot)
   (ii) Keyway cutting
6. Operations on milling machines
   (i) Indexing
   (ii) Gear manufacturing

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II Year - II Semester		**L**	**T**	**P**	**C**
		2	**0**	**0**	**0**
ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE					

Course Objectives:
To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system

- The course aim of the importing basic principle of third process reasoning and inference sustainability is at the course of Indian traditional knowledge system
- To understand the legal framework and traditional knowledge and biological diversity act 2002 and geographical indication act 2003
- The courses focus on traditional knowledge and intellectual property mechanism of traditional knowledge and protection
- To know the student traditional knowledge in different sector

Course Outcomes:
After completion of the course, students will be able to:

- Understand the concept of Traditional knowledge and its importance
- Know the need and importance of protecting traditional knowledge
- Know the various enactments related to the protection of traditional knowledge
- Understand the concepts of Intellectual property to protect the traditional knowledge

UNIT I
Introduction to traditional knowledge: Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge
Learning Outcomes:
At the end of the unit, the student will able to:

- Understand the traditional knowledge.
- Contrast and compare characteristics importance kinds of traditional knowledge.
- Analyze physical and social contexts of traditional knowledge.
- Evaluate social change on traditional knowledge.

UNIT II
Protection of traditional knowledge: the need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.
Learning Outcomes:
At the end of the unit, the student will able to:

- Know the need of protecting traditional knowledge.
- Apply significance of tk protection.
- Analyze the value of tk in global economy.
- Evaluate role of government

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UNIT III

Legal framework and TK: A: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmers Rights Act, 2001 (PPVFR Act);B:The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016. Geographical indications act 2003.

Learning Outcomes:

At the end of the unit the student will able to:

- Understand legal framework of TK.
- Contrast and compare the ST and other traditional forest dwellers
- Analyze plant variant protections
- Evaluate farmers right act

UNIT IV

Traditional knowledge and intellectual property: Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, global legal FORA for increasing protection of Indian Traditional Knowledge.

Learning Outcomes:

At the end of the unit, the student will able to:

- Understand TK and IPR
- Apply systems of TK protection.
- Analyze legal concepts for the protection of TK.
- Evaluate strategies to increase the protection of TK.

UNIT V

Traditional knowledge in different sectors: Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.

Learning Outcomes:

At the end of the unit, the student will able to:

- Know TK in different sectors.
- Apply TK in engineering.
- Analyze TK in various sectors.
- Evaluate food security and protection of TK in the country.

Reference Books:

1) Traditional Knowledge System in India, by Amit Jha, 2009.
2) Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta and Vipin Kumar Singh, PratibhaPrakashan 2012.
3) Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002
4) "Knowledge Traditions and Practices of India" Kapil Kapoor, Michel Danino

e-Resources:

1) https://www.youtube.com/watch?v=LZP1StpYEPM
2) http://nptel.ac.in/courses/121106003/

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III Year - I Semester		L	T	P	C
		3	0	0	3
DYNAMICS OF MACHINERY					

Course Objectives:

1. To analyze the forces in clutches, brakes and dynamometers involving friction.
2. understand the effect gyroscopic couple in motor cycles, aeroplanes and ships.
3. To understand the static and dynamic force analysis of four bar and slider crank mechanisms.
4. To study the turning moment diagrams of reciprocating engines and to learn design procedure of a flywheel
5. To learn analytical and graphical methods for calculating balancing of rotary and reciprocating masses
6. Understanding of vibrations and its significance on engineering design.

UNIT – I

FRICTION: Inclined plane, friction of screw and nuts, pivot and collar, uniform pressure, uniform wear, friction circle and friction axis: lubricated surfaces, boundary friction, film lubrication.

CLUTCHES: Friction clutches- single disc or plate clutch, multiple disc clutch, cone clutch, centrifugal clutch.

BRAKES AND DYNAMOMETERS: Simple block brakes, internal expanding brake, band brake of vehicle. General description and operation of dynamometers: Prony, Rope brake, Epicyclic, Bevis Gibson and belt transmission,

UNIT – II

STATIC AND DYNAMIC FORCE ANALYSIS: Dynamic force analysis of four bar mechanism and slider crank mechanism**,** inertia torque, angular velocity and acceleration of connecting rod, crank effort

TURNING MOMENT DIAGRAMS: Turning moment diagrams – fluctuation of energy – fly wheels and their design.

UNIT-III

PRECESSION: Gyroscopes, effect of precession motion on the stability of moving vehicles such as motor car, motor cycle, aero planes and ships.

GOVERNERS: Watt, porter and proell governors, spring loaded governors – Hartnell and Hartung with auxiliary springs. sensitiveness, isochronism and hunting.

UNIT – IV

BALANCING: Balancing of rotating masses single and multiple – single and different planes, use analytical and graphical methods. Primary, secondary, and higher balancing of reciprocating masses. analytical and graphical methods, unbalanced forces and couples – examination of "V" multi cylinder in line and radial engines for primary and secondary balancing, locomotive balancing, hammer blow, swaying couple, variation of tractive effort.

UNIT – V

VIBRATIONS: Free Vibration of spring mass system –Natural frequency-types of damping – damped free vibration, Simple problems on forced damped vibration, vibration isolation and transmissibility transverse loads, vibrations of beams with concentrated and distributed loads. Dunkerly's methods, Raleigh's method, whirling of shafts, critical speeds, torsional vibrations, two and three rotor systems.

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Text Books :

1. Theory of Machines -S.S Rattan - Mc. Graw Hill
2. Theory of Mechanisms and Machines -Dr.Jagadish Lal - Metropolitan Pvt.Ltd .

References :

1. Mechanism and machine theory - JS Rao & RV Dukkipati - New Age Publishers.
2. Theory of Machines - Shigley - McGrawHill Publishers
3. Theory of Machines - Thomas Bevan - Pearson Publishers

Course outcomes:

(1) To compute the frictional losses and transmission in clutches, brakes and dynamometers
(2) To determine the effect of gyroscopic couple in motor vehicles, ships and aeroplanes
(3) To analyze the forces in four bar and slider crank mechanisms and design a flywheel
(4) To determine the rotary unbalanced mass in reciprocating equipment
(5) To determine the unbalanced forces and couples in reciprocating and radial engines
(6) To determine the natural frequencies of discrete systems undergoing longitudinal, torsional and transverse vibrations.

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III Year - I Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
DESIGN OF MACHINE MEMBERS-II					

Course objectives

- This course gives the insight of slider and roller bearings and the life prediction.
- Learn to design I.C engine parts
- Design the mechanical systems for power transmission such as gears, belts, ropes, chains, keys and levers

UNIT – I

BEARINGS: Classification of bearings- applications, types of journal bearings – lubrication – bearing modulus – full and partial bearings – clearance ratio – heat dissipation of bearings, bearing materials – journal bearing design – ball and roller bearings – static loading of ball & roller bearings, bearing life.

UNIT – II

ENGINE PARTS: Connecting Rod: Thrust in connecting rod – stress due to whipping action on connecting rod ends – cranks and crank shafts, strength and proportions of over hung and center cranks – crank pins, crank shafts.

Pistons, forces acting on piston – construction design and proportions of piston, cylinder, cylinder liners,

UNIT – III

POWER TRANSMISSIONS SYSTEMS, PULLEYS: Transmission of power by belt and rope drives , transmission efficiencies, belts – flat and V types – ropes - pulleys for belt and rope drives, materials, chain drives

DESIGN OF POWER SCREWS: Design of screw, square ACME, buttress screws, design of nut, compound screw, differential screw, ball screw- possible failures.

UNIT – IV

SPUR & HELICAL GEAR DRIVES: Spur gears- helical gears – load concentration factor – dynamic load factor, surface compressive strength – bending strength – design analysis of spur gears – estimation of centre distance, module and face width, check for plastic deformation, check for dynamic and wear considerations.

UNIT – V

MACHINE TOOL ELEMENTS: Levers and brackets: design of levers – hand levers-foot lever – cranked lever – lever of a lever loaded safety valve- rocker arm straight – angular- design of a crank pin – brackets- hangers- wall boxes.

Wire Ropes: Construction, Designation, Stresses in wire ropes, rope sheaves and drums.

Design of curved Beams: introduction, stresses in curved beams, expression for radius of neutral axis for rectangular, circular, trapezoidal and t-section, design of crane hooks, c –clamps**.**

Note: Design data book is permitted for examination

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Text Books:

1. Machine Design/V.B.Bhandari/TMH Publishers
2. Machine Design/ NC Pandya & CS Shaw/ Charotar publishers
3. Design data book.

References:

1. Machine Design: An integrated Approach / R.L. Norton / Pearson Education
2. Mech. Engg. Design / JE Shigley/Tata McGraw Hill education
3. Design of machine elements- spots/Pearson Publications
4. Machine Design-Norton/Pearson Publications

Course outcomes: At the end of the course, The student will able to

1. Select the suitable bearing based on the application of the loads and predict the life of the bearing.
2. Design of IC Engines parts.
3. Design of power transmission elements such as gears, belts, chains, pulleys, ropes, levers and power screws.
4. Design spur & helical gear for different engineering applications.

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DEPARTMENT OF MECHANICAL ENGINEERING

III Year - I Semester		L	T	P	C
		3	0	0	3
MECHANICAL MEASUREMENTS & METROLOGY					

Course objectives: The students will learn

1. Inspection of engineering parts with various precision instruments
2. Design of part, tolerances and fits
3. Principles of measuring instruments and gauges and their uses
4. Evaluation and inspection of surface roughness
5. Inspection of spur gear and thread elements
6. The methods of measurement of displacement, speed, acceleration, vibration, stress and strain, force, torque and power.

UNIT – I

Basic principles of measurement – measurement systems, generalized configuration and functional descriptions of measuring instruments – examples. dynamic performance characteristics – sources of error, classification and elimination of error.

MEASUREMENT OF DISPLACEMENT: Theory and construction of various transducers to measure displacement – piezo electric, inductive, capacitance, resistance, ionization and photo electric transducers, calibration procedures.

MEASUREMENT OF SPEED : Mechanical tachometers – electrical tachometers – stroboscope, noncontact type of tachometer

UNIT-II

STRESS STRAIN MEASUREMENTS : Various types of stress and strain measurements – electrical strain gauge – gauge factor – method of usage of resistance strain gauge for bending compressive and tensile strains – usage for measuring torque, strain gauge rosettes.

MEASUREMENT OF FORCE, TORQUE AND POWER- Elastic force meters, load cells, torsion meters, dynamometers.

MEASUREMENT OF ACCELERATION AND VIBRATION: Different simple instruments – principles of seismic instruments – Vibrometer and accelerometer using this principle.

UNIT-III

SYSTEMS OF LIMITS AND FITS: Introduction, nominal size, tolerance, limits, deviations, fits -Unilateral and bilateral tolerance system, hole and shaft basis systems- interchangeability, deterministic & statistical tolerances, selective assembly. International standard system of tolerances, selection of limits and tolerances for correct functioning.

LIMIT GAUGES:

Taylor's principle – design of go and no go gauges; plug, ring, snap, gap, taper, profile and position gauges.

UNIT-IV

LINEAR MEASUREMENT: Length standards, end standards, slip gauges- calibration of the slip gauges, dial indicators, micrometers.

MEASUREMENT OF ANGLES AND TAPERS:

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Different methods – bevel protractor, angle slip gauges- angle dekkor- spirit levels- sine bar- sine table, rollers and spheres used to measure angles and tapers.

OPTICAL MEASURING INSTRUMENTS: Tools maker's microscope and uses - autocollimators, optical projector, optical flats and their uses. Interferrometry- Interference of light, Michelson's interferometer, NPL flatness interferometer, and NPL gauge interferometer.

COMPARATORS: Types - mechanical, optical , electrical and electronic, pneumatic comparators and their uses.

UNIT-V

SURFACE ROUGHNESS MEASUREMENT: Differences between surface roughness and surface waviness –Numerical assessment of surface finish-CLA, Rt., R.M.S. Rz, R10 values, Method of measurement of surface finish – Profilograph, Talysurf, ISI symbols for indication of surface finish.

GEAR MEASUREMENT: Nomenclature of gear tooth, tooth thickness measurement with gear tooth vernier & flange micro meter, pitch measurement, total composite error and tooth to tooth composite errors, rolling gear tester, involute profile checking.

SCREW THREAD MEASUREMENT: Elements of measurement – errors in screw threads- concept of virtual effective diameter, measurement of effective diameter, angle of thread and thread pitch, and profile thread gauges.

FLATNESS MEASUREMENT:

Measurement of flatness of surfaces- instruments used- straight edges- surface plates – auto collimator.

Text Books:

1. Engineering Metrology / R.K.Jain / Khanna Publishers
.2. Measurement Systems: Applications & design / D.S Kumar/

References:

1. Measurement systems: Application and design/Doeblin Earnest. O. Adaptation/ TMH
2.Experimental Methods for Engineers / J.P.Holman/McGraw Hill
3. Mechanical and Industrial Measurements / R.K. Jain/ Khanna Publishers.
4.Instrumentation, measurement & analysis / B.C.Nakra & K.K.Choudhary/TMH
5.Engineering Metrology / Mahajan / Dhanpat Rai Publishers
6. Engineering Metrology / I.C.Gupta / Dhanpat Rai Publishers
7. Precision Engineering in Manufacturing / R.L.Murthy / New Age
8. Engineering Metrology and Measurements / NV Raghavendra, L Krishna murthy/ Oxford publishers.
9. Engineering Metrology / KL Narayana/Scitech publishers

Course outcomes: Students will be able to

CO1: Describe the construction and working principles of measuring instruments for measurement of displacement and speed and select appropriate instrument for a given application.
CO2: Describe the construction and working principles of measuring instruments for strain, force, Torque, power, acceleration and Vibration and select appropriate instrument for a given application.
CO3: Explain shaft basis system and hole basis systems for fits and represent tolerances for a given fit as per the shaft basis system and hole basis system and design limit gauges based on the tolerances for quality check in mass production.

CO4: Explain methods for linear, angle and flatness measurements and select a suitable method and its relevant instrument for a given application.

CO5: To measure the threads, gear tooth profiles, surface roughness and flatness using appropriate instruments and analyze the data.

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DEPARTMENT OF MECHANICAL ENGINEERING

III Year - I Semester		L	T	P	C
		3	0	0	3
MANAGERIAL ECONOMICS AND FINANCIAL ACCOUNTANCY					

Course Objectives:

- The Learning objectives of this paper are to understand the concept and nature of Managerial Economics and its relationship with other disciplines and also to understand the Concept of Demand and Demand forecasting.
- To familiarize about the Production function, Input Output relationship, Cost-Output relationship and Cost-Volume-Profit Analysis.
- To understand the nature of markets, Methods of Pricing in the different market structures and to know the different forms of Business organization and the concept of Business Cycles.
- To learn different Accounting Systems, preparation of Financial Statement and uses of different tools for performance evaluation.
- Finally, it is also to understand the concept of Capital, Capital Budgeting and the techniques used to evaluate Capital Budgeting proposals.

Unit-I

Introduction to Managerial Economics and demand Analysis:

Definition of Managerial Economics –Scope of Managerial Economics and its relationship with other subjects –Concept of Demand, Types of Demand, Determinants of Demand- Demand schedule, Demand curve, Law of Demand and its limitations- Elasticity of Demand, Types of Elasticity of Demand and Measurement- Demand forecasting and Methods of forecasting, Concept of Supply and Law of Supply.

Unit – II:

Theories of Production and Cost Analyses:

Theories of Production function- Law of Variable proportions-Isoquants and Isocosts and choice of least cost factor combination-Concepts of Returns to scale and Economies of scale-Different cost concepts: opportunity costs, explicit and implicit costs-Fixed costs, Variable Costs and Total costs –Cost –Volume-Profit analysis-Determination of Breakeven point(problems)-Managerial significance and limitations of Breakeven point.

Unit – III:

Introduction to Markets, Theories of the Firm & Pricing Policies:

Market Structures: Perfect Competition, Monopoly, Monopolistic competition and Oligopoly – Features – Price and Output Determination – Managerial Theories of firm: Marris and Williamson's models – other Methods of Pricing: Average cost pricing, Limit Pricing, Market Skimming Pricing, Internet Pricing: (Flat Rate Pricing, Usage sensitive pricing) and Priority Pricing, Business Cycles : Meaning and Features – Phases of a Business Cycle. Features and Evaluation of Sole Trader, Partnership, Joint Stock Company – State/Public Enterprises and their forms.

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Unit – IV:
Introduction to Accounting & Financing Analysis:
Introduction to Double Entry System, Journal, Ledger, Trail Balance and Preparation of Final Accounts with adjustments – Preparation of Financial Statements-Analysis and Interpretation of Financial Statements-Ratio Analysis – Preparation of Funds flow and cash flow analysis (Problems)

Unit – V:
Capital and Capital Budgeting: Capital Budgeting: Meaning of Capital-Capitalization-Meaning of Capital Budgeting-Time value of money- Methods of appraising Project profitability: Traditional Methods(pay back period, accounting rate of return) and modern methods(Discounted cash flow method, Net Present Value method, Internal Rate of Return Method and Profitability Index)

Course Outcomes:
- The Learner is equipped with the knowledge of estimating the Demand and demand elasticities for a product.
- The knowledge of understanding of the Input-Output-Cost relationships and estimation of the least cost combination of inputs.
- The pupil is also ready to understand the nature of different markets and Price Output determination under various market conditions and also to have the knowledge of different Business Units.
- The Learner is able to prepare Financial Statements and the usage of various Accounting tools for Analysis.
- The Learner can able to evaluate various investment project proposals with the help of capital budgeting techniques for decision making.

TEXT BOOKS:
A R Aryasri, Managerial Economics and Financial Analysis, The McGraw – Hill companies.

REFERENCES:
1. Varshney R.L, K.L Maheswari, Managerial Economics, S. Chand & Company Ltd,
2. JL Pappas and EF Brigham, Managerial Economics, Holt, R & W; New edition edition
3. N.P Srinivasn and M. SakthivelMurugan, Accounting for Management, S. Chand & Company Ltd,
4. MaheswariS.N,AnIntroduction to Accountancy, Vikas Publishing House Pvt Ltd
5. I.M Pandey, Financial Management , Vikas Publishing House Pvt Ltd
6. V. Maheswari, Managerial Economics, S. Chand & Company Ltd,

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III Year - I Semester		L	T	P	C
		3	0	0	3
IC ENGINES & GAS TURBINES					

Learning Objectives:
(1) To make the student learn and understand the reasons and affects of various losses that occur in the actual engine operation.
(2) To familiarize the student with the various engine systems along with their function and necessity.
(3) To learn about normal combustion phenomenon and knocking in S.I. and C.I. Engines and to find the several engine operating parameters that affect the smooth engine operation.
(4) To make the student learn to perform testing on S.I and C.I Engines for the calculations of performance and emission parameters.

UNIT – I

Air standard Cycles: otto, diesel and dual cycles, its comparison, Brayton cycle

Actual Cycles and their Analysis: Introduction, Comparison of Air Standard and Actual Cycles, Time Loss Factor, Heat Loss Factor, Exhaust Blowdown-Loss due to Gas exchange process, Volumetric Efficiency. Loss due to Rubbing Friction, Actual and Fuel-Air Cycles of CI Engines.

UNIT – II

I. C. ENGINES : Classification - Working principles, Valve and Port Timing Diagrams, - Engine systems – Fuel, Carburettor, Fuel Injection System, Ignition, Cooling and Lubrication, principle of wankle engine, principles of supercharging and turbo charging.

UNIT – III

Combustion in S.I. Engines : Normal Combustion and abnormal combustion – Importance of flame speed and effect of engine variables – Types of Abnormal combustion, pre-ignition and knocking (explanation of) – Fuel requirements and fuel rating, anti knock additives – combustion chamber – requirements, types.

Combustion in C.I. Engines : Four stages of combustion – Delay period and its importance – Effect of engine variables – Diesel Knock– Need for air movement, suction, compression and combustion induced turbulence – open and divided combustion chambers and nozzles used – fuel requirements and fuel rating.

UNIT – IV

Measurement, Testing and Performance: Parameters of performance - measurement of cylinder pressure, fuel consumption, air intake, exhaust gas composition, Brake power – Determination of frictional losses and indicated power – Performance test – Heat balance sheet and chart.

UNIT –V

GAS TURBINES: Simple gas turbine plant – ideal cycle, essential components – parameters of performance – actual cycle – regeneration, inter cooling and reheating –closed cycle type gas turbines.

JET PROPULSION : Principle of operation –classification of jet propulsive engines – working principles with schematic diagrams and representation on t-s diagram - thrust, thrust power and propulsion efficiency – turbo jet engines – needs and demands met by turbo jet – schematic diagram, thermodynamic cycle, performance evaluation (Definitions and Simple Problems).

ROCKETS: Application – working principle – classification – propellant type – thrust, propulsive efficiency – specific impulse – solid and liquid propellant rocket engines (only Theoretical concepts).

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Text Books:
1. I.C. Engines - V. Ganesan- Tata McGraw Hill Publishers
2. Gas Turbines – V.Ganesan – Tata McGraw Hill Publishers

References:
1. Thermal Engineering - Mahesh Rathore- McGraw Hill publishers
2. I.C.Engines–AppliedThermosciences–C.R.Ferguson&A.T.Kirkpatrick-2nd Edition-Wiley Publ
3. I.C. Engines - J.B.Heywood /McGrawHIll.
4. Heat engines, Vasandani & Kumar - Thermal publications
5. Gas Turbine Theory – HIH Saravanamuttoo, Cohen, Rogers –Pearson Publishers

Course Outcomes: Student must able to,
CO1: Derive the actual cycle from fuel-air cycle and air- standard cycle for all practical applications.
CO2: Explain working principle and various components of IC engine
CO3: Explain combustion phenomenon of CI and SI engines and their impact on engine variables.
CO4: Analyze the performance of an IC engine based on the performance parameters.
CO5: Explain the cycles and systems of a gas turbine and determine the efficiency of gas turbine.
CO6: Explain the applications and working principle of rockets and jet propulsion.

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III Year - I Semester		**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**
THERMAL ENGINEERING LAB					

Course objective: To provide hands on experience in operating various types of internal combustion engines and understand their functioning and performance.

Note: The students have to perform minimum 10 Experiments.

1. I.C. Engines valve and port timing diagrams.
2. Testing of Fuels – Viscosity, flash point/fire point, carbon residue, calorific value.
3. I.C. Engine performance test and Exhaust emission measurements (4 -stroke diesel engine)
4. I.C. Engine performance test and Exhaust emission measurements (2-stroke petrol engine)
5. Evaluation of friction power by conducting Morse test on 4-stroke multi cylinder engine.
6. Determination of Friction Power by retardation or motoring test on IC engine.
7. I.C. Engine heat balance at different loads and show the heat distribution curve.
8. Economical speed test of an IC engine.
9. Performance test on variable compression ratio engines.
10. Performance test on reciprocating air compressor unit.
11. Dis-assembly / assembly of different parts of two wheelers. 3 wheelers & 4 wheelers. Tractor & Heavy duty engines covering 2-stroke and 4 stroke, SI and CI engines.
12. Study of boilers, mountings and accessories.

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DEPARTMENT OF MECHANICAL ENGINEERING

III Year - I Semester		**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**
THEORY OF MACHINES LAB					

1. To determine whirling speed of shaft theoretically and experimentally.
2. To determine the position of sleeve against controlling force and speed of a Hartnell governor and to plot the characteristic curve of radius of rotation.
3. To analyse the motion of a motorized gyroscope when the couple is applied along its spin axis
4. To determine the frequency of undamped free vibration of an equivalent spring mass system.
5. To determine the frequency of damped force vibration of a spring mass system
6. To study the static and dynamic balancing using rigid blocks.
7. To find the moment of inertia of a flywheel
8. To plot follower displacement vs cam rotation for various Cam Follower systems.
9. To plot slider displacement, velocity and acceleration against crank rotation for single slider crank mechanism/Four bar mechanism
10. To find coefficient of friction between belt and pulley.
11. To study simple and compound screw jack and determine the mechanical advantage , velocity ratio and efficiency
12. To study various types of gears- Spur, Helical, Worm and Bevel Gears

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DEPARTMENT OF MECHANICAL ENGINEERING

III Year - I Semester		L	T	P	C
		0	0	3	1.5
MECHANICAL MEASUREMENTS & METROLOGY LAB					

Course Objectives:

(1) The Metrology Lab course is designed for measuring and gauging instruments for inspection of precision linear, geometric forms, angular and surface finish measurements. The student can learn the measurements with and calibration of instruments.

(2) Mechanical Measurements lab introduces the students with the theory and methods for conducting experimental work in the laboratory and calibration of various instruments for measuring pressure, temperature, displacement, speed, vibration etc.

Note: The students have to conduct at least 8 experiments from each lab

METROLOGY LAB

1. Measurement of lengths, heights, diameters by vernier calipers, micrometers etc.
2. Measurement of bores by internal micrometers and dial bore indicators.
3. Use of gear tooth vernier caliper for tooth thickness inspection and flange micro meter for checking the chordal thickness of spur gear.
4. Measurement using Mechanical comparator.
5. Measurements using Optical Projector.
6. Measurement of alignment using Autocollimator.
7. Angle and taper measurements with bevel protractor, Sine bar, rollers and balls.
8. Use of spirit level in finding the straightness of a bed and flatness of a surface.
9. Thread inspection with two wire/ three wire method & tool makers microscope.
10. Surface roughness measurement with roughness measuring instrument.

MECHANICAL MEASUREMENTS LAB

1. Calibration of pressure gauge.
2. Calibration of transducer for temperature measurement.
3. Study and calibration of LVDT transducer for displacement measurement.
4. Calibration of strain gauge.
5. Calibration of thermocouple.
6. Calibration of capacitive transducer.
7. Study and calibration of photo and magnetic speed pickups.
8. Calibration of resistance temperature detector.
9. Study and calibration of a rotameter.
10. Study and use of a seismic pickup for the measurement of vibration amplitude of an engine bed at various loads.
11. Study and calibration of Mcleod gauge for low pressure.

Course outcomes:

Metrology Lab

Student will become familiar with the different instruments that are available for linear, angular, roundness and roughness measurements they will be able to select and use the appropriate measuring instrument according to a specific requirement (in terms of accuracy, etc)

MECHANICAL MEASUREMENTS LAB

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Students will be able to select proper measuring instrument and know requirement of calibration, errors in measurement etc. They can perform accurate measurements.

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III Year - I Semester		**L**	**T**	**P**	**C**
		0	**0**	**0**	**0.5**
SOCIALLY RELEVANT PROJECT					

Student can choose any one of the given below / any other socially relevant problem and work on it to produce a project document.

1. Water Conservation Related Works
2. Swatch Bharath (Internal External)
3. Helping police
4. Traffic monitoring
5. Teaching Rural Kids (Sarva siksha Abhiyan)
6. Street light monitoring
7. Electricity Conservation
8. Solar panel utilization
9. E- policing & cyber solution
10. Pollution
11. Any social related

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DEPARTMENT OF MECHANICAL ENGINEERING

III Year - II Semester		L	T	P	C
		3	0	0	3
OPERATIONS RESEARCH					

Course Objectives:
The objective of the course is to understand the availability of resources and constraints in an industry and optimize them through the applications of appropriate resource management tools.

UNIT – I
Development – definition– characteristics and phases – operation research models – applications.
LINEAR PROGRAMMING: problem formulation – graphical solution – simplex method – artificial variables techniques -two–phase method, big-M method – duality principle.

UNIT – II
TRANSPORTATION PROBLEM: Formulation – optimal solution, unbalanced transportation problem – degeneracy, assignment problem – formulation – optimal solution - variants of assignment problem- traveling salesman problem.
SEQUENCING – Introduction – flow –shop sequencing – *n* jobs through two machines – *n* jobs through three machines – job shop sequencing – two jobs through 'm' machines.

UNIT – III
REPLACEMENT: Introduction – replacement of items that deteriorate with time – when money value is not counted and counted – replacement of items that fail completely, group replacement.

UNIT – IV
THEORY OF GAMES: Introduction to decision theory – mini. max (max. mini) – criterion and optimal strategy – solution of games with saddle points – rectangular games without saddle points – 2 x 2 games – dominance principle – m x 2 & 2 x n games -graphical method.
WAITING LINES: Introduction to Kendallis notation–classification of queuing models, single channel – with infinite population and finite population models– multichannel – with infinite population.

UNIT – V
Network Analysis: Project planning, scheduling and controlling – tools for project management – critical path method – programme evaluation and review technique (PERT) – cost analysis and crashing – resource leveling – updating.

TEXT BOOKS:
1.Operations Research-An Introduction/Hamdy A Taha/Pearson publishers
2. Operations Research –Theory & publications / S.D.Sharma-Kedarnath/McMillan publishers India Ltd

REFERENCES:
1. Introduction to O.R/Hiller & Libermann/TMH
2. Operations Research /A.M.Natarajan,P.Balasubramani,A. Tamilarasi/Pearson Education.
3. Operations Research: Methods & Problems / Maurice Saseini, Arhur Yaspan & Lawrence Friedman/Wiley
4. Operations Research / R.Pannerselvam/ PHI Publications.
5. Operations Research / Wagner/ PHI Publications.

6. Operation Research /J.K.Sharma/MacMilan Publ.
7. Operations Research/ Pai/ Oxford Publications
8. Operations Research/S Kalavathy / Vikas Publishers
9. Operations Research / DS Cheema/University Science Press
10. Operations Research / Ravindran, Philips, Solberg / Wiley publishers

Course Outcomes:

After studying the course, the students are able to

1. Formulate the resource management problems and identify appropriate methods to solve them
2. Apply LPP, transportation and assignment models to optimize the industrial resources
3. Solve decision theory problems through the application of game theory
4. Apply the replacement and queuing models to increase the efficiency of the system
5. Model the project management problems through CPM and PERT

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DEPARTMENT OF MECHANICAL ENGINEERING

III Year - II Semester		L	T	P	C
		3	0	0	3
HEAT TRANSFER					

Course Objective: To understand different modes of heat transfer and apply these basics in the design of thermal systems

UNIT – I:

Introduction: Modes and mechanisms of heat transfer – Basic laws of heat transfer –General discussion about applications of heat transfer.

Conduction Heat Transfer: Fourier rate equation – General heat conduction equation in Cartesian, Cylindrical and Spherical coordinates – simplification and forms of the field equation – steady, unsteady and periodic heat transfer – Initial and boundary conditions

One Dimensional Steady State Conduction Heat Transfer: Homogeneous slabs, hollow cylinders and spheres- Composite systems– overall heat transfer coefficient – Electrical analogy – Critical radius of insulation

UNIT – II:

One Dimensional Steady State Conduction Heat Transfer: Variable Thermal conductivity – systems with heat sources or Heat generation-Extended surface (fins) Heat Transfer – Long Fin, Fin with insulated tip and Short Fin, Application to error measurement of Temperature

One Dimensional Transient Conduction Heat Transfer: Systems with negligible internal resistance – Significance of Biot and Fourier Numbers –Infinite bodies- Chart solutions of transient conduction systems- Concept of Semi infinite body.

UNIT – III:

Convective Heat Transfer: Classification of systems based on causation of flow, condition of flow, configuration of flow and medium of flow – Dimensional analysis as a tool for experimental investigation – Buckingham Π Theorem and method, application for developing semi – empirical non- dimensional correlation for convection heat transfer – Significance of non-dimensional numbers – Concepts of Continuity, Momentum and Energy Equations.

Forced convection: External Flows: Concepts about hydrodynamic and thermal boundary layer and use of empirical correlations for convective heat transfer -Flat plates and Cylinders.

Internal Flows: Concepts about Hydrodynamic and Thermal Entry Lengths – Division of internal flow based on this –Use of empirical relations for Horizontal Pipe Flow and annulus flow.

UNIT – IV:

Free Convection: Development of Hydrodynamic and thermal boundary layer along a vertical plate - Use of empirical relations for Vertical plates and pipes.

Heat Exchangers: Classification of heat exchangers – overall heat transfer Coefficient and fouling factor – Concepts of LMTD and NTU methods - Problems using LMTD and NTU methods.

UNIT V:

Heat Transfer with Phase Change:

Boiling: – Pool boiling – Regimes – Calculations on Nucleate boiling, Critical Heat flux and Film boiling

Condensation: Film wise and drop wise condensation –Nusselt's Theory of Condensation on a vertical plate - Film condensation on vertical and horizontal cylinders using empirical correlations.

Radiation Heat Transfer : Emission characteristics and laws of black-body radiation – Irradiation – total and monochromatic quantities – laws of Planck, Wien, Kirchoff, Lambert, Stefan and Boltzmann– heat exchange between two black bodies – concepts of shape factor – Emissivity – heat exchange between grey bodies – radiation shields – electrical analogy for radiation networks.

TEXT BOOKS:

1. Heat Transfer by HOLMAN, Tata McgrawHill

2. Heat Transfer by P.K.Nag, TMH

REFERENCE BOOKS:

1. Fundamentals of Heat Transfer by Incropera & Dewitt, John wiley
2. Fundamentals of Engineering, Heat& Mass Transfer by R.C.Sachdeva, NewAge.
3. Heat& Mass Transfer by Amit Pal – Pearson Publishers
4. Heat Transfer by Ghosh dastidar, Oxford University press.
5. Heat Transfer by a Practical Approach, YunusCengel, Boles, TMH
6. Engineering Heat and Mass Transfer by Sarit K. Das, DhanpatRai Pub

Note: Heat and Mass transfer Data Book by C P Kothandaraman and Subrahmanyan is used to design and analyze various thermal processes and thermal equipment.

Course Outcomes: At the end of the course, the student should be able to

CO1: Compute rate of heat transfer for 1D, steady state composite systems without heat generation.

CO2: Analyze the system with heat generation, variable thermal conductivity, fins and 1D transient conduction heat transfer problems.

CO3: Develop the empirical equations for forced convection problems by using Buckingham's pi theorem.

CO4: Compute the rate of heat transfer for natural convection systems and design and analysis of heat exchangers.

CO5: Solve the heat transfer systems with phase change and radiation.

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DEPARTMENT OF MECHANICAL ENGINEERING

III Year - II Semester		L	T	P	C
		3	0	0	3
CAD/CAM					

Course Objectives:
The general objectives of the course are to enable the students to

1. Understand the basic fundamentals of computer aided design and manufacturing.
2. To learn 2D & 3D transformations of the basic entities like line, circle, ellipse etc
3. To understand the different geometric modeling techniques like solid modeling, surface modeling, feature based modeling etc. and to visualize how the components look like before its manufacturing or fabrication
4. To learn the part programming, importance of group technology, computer aided process planning, computer aided quality control
5. To learn the overall configuration and elements of computer integrated manufacturing systems.

UNIT – I
Introduction to CAD/CAM, product cycle, CAD / CAM Hardware, basic structure.
COMPUTER GRAPHICS: Raster scan graphics coordinate system, database structure for graphics modeling, transformation of geometry, 2D and 3D transformations, mathematics of projections, clipping, hidden surface removal.
UNIT – II
GEOMETRIC MODELING: Requirements, geometric models, geometric construction models, curve representation methods,parametric representation of various curves:cubic spline, bezier curves. surface representation methods, Solid modelling.
UNIT – III
PART PROGRAMMING FOR NC MACHINES: NC, NC modes, NC elements, CNC machine tools, structure of CNC machine tools, features of Machining center, turning center, CNC Part Programming: fundamentals, manual part programming methods, Computer Aided Part Programming. Direct Numerical Control, Adaptive Control.
UNIT – IV
GROUP TECHNOLOGY: Part family, coding and classification, production flow analysis, types and advantages. Computer aided processes planning – importance, types. FMS-Introduction, Equipment, Tool management systems, Layouts, FMS Control
UNIT – V
COMPUTER INTEGRATED MANUFACTURING SYSTEMS: Types of manufacturing systems, machine tools and related equipment, material handling systems, material requirement planning, computer control systems, human labor in manufacturing systems, CIMS benefits.
COMPUTER AIDED QUALITY CONTROL: Terminology used in quality control, use of computers in Quality control. Inspection methods- contact and noncontact types, computer aided testing, integration of CAQC with CAD/CAM.

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Text Books:

1. CAD / CAM Principles and Applications/PN Rao / McGraw-Hill
2. Automation, Production systems & Computer integrated Manufacturing/ M.P. Groover/Pearson Education

References:

1. Mastering CAD / CAM / Ibrahim Zeid / McGraw-Hill
2. Principles of Computer Aided Design and Manufacturing / Farid Amirouche / Pearson
3. Computer Numerical Control Concepts and programming / Warren S Seames / Thomson learning, Inc
4. Product manufacturing and cost estimation using CAD/CAE/ Kuang Hua Chang/Elsevier Publishers

Course Outcomes:

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

1. Describe the mathematical basis in the technique of representation of geometric entities including points, lines, and parametric curves, surfaces and solid, and the technique of transformation of geometric entities using transformation matrix
2. Describe the use of GT and CAPP for the product development
3. Identify the various elements and their activities in the Computer Integrated Manufacturing Systems.

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III Year - II Semester		L	T	P	C
		3	0	0	3
COMPOSITE MATERIALS					

Course Objective: The prime objective of this course is to introduce, classify, and process composite materials which are novel and widely applied materials. The applications of composite materials that would suit the requirements are also dealt in detail as an integral part.

UNIT - I

Introduction: Definition – Classification of Composite materials based on structure and matrix. Advantages and disadvantages application of composites based on structure – Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT - II

Reinforcements: Preparation, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical behavior of composites; Rule of mixtures, Inverse rule of mixtures. Loading under Isostrain and Isostress conditions.

UNIT - III

Manufacturing of Polymer matrix composites; Preparation of Moulding compounds and prepregs – hand lay-up method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications

UNIT - IV

Manufacturing of Metal Matrix Composites; Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications polymer composites

UNIT - V

Nanocomposites:- Synthesis, properties and characterization, advantages and disadvantages over conventional composites , applications of nano composites.

TEXT BOOKS:

1. Composite Materials – K. K. Chawla
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007

REFERENCE:

1. Composite Materials Science and Applications – Deborah D.L. Chung
2. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi

Course Outcomes:

After learning the course the students should be able to

1. Explain various composite materials with their constituents, advantages, limitations and applications
2. Enumerate different reinforcements with their application.
3. Describe various manufacturing methods of polymer and metal matrix composites materials.
4. Describe various manufacturing methods of metal matrix composites materials and their applications.
5. Explain the synthesis and characterization procedures of nanocomposites.

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III Year - II Semester		L	T	P	C
		3	0	0	3
REFRIGERATION AND AIR CONDITIONING					

Course Objective: To apply the principles of Thermodynamics to analyse different types of refrigeration and air conditioning systems and to understand the functionality of the major components.

UNIT – I:

Introduction to Refrigeration: - Necessity and applications – Unit of refrigeration and C.O.P. – Mechanical Refrigeration – Types of Ideal cycle of refrigeration.

Air Refrigeration: Bell Coleman cycle and Brayton Cycle, Open and Dense air systems – Actual air refrigeration system – Refrigeration needs of Aircrafts- Air systems – Actual Air refrigeration system – Refrigeration needs of Aircrafts – Application of Air Refrigeration, Justification – Types of systems – Problems.

UNIT – II:

Vapour compression refrigeration – working principle and essential components of the plant – Simple Vapour compression refrigeration cycle – COP – Representation of cycle on T-S and p-h charts – effect of sub cooling and super heating – cycle analysis – Actual cycle Influence of various parameters on system performance – Use of p-h charts – Problems.

UNIT III:

System Components: Compressors – General classification – comparison – Advantages and Disadvantages.

Condensers – classification – Working Principles, Evaporators – classification – Working Principles

Expansion devices – Types – Working Principles,

Refrigerants: Desirable properties – common refrigerants used – Nomenclature – Ozone Depletion – Global Warming – Azeotropes and Zeotropes

UNIT IV:

Vapor Absorption System – Calculation of max COP – description and working of NH3 – water system – Li – Br system. Principle of operation Three Fluid absorption system, salient features.

Steam Jet Refrigeration System – Working Principle and Basic Components

Principle and operation of (i) Thermoelectric refrigerator (ii) Vortex tube or Hilsch tube.

UNIT – V:

Introduction to Air Conditioning:

Psychometric Properties & Processes – Sensible and latent heat loads – Characterization – Need for Ventilation, Consideration of Infiltration – Load concepts of RSHF, ASHF, ESHF and ADP.

Concept of human comfort and effective temperature –Comfort Air conditioning – Industrial air conditioning and Requirements – Air conditioning Load Calculations.

Air Conditioning systems - Classification of equipment, cooling, heating humidification and dehumidification, filters, grills and registers, deodorants, fans and blowers.

Heat Pump – Heat sources – different heat pump circuits – Applications.

TEXT BOOKS:

1. A Course in Refrigeration and Air conditioning - SC Arora &Domkundwar, Dhanpatrai Rai Publishers
2. Refrigeration and Air Conditioning - CP Arora, Tata McGraw Hill

REFERENCE BOOKS:

1. Refrigeration and Air Conditioning - Manohar Prasad, New Age
2. Principles of Refrigeration - Dossat, Pearson Education

3. Basic Refrigeration and Air-Conditioning- Ananthanarayanan, TMH

Course Outcomes: At the end of the course, the student should be able to

- Differentiate between different types of refrigeration systems with respect to engineering applications
- Thermodynamically analyse refrigeration and air conditioning systems and evaluate performance parameters
- Apply the principles of Psychrometrics to design the air conditioning loads for the industrial applications
- perform cooling load calculations and select the appropriate process and equipment for the required comfort and industrial air-conditioning.

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DEPARTMENT OF MECHANICAL ENGINEERING

III Year - II Semester		L	T	P	C
		3	0	0	3
UNCONVENTIONAL MACHINING PROCESSES					

Course Objectives:
The objective of the course is to study the fundamentals and operational behaviors of different types of unconventional / nontraditional machining processes

UNIT – I

INTRODUCTION: Need for non-traditional machining methods-classification of modern machining processes – considerations in process selection, applications.

Ultrasonic machining – Elements of the process, mechanics of material removal, MRR process parameters, economic considerations, applications and limitations.

UNIT-II

Abrasive jet machining, Water jet machining and abrasive water jet machining: Basic principles, equipments, process variables, mechanics of material removal, MRR, application and limitations,

UNIT – III

ELECTRO – CHEMICAL MACHINING: Fundamentals of electro chemical machining, electrochemical grinding, electro chemical honing and deburring process, metal removal rate in ECM, Tool design, Surface finish and accuracy, economic aspects of ECM – Simple problems for estimation of metal removal rate, fundamentals of chemical, machining, advantages and applications.

UNIT - IV

THERMAL METAL REMOVAL PROCESSES: General principle and applications of Electric Discharge Machining, Electric Discharge Grinding and wire EDM – Power circuits for EDM, Mechanics of metal removal in EDM, Process parameters, selection of tool electrode and dielectric fluids, surface finish and machining accuracy, characteristics of spark eroded surface

UNIT – V

Electron Beam Machining, Laser Beam Machining and plasma machining - Basic principle and theory, mechanics of material removal, process parameters, accuracy, surface finish, efficiency and applications .

Comparison of various nontraditional machining processes based on MRR, surface finish and applications.

Text Books:

1. Fundamentals of Machining Processes-Conventional and non – conventional processes/Hassan Abdel –Gawad El-Hafy/CRC Press-2016.

References:

1. Modern Machining Process / Pandey P.C. and Shah H.S./ TMH.
2. New Technology / Bhattacharya A/ the Institution of Engineers, India 1984.
3. Non Traditional Manufacturing Processes / Benedict /

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Course outcomes:

After studying the course, the students are able to

- Understand the characteristics and importance of different types of unconventional machining processes
- Identify the appropriate unconventional machining process for the implementation in a typical industrial scenario based on the applications
- Understand the significance of tools and resources used for machining the components in unconventional machining
- Machine the components through ECM / EDM and other machining processes
- Perform experiments in the advanced unconventional machining processes such as laser beam machining and electron beam machining

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III Year - II Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
ADVANCED MECHANICS OF SOLIDS					

COURSE OBJECTIVES:

- To understand the concept of theory of elasticity equations for solving various engineering problems
- To study the failure modes of different structural members.
- To analyse the internal stresses in curved beams and beams subjected to un-symmetrical bending.
- To understand the deformations and stresses in non circular cross section members with torsional loading.

UNIT I

Theories of stress and strain, Definition of stress at a point, stress notation, principal stresses, other properties, differential equations of motion of a deformable body, deformation of a deformable body, strain theory, principal strains, strain of a volume element, small displacement theory.

UNIT II

Failure criteria: Modes of failure, Failure criteria, Excessive deflections, Yield initiation, fracture, Progressive fracture, (High Cycle fatigue for number of cycles $N > 10^6$, buckling.

Application of energy methods: Elastic deflections and statically indeterminate members and structures: Principle of stationary potential energy, Castiglione's theorem on deflections, Castiglione's theorem on deflections for linear load deflection relations, deflections of statically determinate structures.

UNIT III

Unsymmetrical bending: Bending stresses in Beams subjected to Nonsymmetrical bending; Deflection of straight beams due to nonsymmetrical bending.

UNIT IV

Curved beam theory: Winkler Bach formula for circumferential stress – Limitations – Correction factors –Radial stress in curved beams – closed ring subjected to concentrated and uniform loads-stresses in chain links.

UNIT V

Torsion : Linear elastic solution; Prandtl elastic membrane (Soap-Film) Analogy; Narrow rectangular cross Section ;Hollow thin wall torsion members ,Multiply connected Cross Section.

TEXTBOOKS:

1.Advanced Mechanics of materials by Boresi& Sidebottom-Wiely International.

2. Theory of elasticity by Timoschenko S.P. and Goodier J.N. McGraw-Hill Publishers 3rd Edition

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REFERENCES:

1. Strength of materials & Theory of structures (Vol I & II) by B.C Punmia
2. Strength of materials by Sadhu singh.
3. Advanced Mechanics of Solids, L.S Srinath

COURSE OUTCOMES:

- Able to identify the failure modes of different structural members and apply various energy methods for statically determinant and in determinant structures.
- Gets acquainted with solving problems of curved beams and beams with un-symmetrical loading
- Able to apply the Soap-film analogy concept for torsional problems with non-circular cross section

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III Year - II Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
MATERIAL CHARACTERIZATION					

Course Objectives: To introduce the students to the principles of optical and electron microscopy, X-ray diffraction and various spectroscopic techniques.

UNIT I

Introduction to materials and characterization Techniques, X-ray diffraction: Bragg's law, phase identification, indexing and lattice parameter determination. Analytical line profile fitting using various models, Neutron diffraction, Reflection High Energy Electron Diffraction, and Low Energy Electron Diffraction.

UNIT II

Microscopy techniques: Optical microscopy, energy dispersive X-ray microanalysis (EDS), scanning electron microscopy (SEM), transmission electron microscopy (TEM), atomic force microscopy (AFM) and scanning probe microscopy (SPM), merits of TEM over SEM.

UNIT III

Thermal analysis technique: Differential thermal analysis (DTA), Differential Scanning Calorimetry (DSC), Thermo gravimetric analysis (TGA), determination of different thermal properties by DTA, DSC and TGA

UNIT IV

Magnetic characterization techniques: Introduction to Magnetism, Measurement Methods, Measuring Magnetization by Force, Measuring Magnetization by Induction method, Types of measurements using magnetometers: M-H loop, temperature dependent magnetization, time dependent magnetization, Measurements using AC susceptibility, Magneto-optical Kerr effect, Nuclear Magnetic Resonance, Electron Spin Resonance.

UNIT V

Optical and electronic characterization techniques: UV-VIS spectroscopy, Fourier transform infrared spectroscopy, Raman spectroscopy, X-ray photoelectron spectroscopy.

TEXT BOOKS:

1. Characterization of Materials (Materials Science andTechnology:A Comprehensive Treatment, Vol 2A & 2B,VCH (1992).
2. Semiconductor Material and Device Characterization, 3rdEdition, D. K. Schroder, Wiley-IEEE Press (2006).
3. Materials Characterization Techniques, S Zhang, L. Li andshok Kumar, CRC Press (2008).

REFERENCES:

1. Physical methods for Materials Characterization, P. E. J.Flewitt and R K Wild, IOP Publishing (2003).
2. Characterization of Nanophase materials, Ed. Z L Wang,Willet-VCH (2000).

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COURSE OUTCOMES: Students will have achieved the ability to:

1. choose and appropriate electron microscopy techniques to investigate microstructure of materials at high resolution
2. Determine crystal structure of specimen and estimate its crystallite size
3. Use appropriate spectroscopic technique to measure vibrational / electronic transitions to estimate parameters like energy band gap, elemental concentration, etc.
4. Apply thermal analysis techniques to determine thermal stability of and thermodynamic transitions of the specimen.

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III Year - II Semester		L	T	P	C
		3	0	0	3
TRIBOLOGY					

COURSE OBJECTIVES:

- To provide broad based understanding of the interdisciplinary subject 'tribology' and surface characterization techniques.
- To learn about the contact of solid surfaces and their interactions consequences of wear, wear mechanisms, wear theories and analysis of wear problems
- To understand the genesis of friction, the theories/laws of sliding and rolling friction
- To learn about the principles of lubrication, lubrication regimes, theories of hydrodynamic, elastohydrodynamic and mixed/ boundary lubrication
- To learn about tribotesting and experimental techniques in tribology and tribological modelling and simulation
- To learn about tribology of different machine components and emerging areas such as micro/nano tribology

UNIT – I

Introduction: Nature of surfaces and contact-Surface topography-friction and wear mechanisms, wear maps, effect of lubricants- methods of fluid film formation.

Lubrication: Choice of lubricants, types of oil, Grease and solid lubricants- additives- lubrication systems and their selection.

UNIT – II

Selection of rolling element bearings: Nominal life, static and dynamic capacity-Equivalent load, probabilities of survival- cubic mean load- bearing mounting details, pre loading of bearings, conditioning monitoring using shock pulse method.

UNIT – III

Hydrostatic Bearings: Thrust bearings – pad coefficients- restriction- optimum film thickness-journal bearings – design procedure –Aerostatic bearings; Thrust bearings and Journal bearings – design procedure.

UNIT – IV

Hydrodynamic bearings: Fundamentals of fluid formation – Reynold's equation; Hydrodynamic journal bearings – Sommerfield number- performance parameters – optimum bearing with maximum load capacity – Friction – Heat generated and Heat dissipated. Hydrodynamic thrust bearings; Raimondi and Boyd solution for hydrodynamic thrust bearings- fixed tilting pads, single and multiple pad bearings- optimum condition with largest minimum film thickness.

UNIT – V

Seals: different type-mechanical seals, lip seals, packed glands, soft piston seals, Mechanical piston rod packing, labyrinth seals and throttling bushes, oil flinger rings and drain grooves – selection of mechanical seals.

Failure of Tribological components: Failure analysis of plain bearings, rolling bearings, gears and seals, wear analysis using soap and Ferrography.

Dry rubbing Bearings: porous metal bearings and oscillatory journal bearings – qualitative approach only.

TEXT BOOKS:

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1.Rowe WW& O' Dionoghue,"Hydrostatic and Hybrid bearing design " Butterworths& Co.Publishers Ltd,1983.
2.Collacott R.A," Mechanical Fault diagnosis and condition monitoring", Chapman and Hall, London 1977.
3. Bernard J.Hamrock, " Fundamentals of fluid film lubricant", McGraw-Hill Co.,1994.
4. Introduction to Tribology of bearings – B.C.Majumdar – S Chand Publishing.

REFERENCES:

1.Neale MJ, (Editor) " Tribology hand Book"NeumannButterworths, 1975.
2.Connor and Boyd JJO (Editors) " Standard hand book of lubrication engineers " ASLE,Mc Graw Hill Book & Co.,1968
3. Shigley J, E Charles," Mechanical Engineering Design", McGraw Hill Co., 1989

COURSE OUTCOMES:

- Students will demonstrate basic understanding of friction, lubrication and wear rocesses.
- Students will become familiar with mathematical tools used to analyze tribological processes.
- To enhance students' awareness of tribological issues in the design of machine components, such as rolling element bearings, journal bearings, thrust bearings, seals and braking systems.
- Students will become familiar with common anti-friction and anti-wear components and the lubricants used therein.
- Students will be able to describe the detailed operation of selected anti-friction or anti-wear components.
- Students will be exposed to design a tribological system for optimal performance. Students will be able to develop technical project reports and technical presentations

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III Year - II Semester		L	T	P	C
		3	0	0	3
AUTOMOBILE ENGINEERING					

Course Objectives:
(1) Understand the basic lay-out of an automobile.
(2) Understand the operation of engine cooling, lubrication, ignition, electrical and air conditioning systems.
(3) Understand the principles of transmission, suspension, steering and braking systems.
(4) Understand automotive electronics.
(5) Study latest developments in automobiles.

UNIT – I:
Introduction: Components of four wheeler automobile – chassis and body – power unit – power transmission – rear wheel drive, front wheel drive, 4 wheel drive – types of automobile engines, engine construction – engine lubrication, splash and pressure lubrication systems, oil filters, oil pumps – crank case ventilation – engine service, reboring, decarburization, Nitriding of crank shaft.
Emission from Automobiles – Pollution standards, National and international – Pollution Control – Techniques – Noise Pollution & control.

UNIT – II:
Fuel System: S.I. Engine: Fuel supply systems, Mechanical and electrical fuel pumps – carburetor – types – air filters – petrol injection.
C.I. Engines: Requirements of diesel injection systems, types of injection systems, fuel pump, nozzle, Alternative fuels for Automobiles-injection,Classification,Properties, Hybrid vehicles injection timing, testing of fuel, pumps.

UNIT – III:
Cooling System: Cooling Requirements, Air Cooling, Liquid Cooling and Forced Circulation System – Radiators – Types – Cooling Fan - water pump, thermostat, evaporating cooling – pressure sealed cooling – antifreeze solutions.
Ignition System: Function of an ignition system, battery ignition system, constructional features of storage battery, auto transformer, contact breaker points, condenser and spark plug – Magneto coil ignition system, electronic ignition system using contact breaker, electronic ignition using contact triggers – spark advance and retard mechanism.

UNIT – IV:
Electrical System: Charging circuit, generator, current – voltage regulator – starting system, bendix drive mechanism solenoid switch, lighting systems, Horn, wiper, fuel gauge – oil pressure gauge, engine temperature indicator etc.
Transmission System: Clutches, principle, types, cone clutch, single plate clutch, multi plate clutch, magnetic and centrifugal clutches, fluid fly wheel – Gear boxes, types, sliding mesh, construct mesh, synchro mesh gear boxes, epicyclic gear box , over drive torque converter.
Propeller shaft – Hoatch – Kiss drive, Torque tube drive universal joint, differential rear axles – types – wheels and tyres.

UNIT – V:
Steering System: Steering geometry – camber, castor, king pin rake, combined angle toe in, center point steering. Types of steering mechanism – Ackerman steering mechanism, Davis steering mechanism, steering gears – types, steering linkages.
Suspension System: Objects of suspension systems – rigid axle suspension system, torsion bar, shock absorber, Independent suspension system.

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Braking System: Mechanical brake system, Hydraulic brake system, Master cylinder, wheel cylinder tandem master cylinder Requirement of brake fluid, Pneumatic and vacuum brakes.

TEXT BOOKS:

1.Automobile Engineering by Kripal Singh Vol. 1 & Vol. 2
2.Automobile Engineering by K.M Gupta, Umesh publication, Vol. 1 & Vol. 2,

REFERENCE BOOKS:

1.A System approach to Automotive Technology by Jack Erjavec YesDee publishing pvt Ltd.
2.Automobile Engineering by William Crouse
3. Automotive Mechanics by Heitner
4. Alternative fuels of Automobiles by P.Rami Reddy, Frontline publications

Course Outcomes: At the end of the course, the student will be able to:

(1) Describe the basic lay-out of an automobile and its components and enlist the emission standards of an automobile.

(2) Describe different engine cooling, lubrication, ignition, electrical and air conditioning systems and suggest suitable systems for a given application.

(3) Explain the principles of transmission, suspension, steering and braking systems.

(4) Describe various fuel supply systems in SI and CI engines

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III Year - II Semester		L	T	P	C
		3	0	0	3
MECHATRONICS					

Course Objective
The main objective of this course is to introduce the integrative nature of Mechatronics. To describe the different components and devices of mechatronics systems.

UNIT-I
Mechatronics systems – elements & levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor-based controllers, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.

UNIT-II
Hydraulic and pneumatic actuating systems - Fluid systems, Hydraulic systems, and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems. Mechanical actuating systems and electrical actuating systems – basic principles and elements.

UNIT-III
Digital electronics and systems, digital logic control, micro processors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control.

UNIT-IV
System and interfacing and data acquisition – Data Acquisition Systems, Analog to Digital and Digital to Analog conversions; Digital Signal Processing – data flow in DSPs, block diagrams, typical layouts, Interfacing motor drives.

UNIT-V
Dynamic models and analogies, System response. Process Controllers – Digital Controllers, Programmable Logic Controllers, Design of mechatronics systems & future trends.

Text Books:
1.MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran, GK Vijaya Raghavan & MS Balasundaram/WILEY India Edition

References:
1.Mechatronics /Smaili A, Mrad F/ Oxford Higher Education, Oxford University Press
2.Mechatronics Source Book / Newton C Braga/Thomson Publications,Chennai.
3.Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.
4.Mechatronics System Design / Devdas shetty/Richard/Thomson.
5.Mechatronics/M.D.Singh/J.G.Joshi/PHI.
6.Mechatronics – Electronic Control Systems in Mechanical and Electrical Engg. 4th Edition / W. Bolton/ Pearson, 2012
7.Mechatronics – Principles and Application / Godfrey C. Onwubolu/Elsevier, Indian print

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Course outcomes:
After completion of this course, the student shall be able to use the various mechatronics systems devices and components in the design of electro mechanical systems.

Course Outcomes
CO1. Shall be able to use the various mechatronics systems devices and components in the design of electro mechanical systems.
At the end of the course, the student will be able to
CO1: Explain mechatronics design process and outline appropriate sensors and actuators for engineering applications
CO2: Develop a simulation model for simple physical systems
CO3: Write simple microcontroller programs
CO4: Explain linearization of nonlinear systems and elements of data acquisition
CO5: Explain various applications of design of mechatronic systems

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III Year - II Semester		**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**
SIMULATION OF MECHANICAL SYSTEMS LAB					

1. Mass-Spring-Damper with controller
2. Double Mass-Spring- Damper
3. Simple Mechanical System
4. Mechanical System with Translational Friction
5. Mechanical System with Translational Hard stop
6. Mechanical Rotational System with stick-slip motion
7. Linkage Mechanism
8. Steering Mechanism

Softwares Used: MATLAB/SCILAB

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III Year - II Semester		**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**
HEAT TRANSFER LAB					

Objectives:

The laboratory course is aimed to provide the practical exposure to the students with regard to the determination of amount of heat exchange in various modes of heat transfer including condensation & boiling for several geometries.

Note: The students have to perform minimum 12 Experiments.

1. COP of VCR System with Capillary and thermal expansion valve.
2. Determination of overall heat transfer co-efficient of a composite slab
3. Determination of heat transfer rate through a lagged pipe.
4. Determination of heat transfer rate through a concentric sphere
5. Determination of thermal conductivity of a metal rod.
6. Determination of efficiency of a pin-fin
7. Determination of heat transfer coefficient in natural and forced convection
8. Determination of effectiveness of parallel and counter flow heat exchangers.
9. Determination of emissivity of a given surface.
10. Determination of Stefan Boltzman constant.
11. Determination of heat transfer rate in drop and film wise condensation.
12. Determination of critical heat flux.
13. Determination of Thermal conductivity of liquids and gases.
14. Investigation of Lambert's cosine law.

Outcomes:

The student should be able to evaluate the amount of heat exchange for plane, cylindrical & spherical geometries and should be able to compare the performance of extended surfaces and heat exchangers

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DEPARTMENT OF MECHANICAL ENGINEERING

III Year - II Semester		**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**
CAD/CAM LAB					

Course Objectives:

1. To impart the fundamental knowledge on using various analytical tools like ANSYS, FLUENT, etc., for Engineering Simulation
2. To know various fields of engineering where these tools can be effectively used to improve the output of a product.
3. To impart knowledge on how these tools are ued in Industries by solving some real time problems using these tools..

1. **DRAFTING:** Development of part drawings for various components in the form of orthographic andisometric. representation of dimensioning and tolerances scanning and plotting. study of script, DXE and IGES files.
2. **PART MODELING:** Generation of various 3D models through protrusion, revolve, shell sweep. creation of various features. study of parent child relation. feature based and boolean based modeling surface and assembly modeling. study of various standard translators. design simple components.
3. a). Study of various post processors used in NC Machines.
   b). Machining of simple components on NC lathe and Mill by transferring NC Code / from a CAM package. Through RS 232.
   c) Practice on CNC Sinutrain Turning
   d) Practice on CNC Sinutrain Milling
   e) CNC programming for turned components using FANUC Controller
   f) CNC programming for milled components using FANUC Controller
   g) Automated CNC Tool path & G-Code generation using Pro/E/MasterCAM

Packages to be provided to cater to drafting and modeling from the following:

CATIA, Pro-E, I-DEAS, Gibbs CAM, Master CAM etc.

Course outcomes:

Upon successful completion of this course student should be able to:

1. The student will be able to appreciate the utility of the modeling tools in creating 2D and 3D drawings.
2. Use of these tools for any engineering and real time applications
3. Acquire knowledge on utilizing these tools for a better project in their curriculum as well as they will be prepared to handle industry problems with confidence when it matters to use these tools in their Employment

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IV Year - I Semester		L	T	P	C
		3	0	0	3
INDUSTRIAL MANAGEMENT					

Course Objectives:

1. To impart fundamental knowledge and skill sets required in the Industrial Management and Engineering profession, which include the ability to apply basic knowledge of mathematics, probability and statistics, and the domain knowledge of Industrial Management and Engineering
2. To produce graduates with the ability to adopt a system approach to design, develop, implement and innovate integrated systems that include people, materials, information, equipment and energy.
3. To enable students to understand the interactions between engineering, business, technological and environmental spheres in the modern society.
4. To enable students to understand their role as engineers and their impact to society at the national and global context.

UNIT – I

INTRODUCTION: Definition of industrial engineering (I.E), development, applications, role of an industrial engineer, differences between production management and industrial engineering, quantitative tools of IE and productivity measurement. concepts of management, importance, functions of management, scientific management, Taylor's principles, theory X and theory Y, Fayol's principles of management.

UNIT – II

PLANT LAYOUT: Factors governing plant location, types of production layouts, advantages and disadvantages of process layout and product layout, applications, quantitative techniques for optimal design of layouts, plant maintenance, preventive and breakdown maintenance.

UNIT – III

WORK STUDY: Importance, types of production, applications, workstudy, method study and time study, work sampling, PMTS, micro-motion study, rating techniques, MTM, work factor system, principles of Ergonomics, flow process charts, string diagrams and Therbligs,

UNIT – IV

STATISTICAL QUALITY CONTROL: Quality control, Queing assurance and its importance, SQC, attribute sampling inspection with single and double sampling, Control charts – $\overline{X}$ and R – charts $\overline{X}$ and *S* charts and their applications, numerical examples.

TOTAL QUALITY MANAGEMENT: zero defect concept, quality circles, implementation, applications, ISO quality systems. six sigma – definition, basic concepts

UNIT – V

RESOURCE MANAGEMENT: Concept of human resource management, personnel management and industrial relations, functions of personnel management, Job-evaluation, its importance and types, merit rating, quantitative methods, wage incentive plans, types.

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VALUE ANALYSIS: Value engineering, implementation procedure, enterprise resource planning and supply chain management.

TEXT BOOKS:

1.Industrial Engineering and management / O.P Khanna/Khanna Publishers.
2.Industrial Engineering and Production Management/Martand Telsang/S.Chand & Company Ltd. New Delhi

Reference Books:

1.Industrial Management / Bhattacharya DK/Vikas publishers
2. Operations Management / J.G Monks/McGrawHill Publishers.
3.Industrial Engineering and Management Science/T.R. Banga,S.C.Sharma, N. K. Agarwal/Khanna Publishers
4. Principles of Management /Koontz O' Donnel/McGraw Hill Publishers.
5. Statistical Quality Control /Gupta/Khanna Publishers
6. Industrial Engineering and Management /NVS Raju/Cengage Publishers

Course outcome:

Upon successful completion of this course you should be able to:
1. Design and conduct experiments, analyse, interpret data and synthesize valid conclusions
2. Design a system, component, or process, and synthesize solutions to achieve desired needs
3. Use the techniques, skills, and modern engineering tools necessary for engineering practice with appropriate considerations for public health and safety, cultural, societal, and environmental constraints
4. Function effectively within multi-disciplinary teams and understand the fundamental precepts of effective project management

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IV Year - I Semester		L	T	P	C
		3	0	0	3
FINITE ELEMENT METHODS					

Course Objectives:

1. To learn basic principles of finite element analysis procedure
2. To learn the theory and characteristics of finite elements that represent engineering structures
3. To learn and apply finite element solutions to structural, thermal and dynamic problems.
4. Learn to model complex geometry problems and solution techniques.

UNIT-I

Introduction to finite element method, stress and equilibrium, strain – displacement relations, stress – strain relations, plane stress and plane strain conditions, variational and weighted residual methods, concept of potential energy, one dimensional problems.

Discretization of domain, element shapes, discretization procedures, assembly of stiffness matrix, band width, node numbering, mesh generation, interpolation functions, local and global coordinates, convergence requirements, treatment of boundary conditions.

UNIT – II

Analysis of Trusses: Finite element modeling, coordinates and shape functions, assembly of global stiffness matrix and load vector, finite element equations, treatment of boundary conditions, stress, strain and support reaction calculations.

Analysis of Beams: Element stiffness matrix for Hermite beam element, derivation of load vector for concentrated and UDL, simple problems on beams.

UNIT – III

Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions, formulation of axisymmetric problems.

UNIT-IV

Higher order and isoparametric elements: One dimensional quadratic and cubic elements in natural coordinates, two dimensional four noded isoparametric elements and numerical integration.

UNIT – V

Steady state heat transfer analysis : one dimensional analysis of a fin and two dimensional analysis of thin plate, analysis of a uniform shaft subjected to torsion. Dynamic Analysis: Formulation of finite element model, element consistent and lumped mass matrices, evaluation of eigen values and eigen vectors, free vibration analysis.

Text Books:

1.The Finite Element Methods in Engineering / SS Rao / Pergamon.
2. Introduction to Finite Elements in Engineering/ Tirupathi R. Chandrupatla, Ashok D. Belegundu, Pearson Publishers.

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References:

1.Finite Element Method with applications in Engineering / YM Desai, Eldho & Shah /Pearson publishers
2.An introduction to Finite Element Method / JN Reddy / McGraw Hill
3.The Finite Element Method for Engineers – Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smith and Ted G. Byrom / John Wiley & sons (ASIA) Pte Ltd.

Course outcomes:

Upon successful completion of this course you should be able to:

1. Understand the concepts behind variational methods and weighted residual methods in FEM
2. Identify the application and characteristics of FEA elements such as bars, beams, plane and isoparametric elements, and 3-D element .
3. Develop element characteristic equation procedure and generate global equations.
4. Able to apply Suitable boundary conditions to global equations, and reduce it to a solvable form.
5. Able to apply the FE procedure to field problems like heat transfer.

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IV Year - I Semester		L	T	P	C
		3	0	0	3
MECHANICAL VIBRATIONS					

Course Objectives:

- Analyze the various 1-D periodic and periodic responses of a vibrating system with and without damping
- To learn to derive the equations of motion and solution for Two and multi degree freedom systems by the application of analytical methods
- To understand the numerical methods for quick estimation of 1st natural frequency of multi degree freedom systems .
- Have the knowledge of the various physical vibration measuring instruments.
- Learn to solve vibrations problems of continuous systems.

Unit I

Single degree of Freedom systems: Undamped and damped free vibrations: forced vibrations ; coulomb damping; Response to harmonic excitation; rotating unbalance and support excitation, Vibration isolation and transmissibility,.

Unit II

Vibration Measurement: Vibrometers, velocity meters & accelerometers

Two degree of freedom systems: Principal modes – undamped and damped free and forced vibrations; undamped vibration absorbers.

UNIT-III

Multi degree of freedom systems: Matrix formulation, stiffness and flexibility influence coefficients; Eigen value problem; normal modes and their properties; Free and forced vibration by Modal analysis; Method of matrix inversion; Torsional vibrations of multi – rotor systems and geared systems; Discrete-Time systems.

Unit IV

Numerical Methods: Rayleigh's, stodola's, Matrix iteration, Rayleigh-Ritz Method and Holzer's methods.

Unit V

Application of concepts: Free vibration of strings – longitudinal oscillations of bars-transverse vibrations of beams- Torsional vibrations of shafts. Critical speeds without and with damping, secondary critical speed.

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TEXT BOOKS:

1. Elements of Vibration Analysis by Meirovitch.
2. Mechanical Vibrations by G.K. Groover.

REFERENCES:

1. Vibrations by W.T. Thomson
2. Mechanical Vibrations – Schaum series.
3. Vibration problems in Engineering by S.P. Timoshenko.

COURSE OUTCOMES:

- To Analyze the various 1-D periodic and periodic responses of an vibrating system with and without damping
- Able to derive equations of motion and solutions for two and multi degree freedom systems by the application of analytical methods
- Able to understand the numerical methods for quick estimation of 1st natural frequency of multi degree freedom systems.
- Apply the knowledge of the various physical vibration measuring instruments and their applications in real life vibration data acquisition.

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IV Year - I Semester		L	T	P	C
		3	0	0	3
RENEWABLE ENERGY SOURCES					

Course Objective:
The course aims to highlight the significance of alternative sources of energy, green energy systems and processes and provides the theory and working principles of probable sources of renewable and green energy systems that are environmental friendly.

UNIT-I

SOLAR RADIATION: Role and potential of new and renewable sources, the solar energy option, Environmental impact of solar power, structure of the sun, the solar constant, sun-earth relationships, coordinate systems and coordinates of the sun, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data, numerical problems. Photo voltaic energy conversion – types of PV cells.

SOLAR ENERGY COLLECTION: Flat plate and concentrating collectors, classification of concentrating collectors, orientation.

SOLAR ENERGY STORAGE AND APPLICATIONS: Different methods, sensible, latent heat and stratified storage, solar ponds, solar applications- solar heating/cooling technique, solar distillation and drying, solar cookers, central power tower concept and solar chimney.

UNIT – II

WIND ENERGY: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, betz criteria, types of winds, wind data measurement.

BIO-MASS: Principles of bio-conversion, anaerobic/aerobic digestion, types of bio-gas digesters, gas yield, utilization for cooking, bio fuels, I.C. engine operation and economic aspects.

GEOTHERMAL ENERGY: Resources, types of wells, methods of harnessing the energy.

OCEAN ENERGY: OTEC, Principles of utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques.

UNIT –III

ENERGY EFFICIENT SYSTEMS:

(A) ELECTRICAL SYSTEMS: Energy efficient motors, energy efficient lighting and control, selection of luminaire, variable voltage variable frequency drives (adjustable speed drives), controls for HVAC (heating, ventilation and air conditioning), demand site management.

(B) MECHANICAL SYSTEMS: Fuel cells- principle, thermodynamic aspects, selection of fuels & working of various types of fuel cells, Environmental friendly and Energy efficient compressors and pumps**.**

UNIT-IV

ENERGY EFFICIENT PROCESSES: Environmental impact of the current manufacturing practices and systems, benefits of green manufacturing systems, selection of recyclable and environment friendly materials in manufacturing, design and implementation of efficient and sustainable green production systems with examples like environmental friendly machining, vegetable based cutting fluids, alternate casting and joining techniques, zero waste manufacturing.

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UNIT – V

GREEN BUILDINGS: Definition, features and benefits. Sustainable site selection and planning of buildings for maximum comfort. Environmental friendly building materials like bamboo, timber, rammed earth, hollow blocks, lime & lime pozzolana cement, agro materials and industrial waste, Ferro cement and Ferro-concrete, alternate roofing systems, paints to reduce heat gain of the buildings. Energy management.

Text Books:

1. Solar Energy – Principles of Thermal Collection and Storage/Sukhatme S.P. and J.K.Nayak/ TMH
2. Non-Conventional Energy Resources- Khan B.H/ Tata McGraw Hill, New Delhi, 2006
3. Green Manufacturing Processes and Systems - J. Paulo Davim/Springer 2013

References:

1. Alternative Building Materials and Technologies - K.S Jagadeesh, B.V Venkata Rama Reddy and K.S Nanjunda Rao/New age international
2. Principles of Solar Engineering - D.Yogi Goswami, Frank Krieth & John F Kreider / Taylor & Francis
3. Non-Conventional Energy - Ashok V Desai /New Age International (P) Ltd
4. Renewable Energy Technologies -Ramesh & Kumar /Narosa
5. Non conventional Energy Source- G.D Roy/Standard Publishers
6. Renewable Energy Resources-2nd Edition/ J.Twidell and T. Weir/ BSP Books Pvt.Ltd
7. Fuel Cell Technology -Hand Book / Gregor Hoogers / BSP Books Pvt. Ltd.

Course outcome:

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

(1) To understand the principles and working of solar, wind, biomass, geo thermal, ocean energies.

(2) To understand the principles and working and green energy systems and appreciate their significance in view of their importance in the current scenario and their potential future applications.

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IV Year - I Semester		L	T	P	C
		3	0	0	3
PRODUCTION PLANNING & CONTROL					

Course objectives:

This subject provides students with

1. An understanding of the concepts of production and service systems;
2. The ability to apply principles and techniques in the design, planning and control of these systems to optimise/make best use of resources in achieving their objectives.
3. Identify different strategies employed in manufacturing and service industries to plan production and control inventory.
4. Measure the effectiveness, identify likely areas for improvement, develop and implement improved planning and control methods for production systems.

UNIT – I

Introduction: Definition – objectives and functions of production planning and control – elements of production control – types of production – organization of production planning and control department – internal organization of department.

UNIT – II

Forecasting – importance of forecasting – types of forecasting, their uses – general principles of forecasting – forecasting techniques – qualitative methods and quantitive methods.

UNIT – III

Inventory management – functions of inventories – relevant inventory costs – ABC analysis – VED analysis – EOQ model – Inventory control systems – P–Systems and Q-Systems

UNIT – IV

Capacity planning, factors, measures of capacity, economies of scale, aggregate planning, long term and short term strategies, LPP models to solve Aggregate planning problems, Disaggregating

UNIT – V

Material Requirement Planning, Master Production Schedule, Bill of Materials, Lot sizing Methods, MRP-II, Introduction to ERP, Line balancing Methods

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TEXT BOOKS:

1. Elements of Production Planning and Control / Samuel Eilon/Universal Book Corp.
2. Manufacturing, Planning and Control/Partik Jonsson Stig-Arne Mattsson/TataMcGrawHill

REFERENCES:

1. Inventory Control Theory and Practice / Martin K. Starr and David W. Miller/Prentice-Hall
2. Production Planning and Control/Mukhopadyay/PHI.
3.Production Control A Quantitative Approach / John E. Biegel/Prentice-Hall
4. Production Control / Franklin G Moore & Ronald Jablonski/ Mc-GrawHill
5.Production and Operations Management/Shailendra Kale/McGraw Hill
6.Production and Operations Management/Ajay K Garg/McGraw Hill

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Course Outcome:

CO1. Apply the systems concept for the design of production and service systems.
CO2. Make forecasts in the manufacturing and service sectors using selected quantitative and qualitative techniques.
CO3. Apply the principles and techniques for planning and control of the production and service systems to optimize/make best use of resources.
CO4. Understand the importance and function of inventory and to be able to apply selected techniques for its control and management under dependent and independent demand circumstances.

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IV Year - I Semester		L	T	P	C
		3	0	0	3
MACHINE TOOL DESIGN					

Course Objectives:

- To learn and applications of the basics and working principles of different types of machine tools
- To grasp the knowledge of critical functional and operational requirements of different types of machine tools
- To learn the knowledge of design of different types of machine tools to meet varied functional and operational requirements.

Unit I:
Basic features: Classification of machine tools-Basic features of construction and fundamental kinematic mechanisms of general purpose, special purpose machine tools, transfer machines, Automatic and N.C. machines. Mechanisms used for converting rotary to linear motion: Mechanisms for intermittent motion.

Unit II:
Kinematics, Drives of Machine tools: Selection of range of speeds and feeds. Layout in G.P., A.P. and H.P, standardization of speeds and feeds. Productivity loss. Selection of highest and lowest speeds, range ratio. Design of ray diagram and structural diagrams for machine tool gear boxes. Sliding, clustered and clutched drives, support drive.
Unit III:
Feed gear boxes: Norton and Meander drives pre-selection of speed, stepped and stepless regulation. Strength, rigidity and design analysis: Analysis of beds, frames, columns. Materials for structures. Methods to improve the rigidity of structures. Types of Guide ways-overall compliance of machine tool. Thermal effects-functional accuracy of machine tool.
Unit IV:
Spindle units: Spindle units of lathe, drilling, milling and grinding machines, materials for spindles. Spindle design. Effect of clearance on the rigidity of spindle. Hydrodynamic, hydrostatic, rolling bearings. Selection of bearings.
Unit V:
Jigs & Fixtures: Principles of design of jigs and fixtures and uses, classification of jigs & fixtures, principles of location and clamping, types of clamping & work holding devices, typical examples of jigs and fixtures.

Text Books:

1. Sen G.S., & Battacharya, "Principles of Machine Tools", New Central Book Agency, Calcutta, 1986.
2. Machine Tool Design and Numerical Control/ NK Mehata / Tata MeGraw Hills, 2012

Reference Books:

1. Basu S.K., "Design of Machine Tools", Allied Publishers, 1980.
2. Russe W. Henke, "Introduction to Fluid Power Circuits and Systems", Addison Wesley, 1970.
3. Metal Cutting and Tool Design – Dr.B.J.Ranganath - Vikas Publishing House Pvt. Ltd.- 2nd Edition - 2018
4. A Textbook of Production Engineering – P.C.Sharma- S.Chand Publishers.

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Course Outcomes: Student will be able to

1. Understand the basic working principles of different machine tools with kinematic mechanisms.
2. Distinguish the functional and operational requirements of different machine tools
3. Design speed and feed gear boxes for a particular configuration.
4. Design machine tool structures for strength and rigidity
5. Understand various controls used in machine tools

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IV Year - I Semester		L	T	P	C
		3	0	0	3
INDUSTRIAL AUTOMATION AND ROBOTICS					

Course Objectives:

1. The student will be exposed to the concepts of automation
2. The students will be exposed to the concepts of robot kinematics, Dynamics, Trajectory planning.
3. Mathematical approach to explain how the robotic arm motion can be described.
4. The students will understand the functioning of sensors and actuators and their applications
5. The student will be exposed to the applications of robotics in manufacturing.

UNIT-I

INTRODUCTION: Automation and Robotics, types of automation, assembly automation equipment, material handling systems, feed systems, Automated Guided Vehicles, Automated storage and retrieval systems, Flexible Manufacturing Systems, Computer Aided Process Planning Systems, Computer Aided manufacturing. CAD/CAM and Robotics – An over view of Robotics – present and future applications – classification by coordinate system and control system.

COMPONENTS OF THE INDUSTRIAL ROBOTICS: Function line diagram representation of robot arms, common types of arms. Components, Architecture, number of degrees of freedom – Requirements and challenges of end effectors, determination of the end effectors, comparison of Electric, Hydraulic and Pneumatic types of locomotion devices.

UNIT – II

MOTION ANALYSIS: Homogeneous transformations as applicable to rotation and translation – problems.

MANIPULATOR KINEMATICS: Specifications of matrices, D-H notation joint coordinates and world coordinates Forward and inverse kinematics – problems.

UNIT – III

Differential transformation and manipulators, Jacobians – problems

Dynamics: Lagrange – Euler and Newton – Euler formulations – Problems.

UNIT IV

General considerations in path description and generation. Trajectory planning and avoidance of obstacles, path planning, Skew motion, joint integrated motion –straight line motion – Robot programming, languages and software packages-description of paths with a robot programming language.

UNIT V

ROBOT ACTUATORS AND FEED BACK COMPONENTS:

Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors.

Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors.

ROBOT APPLICATIONS IN MANUFACTURING: Material Transfer - Material handling, loading and unloading- Processing - spot and continuous arc welding & spray painting - Assembly and Inspection.

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Text Books:

1. Industrial Robotics / Groover M P /Pearson Edu.
2. Robotics and Control / Mittal R K & Nagrath I J / TMH.

References:

1. Robotics / Fu K S/ McGraw Hill.
2. Robotic Engineering / Richard D. Klafter, Prentice Hall
3. Robot Analysis and Control / H. Asada and J.J.E. Slotine / BSP Books Pvt.Ltd.
4. Introduction to Robotics / John J Craig / Pearson Edu.

Course outcomes:

Upon successful completion of this course you should be able to:

1. Identify various robot configuration and components,
2. Select appropriate actuators and sensors for a robot based on specific application
3. Carry out kinematic and dynamic analysis for simple serial kinematic chains
4. Perform trajectory planning for a manipulator by avoiding obstacles.
5. Use knowledge of robotics for automation in manufacturing applications.

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IV Year - I Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
MICRO AND NANO MANUFACTURING					

UNIT:I
Nanomaterials and their synthesis: Synthesis of Bulk poly crystalline samples, growth of single crystals, synthesis techniques- Bottom –Up approaches – Thin film growth, PVD and CVD. Top-Down approaches – Ball milling, Micro fabrication, Electron beam and Ion beam Lithography, Nano lithography.

UNIT:II
Thin films and Nanocomposites: Micro and Nano scale thin film fabrication techniques, Optical, electrical and magnetic properties of Nano structured thin films, Nano composites and their physical and optical properties, Etching- Wet etching and Dry etching, Diffusion and Ion implantation

UNIT III
Nano Scale Characterization Techniques: X Ray diffraction, Scanning electron microscopy, Transmission electron microscopy, Energy dispersive X-Ray analysis and Atomic force microscopy.

UNIT:IV
An Over view of Micro and Nano mechanical systems and their applications in mechanical engineering, Silicon micro machining methods, Crystal growing and wafer preparation, Films and Film deposition Materials Aspects of Micro Electro Mechanical Systems (MEMS) and Nano Electro Mechanical Systems (NEMS), Silicon, Germanium-Based Materials, Metals, Harsh Environment Semiconductors, GaAs, InP, and Related III-V Materials, Ferroelectric Materials and Polymer Materials,

UNIT:V
Micro machining of MEMS devices, MEMS Fabrication Techniques, Bulk Micromachining, Surface Micromachining, High Aspect-Ratio Micromachining, Silicon micro machining methods, Crystal growing and wafer preparation, Films and Film deposition
Nanofabrication Techniques, E-Beam and Nano-Imprint Fabrication, Epitaxy and Strain Engineering, Scanned Probe Techniques, Self-Assembly and Template Manufacturing

Text Books:
1. Nanoscience and Nanotechnology: Fundamentals to Frontiers/ M.S.Ramachandra Rao, Shubra Singh, Willey.

References:
1. Springer's Hand book of Nano-technology - Bharat Bhusan (Ed.)
2. Nanotechnology and nanoelectronics – WR Fahrner, Springer International

Course Outcomes: Upon successful completion of this course you should be able to:
1. get awareness of different techniques used in micro and nano manufacturing.
2. get in-depth idea of thin films and nano composites
3. get awareness on Characterization Techniques

4. find different materials for Micro and Nano mechanical systems and their applications in mechanical engineering.
5. Explain different MEMS & Nano fabrication Techniques.

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IV Year - I Semester		L	T	P	C
		3	0	0	3
POWER PLANT ENGINEERING					

Course Objectives:
The course is aimed at providing knowledge of power generation through different prime movers viz steam, ICGT, Hydro, nuclear and hybrid systems along with their economics and environmental considerations.

UNIT – I
Introduction to the sources of energy – resources and development of power in india.
STEAM POWER PLANT: Plant layout, working of different circuits, fuel and handling equipments, types of coals, coal handling, choice of handling equipment, coal storage, ash handling systems. Combustion: properties of coal – overfeed and underfeed fuel beds, traveling grate stokers, spreader stokers, retort stokers, pulverized fuel burning system and its components, combustion needs and draught system, cyclone furnace, design and construction, dust collectors, cooling towers and heat rejection, corrosion and feed water treatment.

UNIT – II
INTERNAL COMBUSTION AND GAS TURBINE POWER PLANTS:
DIESEL POWER PLANT: Plant layout with auxiliaries – fuel supply system, air starting equipment, super charging.
GAS TURBINE PLANT: Introduction – classification - construction – layout with auxiliaries, combined cycle power plants and comparison.

UNIT – III
HYDRO ELECTRIC POWER PLANT: Water power – hydrological cycle / flow measurement – drainage area characteristics – hydrographs – storage and pondage – classification of dams and spill ways.
HYDRO PROJECTS AND PLANT: Classification – plant operation and pumped storage plants.
NUCLEAR POWER STATION: Nuclear fuel – breeding and fertile materials – nuclear reactor – reactor operation.
TYPES OF REACTORS: Pressurized water reactor, boiling water reactor, sodium-graphite reactor, fast breeder reactor, radiation hazards and shielding – radioactive waste disposal.

UNIT – IV
COMBINED OPERATIONS OF DIFFERENT POWER PLANTS: Introduction, advantages of combined working, load division between power stations, storage type hydro-electric plant in combination with steam plant, run-of-river plant in combination with steam plant, pump storage plant in combination with steam or nuclear power plant, co-ordination of hydro-electric and gas turbine stations,
POWER PLANT INSTRUMENTATION AND CONTROL: Importance of measurement and instrumentation in power plant, measurement of water purity, gas analysis, O_2 and CO_2 measurements, measurement of smoke and dust, measurement of moisture in carbon dioxide circuit, nuclear measurements.

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UNIT – V

POWER PLANT ECONOMICS AND ENVIRONMENTAL CONSIDERATIONS: Capital cost, investment of fixed charges, operating costs, general arrangement of power distribution, load curves, load duration curve, definitions of connected load, maximum demand, demand factor, average load, load factor, diversity factor – related exercises. effluents from power plants and Impact on environment – pollutants and pollution standards – methods of pollution control.

Text Books:

1. A course in Power Plant Engineering - Arora and Domkundwar/Dhanpatrai & Co.
2. Power Plant Engineering - P.C.Sharma / S.K.Kataria Pub

References:

1. Power Plant Engineering - P.K.Nag/ II Edition /TMH.
2. Power station Engineering – ElWakil / McGrawHill.
3. An Introduction to Power Plant Technology - G.D. Rai/Khanna Publishers

Course outcomes:

After undergoing this course the student can
(1) Understand various conventional methods of power generation
(2) To understand the principle of operation and performance of respective prime movers along with their economics and their impact on environment.
(3) To understand the power plant instrumentation and control

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DEPARTMENT OF MECHANICAL ENGINEERING

IV Year - I Semester		L	T	P	C
		3	0	0	3
OPTIMIZATION TECHNIQUES					

COURSE OBJECTIVES:
To enable the students learn the latest non-linear optimization techniques such as classical optimization methods, integer programming etc. Provide basic knowledge and enough competence to formulate the optimization problems.

UNIT I

INTRODUCTION TO OPTIMIZATION: Engineering applications of optimization- statement of an optimization problem- classification of optimization problem- optimization techniques.

CLASSICAL OPTIMIZATION TECHNIQUES: Single variable optimization- multivariable optimization with equality constraints- multivariable optimization with inequality constraints.

UNIT-II

UNCONSTRAINED OPTIMIZATION TECHNIQUES: Pattern search method- Rosenbrock's method of rotating coordinates- Simplex method- Descent methods- Gradient of function- Steepest Descent method.

UNIT-III

CONSTRAINED OPTIMIZATION TECHNIQUES: Characteristics of a constrained problem- methods of feasible directions - basic approach in the penalty function method- interior penalty function method- convex programming problem- exterior penalty function method.

UNIT-IV

GEOMETRIC PROGRAMMING (G.P): Solution of an unconstrained geometric programming, differential calculus method and arithmetic method. primal dual relationship and sufficiency conditions. Solution of a constrained geometric programming problem (G.P.P). Complimentary geometric programming (C.G.P)

UNIT-V

INTEGER PROGRAMMING (I.P): Graphical representation. Gomory's cutting plane method. Bala's algorithm for zero-one programming problem. Integer non linear programming.

TEXT BOOK:

1. Optimization Theory and Applications/ S.S.Rao/Wiley Eastern Limited, New Delhi.

REFERENCES:

1. Engineering Optimization / Kalyanmanai Deb/Prentice Hall of India, New Delhi.
2. Optimization Techniques-Theory and applications/C.Mohan & Kusum Deep/New Age International
3. Operations Research /S.D.Sharma / MacMillan Publishers

Course Out comes:

1. Students at the end of the course learn advanced optimization techniques to solve real-life problems
2. Students can able to formulate and solve various practical optimization problems in manufacturing and service organizations

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IV Year - I Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
MICRO ELECTRO MECHANICAL SYSTEMS					

UNIT – I

INTRODUCTION: Definition of MEMS, MEMS history and development, micro machining, lithography principles & methods, structural and sacrificial materials, thin film deposition, impurity doping, etching, surface micro machining, wafer bonding, LIGA.

MECHANICAL SENSORS AND ACTUATORS: Principles of sensing and actuation: beam and cantilever, capacitive, piezo electric, strain, pressure, flow, pressure measurement by micro phone, MEMS gyroscopes, shear mode piezo actuator, gripping piezo actuator, Inchworm technology.

UNIT – II

THERMAL SENSORS AND ACTUATORS: Thermal energy basics and heat transfer processes, thermisters, thermo devices, thermo couple, micro machined thermo couple probe, peltier effect heat pumps, thermal flow sensors, micro hot plate gas sensors, MEMS thermo vessels, pyro electricity, shape memory alloys (SMA), U-shaped horizontal and vertical electro thermal actuator, thermally activated MEMS relay, micro spring thermal actuator, data storage cantilever.

MAGNETIC SENSORS AND ACTUATORS: Magnetic materials for MEMS and properties, magnetic sensing and detection, magneto resistive sensor, more on hall effect, magneto diodes, magneto transistor, MEMS magnetic sensor, pressure sensor utilizing MOKE, magnetic MEMS actuators, by directional micro actuator, feedback circuit integrated magnetic actuator, large force reluctance actuator, magnetic probe based storage device.

UNIT – III

MICRO-OPTO-ELECTRO MECHANICAL SYSTEMS: Principle of MOEMS technology, properties of light, light modulators, beam splitter, micro lens, micro mirrors, digital micro mirror device (DMD), light detectors, grating light valve (GLV), optical switch, wave guide and tuning, shear stress measurement.

UNIT – IV

RADIO FREQUENCY (RF) MEMS: RF – based communication systems, RF MEMS, MEMS inductors, varactors, tuner/filter, resonator, clarification of tuner, filter, resonator, MEMS switches, phase shifter.

MICRO FLUIDIC SYSTEMS: Applications, considerations on micro scale fluid, fluid actuation methods, dielectro phoresis (DEP), electro wetting, electro thermal flow, thermo capillary effect, electro osmosis flow, opto electro wetting (OEW), tuning using micro fluidics, typical micro fluidic channel, microfluid dispenser, micro needle, molecular gate, micro pumps.

UNIT - V

CHEMICAL AND BIO MEDICAL MICRO SYSTEMS: Sensing mechanism & principle, membrane-transducer materials, chem.-lab-on-a-chip (CLOC) chemoresistors, chemocapacitors, chemotransistors, electronic nose (Enose), mass sensitive chemosensors, fluroscence detection, calorimetric spectroscopy.

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TEXT BOOK:
1. MEMS, Nitaigour Premchand Mahalik, TMH Publishing co.

REFERENCE BOOKS:
1. Foundation of MEMS, Chang Liu, Prentice Hall Ltd.
2. Bio-MEMS (Micro systems), Gerald Urban, Springer.
3. MEMS and Micro Systems: Design and Manufacture, Tai-Ran Hsu, TMH Publishers.

Course Outcomes: After completion of this course, the student shall be able to understand various micro electro mechanical system devices and components.

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DEPARTMENT OF MECHANICAL ENGINEERING

IV Year - I Semester		L	T	P	C
		3	0	0	3
OPTIMIZATION METHODS					

UNIT -I INTRODUCTION

Concept of optimization – classification of optimization – problems.

UNIT- II LINEAR PROGRAMMING

Examples of linear programming problems – formulation simplex methods variable with upper bounds – duality principle -dual simplex method - sensitivity analysis – revised simplex procedure – solution of the transportation problem – assignment – network minimization – shortest route problem – maximal two problem – L.P. representation of networks.

UNIT -III UNCONSTRAINED OPTIMIZATION

Maximization and minimization of convex functions. Necessary and sufficient conditions for local minima – speed and order of convegence – unibariate search – steepest and desent methods- metcher reeves method -conjugate gradient method.

UNIT- IV CONSTRAINED OPTIMIZATION

Necessary and sufficient condition – equality constraints, inequality constraints -kuhu – tucker conditions – gradient projection method – penalty function methods – cutting plane methods of sibel directions.

UNIT- V GENETIC ALGORITHMS (GA)

Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization, draw backs of GA,

TEXT BOOK(S):

1.Rao S.S,"Optimization – Theory and applications", Wiley Easter Ltd., 1979.

REFERENCE BOOKS:

1. David G.Luerbeggan, "Introduction to Linear and Non Linear Programming", Addison Wesley Publishing Co. 1973.
2. Hadley G. "Nonlinear and – dynamic programming" Addison Wesley Publishing Co. 1964.
3. Cordan C.C. Beveridge and Robert S. Schedther, "Optimization, Theory and Practice" McGraw Hill Co.1970.

4. HarndyA.Tahh. "operations Research, An Introduction", Macmillan Publishers Co.NewYork,1982.

5. Beightferand S. others, "Foundations of Optimization Pill", New Delhi, 1979

Course Outcomes:

1. Students at the end of the course learn advanced optimization techniques to solve real-life problems
2. Students can able to formulate and solve various practical optimization problems in manufacturing and service organizations

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DEPARTMENT OF MECHANICAL ENGINEERING

IV Year - I Semester		L	T	P	C
		3	0	0	3
OPERATIONS MANAGEMENT					

Course objectives:

1. To develop an understanding of how the operations, have strategic importance and can provide a competitive advantage in the workplace.
2. To understand the relationship between operations and other business functions
3. To understand techniques of location and facility planning; line balancing; job designing; and
4. capacity planning in operations management.

UNIT-I

Forecasting: Introduction, types of forecasting and their uses, General principles of forecasting, forecasting techniques: qualitative and quantitative methods of Forecasting.

Production Systems: Types of production systems: job, batch, mass and flow type production.

UNIT-II

Plant Location: Factors affecting the plant location, comparison of rural and urban sites.

Plant Layout: Introduction, principles of plant layout, types of plant layouts

UNIT-III

Materials Management: Introduction, functions of materials management, inventory, inventory management, types of inventories, Selective inventory control techniques: ABC analysis, VED analysis. Material Requirement Planning: Introduction, Inputs, outputs and MRP logic.

UNIT-IV

Aggregate Planning: Introduction, aggregate planning strategies, aggregate planning methods mathematical planning models, heuristic and computer search models, problems. Scheduling: Introduction, difference with loading, scheduling policies, techniques, standard scheduling methods.

UNIT-V

Inventory Control: Deterministic models, safety stock inventory control systems Contemporary management techniques: Introduction to MRP-II, JIT, ERP and Supply chain management

TEXT BOOKS:

1. Operations Management /Joseph. G.Monks, International (3rd) Edition
2. Elements of Production Planning and Control / Samuel Eilon.
3. Modern Production/ operation managements / Baffa & Rakesh Sarin

REFERENCES:

1. Operations Management – S.N. Chary.
2. Inventory Control Theory and Practice / Martin K. Starr and David W. Miller.
3. Production And Operation Management / Martand Telsang
4. Production Control A Quantitative Approach / John E. Biegel.
5. Production Control / Moore.

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

1. Identify the elements of operations management and various transformation processes to enhance productivity and competitiveness
2. Analyze plant and process layout
3. Develop aggregate capacity plans and MPS in operation environments.

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IV Year - I Semester		L	T	P	C
		3	0	0	3
NANO TECHNOLOGY					

Course Objectives:

1. To make the students acquire an understanding the Nanoscience and Applications

UNIT-I

GENERAL INTRODUCTION: Basics of Quantum Mechanics, Harmonic oscillator, magnetic Phenomena, band structure in solids, Mossbauer and Spectroscopy, optical phenomena bonding in solids, Anisotropy.

UNIT-II

SILICON CARBIDE: Application of Silicon carbide, nano materials preparation, Sintering of SiC, X-ray Diffraction data, electron microscopy sintering of nano particles,

NANO PARTICLES OF ALUMINA AND ZIRCONIA: Nano materials preparation, Characterization, Wear materials and nano composites,

UNIT-III

MECHANICAL PROPERTIES: Strength of nano crystalline SiC, Preparation for strength measurements, Mechanical properties, Magnetic properties,

Unit -IV

ELECTRICAL PROPERTIES: Switching glasses with nanoparticles, Electronic conduction with nano particles

OPTICAL PROPERTIES: Optical properties, special properties and the coloured glasses

UNIT-V

Process of synthesis of nano powders, Electro deposition, Important Nano materials

INVESTIGAING AND MANIPULATING MATERIALS IN THE NANOSCALE:

Electron microscopics, scanning probe microscopics, optical microscopics for nano science and technology, X-ray diffraction.

TEXT BOOKS:

1. Nano Materials- A.K.Bandyopadhyay/ New Age Publishers.
2. Nano Essentials- T.Pradeep/TMH

Course Outcomes: After completing this course students will be able to:

1.Learn the basic concepts of nanotechnology
2.Understand the synthesis of nanomaterials and their application
3.Apply their learned knowledge to develop Nanomaterial’s.

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IV Year - I Semester		L	T	P	C
		3	0	0	3
FINITE ELEMENT ANALYSIS					

Course Objectives:

1. To learn basic principles of finite element analysis procedure
2. To learn the theory and characteristics of finite elements that represent engineering structures
3. To learn and apply finite element solutions to structural, thermal and dynamic problems.
4. Learn to model complex geometry problems and solution techniques.

UNIT-I

Introduction to finite element method, stress and equilibrium, strain – displacement relations, stress – strain relations, plane stress and plane strain conditions, variational and weighted residual methods, concept of potential energy, one dimensional problems.

Discretization of domain, element shapes, discretization procedures, assembly of stiffness matrix, band width, node numbering, mesh generation, interpolation functions, local and global coordinates, convergence requirements, treatment of boundary conditions.

UNIT – II

Analysis of Trusses: Finite element modeling, coordinates and shape functions, assembly of global stiffness matrix and load vector, finite element equations, treatment of boundary conditions, stress, strain and support reaction calculations.

Analysis of Beams: Element stiffness matrix for Hermite beam element, derivation of load vector for concentrated and UDL, simple problems on beams.

UNIT – III

Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions, formulation of axisymmetric problems.

UNIT-IV

Higher order and isoparametric elements: One dimensional quadratic and cubic elements in natural coordinates, two dimensional four noded isoparametric elements and numerical integration.

UNIT – V

Dynamic Analysis: Formulation of finite element model, element consistent and lumped mass matrices, evaluation of eigen values and eigen vectors, free vibration analysis.

Text Books:

1.The Finite Element Methods in Engineering / SS Rao / Pergamon.
2. Introduction to Finite Elements in Engineering/ Tirupathi R. Chandrupatla, Ashok D.Belgundu, Pearson Publishers.

References:

1.Finite Element Method with applications in Engineering / YM Desai, Eldho & Shah/Pearson publishers
2.An introduction to Finite Element Method / JN Reddy / McGraw Hill
3.The Finite Element Method for Engineers – Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smith and Ted G. Byrom / John Wiley & sons (ASIA) Pte Ltd.

Course outcomes:

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Upon successful completion of this course you should be able to:

1. Understand the concepts behind variational methods and weighted residual methods in FEM
2. Identify the application and characteristics of FEA elements such as bars, beams, plane and isoparametric elements, and 3-D element .
3. Develop element characteristic equation procedure and generate global equations.
4. Able to apply Suitable boundary conditions to global equations, and reduce it to a solvable form.
5. Able to apply the FE procedure to field problems like heat transfer.

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IV Year - I Semester		L	T	P	C
		0	0	2	1
FINITE ELEMENT SIMULATION LAB					

The objective of this lab is to familiarize finite element simulation soft tools for the following applications:

1. Determination of deflection and stresses in 2D and 3D trusses and beams.
2. Determination of deflections component and principal and Von-mises stresses in plane
3. stress, plane strain and Axisymmetric components.
4. Determination of stresses in 3D and shell structures (at least one example in each case)
5. Estimation of natural frequencies and mode shapes, Harmonic response of 2D beam.
6. Casting processes - Study of Solidification, temperatures, Residual stresses, metallurgical phases etc.
7. Forging processes - Study of cold working and hot working processes for extrusion, drawing, rolling, etc.
8. Forming Processes – Study of blanking, bending, deep drawing, etc.
9. Steady state heat transfer Analysis of plane and Axisymmetric components.
10. Convective heat transfer – Internal flow (study both velocity and thermal boundary layers)
11. Convective heat transfer – External flow (study both velocity and thermal boundary layers)
12. Radiation heat transfer– Emissivity

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IV Year - II Semester		L	T	P	C
		3	0	0	3
ADDITIVE MANUFACTURING					

Course Objectives:
The course aims at the importance of Additive Manufacturing, classifications, models, specifications of various Additive Manufacturing Techniques. To learn the different tools, soft-wares required and the applications of Additive Manufacturing.

UNIT – I

INTRODUCTION: Prototyping fundamentals, historical development, fundamentals of rapid prototyping, advantages and limitations of rapid prototyping, commonly used terms, classification of RP process.

LIQUID-BASED RAPID PROTOTYPING SYSTEMS: Stereo lithography Apparatus (SLA): models and specifications, process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies. Solid Ground Curing (SGC): models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

UNIT-II

SOLID-BASED RAPID PROTOTYPING SYSTEMS: Laminated object manufacturing (LOM) - models and specifications, process, working principle, applications, advantages and disadvantages, case studies. Fused deposition modelling (FDM) - models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

UNIT – III

POWDER BASED RAPID PROTOTYPING SYSTEMS: Selective laser sintering (SLS): models and specifications, process, working principle, applications, advantages and disadvantages, case studies. three dimensional printing (3DP): models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

UNIT-IV

RAPID TOOLING: Introduction to rapid tooling (RT), conventional tooling Vs RT, Need for RT. rapid tooling classification: indirect rapid tooling methods: spray metal deposition, RTV epoxy tools, Ceramic tools, investment casting, spin casting, die casting, sand casting, 3D Keltool process. Direct rapid tooling: direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP.

UNIT – V

RAPID PROTOTYPING DATA FORMATS: STL Format, STL File Problems, consequence of building valid and invalid tessellated models, STL file Repairs: Generic Solution, other Translators, Newly Proposed Formats.

RP APPLICATIONS: Application in engineering, analysis and planning, aerospace industry, automotive industry, jewelry industry, coin industry, GIS application, arts and architecture. RP medical and bioengineering applications: planning and simulation of complex surgery, customized implants & prosthesis, design and production of medical devices, forensic science and anthropology, visualization of bimolecular.

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Text Books:

1. Rapid prototyping: Principles and Applications /Chua C.K., Leong K.F. and LIM C.S/World Scientific publications

References:

1. Rapid Manufacturing / D.T. Pham and S.S. Dimov/Springer
2. Wohlers Report 2000 /Terry T Wohlers/Wohlers Associates
3. Rapid Prototyping & Manufacturing / Paul F.Jacobs/ASME Press
4. Rapid Prototyping / Chua & Liou

Course Outcomes: The student shall be able to identify the use of Rapid Prototyping Techniques in the manufacturing of complex components that are otherwise very difficult to manufacture.

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DEPARTMENT OF MECHANICAL ENGINEERING

IV Year - II Semester		L	T	P	C
		3	0	0	3
GAS DYNAMICS AND JET PROPULSION					

Course objectives:
The purpose of this course is to provide the student with the knowledge of basic principles of gas dynamics and its importance in jet propulsion applications.

UNIT-I
Introduction to gas dynamics: control volume and system approaches acoustic waves and sonic velocity - mach number - classification of fluid flow based on mach number - mach cone-compressibility factor - general features of one dimensional flow of a compressible fluid - continuity and momentum equations for a control volume.

UNIT-II
Isentropic flow of an ideal gas: basic equation - stagnation enthalpy, temperature, pressure and density-stagnation, acoustic speed - critical speed of sound- dimensionless velocity-governing equations for isentropic flow of a perfect gas - critical flow area - stream thrust and impulse function.
Steady one dimensional isentropic flow with area change-effect of area change on flow parameters-chocking- convergent nozzle - performance of a nozzle under decreasing back pressure -De lavel nozzle - optimum area ratio effect of back pressure - nozzle discharge coefficients - nozzle efficiencies.

UNIT- III
Simple frictional flow: adiabatic flow with friction in a constant area duct-governing equations - fanno line limiting conditions - effect of wall friction on flow properties in an Isothermal flow with friction in a constant area duct-governing equations - limiting conditions.
Steady one dimensional flow with heat transfer in constant area ducts- governing equations - Rayleigh line entropy change caused by heat transfer - conditions of maximum enthalpy and entropy.

UNIT-IV
Effect of heat transfer on flow parameters: Intersection of Fanno and Rayleigh lines. Shock waves in perfect gas- properties of flow across a normal shock - governing equations - Rankine Hugoniat equations - Prandtl's velocity relationship - converging diverging nozzle flow with shock thickness - shock strength.

UNIT-V
Propulsion: Air craft propulsion: - types of jet engines - energy flow through jet engines, thrust, thrust power and propulsive efficiency turbojet components-diffuser, compressor, combustion chamber, turbines, exhaust systems.
Performance of turbo propeller engines, ramjet and pulsejet, scramjet engines. Rocket propulsion - rocket engines, Basic theory of equations - thrust equation - effective jet velocity - specific impulse - rocket engine performance - solid and liquid propellant rockets - comparison of various propulsion systems.

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Text Books:

1. Compressible fluid flow /A. H. Shapiro / Ronald Press Co., 1953
2. Fundamentals of compressible flow with aircraft and rocket propulsion/S. M. Yahya/New Age international Publishers
3. Fundamental of Gas dynamics-2nd edition/ M J Zucker/ Wiley publishers

References:

1. Elements of gas dynamics / HW Liepman & A Roshko/Wiley
2. Aircraft & Missile propulsion /MJ Zucrow/Wiley
3. Gas dynamics / M.J. Zucrow & Joe D.Holfman / Krieger Publishers

Course outcomes: At the end of the course student will be able to

CO1: Illustrate fluid flow systems
CO2: Analyze the isotropic flow of an ideal gas and its parameter
CO3: Study simple frictional flow with heat transfer problems
CO4: Analyze the impact of heat transfer on flow parameters.
CO5: Performance evaluation of different propulsion systems

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DEPARTMENT OF MECHANICAL ENGINEERING

IV Year - II Semester		L	T	P	C
		3	0	0	3
PRODUCT DESIGN AND DEVELOPMENT					

COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for the understanding the principles of product development process, customer needs, setting product specification, testing and prototyping for new product design and development.

UNIT I
INTRODUCTION
Introduction – A Generic Development Process – Adapting the Generic Product Development Process - Product Development Process Flows- Digital tools for product design– Identifying Customer Needs - Product Specifications: Establishing Target Specifications; Setting the Final Specifications.

UNIT II
CONCEPT GENERATION
Concept Generation: The Activity of Concept Generation - Concept Selection: Concept Screening; Concept Scoring – Concept Testing – Concept innovation using TRIZ

UNIT III
PRODUCT ARCHITECTURE
Implications of the Architecture; Establishing the Architecture; Delayed Differentiation; Platform Planning; Related System-Level Design Issues – Industrial Design: Assessing the Need for Industrial Design; Impact of Industrial Design; The Industrial Design Process; Management of the Industrial Design Process; Assessing the Quality of Industrial Design.

UNIT IV
DFM AND PROTOTYPING
Design for Manufacturing: Estimate the Manufacturing Costs; Reduce the Costs of Components; Reduce the Costs of Assembly; Reduce the Costs of Supporting Production; Consider the Impact of DFMA– Prototyping: Type; Uses; Principles; Technologies; Planning for Prototypes.

UNIT V
PRODUCT DEVELOPMENT ECONOMICS
Elements of Economic Analysis; Economic Analysis Process – sustainable product development: framework and metrics – life cycle assessment of a product: stages and impact

TEXT BOOK:
1. Jamnia, A., Introduction to Product Design and Development for Engineers, CRC Press, 2018.
2. Karl, T. Ulrich and Steven, D. Eppinger, “Product Design and Development”, McGraw Hill, 2003.

REFERENCES:
1. Belz A., 36-Hour Course: “Product Development” McGraw-Hill, 2010.
2. Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, PHI Learning, 2013.
3. Pugh S., “Total Design – Integrated Methods for successful Product Engineering”, Addison Wesley Publishing, 1991.
4. Rosenthal S., “Effective Product Design and Development”, Business One, 1992.

5. Silva, A., Handbook of Research on Trends in Product Design and Development: Technological and Organizational Perspectives: Technological and Organizational Perspectives, IGI Global, 2010.
6. Devdas Shetty, "Product design for Engineers", Cengage Learning

COURSE OUTCOMES:

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

1. Apply the principles of generic development process; conduct customer need analysis; and set product specification for new product design and development.
2. Generate, select, screen, and test concepts for new product design and development.
3. Apply the principles of product architecture and industrial design to design and develop new products.
4. Apply the principles of DFMA and Prototyping to design and develop new product.
5. Apply the concepts of economics principles sustainable product development and life cycle assessment.

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IV Year - II Semester		L	T	P	C
		3	0	0	3
RELIABILITY ENGINEERING					

Course Objectives:

The aim of the course is to stress the importance of reliability in engineering and products and also the concept of maintainability, failure modes and testing methods.

Unit I : Concepts of Reliability

Definition of Reliability – Reliability Vs Quality-Reliability Function-MTTF – Hazard Rate Function-Bathtub Curve – Derivation Of The Reliability Function-Constant Failure Rate Model – Time Dependent Failure Models. Weibull Distribution – Normal Distribution – The Lognormal Distribution.

Unit II: System and Models

Serial Configuration – Parallel Configuration – Combined Series Parallel Systems – System Structure Function, Minimal Cuts And Minimal Paths – Markov Analysis – Load Sharing Systems, Standby System, Degraded Systems, Three State Devices – Covariate Models, Static Models, Dynamic Models, Physics Of Failure Models.

Unit : III Design for Reliability

Reliability Design Process – System Effectiveness – Economic Analysis And Life Cycle Cost – Reliability Allocation – Optimal, Arinc, Agree, – Design Methods – Parts And Material Selection, Derating, Stress- Strength Analysis – Failure Analysis – Identification Of Failure Mode – Determination Of Causes –Assessment Of Effects – Classification Of Seventy – Computation Of Critically Index – Corrective Action – System Safety And Fta.

Unit-IV: Maintainability

Analysis Of Downtime – The Repair Time Distribution – Stochastic Point Processes – System Repair Time – Reliability Under Preventive Maintenance – State Dependent Systems With Repair – Mttr-Mean System Downtime – Mtr – Mh/Oh – Cost Model – Fault Isolation And Self Diagnostics – Repair Vs Replacement – Replacement Model – Proactive, Preventive, Predictive Maintenance – Maintenance And Spares Provisioning – Maintainability Prediction And Demonstration – Concepts And Definition Of Availability.

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Unit-V : Optimization Of System Reliability

Optimization Techniques For System Reliability With Redundancy – Heuristic Methods Applied To Optimal System Reliability- Redundancy Allocation By Dynamic Programming – Reliability Optimization By Non Linear Programming.

Text Books:

- Charles E. Ebling, "An Introduction To Reliability And Maintainability Engg", Tata Mcgraw-Hill, 2000.

References:

- Patrick D T O'connor, "Practical Reliability Engineringt", John-Wiley And Sons Inc, 2002.
- David J Smith, "Reliability, Maintainability And Risk: Practical Methods For Engineers", Butterworth, 2002
- Way Kuo, Rajendra Prasad V, Frank A And Tillman, Ching- Lai Hwang "Optimal Reliability Design And Applciations", Cambridge University Press P Ltd., 2001.
- Srinath I.S, Engineering Design And Reliability, Iste, 1999.
- Oleg Vinogradov, "Introduction To Mechanical Reliability: A Designers Approach, Hemisphere Publications, 1991.

Course Outcomes

CO1: Explain the basic concepts of Reliability Engineering and its Understand measures.
CO 2. Predict the Reliability at system level using various models.
CO 3. Design the test plan to meet the reliability Requirements.
CO 4. Predict and estimate the reliability from failure data.
CO 5. Develop and implement a successful Reliability programme

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		3	**0**	**0**	**3**
CONDITION MONITORING					

UNIT – I
Introduction to maintenance and condition based maintenance, Definition, system approach, objectives, responsibilities of maintenance department, maintenance strategies, principles of maintenance, concepts of maintainability, availability and reliability, implementation of CBM, comparison of CBM with other maintenance techniques and case studies (overview). Introduction to condition monitoring,Basic concept, techniques - visual monitoring, temperature monitoring, vibration monitoring, lubricant monitoring, crack monitoring, thickness monitoring, noise and sound monitoring.

UNIT – II
Basic signal processing techniques Probability distribution and density, Fourier analysis, Hilbert Transform, Cepstrum analysis, Digital filtering, Deterministic / random signal separation, Time-frequency analysis. WaveletTransform Introduction to Wavelets, Continuous Wavelet Transform (CWT), Discrete WaveletTransform (DWT), Wavelet Packet Transform (WPT),types of wavelets –Haarwavelets, Shannon wavelets, Meyer wavelets, Daubechies wavelets, Coifmann wavelets and applications of wavelets.

UNIT - III
Vibration Monitoring,Introduction, vibration data collection, techniques, instruments, transducers, selection, measurement location, time domain analysis, frequency domain analysis, time-frequency domain analysis and commonly witnessed machinery faults diagnosed by vibration analysis.
Rotating and reciprocating machines, Vibration signals from rotating and reciprocating machines – signal classification, signals,generated by rotating machines, signals generated by reciprocating machines.

UNIT – IV
Mechanical fault diagnosis,Wear monitoring and lubricant analysis - sources of contamination, techniques, Spectrometric, Oil Analysis Procedure (SOAP) and ferrography. Nondestructive testing techniques,Measurement of surface and subsurface flaws – liquid penetrant inspection, eddy current inspection, radiographic inspection, ultrasonic inspection.

UNIT – V
Condition monitoring of rolling element bearings and gear, Introduction, construction, types of faults, rolling element bearing diagnostics and gear diagnostics. Tool wear monitoring, Introduction, techniques and case studies.

TEXT BOOKS:
1. Robert Bond Randall – Vibration-Based Condition Monitoring – Industrial, Aerospace and Automotive applications, John Wiley & Sons Ltd., 2011
2. R.A.Collacot – Mechanical Fault Diagnosis – Chapman and Hall Ltd., 1977.
3. ISTE Course material on Condition Monitoring.
4. R.C.Mishra, K.Pathak – Maintenance Engineering and Management, Prentice Hall ofIndia Pvt. Ltd., 2002.
5. K. P. Soman, K. I. Ramachandran, N. G. Resmi – Insight into wavelet from theory to practice, Third Edition, Prentice Hall of India,

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DEPARTMENT OF MECHANICAL ENGINEERING

REFERENCES BOOKS:

1. John S.Mitchell, Introduction to Machinery Analysis and Monitoring, PennWell Books,1993.
2. Elsevier-"Hand book of Condition Monitoring" ELSEVIER SCIENCE
3. R.A.Collacott, "Vibration monitoring and diagnosis", Wiley,1979.
4. RaoJ.S.,"VibratoryConditionMonitoringofMachines",CRCPress,2000.
5. "ConditionMonitoringmanual",NationalProductivityCouncil,NewDelhi.

Course Outcomes:

At the end of this course the student shall be able to:

1. Understand the types of maintenance used and its significance, role of condition based maintenance in industries, familiarize with different condition monitoring techniques and its advantages in industries.
2. Implement the basic signal processing techniques.
3. Understand the role of vibration monitoring, its methodology and its use in condition monitoring of rotating and reciprocating machines.
4. Understand the significance of mechanical fault diagnosis and non-destructive testing techniques in monitoring and maintenance.
5. Study condition monitoring of rolling element bearing, gears and tool condition monitoring techniques in machining.

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IV Year - II Semester		L	T	P	C
		3	0	0	3
COMPUTATIONAL FLUID DYNAMICS					

Course Objectives:
The course aims at providing required numerical and software techniques for solving various engineering problems involving fluid flow.

UNIT-I

Number system and errors, representation of integers, fractions, floating point arithmetic, loss of significance and error propagation, condition and instability, computational methods for error estimation, convergence of sequences.
Solution of a system of simultaneous linear algebraic equations, iterative schemes of matrix inversion, direct methods for matrix inversion, direct methods for banded matrices.

UNIT-II

conservation of mass, Newton's second law of motion, expanded forms of navier-stokes equations, conservation of energy principle, special forms of the Navier-stokes equations.
Steady flow, dimensionless form of momentum and energy equations, stokes equation, conservative body force fields, stream function - vorticity formulation.

UNIT-III

Finite difference applications in heat conduction and convention – heat conduction, steady heat conduction in a rectangular geometry, transient heat conduction, finite difference application in convective heat transfer, closure.
Finite differences, discretization, consistency, stability, and fundamentals of fluid flow modelling: introduction, elementary finite difference quotients, implementation aspects of finite-difference equations, consistency, explicit and implicit methods.

UNIT –IV

Introduction to first order wave equation, stability of hyperbolic and elliptic equations, fundamentals of fluid flow modelling, conservative property, the upwind scheme.

UNIT –V

FINITE VOLUME METHOD: Approximation of surface integrals, volume integrals, interpolation and differentiation practices, upwind interpolation, linear interpolation and quadratic interpolation.

Text Books:

1. Numerical heat transfer and fluid flow / Suhas V. Patankar/Butter-worth Publishers
2. Computational fluid dynamics - Basics with applications /John. D. Anderson / Mc Graw Hill.

References:

1. Computational Fluid Flow and Heat Transfer/ Niyogi/Pearson Publications
2. Fundamentals of Computational Fluid Dynamics /Tapan K. Sengupta / Universities Press.
3. Computational fluid dynamics: An introduction, 3rd edition/John.F Wendt/Springer publishers

Course Outcomes:
After undergoing the course the student shall be able to apply various numerical tools like finite volume, finite difference etc for solving the different fluid flow heat transfer problems.

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IV Year - II Semester		L	T	P	C
		3	0	0	3
NON - DESTRUCTIVE EVALUATION					

Course Objectives:
1. The students are to be exposed to the concepts of various NDE techniques using radiography, ultrasonics, liquid penetrates, magnetic patches and Eddy currents
2. They will learn basic principles of these methods and will be able to select a testing process
3. They will understand the advantages and disadvantages of these techniques.

UNIT – I
Introduction to non-destructive testing: Visual Inspection. Radiography: Sources of ray-x-ray production - properties of d and x rays - film characteristics - exposure charts - contrasts - operational characteristics of x ray equipment - applications.

UNIT – II
Ultrasonic test: Reflection, Refraction, Diffraction, Mode Conversion and Attenuation, Sound Field, Piezo-electric Effect .Production of ultrasonic waves - different types of waves - general characteristics of waves - pulse echo method –A, B, C scans - Principles of acoustic emission techniques - Advantages and limitations - Instrumentation - applications. Ultrasonic Transducers and their Characteristics.

UNIT – III
Liquid Penetrant Test: Liquid Penetrant Test, Basic Concepts, Liquid Penetrant System, Test Procedure, Effectiveness and Limitations of Liquid Penetrant Testing, Eddy Current Test: Principle of Eddy Current, Eddy Current Test System, Applications of Eddy Current Testing Effectiveness of Eddy Current Testing

UNIT – IV
Magnetic Particle Test: Magnetic Materials, Magnetization of Materials , Demagnetization of Materials, Principle of Magnetic Particle Test, Magnetic Particle Test Equipment, Magnetic Particle Test Procedure, Standardization and Calibration, Interpretation and Evaluation, Effective Applications and Limitations of the Magnetic Particle Test.

UNIT – V
Thermography: Thermography Principles, types, applications, advantages and limitations. Optical and Acoustical holography- Principles, types, applications, advantages and limitations. Case studies: weld, cast and formed components.
Industrial Applications of NDE: Span of NDE Activities Railways, Nuclear, Non-nuclear and Chemical Industries, Aircraft and Aerospace Industries, Automotive Industries, Offshore Gas and Petroleum Projects, Coal Mining Industry, NDE of pressure vessels, castings, welded constructions

TEXT BOOKS:
1. Non-Destructive Examination and Quality Control, ASM International, Vol.17, 9th edition (1989)
2. J.Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-Hill Education, 2nd edition (2011).
3. B.Raj, T. Jayakumar and M. Thavasimuthu, Practical Non Destructive Testing, Alpha Science International Limited, 3 rd edition (2007).
4. Ultrasonic testing of materials/ H Krautkramer/Springer

5. J. Krautkramer and H. Krautkramer, Ultrasonic Testing of Materials, Springer, 4 th edition (1990)
6. Nondestructive evaluation of materials by infrared thermography / X. P. V. Maldague, Springer-Verlag, 1 st edition, (1993)

REFERENCES:

1. Ultrasonic inspection training for NDT/ E. A. Gingel/Prometheus Press,
2. ASTM Standards, Vol 3.01, Metals and alloys
3. Non-destructive, Hand Book – R. Hamchand

Course Outcomes:

1. Comprehensive, theory based understanding of the techniques and methods of non destructive testing
2. Apply methods knowledge of non destructive testing to evaluate products of railways, automobiles, aircrafts, chemical industries etc.

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IV Year - II Semester		L	T	P	C
		3	0	0	3
CONTROL SYSTEMS					

Course Objectives:

- To learn the mathematical modeling of physical systems and to use block diagram algebra and signal flow graph to determine overall transfer function
- To analyze the time response of first and second order systems and improvement of performance by proportional plus derivative and proportional plus integral controllers
- To investigate the stability of closed loop systems using Routh's stability criterion and the analysis by root locus method.
- To discuss basic aspects of design and compensation of linear control system using Bode plot.
- To present the Frequency Response approaches for the analysis of linear time invariant (LTI) systems using Bode plots, polar plots.
- Ability to formulate state models and analyze the systems. To learn the concepts of Controllability and observability.

UNIT – I:
Mathematical modeling of control systems
Classification of control systems, open loop and closed loop control systems and their differences, Feedback characteristics, transfer function of linear system, differential equations of electrical networks, translational and rotational mechanical systems, transfer function of DC servo motor – AC servo motor – stepper motor – synchro, transmitter and receiver – block diagram algebra – representation by signal flow graph – reduction using Mason's gain formula.

UNIT-II:
Time response analysis
Standard test signals – time response of first and second order systems – time domain specifications, steady state errors and error constants, P, PI, PID controlles.

Stability and rootlocus technique
The concept of stability – Routh's stability criterion –limitations of Routh's stability,
Root locus concept – construction of root loci (simple problems).

UNIT–IV:
Frequency response analysis
Introduction to frequency domain specifications – Bode diagrams – transfer function from the Bode diagram – phase margin and gain margin – stability analysis from Bode plots,Polar plots, Nyquist stability criterion.

UNIT–V:
State space analysis of LTI systems
Concepts of state, state variables and state model, state space representation of transfer function, State Transition Matrix and it's Properties, concepts of controllability and observability.

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Course Outcome:
The student should be able to:

- Derive the transfer function of physical systems and determination of overall transfer function using block diagram algebra and signal flow graphs.
- Determine time response specifications of second order systems and to determine error constants.
- Analyze absolute and relative stability of LTI systems using Routh's stability criterion and the root locus method.
- Analyze the stability of LTI systems using frequency response methods.
- Represent physical systems as state models and determine the response. Understanding the concepts of controllability and observability.

Text Books:
1.Modern Control Engineering by Kotsuhiko Ogata, Prentice Hall of India.
2. Automatic control systems by Benjamin C.Kuo, Prentice Hall of India,2nd Edition.

Reference Books:
1. Control Systems principles and design by M.Gopal, Tata Mc Graw Hill education Pvt Ltd., 4th Edition.
2. Control Systems by Manik Dhanesh N, Cengage publications.
3. Control Systems Engineering by I.J.Nagarath and M.Gopal, Newage International Publications, 5th Edition.
4. Control Systems Engineering by S.Palani,Tata Mc Graw Hill Publications.

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IV Year - II Semester		L	T	P	C
		3	0	0	3
ENTREPRENEURSHIP DEVELOPMENT					

COURSE OBJECTIVE:
The aim of this course is to develop and strengthen entrepreneurial quality and motivation among students. This course will impart the basic entrepreneurial skills and understandings to run a business efficiently and effectively.

UNIT I ENTREPRENEURAL COMPETENCE
Entrepreneurship concept – Entrepreneurship as a Career – Entrepreneurial Personality -Characteristics of Successful, Entrepreneur – Knowledge and Skills of Entrepreneur, types of entrepreneurship, women-rural- tourism- social – agri –family - entrepreneurship.

UNIT II ENTREPRENEURAL ENVIRONMENT AND POLICIES
Business Environment - Role of Family and Society - Entrepreneurship Development Training and Other Support Organisational Services –Central and State Government Industrial Policies and Regulations - International Business.

UNIT III BUSINESS PLAN PREPARATION
Sources of Product for Business - Prefeasibility Study - Criteria for Selection of Product -Ownership - Capital - Budgeting Project Profile Preparation - Matching Entrepreneur with the Project - Feasibility Report Preparation and Evaluation Criteria.

UNIT IV LAUNCHING OF SMALL BUSINESS
Finance and Human Resource Mobilization Operations Planning - Market and Channel Selection - Growth Strategies - Product Launching – Incubation, Venture capital, IT startups.

UNIT V MANAGEMENT OF SMALL BUSINESS
Monitoring and Evaluation of Business - Preventing Sickness and Rehabilitation of Business Units- Effective Management of small Business. Intellectual property rights (IPR) and Micro small medium enterprises (MSME).

Text Books:
1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2001.
2. S.S.Khanka, Entrepreneurial Development, S.Chand and Company Limited, New Delhi, 2001.

References
1. Mathew Manimala, Entrepreneurship Theory at the Crossroads, Paradigms & Praxis, Biztrantra ,2nd Edition 2005
2. Prasanna Chandra, Projects – Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill, 1996.
3. P.Saravanavel, Entrepreneurial Development, Ess Pee kay Publishing House, Chennai -1997.

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COURSE OUTCOME:

Upon completing this course, students are able to

- Gain the competency of preparing business plans
- Get the awareness on industrial policies
- Study the impact of launching small business
- Understand the recourse planning and market selection for start ups.

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IV Year - II Semester		L	T	P	C
		3	0	0	3

HYDROGEN & FUEL CELLS

Course Objective : To introduce to emerging technologies like production and storage of Hydrogen

Unit-1

Hydrogen Energy Economy: Hydrogen Energy Economy – Conception, Present status and a vision – Applications of Hydrogen - Transport application-cars, light trucks, buses - Stationary and Portable-Electronic gadgets.

Unit-2

Hydrogen And Production Techniques: Hydrogen – Physical and chemical properties, salient characteristics - Production of hydrogen – Steam reforming – Water electrolysis – Gasification and woody biomass conversion – Biological hydrogen production – Photo dissociation – Direct thermal or catalytic splitting of water.

Unit-3

Hydrogen Storage & Transport: Hydrogen storage options – Compressed gas – Liquid hydrogen – Hydride – Chemical Storage – Comparisons - Transport of Hydrogen - Pipelines, gaseous, liquid and compound materials.

Unit-4

Fuel Cells: History – Principle - Working - Thermodynamics and kinetics of fuel cell process – Performance evaluation of fuel cell – Comparison on battery Vs fuel cell - Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC – Relative merits and demerits.

Unit-5

Application Of Fuel Cell: Fuel cell usage for domestic power systems - Large scale power generation – Automobile - Space - Environmental analysis of usage of Hydrogen in Fuel cell - Future trends in fuel cells.

Reference Books:

1. Hydrogen and Fuel Cells: A Comprehensive Guide, Rebecca L. and Busby, Penn Well Corporation, Oklahoma (2005)
2. Hydrogen and Fuel Cells: Emerging Technologies and Applications, Bent Sorensen (Sørensen), Elsevier, UK (2005)
3. Fuel Cell and Their Applications, Kordesch, K and G.Simader, Wiley-Vch, Germany (1996).
4. Fuel Cells: Theory and Application, Hart, A.B and G.J.Womack, Prentice Hall, NewYork Ltd., London (1989)
5. The Hydrogen Economy, Jeremy Rifkin, Penguin Group, USA (2002).
6. Fuel Cells – Principles and Applications, Viswanathan, B and M Aulice Scibioh, Universities Press (2006)

Course Outcome:

CO1: Students gets exposure to different fuel cells in particularly Hydrogen fuel cells

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IV Year - II Semester		L	T	P	C
		3	0	0	3
ROBOTICS					

Course Objectives: The goal of the course is to familiarize the students with the concepts and techniques in robotic engineering, manipulator kinematics, dynamics and control, chose, and incorporate robotic technology in engineering systems.

- Make the students acquainted with the theoretical aspects of Robotics
- Enable the students to acquire practical experience in the field of Robotics through design projects and case studies.
- Make the students to understand the importance of robots in various fields of engineering.
- Expose the students to various robots and their operational details.

UNIT - I

Robotics-Introduction-classification with respect to geometrical configuration (Anatomy), Controlled system & chain type: Serial manipulator & Parallel Manipulator. Components of Industrial robotics-precession of movement-resolution, accuracy & repeatability-Dynamic characteristics- speed of motion, load carrying capacity & speed of response-Sensors-Internal sensors: Position sensors,& Velocity sensors, External sensors: Proximity sensors, Tactile Sensors, & Force or Torque sensors.

UNIT - II

Grippers - Mechanical Gripper-Grasping force-Engelberger-g-factors-mechanisms for actuation, Magnetic gripper , vaccume cup gripper-considerations in gripper selection & design . Industrial robots specifications. Selection based on the Application.

UNIT - III

Kinematics-Manipulators Kinematics, Rotation Matrix, Homogenous Transformation Matrix, D-H transformation matrix, D-H method of assignment of frames. Direct and Inverse Kinematics for industrial robots. Differential Kinematics for planar serial robots

UNIT - IV

Trajectory planning: Joint space scheme- Cubic polynomial fit-Obstacle avoidance in operation space-cubic polynomial fit with via point, bleding scheme. Introduction Cartesian space scheme.

Control- Interaction control, Rigid Body mechanics, Control architecture- position, path velocity, and force control systems, computed torque control, adaptive control, and Servo system for robot control.

UNIT - V

Programming of Robots and Vision System-Lead through programming methods- Teach pendent-overview of various textual programming languages like VAL etc.

Machine (robot) vision:

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TEXT BOOKS:

1. Industrial Robotics / Groover M P /Mc Graw Hill
2. Introduction to Robotics / John J. Craig/ Pearson

REFERENCE BOOKS:

1. Theory of Applied Robotics /Jazar/Springer.
2. Robotics / Ghosal / Oxford

Course outcomes: After this completion of this course, the student should be able to

- Understand the basic components of robots.
- Differentiate types of robots and robot grippers.
- Model forward and inverse kinematics of robot manipulators.
- Analyze forces in links and joints of a robot.
- Programme a robot to perform tasks in industrial applications.
- Design intelligent robots using sensors.

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IV Year - II Semester		L	T	P	C
		3	0	0	3
ENERGY MANAGEMENT					

Course Objectives: The course is intended to

- Demonstrate the importance and role of energy management in the functional areas like Manufacturing Industry, Process Industry, Commerce and Govemment.
- To know the different energy resources
- Understand thermodynamic power cycles and the associated processes and fuels.
- Understand the economics of energy conversion
- Enable the students to understand the basic energy conversion and management principles and to identify sources of energy loss and target savings
- Enable students in carrying out budgeting and risk analysis

UNIT-I: INTRODUCTION: Principles of energy management Managerial organization, Functional areas for i) manufacturing industry, ii) Process industry, iii) Commerce, iv) Government, Role of Energy manager in each of these organizations. Initiating, Organizing and managing energy management programs

UNIT-II: ENERGY AUDIT: Definition and concepts. Types of energy audits, Basic energy concepts, Resources for plant energy studies. Data gathering, Analytical techniques. Energy Conservation: Technologies for energy conservation, Design for conservation of energy materials, Energy flow networks. Critical assessment of energy usage. Formulation of objectives and constrains, Synthesis of alternative options and technical analysis of options. Process integration.

UNIT-III: ECONOMIC ANALYSIS: Scope, Characterization of an investment project. Types of depreciation, Time value of money. Budget considerations, Risk analysis.

UNIT-IV: METHODS OF EVALUATION OF PROJECTS: Payback, Annualized costs, Investor's rate of retum, Present worth, Internal rate of return. Pros and cons of the common method of analysis. Replacement analysis.

UNIT-V: ALTERNATIVE ENERGY SOURCES: SOLAR ENERGY: Types of devices for solar energy collections, Thermal storage system, Control systems. Wind Energy. Availability, Wind Devices. Wind Characteristics, performance of turbines and systems.

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TEXT BOOKS:

- Energy Management by Murfy
- General Aspects of Energy Management and Audit, National Productivity Council of India, Chennai (Course Material- National Certification Examination for Energy Management)

REFERENCE BOOKS:

- Energy Management Handbook, W.C. Turner, 5th Edition, Marcel Dekker, Inc, New York, 2005.
- Guide to Energy Management, B. L. Capehart, W. C. Turner, W. J. Kennedy, CRC Press, New York, 2005.
- Energy Management by O.P. Collagan

Course Outcomes: At the end of the course, the student will be able to:

1. Explain the fundamentals of energy management and its influence on environment
2. Describe methods of energy production for improved utilization.
3. Apply the principles of thermal engineering and energy management to improve the performance of thermal systems. Analyze the methods of energy conservation and energy efficiency for buildings, airconditioning, heat recovery and thermal energy storage systems.
4. Assess energy projects on the basis of economic and financial criteria.

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IV Year - II Semester		L	T	P	C
		3	0	0	3
3D PRINTING TECHNOLOGIES					

Course Objectives:

- To understand the fundamental concepts of Rapid Prototyping and 3-D printing, its advantages and limitations.
- To classify various types of Additive Manufacturing Processes and know their working principle, advantages, limitations etc.
- To have a holistic view of various applications of these technologies in relevant fields such as mechanical, Bio-medical, Aerospace, electronics etc.

UNIT – I

Introduction: Prototyping fundamentals, Historical development, Fundamentals of Rapid Prototyping, Advantages, and Limitations of Rapid Prototyping, Commonly used Terms, Classification of RP process, Rapid Prototyping Process Chain: Fundamental Automated Processes, Process Chain.

UNIT - II

Liquid-based Rapid Prototyping Systems: Stereo lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Solid ground curing (SGC): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies Solid-based Rapid

Prototyping Systems: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

UNIT - III

Powder Based Rapid Prototyping Systems: Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Three dimensional Printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT. Rapid Tooling Classification; Indirect Rapid Tooling Methods: Spray Metal Deposition, RTV Epoxy Tools, Ceramic tools, Investment Casting, Spin Casting, Die casting, Sand Casting, 3D Keltool process. Direct Rapid Tooling : Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP

UNIT - IV

Rapid Prototyping Data Formats: STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. Rapid Prototyping Software's: Features of various RP software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor.

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UNIT - V

RP Applications : Application - Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Biomolecules.

Course Outcomes:

- Describe various CAD issues for 3D printing and rapid prototyping and related operations for STL model manipulation.
- Formulate and solve typical problems on reverse engineering for surface reconstruction from physical prototype models through digitizing and spline-based surface fitting.
- Formulate and solve typical problems on reverse engineering for surface reconstruction from digitized mesh models through topological modelling and subdivision surface fitting.
- Explain and summarize the principles and key characteristics of additive manufacturing technologies and commonly used 3D printing and additive manufacturing systems.
- Explain and summarize typical rapid tooling processes for quick batch production of plastic and metal parts

TEXT BOOKS:

1. Rapid prototyping; Principles and Applications /Chua C.K., Leong K.F. and LIM C.S/World Scientific Publications
2. Rapid Manufacturing /D.T. Pham and S.S. Dimov/Springer

REFERENCE BOOKS:

1. Terry Wohlers, Wholers Report 2000, Wohlers Associates
2. Rapid Prototyping and Manufacturing /PaulF.Jacobs/ASME

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IV Year - II Semester		L	T	P	C
		3	0	0	3
MECHATRONICS					

Course Objective
The main objective of this course is to introduce the integrative nature of Mechatronics.
To describe the different components and devices of mechatronics systems.

UNIT-I
Mechatronics systems – elements & levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor-based controllers, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.

UNIT-II
Hydraulic and pneumatic actuating systems - Fluid systems, Hydraulic systems, and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems. Mechanical actuating systems and electrical actuating systems – basic principles and elements.

UNIT-III
Digital electronics and systems, digital logic control, micro processors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control.

UNIT-IV
System and interfacing and data acquisition – Data Acquisition Systems, Analog to Digital and Digital to Analog conversions; Digital Signal Processing – data flow in DSPs, block diagrams, typical layouts, Interfacing motor drives.

UNIT-V
Dynamic models and analogies, System response. Process Controllers – Digital Controllers, Programmable Logic Controllers, Design of mechatronics systems & future trends.

Text Books:
1.MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran, GK Vijaya Raghavan & MS Balasundaram/WILEY India Edition

References:
1.Mechatronics /Smaili A, Mrad F/ Oxford Higher Education, Oxford University Press
2.Mechatronics Source Book / Newton C Braga/Thomson Publications,Chennai.
3.Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.
4.Mechatronics System Design / Devdas shetty/Richard/Thomson.
5.Mechatronics/M.D.Singh/J.G.Joshi/PHI.

Course outcomes: After completion of this course, the student shall be able to use the various mechatronics systems devices and components in the design of electro mechanical systems.

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IV Year - II Semester		L	T	P	C
		3	0	0	3
TOTAL QUALITY MANAGEMENT					

Course Objectives

1. To understand the concept of Quality
2. To understand the Implication of Quality on Business
3. To Implement Quality Implementation Programs
4. To have exposure to challenges in Quality Improvement Programs

UNIT – I:

INTRODUCTION: The concept of TQM, Quality and Business performance, attitude and involvement of top management, communication, culture and management systems. Management of Process Quality: Definition of quality, Quality Control, a brief history, Product Inspection vs, Process Control, Statistical Quality Control, Control Charts and Acceptance Sampling.

UNIT – II:

CUSTOMER FOCUS AND SATISFACTION: The importance of customer satisfaction and loyalty- Crating satisfied customers, Understanding the customer needs, Process Vs. Customer, internal customer conflict, quality focus, Customer Satisfaction, role of Marketing and Sales, Buyer – Supplier relationships. Bench Marketing: Evolution of Bench Marketing, meaning of Bench marketing, benefits of bench marketing, the bench marketing process, pitfalls of bench marketing.

UNIT – III:

ORGANIZING FOR TQM: The systems approach, Organizing for quality implementation, making the transition from a traditional to a TQM organizing, Quality Circles. Productivity, Quality and Reengineering: The leverage of Productivity and Quality, Management systems Vs. Technology, Measuring Productivity, Improving Productivity Re-engineering.

UNIT – IV:

THE COST OF QUALITY: Definition of the Cost of Quality, Quality Costs, Measuring Quality Costs, use of Quality Cost Information, Accounting Systems and Quality Management.

UNIT – V:

ISO9000: Universal Standards of Quality: ISO around the world, The ISO9000 ANSI/ASQCQ-Series Standards, benefits of ISO9000 certification, the third party audit, Documentation ISO9000 and services, the cost of certification implementing the system.

TEXT BOOKS:

1. Total Quality Management / Joel E.Ross/Taylor and Franscis Limited
2. Total Quality Management/P.N.Mukherjee/PHI

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REFERENCES:

1 Beyond TQM / Robert L.Flood
2 Statistical Quality Control / E.L. Grant / McGraw Hill.
3 Total Quality Management- A Practical Approach/H. Lal
4 Quality Management/Kanishka Bedi/Oxford University Press/2011
5 Total Engineering Quality Management/Sunil Sharma/Macmillan

Course Outcomes: On completion of this course, the students will be able to:
CO1. To realize the importance of significance of quality
CO2. Manage quality improvement teams
CO3. Identify requirements of quality improvement programs

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IV Year - II Semester		L	T	P	C
		3	0	0	3
SUPPLY CHAIN MANAGEMENT					

Course Objectives: To understanding of the processes of supply chain management and their interrelationships within individual companies and across the supply chain

Unit-I

Strategic Framework: Introduction to Supply Chain Management, Decision phases in a supply chain, Process views of a supply chain: push/pull and cycle views, Achieving Strategic fit, Expanding strategic scope.

Unit-II

Supply Chain Drivers and Metrics: Drivers of supply chain performance, Framework for structuring Drivers, Obstacles to achieving strategic fit.

Unit-III

Designing Supply Chain Network: Factors influencing Distribution Network Design, Design options for a Distribution network, E-Business and Distribution network, Framework for Network Design Decisions, Models for Facility Location and Capacity Allocation.

Unit-IV

Forecasting in SC: Role of forecasting in a supply chain, Components of a forecast and forecasting methods, Risk management in forecasting.

Unit-V

Aggregate Planning and Inventories in SC: Aggregate planning problem in SC, Aggregate Planning Strategies, Planning Supply and Demand in a SC, Managing uncertainty in a SC: Safety Inventory.
Coordination in SC: Modes of Transportation and their performance characteristics, Supply Chain IT framework, Coordination in a SC and Bullwhip Effect.

Text Books:

2. Sunil Chopra and Peter Meindl, Supply Chain Management - Strategy, Planning and Operation, 4th Edition, Pearson Education Asia, 2010.
3. David Simchi-Levi, PhilpKamintry and Edith Simchy Levy, Designing and Managing the Supply Chain - Concepts Strategies and Case Studies, 2nd Edition, Tata-McGraw Hill, 2000.

Course Outcomes: Up on completion of course students will be able to

CO1. To realize the importance of Supply chain management frame work in business management
CO2. Understand basic concepts of forecasting and risk management
CO3. Explain and implement the concept of aggregate planning and inventory.

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IV Year - II Semester		L	T	P	C
		3	0	0	3
PRODUCT DESIGN AND DEVELOPMENT					

COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for the understanding the principles of product development process, customer needs, setting product specification, testing and prototyping for new product design and development.

UNIT I
INTRODUCTION
Introduction – A Generic Development Process – Adapting the Generic Product Development Process - Product Development Process Flows- Digital tools for product design– Identifying Customer Needs - Product Specifications: Establishing Target Specifications; Setting the Final Specifications.

UNIT II
CONCEPT GENERATION
Concept Generation: The Activity of Concept Generation - Concept Selection: Concept Screening; Concept Scoring – Concept Testing – Concept innovation using TRIZ

UNIT III
PRODUCT ARCHITECTURE
Implications of the Architecture; Establishing the Architecture; Delayed Differentiation; Platform Planning; Related System-Level Design Issues – Industrial Design: Assessing the Need for Industrial Design; Impact of Industrial Design; The Industrial Design Process; Management of the Industrial Design Process; Assessing the Quality of Industrial Design.

UNIT IV
DFM AND PROTOTYPING
Design for Manufacturing: Estimate the Manufacturing Costs; Reduce the Costs of Components; Reduce the Costs of Assembly; Reduce the Costs of Supporting Production; Consider the Impact of DFMA– Prototyping: Type; Uses; Principles; Technologies; Planning for Prototypes.

UNIT V
PRODUCT DEVELOPMENT ECONOMICS
Elements of Economic Analysis; Economic Analysis Process – sustainable product development: framework and metrics – life cycle assessment of a product: stages and impact

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TEXT BOOK:

1. Jamnia, A., Introduction to Product Design and Development for Engineers, CRC Press, 2018.
2. Karl, T. Ulrich and Steven, D. Eppinger, "Product Design and Development", McGraw Hill, 2003.

REFERENCES:

1. Belz A., 36-Hour Course: "Product Development" McGraw-Hill, 2010.
2. Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, PHI Learning, 2013.
3. Pugh S., "Total Design – Integrated Methods for successful Product Engineering", Addison Wesley Publishing, 1991.
4. Rosenthal S., "Effective Product Design and Development", Business One, 1992.
5. Silva, A., Handbook of Research on Trends in Product Design and Development: Technological and Organizational Perspectives: Technological and Organizational Perspectives, IGI Global, 2010.
6. Devdas Shetty, "Product design for Engineers", Cengage Learning

COURSE OUTCOMES:

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

1. Apply the principles of generic development process; conduct customer need analysis; and set product specification for new product design and development.
2. Generate, select, screen, and test concepts for new product design and development.
3. Apply the principles of product architecture and industrial design to design and develop new products.
4. Apply the principles of DFMA and Prototyping to design and develop new product.
5. Apply the concepts of economics principles sustainable product development and life cycle assessment.

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IV Year - II Semester		L	T	P	C
		3	0	0	3
ENTREPRENEURSHIP					

COURSE OBJECTIVE:
The aim of this course is to develop and strengthen entrepreneurial quality and motivation among students. This course will impart the basic entrepreneurial skills and understandings to run a business efficiently and effectively.

UNIT I ENTREPRENEURAL COMPETENCE
Entrepreneurship concept – Entrepreneurship as a Career – Entrepreneurial Personality - Characteristics of Successful, Entrepreneur – Knowledge and Skills of Entrepreneur.

UNIT II ENTREPRENEURAL ENVIRONMENT AND POLICIES
Business Environment - Role of Family and Society - Entrepreneurship Development Training and Other Support Organisational Services –
Central and State Government Industrial Policies and Regulations - International Business.

UNIT III BUSINESS PLAN PREPARATION
Sources of Product for Business - Prefeasibility Study - Criteria for Selection of Product - Ownership - Capital - Budgeting Project Profile Preparation - Matching Entrepreneur with the Project - Feasibility Report Preparation and Evaluation Criteria.

UNIT IV LAUNCHING OF SMALL BUSINESS
Finance and Human Resource Mobilization Operations Planning - Market and Channel Selection - Growth Strategies - Product Launching – Incubation, Venture capital, IT startups.

UNIT V MANAGEMENT OF SMALL BUSINESS
Monitoring and Evaluation of Business - Preventing Sickness and Rehabilitation of Business Units- Effective Management of small Business.

Text Books:
1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2001.
2. S.S.Khanka, Entrepreneurial Development, S.Chand and Company Limited, New Delhi, 2001.

References
1. Mathew Manimala, Entrepreneurship Theory at the Crossroads, Paradigms & Praxis, Biztrantra ,2nd Edition 2005
2. Prasanna Chandra, Projects – Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill, 1996.
3. P.Saravanavel, Entrepreneurial Development, Ess Pee kay Publishing House, Chennai -1997.

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COURSE OUTCOME:

- Up on completing this course, students are able to
- Gain the competency of preparing business plans
- Get the awareness on industrial policies
- Study the impact of launching small business
- Understand the recourse planning and market selection for start ups.

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IV Year - II Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
ADVANCED MATERIALS					

Course Objectives
The objective for this course is to understand the mechanics of different materials. This understanding will include concepts such as anisotropic material behaviour, constituent properties and manufacturing processes of different composites. Suitability of smart and nano materials for engineering applications.

UNIT-I
INTRODUCTION TO COMPOSITE MATERIALS: Introduction, classification: polymer matrix composites, metal matrix composites, ceramic matrix composites, carbon–carbon composites, fiber- reinforced composites and nature-made composites, and applications
REINFORCEMENTS: Fibres- glass, silica, kevlar, carbon, boron, silicon carbide, and born carbide fibres.

UNIT-II
Polymer composites, thermoplastics, thermosetting plastics, manufacturing of PMC, MMC & CCC and their applications.
MANUFACTURING METHODS: Autoclave, tape production, moulding methods, filament winding, hand layup, pultrusion, RTM.

UNIT-III
MACROMECHANICAL ANALYSIS OF A LAMINA: Introduction, generalized Hooke's law, reduction of Hooke's law in three dimensions to two dimensions, relationship of compliance and stiffness matrix to engineering elastic constants of an orthotropic lamina, laminate-laminate code.

UNIT-IV
FUNCTIONALLY GRADED MATERIALS: Types of functionally graded materials-classification-different systems-preparation-properties and applications of functionally graded materials.
SHAPE MEMORY ALLOYS: Introduction-shape memory effect-classification of shape memory alloys-composition-properties and applications of shape memory alloys.

UNIT-V
NANO MATERIALS: Introduction-properties at nano scales-advantages & disadvantages-applications in comparison with bulk materials (nano – structure, wires, tubes, composites). state of art nano advanced- topic delivered by student.

Text Books:
1. Nano material /A.K. Bandyopadyay/New age Publishers
2. Material science and Technology: A comprehensive treatment/Robert W.Cahn,/VCH
3. Engineering Mechanics of Composite Materials / Isaac and M Daniel/Oxford University Press

References:
1. Mechanics of Composite Materials / R. M. Jones/ Mc Graw Hill Company, New York, 1975.
2. Analysis of Laminated Composite Structures / L. R. Calcote/Van Nostrand Rainfold,NY 1969
3. Analysis and performance of fibre Composites /B. D. Agarwal and L. J. Broutman /Wiley-Interscience, New York, 1980

4. Mechanics of Composite Materials - Second Edition (Mechanical Engineering) /Autar K.Kaw / CRC Press

Course Outcomes

After learning the course the students should be able to

1. Explain various composite materials with their constituents, advantages, limitations and applications
2. Describe various manufacturing methods of polymer matrix composites materials.
3. Derive stress strain relationships for orthotropic materials and analyze orthotropic lamina.
4. Explain various functionally graded materials with their properties, preparation and applications
5. Explain different smart materials with their application.