Scheme and Syllabus for

B.Tech. in

Mechanical Engineering with specialization in Design and manufacturing

First Year (I Semester): Common to All Branches

S. No.	Course Code	Course Name	Category Code	I	P	No. of Credits
1.		Differential and Integral Calculus	BSC	3	0	3
2.		Physics I	BSC	3	0	3
3.		Engineering Mechanics	BEC	3	0	3
4.		Basic Electrical and Electronics Engineering	BEC	3	0	3
5.		Problem-Solving and Computer Programming	BEC	3	0	3
6.		Technical and Professional Communication	HMC	2	2	3
7.		Physics I Practice	BSC	0	3	2
8.		Problem-Solving and Computer Programming Practice	BEC	0	3	2
9.		Engineering Skills Practice	BEC	0	3	2
10.		NSS/NSO/NCC	-	0	0	0
Total No. of Credits						**24**

Note:

(1) Branch change may be permitted after the successful completion of 1st Semester.

(2) Physics I (3-0-3) is to be proposed as a new course by the Department of Sciences.

(3) Physics I Practice (0-3-2) is to be proposed as a new course by the Department of Sciences.

(4) NSS/NSO/NCC must be offered as a mandatory course to all the students of 1st Semester. However, students will be given the choice to register for at least 01 course from NSS, NSO, and NCC.

(5) Engineering Mechanics syllabus may be revised and must be taught as a new course by the Department of Mechanical Engineering.

First Year (II Semester)

S. No.	Course Code	Course Name	Category Code	I	P	No. of Credits
1.		Differential Equations	BSC	3	0	3
2.		Physics II	BSC	3	0	3
3.		Design Course	DES	2	0	2
4.		Humanities Course	HMC	2	0	0
5.		Concepts in Engineering Design	DES	3	0	3
6.		Engineering Graphics (ME & ECE) (OR) Linear Algebra (CSE & AIDS)	BEC BSC	1 3	3 0	3 3
7.		Design Realization Practice	DES	0	3	2
8.		Physics II Practice	BSC	0	3	2
9.		Material Science and Metallurgy	PEC	3	0	3
10.		Thermodynamics	PEC	3	0	3
11.		NSS/NSO/NCC	-	0	0	0
Total No. of Credits						**24**

Note:

(1) Engineering Graphics will be offered to only ME and ECE students.

(2) Linear Algebra will be offered to only CSE and AIDS students.

(3) Physics II (3-0-3) is to be proposed as a new course by the Department of Sciences.

(4) Physics II Practice (0-3-2) is to be proposed as a new course by the Department of Sciences.

(5) Department Core Courses 01 and 02 will be offered by the individual department.

(6) List of courses under Design Course:

- (a) Design History
- (b) Sociology of Design
- (c) Earth, Environment, and Design

(7) List of courses under Humanities Course:

- (a) Professional Ethics for Engineers
- (b) Universal Human Values
- (c) History of Science and Technology in India
- (d) Constitution of India

Second Year (III Semester)

S. No.	Course Code	Course Name	Category Code	I	P	No. of Credits
1.		Linear Algebra (ME and ECE) (OR) Probability and Statistics (CSE and AIDS)	BSC BSC	3 3	0 0	3 3
2.		Mechanics of Materials	PEC	3	0	3
3.		Kinematics of Machines	PEC	3	0	3
4.		Fluid Mechanics and Hydraulic Machinery	PEC	3	0	3
5.		Electrical Drives, Sensors, and Microprocessor	PEC	3	0	3
6.		Materials and Mechanics Practice	PEC	0	3	2
7.		Electrical Drives, Sensors, and Microprocessor Practice	PEC	0	3	2
8.		Machine Drawing & Manufacturability Analysis Practice	PEC	0	3	2
Total No. of Credits						**21**

Electrical Drives, Sensors, and Microprocessors (Theory & Practice) will be offered by ECE Dept.

Second Year (IV Semester)

S. No.	Course Code	Course Name	Category Code	I	P	No. of Credits
1.		Probability and Statistics (ECE and ME) (OR) Department Core Course (CSE and AIDS)	BSC PEC	3 3	0 0	3 3
2.		Basic Concepts in Manufacturing Processes	PEC	3	0	3
3.		Dynamics of Machines	PEC	3	0	3
4.		Design of Machine elements	PEC	3	0	3
5.		Heat Transfer	PEC	3	0	3
6.		Basic Manufacturing Processes Practice	PEC	0	3	2
7.		Dynamics of Machines Practice	PEC	0	3	2
8.		Fluid Mechanics and Heat Transfer Practice	PEC	0	3	2
9.		Skill Development Course 01	PCD	2	0	2
Total No. of Credits						**23**

Third Year (V Semester)

S. No.	Course Code	Course Name	Category Code	I	P	No. of Credits
1.		Managerial Economics and Financial Accountancy	HMC	3	0	3
2.		Quality Inspection and Product Validation	PEC	3	0	3
3.		Automation in Manufacturing	PEC	3	0	3
4.		Thermal Engineering	PEC	3	0	3
5.		Operation Research	PEC	3	0	3
6.		Quality Inspection and Product Validation Practice	PEC	0	3	2
7.		Automation in Manufacturing Practice	PEC	0	3	2
8.		Thermal Engineering Practice	PEC	0	3	2
Total No. of Credits						**21**

Third Year (VI Semester)

S. No.	Course Code	Course Name	Category Code	I	P	No. of Credits
1.		Entrepreneurship and Management Functions	HMC	3	0	3
2.		Computational Methods in Engineering	PEC	3	0	3
3.		Machine Tool Technology	PEC	3	0	3
4.		Department Elective I	PEC	3	0	3
5.		Free Elective I	PEC	3	0	3
6.		Computational Methods in Engineering Practice	PEC	0	3	2
7.		Machine Tool Technology Practice	PEC	0	3	2
8.		Product Design Practice	DES	0	3	2
9.		Skill Development Course 02	PCD	2	0	2
Total No. of Credits						**23**

Fourth Year (VII Semester)

S. No.	Course Code	Course Name	Category Code	I	P	No. of Credits
1.		Project I	PCD	-	-	3
2.		Departmental Elective II	PEC	3	0	3
3.		Departmental Elective III	PEC	3	0	3
4.		Departmental Elective IV	PEC	3	0	3
5.		Free Elective II	PEC	3	0	3
6.		Seminar	PCD	-	-	1
Total No. of Credits						**16**

Fourth Year (VIII Semester)

S. No.	Course Code	Course Name	Category Code	I	P	No. of Credits
1.		Internship	PCD	-	-	3
2.		Project II	PCD			8
Total No. of Credits						**11**

*The student can enroll for the Elective courses from (i) the basket of electives listed and (ii) the list of all courses offered as part of the M.Tech programs with prior approval from the faculty advisor, and HoD.

Grand Total credits for B.Tech = 163

Course Title	Course Code	Structure (I-P-C)		
Engineering Mechanics		**3**	**0**	**3**

Pre-requisite: Nil

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

CO1	Draw free body diagrams and understand equilibrium analysis techniques.
CO2	Apply static equilibrium equations to various mechanical systems.
CO3	Understand particle kinematics and kinetics.
CO4	Understand rigid body kinematics and kinetics.
CO5	Apply the concepts of angular momentum and torque for rigid body dynamics.

Syllabus:

Forces and Particle Equilibrium: definition of a force, representation of a force as a vector in two (2D) and three (3D) dimensions, particle equilibrium; equilibrium of systems of particles. Moments: definition of a moment, moment of a force about a point, line or axis, and moment due to a couple. Equilibrium and Equivalence of Force Systems: equilibrium equations in two (2D) and three (3D) dimensions. Free Body Diagrams and Equilibrium Analysis Techniques. Application of Static Equilibrium Equations.

Applications of the Equations of Static Equilibrium to Interacting Bodies or Parts of a Structure; Systems Containing Multi-Force Members; Frames and Machines. Plane Trusses. Space Trusses. Shear Force and Bending Moment Diagrams. Cable Support Systems. Coulomb Friction and Belt Friction.

Particle Kinematics; Particle Kinetics – Newton's Laws and Euler's Laws; Motion of Particles and Mass Centers of Bodies. Work-Energy Principle for Particles/Systems of Particles. Planar (2D) Rigid Body **Kinematics**: planar (2D) rigid body kinematics, relative velocity equation, rotation about a fixed axis, instantaneous center of zero velocity, and relative acceleration equations. Planar (2D) Rigid Body Kinetics: planar (2D) rigid body kinetics, translation, moment of momentum - angular momentum, and equations of motion; Work-Energy Method; Impulse-Momentum Method and Conservation of Momentum.

Angular Velocity; Angular Acceleration. Velocities in Moving Reference Frames; Accelerations in Moving Reference Frames; The Earth as a Moving Frame. Eulerian Angles; Eulerian Angles Rotation Matrices; Angular Momentum in 3D; Inertial Properties of 3D Bodies. Translational and Rotational Transformations of Inertial Properties; Principal Axes and Principal Moments of Inertia.

Textbook(s) and Reference(s):

1. Andy Ruina and Rudra Pratap, Introduction to Mechanics for Engineers. Springer, 2019.
2. F. Beer. R. Johnston, Vector mechanics for engineers: statics and dynamics. Tata McGraw-Hill, 2010.
3. Meriam. J. L and Kraige. L. G, Engineering Mechanics, Vol. I – Statics, Vol 2: Dynamics, 2007.
4. Daniel Kleppner and Rober Kolenkow, An Introduction to Mechanics, McGraw Hill Education, 2017.

Course Title	Course Code	Structure (I-P-C)		
Engineering Skills Practice		**0**	**3**	**2**

Pre-requisite, if any: Nil

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

CO1	Understand the basic manufacturing processes.
CO2	Apply knowledge for various joining processes.
CO3	Apply knowledge for assembling of simple circuits.
CO4	Design and fabrication of domestic wiring.
CO5	Dissemble and assemble a PC to working condition
CO6	Perform the installation of various PC system software and required device drivers

Syllabus:
Experiments will be framed to train the students in following common engineering practices:
Basic manufacturing processes: Fitting, Drilling & Tapping, Material joining processes
Familiarization on conventional lathe operation
Familiarization on CNC programming and CNC machine operation
Familiarization of electronic components by Nomenclature, meters, power supplies, function generators and Oscilloscope

Bread board assembling of simple circuits: IR transmitter and receiver – LED emergency lamp – Communication study: amplitude modulation and demodulation

PCB: designing and making of simple circuits – Soldering and testing of electronic components and circuits

Various types of Domestic wiring practice: Fluorescent lamp connection, Staircase wiring
Estimation and costing of domestic and industrial wiring – power consumption by Incandescent, CFL and LED lamps

Identify the peripherals of a computer and prepare for assembly and dissembling to working condition.
Installation of operating system and applications.
Working with word processing tools.
Working with spread sheet tools.
Working with Presentation

References:

1. Uppal S. L., “Electrical Wiring & Estimating”, 5Edn, Khanna Publishers, 2003.
2. Chapman. W. A. J., Workshop Technology, Part 1 & 2, Taylor & Francis.
3. Clyde F. Coombs, “Printed circuits hand book”, 6Edn, McGraw Hill, 2007.
4. John H. Watt, Terrell Croft, “American Electricians' Handbook: A Reference Book for the Practical Electrical Man”, Tata McGraw Hill, 2002.
5. The Complete Computer upgrade and repair book, 3rd edition Cheryl A Schmidt, WILEY Dreamtech
6. Introduction to Information Technology, ITL Education Solutions limited, Pearson Education.
7. PC Hardware - A Handbook – Kate J. Chase PHI (Microsoft)
8. LaTeX Companion – Leslie Lamport, PHI/Pearson.
9. IT Essentials PC Hardware and Software Companion Guide Third Edition by David Anfinson and Ken Quamme. – CISCO Press, Pearson Education.
10. IT Essentials PC Hardware and Software Labs and Study Guide Third Edition by Patrick Regan – CISCO Press, Pearson Education.

Course Title	Course Code	Structure (I-P- C)		
Concepts in Engineering Design		**3**	**0**	**3**

Pre-requisite, if any: Nil

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

CO1	Identify different types of engineering design.
CO2	Describe the life cycle of a product.
CO3	Apply conceptualization techniques in the engineering design process.
CO4	Apply and validate different screening and testing methods.
CO5	Analyze the design and development of a product.

Syllabus:
Design Conceptualization and Philosophy, Original, Adaptive, Variant and Re-Design, Evolution of Concept, Need for Systematic design Past methods of and design.

Product life cycle, Innovation, Types of innovation

Needs and opportunities, Vision and Mission of a concept, Type of needs, Technology S - curve, Need analysis, market analysis and competitive analysis, Kano Diagrams, SWOT analysis

Conceptualization techniques – Idea generation – ideation, brainstorming, Trigger session Brainwriting, Mind maps, SCAMPER, TRIZ, Biomimicry, Shape mimicry, Familiarity Matrix

Concepts screening, Concept testing - exploratory tests, Assessment tests, Validation tests Comparison tests – Case studies

Organization of design concept and design methods, Engineering Design - Descriptive and prescriptive model, Design decisions and development of design

Group work and case studies

Text Book(s) and References:

1. Otto. K and Wood, K, Product Design, Pearson Education, 2001.
2. Pahl. G and Beitz. G, Engineering Design, Springer, 1996.
3. Ullman. D. G, The Mechanical Design Process, McGraw- Hill, 1997.

Course Title	Course Code	Structure (I-P-C)		
Engineering Graphics		**1**	**3**	**3**

Pre-requisite: Nil

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

CO1	Learn the basic concepts involved in technical drawing skills.
CO2	Develop basic visualization competency.
CO3	Understand engineering drawings used in 3D objects.
CO4	Represent ideas on both paper and computer.
CO5	Develop the necessary artistic skills required for the engineer to make communication with the industria designers.

Syllabus:

- Importance of engineering drawing; Engineering drawing instruments and uses, B.I.S and I.S.O. conventions for drawings; Construction of basic shapes; Use of plane scales and representative fraction.
- Introduction to principal planes, Notation system, Projection of line parallel/perpendicular to principal plane, Concept of true length of line.
- Concept of different planes, Projections of planes with its inclination to one principal plane and with two principal planes; Concept of auxiliary plane method for projections of the plane.
- Classifications of solids, Projections of solids with their axis parallel to two and perpendicular to one of the principal planes, axis parallel to one and inclined to two principal planes, axis inclined to all the three principal planes.
- Section of solids.
- Principle of projection, Principal planes of projection, Projections from the pictorial view of the object on the principal planes using first angle projection method and third angle projection method.
- Isometric projection.
- Intersection of solids and development of surfaces.
- Principles of perspective drawing, perspective drawing of planar and curved shapes.
- Introduction to CAD.
- Part modelling and assembly.

Textbook(s) and Reference(s):

1. Bhatt. N.D., Engineering Drawing, New Age International, 2007.
2. Jolhe D.A., Engineering Drawing with an Introduction to AutoCAD, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
3. Venugopal K., Engineering Drawing and Graphics, New Age International.
4. Gill P.S., A text book of Engineering Drawing, S.K. Kataria & Sons, Delhi.
5. Jeyapoovan T., Engineering Drawing & Graphics using Auto CAD, Vikas Publishing House Pvt. Ltd., New Delhi.

Course Title	Course Code	Structure (I-P-C)		
Design Realization Practice		**0**	**3**	**2**

Pre-requisite, if any: Nil

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

CO1	Develop an understanding of the design process and principles of design thinking.
CO2	Develop proficiency in prototyping, model-making, and fabrication techniques.
CO3	Evaluate the properties and characteristics of different materials for specific applications.
CO4	Demonstrate an ability to test and evaluate designs based on performance and user feedback.
CO5	Develop skills in design optimization and refinement techniques.
CO6	Develop proficiency in project management, teamwork, and presentation skills.

Syllabus:

Introduction to Design Realization: Introduction to design thinking and the design process; Design brief development; Conceptualization and ideation; Sketching and visualization techniques

Experiments:

1. Brainstorming and ideation exercises to develop creative solutions to design problems.
2. Sketching and visualization exercises to explore different design options.
3. Model-making exercises to bring designs to life in three dimensions.
4. Design brief development exercises to define project goals and objectives.
5. User research exercises to understand user needs and preferences.

Design Implementation and Prototyping: Introduction to prototyping and model-making techniques; Materials selection and sourcing; Basic machining and fabrication techniques; Introduction to Computer-Aided Design (CAD) and 3D printing

Experiments:

1. Basic prototyping exercises using a range of materials and fabrication techniques.
2. Rapid prototyping exercises using CAD and 3D printing.
3. Material selection exercises to evaluate the properties and characteristics of different materials for specific applications.
4. Fabrication exercises to develop skills in basic machining, forming, and joining techniques.
5. Design for manufacturing exercises to optimize designs for efficient production.

Testing and Evaluation: Introduction to testing and evaluation methods; Performance testing of designs; User testing and feedback; Data analysis and interpretation

Experiments:

1. Performance testing exercises to evaluate the functional capabilities of designs.
2. User testing exercises to assess usability and user experience.
3. Materials testing exercises to evaluate the properties and characteristics of materials under different conditions.
4. Data analysis and interpretation exercises to draw conclusions from test results and user feedback.

5. Prototype iteration exercises to refine designs based on testing and evaluation.

Design Optimization and Refinement: Introduction to design optimization and refinement techniques**;** Reducing design complexity and cost**;** Enhancing design functionality and performance**;** Design iteration and improvement

Experiments:
1. Design optimization exercises to reduce complexity and cost while maintaining functionality and performance.
2. Design refinement exercises to enhance functionality and performance while maintaining simplicity and affordability.
3. Design iteration exercises to refine designs based on feedback and testing results.
4. Material substitution exercises to identify suitable alternatives for materials that are difficult to source or too expensive.
5. Value engineering exercises to optimize designs for cost, reliability, and performance.

Project Management and Presentation: Introduction to project management principles**;** Project scheduling and budgeting**;** Project team management and collaboration**;** Presentation skills and techniques

Experiments:
1. Project management exercises to develop skills in project scheduling, budgeting, and team management.
2. Collaboration exercises to develop teamwork and communication skills.
3. Presentation skills exercises to improve communication skills and build confidence in presenting design concepts and ideas.
4. Design documentation exercises to develop skills in technical writing and project reporting.
5. Final project presentation and exhibition to showcase design projects and receive feedback from peers and industry professionals.

Text Book(s) and References:

1. Shamieh, C. (2015). Electronics for dummies. John Wiley & Sons.
2. Abbey, J. E. (2015). Mechanics of materials lab manual. Jones & Bartlett Learning.
3. Alciatore, D. G., & Histand, M. B. (2018). Introduction to mechatronics and measurement systems. McGraw-Hill Education.
4. Leake, J. (2017). Engineering Design Graphics: Sketching, Modeling, and Visualization (2nd ed.). Wiley.
5. Craig, J. J. (2019). Introduction to Robotics: Mechanics and Control (4th ed.). Pearson.
6. Monk, S. (2016). Programming Arduino: Getting Started with Sketches (2nd ed.). McGraw-Hill Education.
7. Severance, C. (2016). Python for Everybody: Exploring Data in Python 3. CreateSpace Independent Publishing Platform.

Course Title	Course Code	Structure (I-P-C)		
Material Science and Metallurgy		**3**	**0**	**3**

Pre-requisite, if any: Nil

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

CO1	Understand the basic concept of material science and metallurgy.
CO2	Analyze the crystal structures, crystal defects, deformation, and strengthening mechanisms.
CO3	Classify steels, cast irons, and their alloys based on their constitutions and applications.
CO4	Interpret the phase diagrams and apply the heat treatment process for various materials.
CO5	Describe different mechanical properties of engineering materials
CO6	Understand the basic concepts of powder metallurgy and its applications.

Syllabus:

Introduction to Material Science and Metallurgy: Classification of Engineering Materials, Engineering Requirements of Materials, Properties of Engineering Materials, Criteria for Selection of Materials for Engineering Applications, Environmental Degradation of Engineering Materials.

Introduction to Crystal Structure: Coordination Number, Atomic Packing Factor, Simple Cubic, BCC, FCC, and HCP Structures, Crystal Directions and Planes, Miller Indices, Polymorphism or Allotropy, Mechanism of Crystallization - Nucleation and Growth, Factors affecting Nucleation and Growth. Crystal Imperfections– Point, Line, Surface, and Volume Imperfections, Geometry and Properties of Dislocation, Deformation of Single Crystal by Slip and Twinning, Mechanisms of Strengthening in Metals, Atomic Diffusion, and Factors affecting Diffusion.

Constitution of Alloys: Types of Alloys, Types of Solid Solution, Substitutional and Hume Rothary's Rules for Solid Solution, Construction and Interpretation of Binary Equilibrium Diagram - Isomorphous, Eutectoid, Eutectic and Peritectic diagrams, Lever Rule, Intermediate Phases and Gibb's Phase Rule.

Iron Carbon System: Allotropy of Iron, Iron-Carbon Diagram - Phases Present and their Properties, Different Reactions of the Iron-Carbon System, Constituents, Microstructures and Properties of Plain Carbon Steels. Alloy groups (Wrought Irons, Steels, and Cast Irons) of Iron-Carbon System and their Characteristics, Equilibrium Cooling of Eutectoid, Hypoeutectoid, and Hypereutectoid Steels – Microstructures, Correlated Properties, and Applications. IS and ISO Codification, Different Specifications, and Designations of Steels.

Heat Treatments of Steels: Classification of Steels with Applications, Effect of Common Alloying Elements on Steels, Theory of Heat Treatment, Time-Temperature Transformation (TTT) Curves, Continuous Cooling Transformation (CCT) Curves, Study of Heat Treatment Processes – Annealing, Normalizing, Hardening, Tempering, Austempering & Martempering, Surface Hardening – Carburizing, Nitriding, Cyaniding, Induction Hardening, Flame Hardening and Age Hardening of Aluminum-Copper Alloys and PH steels, Types of Cast Irons – White, Grey, Malleable, and Nodular, etc., Properties and Application of Cast Irons.

Mechanical Properties: Stress-Strain Diagrams showing Ductile and Brittle Behavior of Materials, Engineering Stress and True Strains, Mechanical Properties– Stiffness, Yield strength, Ductility, Ultimate Tensile strength, Toughness, Hardness and Hardness measurement, Elasticity, Tensile property, Impact property and Ductile to Brittle Transition Temperature (DBTT), Fatigue, Creep**,** etc.

Powder Metallurgy: Basic Concepts, Applications, and Advantages of Powder Metallurgy, Manufacturing Processes, Production of Powder, Compacting, Sintering, Products of Powder Metallurgy.

Text Book(s) and References:

1. Callister's Materials Science and Engineering, 2nd ED, adapted by R Balasubramaniam, 2010, ISBN-13: 978-8126521432, Wiley India Ltd.
2. V. Raghavan, Materials Science and Engineering, 4th Ed, Prentice-Hall of India Pvt. Ltd, New Delhi, 2004.
3. D. R. Askland & P. P. Phule, The Science and Engineering of Materials, 4th Ed. Cengage Learning, 2003.
4. Principles of Physical Metallurgy by Prof. R. N. Ghosh, NPTEL (https://nptel.ac.in/courses/113105023)

Course Title	Course Code	Structure (I-P-C)		
Thermodynamics		**3**	**0**	**3**

Pre-requisite, if any: Nil

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

CO1	Identify different forms of energy.
CO2	Describe the laws of thermodynamic principles related to various thermal systems.
CO3	Apply the laws of thermodynamics to estimate the performance parameters of thermal systems.
CO4	Estimate the properties of ideal gases and pure substances.
CO5	Analyze the thermodynamic cycles of various thermal systems.

Syllabus:
Fundamentals: System, Control volume, Property, State, Process, Cycle, Equilibrium, Zeroth law, Principles of Thermometry, Energy-Forms of Energy, Heat, Work, Different forms of work.

First law: First law Analysis of Closed System for Cyclic & non-cyclic process, Internal energy, Enthalpy, Free expansion process, Application of First law to flow processes, SFEE, Examples of steady flow devices: Nozzle, Diffuser, Turbine, Compressor, Throttling Valve and Heat Exchangers, PMM-I, Limitations of first law.

Second law: Qualitative difference between the heat and work, Heat Engines, Refrigerators, Heat Pumps, Kelvin-Planck & Clausius Statements, PMM-II, Carnot Cycle, Reversible &Irreversible cycles. Entropy: Clausius inequality, Definition of Entropy, Demonstration that entropy is a property, T-s diagram, Isentropic efficiency, Available and unavailable energy, Concept of irreversibility and lost work, T-ds equations.

Pure Substances: Properties of pure substances, Water and steam - Constant temperature and constant pressure heating, Use of steam tables: Saturation tables, Superheated tables, Mollier chart.

Thermodynamic relations: Maxwell relations - TdS Equations - heat capacities relations - Energy equation, Joule- Thomson experiment - Clausius-Clapeyron equation

Properties of gases and Mixtures: Properties of Ideal gas, real gas - Equations of state for ideal and real gases. Vander Waal's relation - Reduced properties - Principle of Corresponding states - Generalized Compressibility Chart.

Text Book(s) and References:

1. P. K. Nag, “Engineering Thermodynamics,” McGraw-Hill, 6th Edition, 2013.
2. Y. A. Cengel, and M. A. Boles, “Thermodynamics: An Engineering Approach”, McGraw-Hill, 8thEdition, 2011.
3. C. Borgnakke and R. E. Sonntag, “Fundamentals of Thermodynamics,” 7th Edition, Wiley, 2009.
4. Moran, Shapiro, Boettner and Bailey, "Principles of Engineering Thermodynamics", 8th Edition, Wiley, 2015.

Course Title	Course Code	Structure (I-P-C)		
Mechanics of Materials		**3**	**0**	**3**

Pre-requisite, if any: Engineering Mechanics

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

CO1	Describe the material behavior under different kind of static loading conditions
CO2	Analyze the problems related to deformation of elastic bodies
CO3	Design simple structures under static loadings, i.e. beams, shafts, columns,etc.
CO4	Design the structures under combined loads
CO5	Apply the different failure theories based on the application

Syllabus:
Review of equilibrium, compatibility, stress and strain at a point and Mohr's circle.

Pure bending of beams – shear force and bending moment diagrams; beams with composite cross- sections; Deflection of beams

Torsion of circular cross sections – application and transmission of torque; Combined loads – application to pressure vessels and springs.

Theory of failures for ductile and brittle materials.

Buckling of columns – eccentric loading; various end constraints.

Text Book(s) and References & Web Resources:

1. W. Nashand, N. Malik, "Strength of Materials", McGraw Hill Education Pvt. Ltd, 4th Edition, 2010.
2. F. P. Beer, E. R. Johnston, J. T. Dewolf, and D. Mazurek, "Mechanics of Materials," McGraw Hill, 7th Edition, 2014.
3. R. C. Hibbeler, "Mechanics of Materials," Prentice Hall, 8th Edition, 2010.
4. A. C. Ugural, "Mechanics of Materials," Wiely, 1st Edition,2007.
5. J. M. Gere and S. Timoshenko, "Mechanics of Materials", PWS Publishing Company, 4th Edition,1997.

Course Title	Course Code	Structure (I-P-C)		
Kinematics of Machines		**3**	**0**	**3**

Pre-requisite: Engineering Mechanics

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

CO1	Demonstrate a good understanding of the principles of rigid body motion.
CO2	Predict the degrees of freedom, velocity and acceleration of different mechanisms using graphical o analytical methods.
CO3	Synthesize the four bar and slider crank mechanism using path synthesis, function generation and poir synthesis.
CO4	Analyze the problems related to cam and follower motions.
CO5	Illustrate different types of gears, gear trains and analyze the speed of gear train.

Syllabus:

Introduction to mechanisms-rigid body motion- joints, pairs and couplings; Constraints, Kinematic Chains, Kinematic Diagrams, Kinematic Inversion.

Mobility and degree of freedom, Kutzbach and Grubler criterion, Number Synthesis, Grashof's law.

Kinematics (Displacement, Velocity and Acceleration analysis) of rigid bodies – analytical and graphical methods. Instantaneous Centre (IC) of Velocity, Velocity analysis using IC.

Dimensional synthesis of mechanism; motion, path and function generation. Three position synthesis, graphical approach for four link mechanisms. Advanced synthesis solutions, branch and order defects.

Cams – classification of cams and followers, nomenclature, description and analysis of follower motion. Determination of basic dimensions and synthesis of cam profiles.

Gears – terminology, fundamental law of gearing, interference and undercutting, minimum number of teeth, contact ratio.

Gear Trains – simple, compound and epicyclic gear trains.

Textbook(s) and Reference(s):

1. A. Ghosh and A. K. Mallik, "Theory of Mechanism and Machines," Affiliated East –West Press Private Ltd., 2009.
2. Kenneth J. Waldron, Gary L. Kinzel, Sunil K. Agrawal, "Kinematics, Dynamics, and Design of Machinery," Wiley, 3rd edition, 2016.
3. J. S. Rao, and R. V. Dukkipati, "Mechanism and Machine Theory," New Age International, 2006.
4. S. S. Rattan, "Theory of Machines," Tata McGraw-Hill, 2005.
5. T. Bevan, "Theory of Machines," Pearson Education, 3rd Edition, 2009.

Course Title	Course Code	Structure (I-P-C)		
Fluid Mechanics and Hydraulic Machinery		**3**	**0**	**3**

Pre-requisite, if any: Engineering Mechanics

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

CO1	Understand the concepts of fluid statics and dynamics.
CO2	Apply the concepts of fluid statics and dynamics to various engineering applications and flow-measuring devices.
CO3	Understand the concepts of laminar & turbulent flows and boundary layer formation.
CO4	Understand the working principles of hydraulic devices such as Turbines and Pumps.
CO5	Analyze the performance parameters of hydraulic devices.

Syllabus:

Fluid Statics: Physical properties of fluids - Specific Gravity, Viscosity, Surface Tension, Vapour Pressure and their influence on fluid motion, Basic equations of hydrostatics – pressure measurement, Analysis of submerged surfaces – Buoyancy and stability

Fluid Kinematics and Dynamics: Classification of Flows, Stream function, Velocity potential, Conservation of mass, momentum and energy, Application of Bernoulli‘s Equation and Momentum equations, Measurement of flow: Venturi-meter, Orifice Meter and Pitot Tube

Flow through Pipes and the Concept of Boundary layer: Reynolds Experiment, Losses in pipes, Pipe connections, Total Energy Line, Hydraulic Gradient Line, Water hammer, Laminar & Turbulent Boundary Layer, Boundary Layer Thickness, Boundary layer separation.

Hydraulic Turbines: Impact of jets, Classification of Turbines, Pelton Wheel, Francis Turbine, Kaplan Turbine, Velocity diagrams, Governing of Turbines, Unit and Specific Quantities, Geometric Similarity, Cavitation, Performance characteristic curves.

Hydraulic Pumps: Classification of reciprocating and centrifugal pumps, working principles, Velocity triangles, Losses and Efficiencies, Specific Speed, Pumps in Series, Parallel, Performance characteristic curves, NPSH, Cavitation.

Text Book(s) and References & Web Resources:

1. S K Som, Gautam Biswas and S Chakraborty, "Introduction to Fluid Mechanics & Fluid Machines", McGraw Hill, 3rd edition, 2011.
2. Robert W. Fox, Philip Journal Pritchard and Alan T. McDonald, "Introduction to Fluid Mechanics", 8th Edition, Wiley India Pvt. Ltd.,2013.
3. Merle C Potter, David C Wiggert and Bassem H Ramadan, "Mechanics of Fluids", Cengage Learning India; 4th edition, 2012.
4. Streeter V.L., Benjamin Wylie, Bedford K.W., "Fluid Mechanics", McGraw Hill, 9th Edition, 2017.
5. P. N. Modi and S. M. Seth, "Hydraulics & Fluid Mechanics Including Hydraulics Machines", 22nd Edition, Standard Book House, 2017.

Course Title	Course Code	Structure (I-P-C)		
Electrical Drives, Sensor and Microprocessor		**3**	**0**	**3**

Pre-requisite, if any: Nil

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

CO1	Understand the working principles of power electronic rectifiers, converters and inverters operate.
CO2	Understand the control mechanism of electrical drives.
CO3	Select a suitable sensor for a particular instrumentation task
CO4	Design signal conditioning circuit and calibrate the sensor
CO5	Program the microprocessors/microcontrollers for solving practical problems
CO6	Interface peripherals with microprocessors/microcontrollers and run the devices like stepper motor etc.

Syllabus:

Power Electronics: Semiconductor Power Devices-DC converter, DC-DC Converter, DC-AC Converter, AC-AC Converter

Electrical Machines: DC Motor, AC Motor, BLDC, PMDC, Servomotor, Stepper motor – Construction, Working Principles, Starting and Control Mechanism

Sensor: Introduction: Description of measuring devices and dynamic characteristics, active and passive sensors and transducers, classifications, Basics of Signal Conditioning for sensor

Sensors and Transducers: Flow, temperature, force, pressure and torque sensors; Current, torque and speed measurements using digital measurement techniques**.**

Microprocessor: Architecture and Programming of 8085 Microprocessor. Interfacing of 8085 with memory and input /output ports, hex keyboards etc., Architecture and Programming of 8085 Microprocessor. Interfacing of 8085 with memory and input /output ports, hex keyboards etc.,

Introduction to the ARM microcontrollers programming and interfacing with A/D, D/A converters, Sensor interfacing and signals conditioning.

Text Book(s) and References:

1. M. Rashid, “Power Electronics: Circuits, Devices & Applications”, 3rd Edition, Prentice Hall, 2003.
2. Doebelin, “Measurement systems: Applications and Design”, 5th Edition, McGraw Hill, 2004.
3. Ian R. Sinclair, “Sensors and Transducers”, Elsevier, 2001, ISBN: 978-0-7506- 4932-2.
4. R. Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", 6th Edition, Penram,2013.
5. R. Krishnan, “Electric Motor Drives: Modelling, Analysis, and Control,” Prentice Hall, 2001.
6. N. Mohan, “Electric Drives: An Integrative Approach”, MNPERE, 2001
7. Jon S. Wilson, “Sensor Technology Handbook”, Newnes, 2004, ISBN: 0750677295.
8. M. MorrisMano, "DigitalLogicandComputerDesign",1st Edition, Pearson,2013.

Course Title	Course Code	Structure (I-P-C)		
Materials and Mechanics Practice		**0**	**3**	**2**

Pre-requisite(s): Nil.

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

CO1	Understand the stress-strain curve of materials under tension and compression.
CO2	Understand torsional stresses for large plastic strains.
CO3	Measure hardness of different materials.
CO4	Understand the S-N curve and effect of stress concentration on fatigue.
CO5	Understand and design different mechanisms and their applications, and perform the displacement analysis
CO6	Design cam profiles based on follower displacements.

Syllabus:

Experiments on

- The tension test.
- The torsion test.
- The hardness test.
- Fatigue of metals.
- Brittle failure and impact testing.
- Residual stresses.
- Study of applications of kinematic linkages and mechanisms.
- Freudenstein's method: an analytical solution for 4-bar synthesis 3-pt function generation.
- Study of quick return mechanism.
- Graphical Synthesis – Path Generation Mechanism using Kinematic Inversion.
- Cam design.

Textbook(s) and Reference(s):

1. George E. Dieter, "Mechanical Metallurgy," McGraw Hill Education, 3rd edition, 2017.
2. A. Ghosh and A. K. Mallik, "Theory of Mechanism and Machines," Affiliated East –West Press Private Ltd., 2009.
3. Kenneth J. Waldron, Gary L. Kinzel, Sunil K. Agrawal, "Kinematics, Dynamics, and Design of Machinery," Wiley, 3rd edition, 2016.

Course Title	Course Code	Structure (I-P-C)		
Electrical Drives, Sensor, and Microprocessor Practice		**0**	**3**	**2**

Pre-requisite, if any: Nil

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

CO1	Choose the right sensing system for various applications.
CO2	Design signal conditioning circuit and calibrate the sensor
CO3	Choose the right Electrical drive system for various applications.
CO4	Select a suitable sensor for a particular instrumentation task
CO5	Design signal conditioning circuit and calibrate the sensor
CO6	Program the microprocessors/microcontrollers for solving practical problems
CO7	Interface peripherals with microprocessors/microcontrollers and run the devices like stepper motor etc.

Syllabus:
Experiments on:
Electrical Drives Experiments: Converters, Inverters, DC Motor, Induction Motor, BLDC motor, Stepper Motor, PMDC motor

Sensor: Signal Conditioning Circuits, Temperature sensor, Strain Gauge, Magnetic Sensor

Microprocessor: Interfacing of 8085 with memory and input /output ports, hex keyboards etc.,
ARM microcontrollers programming and interfacing with A/D, D/A converters, Sensor interfacing and signals conditioning.

Textbook(s) and References:

1. M. Rashid, “Power Electronics: Circuits, Devices & Applications”, 3rd Edition, Prentice Hall, 2003.
2. Doebelin, “Measurement systems: Applications and Design”, 5th Edition, McGraw Hill, 2004.
3. Ian R. Sinclair, “Sensors and Transducers”, Elsevier, 2001, ISBN: 978-0-7506- 4932-2.
4. R. Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", 6th Edition, Penram,2013.
5. R. Krishnan, “Electric Motor Drives: Modelling, Analysis, and Control,” Prentice Hall, 2001.
6. N. Mohan, “Electric Drives: An Integrative Approach”, MNPERE, 2001
7. Jon S. Wilson, “Sensor Technology Handbook”, Newness, 2004, ISBN: 0750677295.
8. M. Morris Mano, "Digital Logicand ComputerDesign",1st Edition, Pearson,2013

Course Title	Course Code	Structure (I-P-C)		
Machine Drawing and Manufacturability Analysis Practice		**0**	**3**	**2**

Pre-requisite, if any: Engineering Graphics

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

CO1	1. Develop 3D models of machine components and generate 2D drawing from 3D models
CO2	2. Digitize existing products using reverse engineering
CO3	3. Create assembled and exploded views of machine components
CO4	4. Analyze the machine component design for its manufacturability, environmental impact and eas of assembly using 3D models

Syllabus:

<u>Machine drawing</u>:

1. Introduction to Machine drawing and Conventional representation of different materials and threaded joints
2. Orthographic projections of different part drawings.
3. Generating 2D drawings from 3D models and create production drawings using standard notations.
4. Assembly drawing of simple machine components like cotter and sleeve joint.
5. Assembly drawing of knuckle joint.

Modelling using CATIA:

1. Drafting: Development of part drawings for various components in the form of orthographic and isometric.
2. Modeling machine components in 3D modeling software using feature-based design concepts.
3. Modeling machine components in 3D modeling CATIA software using Boolean based design concepts.
4. Assembly Modelling of cotter and sleeve joint in 3D modeling software using feature-based design concepts.
5. Assembly Modelling of knuckle joint in 3D modeling software
6. Term project on assembly modeling of different components like screw jack, plumber block, footstep bearing, connecting rod, clutch, Oldham coupling, etc.

Text Book(s) and References:

1. N.D Bhatt, “Engineering Drawing”, Charotar Publishing house, 2017.
2. K.L. Narayana, P. Kannaiah, K.Venkata Reddy, “Machine Drawing”, New age company, 2015.
3. S. Bogolyubov. A. Voinov., “Engineering Drawing”, Van Nostrand Reinhold Company, 2001.
4. D. E. Hewitt., “Engineering Drawing and Design for Mechanical Technicians”, Macmillan Press Ltd,2006.
5. Boothroyd G., Dewhurst P., and Knight W. A., “Product Design for Manufacture and Assembly”, 3rd Edition, CRC Press,2010.

Course Title	Course Code	Structure (I-P-C)		
Basic Concepts in Manufacturing Processes		**3**	**0**	**3**

Pre-requisite, if any: Nil

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

CO1	Understand the basic concept of manufacturing processes.
CO2	Determine the appropriate manufacturing process(es) for the product to be made.
CO3	Analyze the suitability of a manufacturing process to convert the raw material to designe specifications.
CO4	Perform cost analysis for various manufacturing processes to minimize the cost of processing th material.
CO5	Understand the basics of material joining processes

Syllabus:
Introduction: Introduction of manufacturing processes, manufacturing process categories and classification
Casting: Types of casting processes and applications; Sand casting: patterns – types, materials and allowances; molds and cores–materials, making, and testing; design of gating system and riser; casting techniques of cast iron, steels, and non-ferrous metals and alloys; analysis of solidification and microstructure development; Other casting techniques: Pressure die casting, Centrifugal casting, Investment casting, Shell mold casting; Casting defects, inspection and testing.

Metal Forming: Stress-strain relations in elastic and plastic deformation; von Mises and Tresca yield criteria, Concept of flow stress; Hot, warm, and cold working.
Bulk forming processes – forging, rolling, extrusion and wire drawing.
Sheet metal working processes – blanking, punching, bending, stretch forming, spinning and deep drawing; Ideal work and slab analysis; Defects in metal working and their causes.

Materials Removal Processes: Introduction and classification of material removal processes.
Conventional Machining: Orthogonal and oblique machining, Single point cutting tool and tool signature, Chip formation, cutting forces, Merchant's analysis, Specific cutting energy and power; Machining parameters and material removal rate; tool materials, Tool wear and tool life; Thermal aspects of machining, cutting fluids, machinability; Economics of machining; Machining processes – turning, taper turning, thread cutting, drilling, boring, milling, gear cutting, thread production; Finishing processes – grinding, honing, lapping and super-finishing.
Non-Conventional Machining: Introduction, Classification, Principles and applications of USM, AJM, WJM, AWJM, EDM and Wire EDM, LBM, EBM, PAM, CHM, ECM; Effect of process parameters on material removal rate, surface roughness and power consumption.

Material Joining Processes: Introduction and classification of material joining processes; Principles of fusion welding processes using different heat sources (flame, arc, resistance, laser, electron beam), Heat transfer and associated losses; Arc welding processes – SMAW, GMAW, GTAW, plasma arc, submerged arc welding processes; Principles of solid state welding processes – friction welding, friction stir welding, ultrasonic welding; Welding defects – causes and inspection; Principles of adhesive joining, brazing and soldering processes.

Textbook(s) and References:

1. S. Kalpakjian, and S.R. Schmidt, "Manufacturing Engineering and Technology," 7th Edition, Pearson India, 2009.
2. M. P. Groover, "Principles of Modern Manufacturing," 5th Edition, Wiley, India, 2014.
3. A. Ghosh and A. K. Mallik, Manufacturing Science, Wiley Eastern, 2010
4. P. N. Rao, Manufacturing Technology: Foundry, Forming And Welding, Tata McGraw Hill, 2017.
5. M. P. Groover, Introduction to Manufacturing Processes, Wiley, 2011
6. E. P. DeGarmo, J. T. Black, and R. A. Kohser, "DeGarmo's materials and processes in manufacturing," John Wiley & Sons,2011.
7. Gibson, D. W. Rosen, and B. Stucker, "Additive manufacturing technologies," Springer, 2010.
8. Stephenson, David A., and John S. Agapiou, "Metal cutting theory and practice," Vol. 68, CRC press,2005.
9. S. Kalpakjain, and S. R. Schmid, "Manufacturing processes for engineering materials," 5th Edition, Pearson Education, India,2010.

Course Title	Course Code	Structure (I-P-C)		
Dynamics of Machines		**3**	**0**	**3**

Pre-requisite(s): Kinematics of Machines and Engineering Mechanics.

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

CO1	Analyse the forces in different mechanisms.
CO2	Apply the analytical and graphical methods for balancing of rotating and reciprocating engines.
CO3	Understand and design different machinery such as gyroscopes, clutches, brakes, governors an flywheels.
CO4	Understand the concepts of vibration.
CO5	Use the knowledge in any possible domains of applications such as mechanical engineering, civi engineering, aerospace engineering, and many others.

Syllabus:

Dynamics of rigid body in plane and planar mechanisms – static and dynamic force analysis of slider crank mechanism.

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

Balancing of rotating and reciprocating masses and engine balancing.

Turning moment diagram and flywheel analysis.

Clutches: single plate, multi-plate and centrifugal clutch.

Brakes: Simple block brakes, Band brake, internal expanding brake, braking of vehicle. Dynamometers – absorption and transmission types.

Governors-spring loaded and gravity-controlled governors.

Review of vibrations; free vibrations and harmonically excited vibration of single degree of freedom system; Vibration isolation.

Textbook(s) and Reference(s):

1. A. Ghosh and A. K. Mallik, "Theory of Mechanism and Machines," Affiliated East –West Press Private Ltd., 2009.
2. Kenneth J. Waldron, Gary L. Kinzel, Sunil K. Agrawal, "Kinematics, Dynamics, and Design of Machinery," Wiley, 3rd edition, 2016.
3. J. S. Rao, and R. V. Dukkipati, "Mechanism and Machine Theory," New Age International, 2006.
4. S. S. Rattan, "Theory of Machines," Tata McGraw-Hill, 2005.
5. T. Bevan, "Theory of Machines," Pearson Education, 3rd Edition, 2009.

Course Title	Course Code	Structure (I-P-C)		
Design of Machine Elements		**3**	**0**	**3**

Pre-requisite: Engineering Mechanics, Mechanics of Materials

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

CO1	Outline the knowledge of design process and design standards, theories of failures, analyses the stresse and strains for various machine elements.
CO2	Understand the Design procedure of riveted joints and welded joints for engineering, apply application like boilers, pressure vessels, ships and trusses.
CO3	Inculcate an ability to design belt drives and selection of belt, rope and chain drives.
CO4	Apply the design and development procedure for different types of springs by using Design Data Han book.
CO5	Determine the fatigue life of shafts, gears and bearings under varying loads.

Syllabus:
Design philosophy, revision of failure theories, limits, fits and design under static load.

Design for variable loading - fatigue strength and design of shafts.

Design of riveted, bolted, welded joints and power screws.

Design of springs: basic spring nomenclature, spring stiffness, various spring type and configurations, materials for spring.

Design and selection of belt drives.

Design of gears: spur and worm gears, contact fatigue strength, gear accuracy.

Design of brakes and clutches.

Tribology: lubricant theories, design of Journal bearings; selection of ball and roller bearings.

Textbook(s) and Reference book(s):

1. V Bhandari, ‘Design of Machine Elements’, McGraw-Hill Education, 3rd Edition, 2010.
2. R G Budynas, K J Nisbett, ‘Mechanical Engineering Design’, McGraw Hill, 10th Edition, 2014.
3. R L Norton, ‘Machine Design’, Prentice Hall, 5th Edition, 2013.
4. C S Sharma and K Purohit, ‘Design of Machine Elements’, Prentice Hall, 2008 P C Gope, ‘Machine Design: Fundamentals and Applications’, Prentice Hall India, 201.
5. Hall A. S., Holowenko A. R. and Laughlin H. G., “Theory and Problems of Machine Design”, Schaum’s outline series, Tata McGraw Hill Publication. Co. Ltd, New Delhi

Course Title	Course Code	Structure (I-P-C)		
Heat Transfer		**3**	**0**	**3**

Pre-requisite, if any: Thermal Engineering – Concepts & Applications, Fluid Mechanics and Hydraulic Machinery

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

CO1	Understand the basics of heat transfer and its practical relevance in various simple geometries.
CO2	Interpret the steady and unsteady state heat transfer scenarios.
CO3	Apply the relevant expressions to solve free and forced convection problems.
CO4	Apply the concepts of heat transfer in boiling, condensation, and radiation thermal systems.
CO5	Design the Fins and heat exchangers for engineering applications

Syllabus:
Basics: Basic modes and Applications of heat transfer.

Conduction: General heat conduction equation, Initial and boundary conditions, One-dimensional steady-state conduction in the plane and composite systems, Electrical analogy, Systems with variable thermal conductivity, heat generation, Critical radius of insulation, Analysis of Extended surfaces, One-dimensional transient conduction, lumped system analysis.

Convection: Dimensional analysis, the concept of the boundary layer, Forced convection in external and internal flows, natural convection in external flows, heat transfer phenomena in boiling and condensation.

Thermal Radiation: Nature of radiation, Concept of Black and Non-black bodies, Laws of Black Body Radiation, Radiation heat exchange between surfaces, Radiation shields.

Heat exchangers: Classification, flow arrangement, Overall heat transfer coefficient, fouling, compactness, LMTD & ε-NTU methods of Heat Exchanger analysis

Text Book(s) and References:
1. J. P. Holman and Souvik Bhattacharyya, "Heat Transfer", McGraw Hill, 10th edition, 2017.
2. Incropera, Dewitt, Bergmann, Lavine, "Incropera's Principles of Heat and Mass Transfer, Wiley India Edition", Wiley, 2018.
3. Frank Kreith, Mark S. Bohn, Raj Manglik, "Principles of Heat Transfer", Cengage Learning Custom Publishing; 7th International student edition, 2010.
4. M. Necati Ozisik, "Heat Transfer- A basic Approach", 4th Edition, McGraw, 1985.
5. C. P. Kothandaraman and Subramanian, "Heat and Mass Transfer Data Book", New Age International Publications, 9th Edition, 2018.

Course Title	Course Code	Structure (I-P-C)		
Basic Manufacturing Processes Practice		**0**	**3**	**2**

Pre-requisite, if any: Design Realization

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

CO1	Understand the basic manufacturing processes.
CO2	Accustomed to the handling of Machine tools.
CO3	Realize the products using primary manufacturing processes
CO4	Understand the 3D printer basics.

Syllabus:

The following experiments will be conducted:

1. Realization of Cylindrical Parts using Traditional Lathe (Turning operation)
2. Realization of Cylindrical Parts using Traditional Lathe (Step Turning operation)
3. Realization of Cylindrical Parts using Traditional Lathe (Threading operation)
4. Realization of Cylindrical Parts using Traditional Lathe (Taper Turning operation)
5. Making of Square box with GI sheet by using Sheet Metal Bending Practice
6. Making of Rectangular box with required dimensions of GI sheet by using Sheet Metal Bending Practice
7. Practice on Universal Milling Machine (Facing operation)
8. Gear Cutting by using indexing on Universal Milling Machine
9. Machining on CNC Router cum Milling machine
10. Developing a physical model by using Fusion Deposition Modelling (3D Printer)

Text Book(s) and References

1. E. P. DeGarmo, J. T. Black, and R. A. Kohser, “DeGarmo's materials and processes in manufacturing”, John Wiley & Sons,2011.
2. M. P. Groover, “Principles of Modern Manufacturing”, 5th Edition, Wiley, 2014
3. S. Kalpakjain, and S. R. Schmid, “Manufacturing processes for engineering materials”, 5th Edition, Pearson Education, 2010.

Course Title	Course Code	Structure (I-P-C)		
Dynamics of Machines Practice		**0**	**3**	**2**

Pre-requisite(s): Nil.

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

CO1	Apply the principles of balancing of masses to various links, mechanisms and engines.
CO2	Analyze the principles of cam & follower motion.
CO3	Understand and design different machinery such as gyroscopes, governors and flywheels.
CO4	Understand the concepts of free vibration, forced vibration, viscous damping and coulomb damping
CO5	Gain hands on experience on sensor data acquisition, signal processing and data analysis.
CO6	Learn traditional control using P, PI, PID and speed and position control under variable loads.

Syllabus

Experiments on:

1. Estimate the applied torque of given motorized gyroscope.
2. Study the balancing of rotating masses under static condition and dynamic condition.
3. Study the pressure distribution in the journal bearing.
4. Estimate the critical speed of the shaft with different end conditions.
5. Analyse the follower displacement versus cam rotation angle for different types of cams.
6. Predict the radius of gyration of rod by using bi-filler and tri-filler suspension.
7. Estimate the natural frequency of underdamped free vibrations of spring-mass system.
8. Analyse the forced vibration of spring mass system.
9. Analyse the natural frequency of torsional vibration of single rotor system using universal vibration test setup.
10. Acquire the MEMS accelerometer data with the help of data acquisition system and estimate the coefficient of viscous damping.
11. Study the effect of coulomb friction.
12. Tradition control experiments using P, PI, and PID on a DC motor control kit.

Textbook(s) and Reference(s):

1. A. Ghosh and A. K. Mallik, “Theory of Mechanism and Machines,” Affiliated East –West Press Private Ltd., 2009.
2. Kenneth J. Waldron, Gary L. Kinzel, Sunil K. Agrawal, “Kinematics, Dynamics, and Design of Machinery,” Wiley, 3rd edition, 2016.
3. S. S. Rattan, “Theory of Machines,” Tata McGraw-Hill, 2005.
4. L. Meirovitch, “Fundamentals of Vibrations,” McGraw-Hill Education, 2000.

Course Title	Course Code	Structure (I-P-C)		
Fluid Mechanics and Heat Transfer Practice		**0**	**3**	**2**

Pre-requisite, if any: Fluid Mechanics and Hydraulic Machinery

Course Objective: The objective of this course is to familiarize the students with fluid mechanics and heat transfer equipment.
Course Outcomes: At the end of the course the students will be able to:

CO1	Compute the different losses in pipe flows.
CO2	Estimate the thermal conductivity of different materials
CO3	Estimate the Fin performance parameters.
CO4	Evaluate the free and forced convection heat transfer coefficients.
CO5	Determine the overall heat transfer coefficient of the Drop and Film wise condensation.

Syllabus:
The following Experiments are designed to:
- Estimate the major and minor losses in a flow through pipe.
- Study of linear and radial heat transfer conduction using Fourier's Law.
- Measurement of thermal conductivity of non-metallic material under steady state experiments.
- Estimate the Effectiveness and efficiency of the pin fin apparatus under forced condition.
- Determine the overall heat transfer coefficient of both the Drop and Film wise condensation.
- Estimate the Heat Transfer coefficient of both Natural and forced convective system.

Text Book(s) and References:

1. J. P. Holman and Souvik Bhattacharyya, "Heat Transfer", McGraw Hill, 10th edition, 2011.
2. Incropera, Dewitt, Bergmann, Lavine, "Fundamentals of Heat and Mass Transfer", Wiley, 6th edition, 2010.
3. Robert W. Fox, Philip Journal Pritchard and Alan T. McDonald, "Introduction to Fluid Mechanics", 8th Edition, Wiley India Pvt. Ltd.,2013.

Course Title	Course Code	Structure (I-P-C)		
Quality Inspection and Product Validation		**3**	**0**	**3**

Pre-requisite, if any: Nil

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

CO1	Understand various metrology principles and techniques
CO2	Acquire the knowledge to select suitable techniques and equipment to inspect and to ensure produc quality
CO3	Acquaintance with various quality control methodologies, standards, and certifications
CO4	Understand the basics concepts of surface metrology
CO5	Analyze the suitability of statistical quality control tools in a real time manufacturing system

Syllabus:

Engineering Metrology: Basic principles of engineering metrology – Metrology, need for inspection, accuracy and precision, objectives of metrology and measurements, role of metrology in quality assurance, errors in measurement, Standards of measurement: standards and their roles, line and end standards, transfer from line standard to end standard. Limits, Fits and Tolerance, Linear Measurement, Angular Measurement, Gauges and Comparators.

Measurement Practices: Optical metrology and laser interferometers, measurement of flatness, straightness and form errors, Metrology of surface finish: concepts, terminology, analysis of surface traces, method of measuring surface finish, coordinate measuring machine (CMM), vision application in metrology, Mechanical measurements: concepts, basic definitions, transducers, measurement of temperature, pressure, and force.

Statistical Methodologies: Graphical methods, Statistical control charts, Regression analysis, Analysis of variance, Sampling and acceptance.

Standards and Certifications: BIS, ISO, SAE, ASME, ASTM, IEEE

Case studies: Inspection and Validation practices adopted in various industries.

Textbook(s) and References:

1. T. G. Beckwith, R. D. Marangoni, and J. H. Lienhard, "Mechanical Measurements", 6thEdition, Pearson Higher Education, 2007.
2. R. K. Jain, "Engineering Metrology", Khanna Publishers, 20thEdition,2014.
3. D. J. Whitehouse, "Hand book of surface and nanometrology", 2nd Edition, CRC Press,2010.
4. G. T. Smith, "Industrial Metrology", Springer, 2002.
5. R. C. Gupta, "Statistical Quality Control", Khanna Publishers, 8thEdition, 2008.
6. Doebelin E O, Measurement Systems, Application and Design, 4th Edition, McGraw Hill Higher Education (1989).
7. Hume K J, Engineering Metrology, 3rd Edition, TBS The Book Service Ltd (1970).

Course Title	Course Code	Structure (I-P-C)		
Automation in Manufacturing		**3**	**0**	**3**

Pre-requisite, if any: Nil

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

CO1	Understand the concept of Product Life Cycle and Importance of Automation in Manufacturing.
CO2	Analyze and design the mechatronics-based system in the manufacturing environment.
CO3	Develop a manufacturing system with various sensors, actuators and controllers.
CO4	Apply the learnings of PLC and microprocessors in manufacturing automation.
CO5	Develop pneumatic and hydraulic circuits for manufacturing applications.
CO6	Understand the concepts of Robotics in Automation.

Introduction: Introduction to Automation in Manufacturing; Types of Automation; Automation in Production System; The Product Life Cycle: Importance of Automation in the Manufacturing Industry

Introduction to Mechatronics: Overview and Disciplines of Mechatronics, Mechatronics for Replacement of Mechanics; Mechatronics based Systems; Design of an Automated System: Building Blocks of Mechatronics based Automated System, Development of an equivalent mechatronics-based system: working principle and example; Elements of an Automated System and their selection; Flexible Manufacturing System; Elements of FMS; CNC Machine Tools: Tool magazines, Automatic Palletizing System, Adaptive Control in CNC Operation: Tool Wear Monitoring System, Automated Storage & Retrieval System (AS/RS); Industrial Conveyors.

Measurement System & its elements in Manufacturing: Terms related to sensors and actuators; Sensor and Transducer: Examples and the Concept of Smart Sensor; Construction and principle of operation of sensors required in a typical automated system for manufacturing.

PLCs and Microprocessors: Basic Structure-Input/Output Processing-Programming-Mnemonics Timers, Internal relays and counters-Data Handling-Analog input/output- Selection of PLC, Programming and interfacing of microprocessors in manufacturing applications.

Hydraulic Systems: Flow, pressure and direction control valves, actuators, supporting and control elements, pumps, servo valves and actuators, electro hydraulic servo-valves, proportional valves and their applications, design of hydraulic circuits for manufacturing applications and performance analysis.

Pneumatic Systems: Production, distribution and conditioning of compressed air, System components and graphic representations, Design of circuits-switching circuits and sequential circuits, Cascade methods, Step counter method, compound circuit design.

Robotics in Automation: Robot classification and anatomy, forward and inverse kinematics, DH matrix transformation, Jacobian and differential motion, Trajectory planning, Static and dynamic analysis, applications in manufacturing.

Text Book(s), References & Web Resources:

1. Morris A. Cohen and Uday M. Apte, “Manufacturing Automation”, McGraw Hill, 1997.
2. HMT Ltd. Mechatronics, Tata McGraw-Hill, New Delhi, 1988.
3. Groover, M. P., Automation, Production Systems, and Computer-Integrated Manufacturing, Prentice Hall, 2001.
4. Parr, A. A., Hydraulics and pneumatics, Elsevier, 1999.
5. M P. Groover, “Industrial Robotics: Technology, Programming and Applications”, McGraw- Hill, 2nd Edition, 2012.
6. Bolton, W., “Mechatronics: electronic control systems in mechanical and electrical engineering”, McGraw Hill, 2009.
7. Deb S. R., “Robotics technology and flexible automation”, 2nd Edition, Mc Graw Hill, 2009.
8. Boucher, T. O., “Computer automation in manufacturing - an Introduction”, Chapman and Hall, 1996.
9. Automation in Manufacturing by Prof. Shrikrishna N. Joshi, IIT Guwahati, NPTEL (https://onlinecourses.nptel.ac.in/noc21_me120/preview)

Course Title	Course Code	Structure (I-P-C)		
Thermal Engineering		**3**	**0**	**3**

Pre-requisite, if any: Thermodynamics

Course Objective: The objective this course is to provide an insight of fundamentals and salient features of major energy conversion systems using the concepts of Thermal Engineering.

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

CO1	Understand the concepts of a Steam power plant.
CO2	Comprehend the concepts of a Gas turbine plant.
CO3	Acquire the knowledge of the Internal Combustion engine components.
CO4	Appreciate the concepts of Refrigeration and their applications.
CO5	Analyze the psychrometric properties and processes used in Air Conditioning systems.

Syllabus:
Steam power cycles: Steam Power plant and its components, site selection, Carnot Vapour Power Cycle, Rankine cycle, Rankine Cycle with Reheat, Superheat, and Regeneration, Plant efficiency, Cogeneration.

Gas Turbines: Gas turbine plant and its components, Brayton cycle, Classification, Analysis of Closed and Open cycle Gas Turbine plants, Methods of improving performance, Intercooler, Regeneration and Reheating, Applications.

Internal Combustion Engines: Basic components and nomenclature, Classification, working principles of 2-stroke & 4-stroke SI and CI, Engines, Air-standard and Real cycles, Fuels, Stoichiometric Air-Fuel ratio, Combustion: Detonation and Knocking, Carburetion, Injection, Ignition and cooling systems, Parameters of performance, Exhaust emissions.

Refrigeration: Gas Refrigeration system, Vapour compression cycle, Effect of sub-cooling and superheating, Multistage systems, Cascade systems, Vapour Absorption cycle, Refrigerants

Air-conditioning: Psychrometric properties, Psychrometric chart, Psychrometric processes, Components of Air conditioning system, Classification of Air conditioning systems

Text Book(s) and References:

1. T. D. Eastop, A. McConkey, "Applied Thermodynamics for Engineering Technologists", 5th Edition, Pearson India,2002.
2. P. K. Nag, "Power Plant Engineering", 4thEdition, McGraw Hill, 2014.
3. Wilbert F. Stoecker and J.W. Jones, "Refrigeration and Air Conditioning", 2nd Edition, McGrawHill,2002.
4. John B. Heywood, "Internal Combustion Engine Fundamentals, McGraw Hill,2011.
5. V. Ganesan, "Internal Combustion Engines", 4th edition, McGraw Hill, 2012.
6. V. Ganesan, "Gas Turbines" – McGraw Hill, 3rd Edition, 2010.
7. H. I. H. Saravanamuthoo, H. Cohen, G. F. C. Rogers, "Gas Turbine Theory", 5th Edition, Pearson, 2001.

Course Title	Course Code	Structure (I-P-C)		
Operations Research		**3**	**0**	**3**

Pre-requisite, if any: Nil

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

CO1	Understand the concepts of operations research modeling approaches.
CO2	Formulate and solve linear programming problems in engineering and management
CO3	Formulate and solve transportation, assignment, and sequencing-related problems
CO4	Understand and solve CPM/PERT and network model problems
CO5	Solve queueing, forecasting, and inventory-related problems
CO6	Understand and analyze managerial problems in industry for effective utilization of resources (Men Machines, Materials, Methods, Money).

Syllabus:

Introduction: Historical Overview of Operations Research (OR) – Origin and Development, General Methodology and Basic OR Models, Applications of OR to Industrial Problems.

Introduction to Linear Programming: Formulation of Linear Programming Problems (LPPs), Product mix Problems, Deterministic Models, Graphical Solutions, Simplex Method, Artificial Variable Technique, Degeneracy in LPPs, Duality and Sensitivity Concept, Dual Linear Programming, Application of Elementary Sensitivity Analysis.

Transportation Model: Formulation, Finding an Initial Feasible Solution – North West Corner Method, Least Cost Method, Vogel's Approximation Method, Finding an Optimal Solution using MODI method, Special cases in Transportation problems – Unbalanced Transportation Problem, Degeneracy, and the Transportation Problem, Testing the Solution for Optimality, Prohibited Routes; Maximization and the Transportation Techniques.

Assignment Model: Assignment Table, Special Features of Assignment Problems, Methods for Solving Assignment Problems – Hungarian Method, Sequencing Models – Processing 'n' Jobs through Two Machines and Three Machines, Processing Two Job Through 'n' Machines.

Network Optimization: The Terminology of Networks, Network Optimization Models – Examples, The Shortest-Path Problem, The Minimum Spanning Tree Problem, The Maximum Flow Problem.

CPM/PERT: Origin, History, and Applications, Using a Network to Visually Display a Project, Scheduling a Project with CPM/PERT, Dealing with Uncertain Activity Durations, An Evaluation of PERT/CPM.

Queuing Theory: Queuing Systems and Concepts, Classification of Queuing Situations; Kendall's Notation, Solution of Queuing Problems, Single Channel, Single Stage, Finite and Infinite Queues with Poisson Arrival and Exponential Service Time, Applications to Industrial Problems.

Forecasting: Judgmental Forecasting, Time Series, Forecasting Errors

Inventory Model: Components, Deterministic, Continuous-Review, Models, Deterministic, Periodic-Review Model

Text Book(s), References & Web Resources:

1. F. S Hillier and G. J Liberman, Introduction to Operations Research, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2006.
2. H. A Taha, Operations Research: An Introduction, Prentice Hall of India, 2002.
3. S D Sharma, Operations Research, Kedarnath, Ramnath & Co., Meerut, 2010.
4. P K Gupta and D S Hira, Operations Research, S Chand & Co., New Delhi, 2008
5. R L Rardin, Optimization in Operations Research, Pearson Education, Prentice Hall, 1997.
6. https://www.edx.org/course/operations-research-an-active-approach

Course Title	Course Code	Structure (I-P-C)		
Quality Inspection and Product Validation Practice		**0**	**3**	**2**

Pre-requisite, if any: Nil

Course Objective: Students will learn to Calibrate and understand the sources of various measurement errors and familiarize with the use of metrological equipment.

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

CO1	Identify the suitable metrology instruments, gauges, and tools
CO2	Calibrate and understand the sources of various measurement errors
CO3	Apply various statistical control charts in process control.

Syllabus:

The following experiments will be performed in this Practice session:

1. Error mapping of measuring Instruments and measurement of Linear dimensions of aluminum rod using Vernier height gauge and Dial Vernier
2. Calibration of Inside micrometer and Digital micrometer by measuring Internal dimensions of Specimen (Washer)
3. Measuring and Comparing the Depth & Thickness of Gear tooth with Theoretical Values
4. Measuring and comparing the internal dimensions of specimens (Gear block, Pipe) by Telescopic gauge
5. Comparing Flatness measurement using Spirit level and Sine bar finding angles of the Specimen
6. Temperature Measurement during the machining operation using Infrared gun
7. Measuring the Angles of the specimen by using Bevel Protractor
8. Calibration of dial gauge & bore gauge and measurement of internal dimensions and bores.
9. Measurement of roundness and cylindricity of the specimen.

Text Book(s) and References:

1. T. G. Beckwith, R. D. Marangoni, and J. H. Lienhard, “Mechanical Measurements”, 6thEdition, Pearson Higher Education.
2. R. K. Jain, “Engineering Metrology”, Khanna Publishers, 20thReprint,2014.
3. R. C. Gupta, “Statistical Quality Control”, Khanna Publishers, 8thEdition,2008.

Course Title	Course Code	Structure (I-P-C)		
Automation in Manufacturing Practice		**0**	**3**	**2**

Pre-requisite, if any: Nil
Course Objective: To acquire hands-on experience in integrating various mechatronic and automation devices such as hydraulic, pneumatic, robotic systems, PLCs and computers in manufacturing systems.

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

CO1	Integrate various electro-mechanical devices in manufacturing.
CO2	Develop pneumatic and hydraulic circuits for manufacturing applications.
CO3	Automate a manufacturing system with various sensors, actuators, robot mechanisms, PLCs and othe controllers

Syllabus:
The following experiments are conducted:
1. Integration of various sensors, actuators and other mechatronic devices in manufacturing applications.
2. Identification of faulty components, orientation errors, assembly errors etc.
3. Computer based design and simulation of automated manufacturing systems.
4. Design, development and implementation of pneumatic and hydraulic circuits for the given manufacturing problem.
5. Programming and integration of robot mechanisms in manufacturing automation.
6. Programming and integration of PLCs and control of equipment in manufacturing.
7. Design and development of microprocessor and computer-based control schemes in manufacturing automation

Text Book(s) and References:
1. Anthony Esposito, "Fluid power with applications", 7th Edition, PrenticeHall, 2008.
2. M P. Groover, "Industrial Robotics: Technology, Programming and Applications", McGraw- Hill, 2ndEdition, 2012.
3. K. S. Fu, "Robotics: control, sensing, vision and intelligence",Mcgraw-Hill,1987.
4. Bolton, W., "Mechatronics: electronic control systems in mechanical and electrical engineering", McGraw Hill,2009.

Course Title	Course Code	Structure (I-P-C)		
Thermal Engineering Practice		**0**	**3**	**2**

Pre-requisite, if any: Heat Transfer

Course Objective: The objective of this course is to imbibe practical knowledge of various modern thermal systems

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

CO1	Estimate the heat transfer coefficients of various heat exchangers.
CO2	Estimate LMTD and effectiveness for parallel and counter flow heat exchanger
CO3	Study the performances of Solar PV Trainer kit and Wind energy trainer kit.
CO4	Familiarize the students with Refrigeration and Air-Conditioner test rigs.
CO5	Familiarize the students with IC engines.

Syllabus:

The following experiments are conducted to:

1. Find out the COP of a Refrigeration Test rig at various loading conditions.
2. Estimate the COP of Air Conditioner Test rig at various loading conditions.
3. Determine the overall heat transfer coefficient and dirt coefficient of the given shell and tube heat exchanger.
4. Determine the overall heat transfer coefficient and film coefficient for jacketed vessel with coil heat exchanger.
5. Determine LMTD, effectiveness and overall heat transfer coefficient for parallel and counter flow heat exchanger for concentric tube flow.
6. Understand relationship of heat transfer and flow regime in a plate heat exchanger geometry.
7. Study the performance of Petrol Engine
8. Study the performance of Solar PV Trainer kit.
9. Study the performance of Wind energy trainer kit.

Text Book(s) and References:

1. J. P. Holman and Souvik Bhattacharyya, “Heat Transfer”, 10th edition, McGraw Hill, 2011.
2. V. Ganesan, “Internal Combustion Engines”, 4th edition, McGraw Hill, 2012.
3. Wilbert F. Stoecker and J.W. Jones, “Refrigeration and Air Conditioning”, 2ndEdition, McGraw Hill, 2002.
4. P. K. Nag, “Power Plant Engineering”, 4th Edition, McGraw Hill, 2014.

Course Title	Course Code	Structure (I-P-C)		
Computational Methods in Engineering		3	0	3

Pre-requisite, if any: Engineering Mechanics, Fluid Mechanics, Heat Transfer, Mechanics of Materials

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

CO1	Understand the importance of obtaining approximate solutions to various practical problems
CO2	Model machine elements and structures, and analyze the stresses and strains
CO3	Analyze the heat transfer problems

Syllabus:
Fluid flow & Heat Transfer: Difference representation of PDEs including errors, consistency and stability.

Application of Numerical Methods: To Heat equation, Laplace's equation and Burgers'equation. Application of Finite Volume Formulation to One-dimensional Steady diffusion.

Boundary value problems - Classical solution methods: Weighted residual techniques and Rayleigh-Ritz method.

Finite Element Method: Discretization, shape functions, boundary conditions, element stiffness matrix, assembly technique for global matrices - Numerical integration - Application to trusses, beams and heat transfer problems. Tutorials.

Text Book(s) and References:
1. Richard H. Pletcher, John C. Tannehill, Dale Anderson, "Computational Fluid Mechanics and Heat Transfer", Third Edition (Series in Computational and Physical Processes in Mechanics and Thermal Sciences), CRC Press, 2012.
2. T R Chandrupatla and A D Belegundu, 'Introduction to Finite Elements in Engineering',3rd Edition, PHI Learning, 2009
3. J N Reddy, 'An Introduction to the Finite Element Method', McGraw-Hill Education, 3rdEdition, 2005
4. Patankar, S.V., Numerical Heat Transfer and Fluid Flow, McGraw-Hill, 1980.
5. Muralidhar, K., Sundarajan T., "Computational Fluid Flow and Heat Transfer", NarosaPublishing House, New Delhi, 1995.
6. Versteeg Henk Kaarle, MalalasekeraWeeratunge, "An introduction to computational fluid dynamics: The finite volume method", Pearson Education, 2007.
7. Seshu P., "Finite Element Analysis", Prentice Hall India, 2003.
8. JacobFish and Ted Belytschko, "A first Course in Finite Elements", John Wily & Sons,2007

Course Title	Course Code	Structure (I-P-C)		
Machine Tool Technology		**3**	**0**	**3**

Pre-requisite, if any: Basic Concepts in Manufacturing Process

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

CO1	Tabulate different types tool-based machine tools used in manufacturing industry
CO2	Identify different parts of the machine tools
CO3	Explain various machine tool mechanisms
CO4	Propose an ideal machining process for fabricating a product for specific application with du consideration for the process capabilities and product quality requirements.
CO5	Recommend appropriate finishing process to achieve final product requirement
CO6	Design Jigs and Fixtures for work and tool holding in machining a given product.

Syllabus:

Engine Lathe: Principle of working and specification of lathe–Types of lathes–Work holders and tool holders–Lathe accessories–Operations on Lathe–Taper turning–Thread turning and lathe attachments.

Turret and Capstan Lathes: Principle of working–Collet chucks–Other work and tool holding devices–Box and tool layout.

Shaping, Slotting and Planing Machines: Principles of working–Principal parts–Specification, classification, operations performed, machining time calculations.

Drilling and Boring Machines: Principles of working, specifications, types, operations performed–tool holding devices–twist drill–Boring machines–Fine boring machines–Jig Boring machine. Deep hole drilling machine.

Milling Machines: Principle of working–Specifications–Classifications of milling machines–Principal features of horizontal, vertical and universal milling machines–Machining Operations-Types–Geometry of milling cutters–Milling cutters–Methods of indexing–Accessories to milling machines.

Grinding Machines–Fundamentals–Theory of grinding–Classification of grinding machine–Cylindrical and surface grinding machine–Tool and cutter grinding machine–special types of grinding machines.

Lapping, Honing and Broaching Machines: Comparison to grinding–lapping and honing. Constructional features of speed and feed units, machining time calculations.

Jigs and 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.

Textbooks and References:

1. G. C. Sen and A. Bhattacharya, "Principles of Machine Tools," New Central Book Agency.
2. G. Boothroyd, and W. A. Knight, "Fundamentals of machining and machine tools," 3rd Edition, Taylor & Francis.

3. D. K. Pal and S. K. Basu, "Design of Machine Tool," 4th Edition, Oxford & IBH Publishing Pvt. Ltd.
4. G. E. Dieter, "Engineering Design: A Materials and processing approach," McGraw Hill, 1991.

Course Title	Course Code	Structure (I-P-C)		
Computational Methods in Engineering Practice		**0**	**3**	**2**

Pre-requisite, if any: Heat Transfer, Mechanics of Materials

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

CO1	Draw 1D, 2D and 3D Finite Element Models of mechanical systems.
CO2	Understand the solution techniques available in computer-aided engineering tools.
CO3	Evaluate the design of mechanical systems by conducting stress analysis, thermal analysis or flui flow analysis.

Syllabus:

Creation of Finite Element Models and Evaluation of Displacements, Stresses and Reaction Forces of axially and transversely loaded members, thin plates or discs, long pipes or dams, and brackets using Static Structural Analysis.

Evaluation of natural frequencies and mode shapes of axially and transversely loaded members using Dynamic Structural Analysis.

Construction of Finite Element Models and study of temperature distribution in fins or composite plane walls and chimneys or other plane sections using Thermal Analysis.

Building of Finite Element Models and study of velocity distribution of fluid in channels or pipes over bluff bodies using steady state fluid flow analysis.

Text Book(s) and References:

1. Saeed Moaveni, "Finite Element Analysis: Theory and Application with ANSYS", Pearson, 2011.
2. Tirupathi R. Chandrupatla and Ashok D. Belegundu, "Introduction to Finite Elements in Engineering", Prentice Hall of India,2001.
3. Erdogan Madenci and Ibrahim Guven, "The Finite Element Method and Applications in Engineering Using ANSYS", Springer,2015.

Course Title	Course Code	Structure (I-P-C)		
Machine Tool Technology Practice		**0**	**3**	**2**

Pre-requisite, if any: Machine Tool Technology

Course Objective: The objective of this course is to develop competency in understanding machine tools and their working principles.

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

CO1	Select suitable machining operations for manufacturing a given component by applying knowledge c machine tools.
CO2	Make use of measuring devices like vernier, micrometer, surface roughness tester, CMM, etc.
CO3	Plan sequence of various operations so as to complete the task with minimum time
CO4	Create simple components using Lathe, CNC Lathe, Milling machine, Shaper, Grinding machine.

Syllabus:

List of suggested experiments:

1. Machining operations on conventional lathe like (a) straight turning, (b) taper turning (c) thread cutting (d) Knurling, (e) boring, etc.
2. Machining operation on CNC lathe like (a) straight turning, (b) taper turning (c) step turning
3. Machining operation on shaping machine (a) flat surface (b) inclined surface (c) slots, etc.
4. Machining operation on milling machine (a) flat surface (b) slot, (c) gear cutting
5. Grinding operation using surface grinding

References:

1. HMT, Production Technology. Tata McGraw Hill, 2004
2. ASTME, Tool Engineer's Handbook
3. E. P. DeGarmo, J. T. Black, and R. A. Kohser, "DeGarmo's materials and processes in manufacturing", John Wiley & Sons,2011.
4. M. P. Groover, "Principles of Modern Manufacturing", 5th Edition, Wiley, 2014
5. S. Kalpakjain, and S. R. Schmid, "Manufacturing processes for engineering materials", 5th Edition, Pearson Education, 2010.
6. W. A. J. Chapman, Workshop Technology, Vol. 2 & 3. CBS Publishers & Distributors, 1980
7. N. K. Mehta, Machine Tool Design and Numerical Control, 2nd ed. Tata McGraw Hill, 1996

Course Title	Course Code	Structure (I-P-C)		
Product Design Practice		**0**	**3**	**2**

Pre-requisite, if any: Design Realization Practice, Product Realization Practice

Course Objective: Students will develop cross-discipline products and prototype them using product realization tools in a multi-disciplinary team setting.

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

CO1	Develop a cross-disciplinary idea
CO2	Conceive, design and prototype an innovative idea
CO3	Work in cross-functional groups and to apply the concepts learnt in theory to a practical problem
CO4	Manage group projects, maintain timeliness and follow a method-oriented approach to problem solving

- This course is an interdisciplinary team-based product design and prototyping course.
- The concept of the course is to provide hands-on learning experience in interdisciplinary fields of engineering and exposure to the context of a "real" product design problems. In this course, students will design a product by following the systematic product design process.
- A team consist of students from different discipline will choose their own innovative product and while designing, students will consider many issues like market opportunities, formal requirements and constraints, the environment in which the product will be used, product look and feel; technical legitimacy, and manufacturing considerations for the products.
- During the course, students will learn and put in to practice team working, project management and product realization practices commonly found in product developers in industry. Throughout the semester, the student teams have several opportunities to present their progress to their fellow students and faculty.

Text Book(s) and References:

1. Carl Liu, "Innovative Product Design Practice", Kindle Edition, ASIN: B00B29V9RQ
2. Bjarki Hallgrimsson, "Prototyping and Model making for Product Design", Laurance King Publishing Limited, 2012.