Production Engineering				
Second Year (Third Semester)				
Sl.No	**Course Code**	**Subject (Theory)**	**Contact Hrs. L-T-P**	**Credit**
1	MA1201	Mathematics–III	3-0-0	3
2	PE1201	Professional Core-1: Thermal and Fluids Engineering	3-0-0	3
3	PE1202	Professional Core-2: Materials Engineering & Metallurgy	3-0-0	3
4	PE1203	Professional Core-3: Mechanics of Materials	3-0-0	3
5	CS1204	Advanced Competency Course-1: Programming in Python (PC-4)	3-0-0	2
6	HS1202	Organizational Behaviour	3-0-0	2
Subject (Sessional)				
7	PE1281	Thermal and Fluid Engineering Lab	0-0-3	1.5
8	PE1282	Material Testing Lab	0-0-3	1.5
9	PE1283	Computer Aided Machine Drawing	0-0-3	1.5
10	CS1284	Programming in Python Lab	0-0-3	1.5
		Total	**18-0-12**	**22**
Second Year (Fourth Semester)				
Sl.No	**Course Code**	**Subject (Theory)**	**Contact Hrs. L-T-P**	**Credit**
1	PE1204	Professional Core-5: Theory of Metal Cutting	3-0-0	3
2	PE1205	Professional Core-6: Theory of Machine	3-0-0	3
3	PE1206	Professional Core-7: Inspection & Metrology	3-0-0	3
4	PE1207	Professional Core-8: Manufacturing Technology-I	3-0-0	3
5	CS1209	Advanced Competency Course-2: Artificial Intelligence and Machine Learning (PC-9)	3-0-0	2
6	HS1201	Engineering Economics	3-0-0	2
Subject (Sessional)				
7	PE1284	Metal Cutting Lab	0-0-3	1.5
8	PE1285	Machine Dynamics Lab	0-0-3	1.5
9	PE1286	Metrology Lab	0-0-3	1.5
10	PE1287	Production Practice Lab-I (casing, welding etc.)	0-0-3	1.5
	Summer Internship and Research Experience (SIRE- I) *			
		Total	**18-0-12**	**22**

PRODUCTION ENGINEERING			
Subject Code	**MA1201**	**Total Contact Hour**	**30**
Semester	**3rd**	**Total Credit**	**3**
Subject Name	**Mathematics–III**		
SYLLABUS			
Module-I	Random variables (Discrete and Continuous. Cumulative Distribution Function (CDF). Variance and standard deviation. Moments. Functions of a random variable. Distributions: Binomial, Poisson, normal, Gaussian, uniform (definitions and examples only). Moment generating function.		**6 Hrs**
Module-II	Pairs of random variables. Joint probability density function. Joint probability mass function. Marginal distribution. Functions of two random variables, PDF and expected values of the sum of two random variables		**6 Hrs**
Module-III	Probability Models of n Random Variables. Vector notation. Independence of random variables and random vectors. Functions of random vectors. Expected value vector and correlation matrix.		**6 Hrs**
Module-IV	Stochastic Processes. Definitions and examples. Types of stochastic processes. Random variables from random processes. The Poisson process.		**6 Hrs**
Module-V	Markov Chains. Discrete-time Markov chain. Discrete-Time Markov chain dynamics. Limiting state probabilities for a finite Markov chain. State classification.		**6 Hrs**
Essential Reading	1. Roy D. Yates, Rutgers and David J. Goodman, Stochastic Processes, 2d Edition, John Wiley and Sons, INC. 2. Gregory F Lawler, Introduction to Stochastic Processe, Chapman & Hall/ CRC Press (Taylor Francis Group).		
Course Outcomes	The objective of this course is to familiarize the prospective engineers with techniques in Probability and Statistics. It aims to equip the students to deal with advanced level of Statistics that would be essential for Engineering disciplines. CO1. To apply different distributions in real life problems of industries CO2. To deal with problems that contains multivariable probability distribution. CO3.To enrich knowledge Probability Models of multi-Random Variables CO4. To learn use of stochastic processes in daily life		

Subject Code	**PE1201**	**Total Contact Hour**	**30**
Semester	**3rd**	**Total Credit**	**3**
Subject Name	**Thermal & Fluids Engineering**		
Course Objective	**To obtain knowledge on the basic concepts of thermal and fluids engineering**		
SYLLABUS			
Module-I	Basic Concepts: Thermodynamic systems and surrounding, state properties, processes and cycles. Thermodynamic equilibrium, heat and work transfer across boundaries, Quasi-static processes. Zeroth &First Law of Thermodynamics: First law for a closed system undergoing a cycle and undergoing a change of state. Internal energy as a system properties. Application of first law to different thermodynamic processes.		**7 Hrs**
Module-II	Second Law of Thermodynamics: Reversible and irreversible processes. Refrigerator and heat pump. Equivalence of Kelvin-Plank and Clausis statements, Carnot theorem and its efficiency. Inequality of Clasius and entropy concept. Change of entropy for various thermodynamic processes. Air Standard Cycle: Otto, diesel and dual cycles, Heat transfer – basic of conduction, convection and radiation.Heat transfer concepts & applications.		**6 Hrs**
Module-III	Introduction: Physical properties of fluids, Density, Specific weight, Specific volume, Specific gravity, Compressibility, Elasticity, Surface tension, Capillarity, Vapour pressure, Viscosity, Ideal and real fluids, Concept of shear stress, Newtonian and Non Newtonian Fluids.		**6 Hrs**
Module-IV	Fluid Statics: Pressure-Density-Height relationship, Manometers, Pressure on plane and curved surface, Centre of pressure, Buoyancy, Stability of immersed and floating bodies, Fluid masses subjected to uniform acceleration, Free and Forced vortex.		**5 Hrs**
Module-V	Fluid Dynamics: Basic Equations- equation of continuity, One-dimensional Euler's equations of motion and its integration to obtain Bernoulli's equation and Momentum equation. Dimensional Analysis and Principles of Model Testing: Dimensional homogeneity, Dimensional analysis, Rayleigh's method and Buckingham Theorem. Similarity laws and model studies. Distorted models.		**6 Hrs**
Essential Reading	1. Engineering Thermodynamics by P. K. Nag, TMH 2. Fluid Mechanics & Hydraulics Machines –By: Modi and Seth, Standard Book House, New Delhi		
Supplementary Reading	1. Thermodynamics, An Engineering Approach by Cengel and Boles. Publisher: McGrawHill 2. Introduction to Fluid Mechanics by Fox & McDonald, Willey Publisher.		
Course Outcomes	At the end of the course, the student will able to: CO1. Demonstrate the basic concepts, zeroth and first law of thermodynamics. CO2.Demonstrate the second law of thermodynamics, air standard cycles and basic heat transfer. CO3. Identify importance of various fluid properties at rest and in motion and express the principles of continuity, momentum, and energy as applied to fluid motions. CO4. Demonstrate fluid statics principles on various surfaces. CO5.Apply dimensional analysis and model testing to predict physical parameters that influence the flow in fluid mechanics.		

Subject Code	PE1202	**Total Contact Hour**	**30**
Semester	**3rd**	**Total Credit**	**3**
Subject Name	**Materials Engineering & Metallurgy**		
Course Objective	**To obtain domain knowledge on material characteristics**		
Module-I	Introduction to materials- Metal and alloys, ceramics, polymers and semiconducting materials—introduction and application as engineering materials. Defects in solids- Point, line and surface defects. Diffusion in solids. Deformation of metals- Elastic and plastic deformation, slip, twin, dislocation theory, critical resolved shear stress, Bauschinger's effect, work hardening, recovery, recrystallization and grain growth.		**10 Hrs**

Module-II	Equilibrium Diagrams: Experimental methods for construction of equilibrium diagrams, Isomorphous alloy system, Types of Nucleation, determination of the size of critical nucleus, equilibrium cooling and heating of alloys, lever rule, coring, miscibility gaps – eutectic reactions.	**08 Hrs**
Module-III	Transformation in solid state, allotropy, order-disorder transformation, eutectoid, peritectoid reaction and complex phase diagrams, relation between equilibrium diagrams and physical properties of alloys. Study of important binary phase diagrams Fe-Fe3C. Phase transformations in steels pearlitic, martensitic and bainitic transformations cooling curves. Isothermal transformation diagrams, transformations on continuous cooling.	**12 Hrs**
Module-IV	Heat treatment- Iron-carbon system. Annealing, normalizing, hardening, critical cooling rate, hardenability, age hardening, surface hardening, tempering.	**05 Hrs**
Module-V	High temperature materials, materials for cryogenic application, thermally insulating materials, smart materials, Steels: High Speed Steel, Stainless Steel and Tool Steels.	**05 HrS**
Essential Reading	1. Introduction to Physical Metallurgy – S.H. Avner, TMH. 2. Material Science and Engineering- V.Raghavan, PHI.	
Supplementary Reading	1. Material Science and Engineering: An Introduction- W.D.Callister, Wiley. 2. Physical Metallurgy - V. Raghavan, PHI.	
Course Outcomes	At the end of this course, students will able to CO1. Relate the processing-structure-property-performance of various materials. CO2. Interpret different equilibrium diagrams with various transformation phases. CO3. Make use of iron- carbon equilibrium diagram. CO4. Analyze heat treatments techniques and their effects in the engineering materials. CO5. Decide materials for various applications and beyond room temperature application.	

Subject Code	**PE1203**	**Total Contact Hour**	**30**
Semester	**3rd**	**Total Credit**	**3**
Subject Name	**Mechanics of Materials**		
Pre-requisites	**Engineering Mechanics**		
Course Objective	To provide basic knowledge in mechanics of materials to enable the students to solve real engineering problems and design engineering systemswith some specific materials under different kinds of loadings.		
SYLLABUS			**Contact Hours**
Module-I	Simple Stress and Strain: Stress, strain, elastic constants, and their relationship;temperature stresses, statically indeterminate problems Compound Stress and Strain: Material subjected to biaxial state of stress, Principal Planes, Principal stress, Graphical solution (Mohr's stress circle), Strain measurement and analysis, Principal stresses from principal strains		**10 Hrs**
Module-II	Shear force and bending moment: Statically determinate beams, Relationship between bending moment and shear force, shear force and bending moment diagrams for statically determinate beams.		**05 Hrs**
Module-III	Simple bending of beams: Theory of simple bending of initially straight beams, Bending of Composite or Flitched Beams,Shearing stress distribution in typical cross-sections of beams, Torsion: Torsion of solid and hollow circular shafts, combined bending, and torsion.		**06 Hrs**
Module-IV	Deflection of Beams: Slope and deflection of beams by double integration method and Macaulay's method. Thin cylinders: Cylindrical Vessel with Hemispherical Ends, Longitudinal or axial stress, Circumferential or hoop stress.		**05 Hrs**
Module-V	Buckling of columns: Euler's theory for initially straight columns with various end conditions. Theories of failure: Maximum Principal Stress Theory, Maximum Shear Stress Theory, Maximum Principal Strain Theory, Maximum Strain Energy Theory and Maximum Distortion Energy Theory		**04 Hrs**
Essential Reading	1. Strength of Materials- G.H.Ryder, Macmillan India 2. Strength of Materials- S.S. Rattan, TMH Publications.		
Supplementary Reading	1. Mechanics of Materials- R.C. Hibbeler, Pearson. 2. Mechanics of Materials-I- E.J. Hern; Paragaman. 3. Strength of Materials by R. Subramanian, Oxford Univ. Press		
Course Outcomes	At the end of this course, students will demonstrate the ability to:- CO1. Understand and apply the concept of stress and strain to solve engineering problems analytically and graphically. CO2. Construct shear force and bending moment diagrams for statically determinate beams. CO3. Analyze problems of simple bending in initially straight beams/composite beams and determine the strength of circular solid and hollow shafts under combined bending, and torsion. CO4. Calculate the slope and deflection of beams by double integration and Macaulay's method and interpret stresses in cylindrical vessel with hemispherical ends. CO5.Determine the buckling load in columns with various end conditions and apply the concept of theories of elastic failure for structural design under combined conditions of applied stress.		

Subject Code	**CS1204**	**Total Contact Hour**	**30**
Semester	**3rd**	**Total Credit**	**2**
Subject Name	**Programming in Python**		
Course Objective	1: Introduction to Python Language and its features. 2: To understand the concept of Python Program using sequence data and Control statements. 3: To be able to understand and create User Defined Function. 4: To understand the concept of OOPs and its implementation. 5: To understand the concept of strings and file handling		
SYLLABUS			

Module-I	**Beginning Python Basics:** Introduction to Python Features of Python, Application of Python Data Types, Keywords, Identifiers, Literals, Constants. Python Indentation. Operators and expressions. Naming Conventions with examples, Managing Input and Output, Concept of Indentation. Conditional statement, Looping statements, break and continue, pass & return statements, Nesting of loops.	**6 Hrs**
Module-II	**Modules:** Built-in Modules, Import statement, Packages, Date and Time Modules. Array and its operations, Handling Strings and Characters, List: slicing, bound, cloning, nested list, list and methods, Adding Element: append, extend, count, index and insert). Mutability: Sort, reverse, remove, clear and pop. Map, Filter.	**8 Hrs**
Module-III	Tuple and methods, Sets and methods, Dictionary: Basic operation, iterator and methods. **Function:** Introduction to Functions, passing arguments, Anonymous functions (Lambda Function), Recursive Functions.	**6 Hrs**
Module-IV	**Object Oriented Programming:** Classes and Objects, Class methods. Encapsulation, Data Abstraction, Constructor, Destructor and Inheritance. **Exception Handling:** Handling Exceptions: try-except, try-finally	**6 Hrs**
Module-V	**Strings and Regular Expressions :** Methods of String Objects, Escape Sequence, Iterating Strings, String Module, String Formatting, Regular Expressions: Re-Module. **File Handling:** Introduction to File Handling, File Operations, Directories.	**4 Hrs**
Essential Reading	1. Python Programming for Beginners by Adam Stewart 2. Python Cookbook by David Beazley and Brian K. Jones	
Supplementary Reading	1. Introduction to Python Programming By Gowrishankar S. Veena A 2.Python Programming: Using Problem Solving Approach, Oxford University Press by Reema Thareja 3.Python Programming University Press by Ch Satyanarayan, M Radhika, B N Jagadesh	
Course Outcomes	CO1: Understand the Python Language and its features. CO2: Apply sequence data and control statements to solve problem CO3: Able to create user defined functions to solve problems. CO4: Analyze the concept of OOPs and its implementation. CO5: Create the python program using strings and files.	

Subject Code	**HS1202**	**Total Contact Hour**	**30**
Semester	**3rd**	**Total Credit**	**2**
Subject Name	**Organizational Behaviour**		
Course Objective	1: To understand the relevance of organizational behavior concepts and theories in real-life organizational settings & to develop skills in critical thinking, decision –making, problem-solving in applying organizational behavior concepts to practical situations. 2: To provide an understanding of individual behavior in the workplace, including personality, motivation, perception, learning, and attitudes. 3: To understand the impact of team composition, diversity, and communication on team performance & to understand the role of motivation and leadership in managing organization. 4: To explore how organisational culture affects behavior, communication and decision making by enhancing creativity and innovation and give an episteme how to cope with change and stress. 5: To Develop intercultural competence, including awareness, knowledge, and skills for effective communication, negotiation, and collaboration across culture		
SYLLABUS			
Module-I	**Fundamentals of OB & Understanding the Basic Framework of OB:** Evolution of OB through Quality Management movement, Definitions, Scope & Importance of OB,Challenges (Diversity, Globalisation& Ethical Perspective) and opportunities for OB, models of OB, applying OB to solving problems.		**6 Hrs**
Module-II	**Understanding the Determinants of Individual Behavior:** **Personality:** Determinants of personality, Theories of Personality (Type &Psychoanalytic theory), MBTI, Big five personality traits and other major traits influence workplace behavior. **Perception:** Meaning, Perceptual Process, Application of Perception at Workplace. **Motivation:** Motivation Framework, Content theory (Maslow's need hierarchy & Hertzberg's two factors theory), Process theory (Adam's Equity & Vroom's Expectancy theory), Job Design And motivation, Importance of motivation at Workplace. **Learning:** Theories of learning (Classical Conditioning, Operant Conditioning,& Cognitive Theory), Principles of Learning. Bhavioral modification through learning.		**6 Hrs**
Module-III	**Understanding Group and Team Behavior at Workplace:** **Group & Team:** Defining and classifying groups, the five-stage model of group development Group properties: Roles, norms, status, size and cohesiveness, Group decision making. **Leadership:** Meaning, Definition & types of leadership, Traditional theories of leadership: Trait theories, Behavioral theories, Contingency theories, Contemporary approaches to leadership, importance of leader in organisations.		**6 Hrs**
Module-IV	**Understanding Group and Team Behavior at Workplace:** **Organisational Culture:** Meaning, Definition, Cultural dimensions,effect of Organisational culture **Organisational Change & Development:** Nature, Levels & types of Change, Change Agents: Resistance to Change, Force field theory of Change, Managing the Change.		**6 Hrs**
Module-V	**Conflict & International Organisational Behavior:** **Managing Conflict and Negotiations:** Meaning,views, & levels of Conflict, Process of conflict, Conflict resolution techniques. **Transactional Analysis:** Meaning, Importance of TA, Life position, Ego states And their encounters. **IOB:** Internationalisation of Business, Cultural differences and similarities, Understanding Interpersonal behavior across culture through Hofstede's Cultural Dimensions		**6 Hrs**
Essential Reading	1. "Organizational Behavior: Text, Cases, & Games" by K. Aswathappa .Publisher: Himalaya Publishing House 2. "Essentials of Organizational Behavior" by Stephen P. Robbins and Timothy A. Judge. Publisher: Pearson Education.		
Supplementary Reading	1. "Organizational Behavior: Improving Performance and Commitment in the Workplace" by Jason A. Colquitt, Jeffery A. LePine, and Michael J. Wesson. Publisher: McGraw-Hill Education. 2. "Organizational Behavior: Human Behavior at Work" by John W. Newstrom and Keith Davis. Publisher: McGraw-Hill Education. 3. "Organizational Behavior: An Evidence-Based Approach" by Fred Luthans. Publisher: McGraw-Hill Education. 4. "Organizational Behavior: Emerging Knowledge, Global Reality" by Steven L. McShane and Mary Ann Von Glinow. Publisher: McGraw-Hill Education. 5. "Organizational Behavior and Management" by Ivancevich, Konopaske, and Matteson. Publisher: McGraw-Hill Education. 6. "Organizational Behavior: Theory, Research, and Practice" by John R. Schermerhorn Jr., James G. Hunt, and Richard N. Osborn. Publisher: Wiley		

Course Outcomes	CO1. Explain the importance of organizational behavior in improving individual and organizational effectiveness with Ethical practices. CO2. Evaluate the effectiveness of different leadership styles and their application in different situations. CO3.Develop critical thinking, Creativity& Innovation, problem-solving, and communication skills necessary for success in organisational settings. CO4. Develop strategies for managing organisational change effectively and maintainingsustainability. CO5. Apply organistional behavior concepts and theories to practical organisational situations.		
	SESSIONAL		
Subject Code	**PE1281**	**Total Contact Hour**	**16**
Semester	**3rd**	**Total Credit**	**1.5**
Subject Name	**Thermal &Fluid Engineering Laboratory**		
	List of Experiments		
1	Study of IC engines (cut model)		
2	To draw the valve timing diagram of IC Engines.		
3	Performance characteristics of multi-cylinder engine (Morse Test)		
4	Study of power Transmission system.		
5	Determination of metacentric height of a floating object.		
6	Determination of flow rate using orifice meter/ Rota meter.		
7	Determination of flow rate using orifice meter/ Rota meter.		
8	Study of a hydraulic test rig.		
Course Outcomes	At the end of this course, students will demonstrate the ability to CO1. Show wears characteristics of various materials. CO2. Interpret different principles and operations of IC engine. CO3. Make use of power transmission system. CO4. Analyze the methods to enhance the properties of the material from heat treatment process. CO5. Test the structure-property relationships of various materials.		
	SESSIONAL		
Subject Code	**PE1282**	**Total Contact Hour**	**16**
Semester	**3rd**	**Total Credit**	**1.5**
Subject Name	**Material Testing Laboratory**		
	List of Experiments		
1	Determination of the tensile properties of a given sample.		
2	Determination of the compressive strength of a given specimen.		
3	To perform three point bend test on a given sample.		
4	To perform three point bend test on a given sample.		
5	Effect of work hardening on tensile properties of metal.		
6	Determination of hardness of the given specimen.		
7	Fatigue test of a given specimen.		
8	Impact test on the given sample.		
Course Outcomes	At the end of this course, students will demonstrate the ability to CO1 Evaluate the tensile properties of mild steel specimen. CO2 Evaluate the flexural strength and modulus of a given material. CO3 Evaluate the hardness and compressive strength of a given material. CO4 Evaluate the fatigue strength of a given material CO5 Evaluate the impact strength of a given material.		
	SESSIONAL		
Subject Code	**PE1283**	**Total Contact Hour**	**12**
Semester	**3rd**	**Total Credit**	**1.5**
Subject Name	**Computer Aided Machine Drawing**		
	List of Experiments		
1	Introduction to CAD		
2	Interactive graphics for Generation of polyhedron, cylinder, sphere, cone etc.		
3	3D viewing and transformation, hidden surface removal.		
4	Generation of curves and surfaces; Geometric modelling		
5	Preparation of product assembly details.		
6	Aggregation for assembly.		
Course Outcomes	At the end of this course, students will demonstrate the ability to CO1 Describe the fundamentals of Computer Aided Design. CO2 Use interactive graphic for generation of basic features. CO3 Generate geometric modelling, curves and surfaces using the CAD software. CO4 Create Assemblies for different product. CO5 Apply Computer Aided Design to solve engineering problems.		
	SESSIONAL		
Subject Code	**CS1284**	**Total Contact Hour**	**20**
Semester	**3rd**	**Total Credit**	**1.5**
Subject Name	**Programming in Python Laboratory**		
Course Objectives	1: Introduction to Python Language and its features. 2: To understand the concept of Python Program using sequence data and Control statements. 3: To be able to understand and create User Defined Function. 4: To understand the concept of OOPs and its implementation. 5: To understand the concept of strings and file handling		
	List of Experiments		
1	Program on basics of python Programming Language.		
2	Program on basic Data Structures in Python.		
3	Program on Conversion from on data type to another.		

4	Program on Functions in Python.
5	Program using Object Oriented Programming in Python.
6	Program using Inheritance in Python.
7	Program using String in Python.
8	Program using Regular expression in Python.
9	Program using File Handling in Python.
10	Program using basics of Pandas and Matplotlib module in Python.
Course Outcomes	CO1: Understand the Python Language and its features. CO2: Apply sequence data and control statements to solve problem CO3: Able to create user defined functions to solve problems. CO4: Analyze the concept of OOPs and its implementation. CO5: Create the python program using strings and files.

4TH SEMESTER

Subject Code	**PE1204**	**Total Contact Hour**	**30**
Semester	4th	**Total Credit**	**3**
Subject Name	**Theory of Metal Cutting**		
Pre-requisites	**Materials Engineering & Metallurgy**		
Course Objective	To obtain domain knowledge on basic shapes of machine tools, mechanism of chip formation, force analysis in turning, thermodynamics of chip formation and tool wear criteria.		

SYLLABUS		
Module-I	Basic shapes of machine tools, Geometry of cutting tools: Classification of cutting tools, Wedge action, Function of different angles of cutting tools, tool point reference systems, tool nomenclatures in ASA, ORS systems, tool signature, Geometry of twist drill & slab milling cutter. Tool materials and their applications: Characteristics of tool materials, developments cutting tool materials, types of tool materials – carbon tool steels, high speed steels, cast alloys, cemented carbides, ceramics, diamonds, CBN, recommended cutting speeds for the above tools.	**7 Hrs**
Module-II	Orthogonal and oblique cutting, Mechanism of chip formation: Mode of failure under stress- fracture & yielding mechanism. Types of chips, Factors involved in chip formation, shear plane, determination of shear plane angle, Kronenberg's shear angle relation, effect of cutting variable on chip reduction coefficient, Chip formation in drilling and milling.	**5 Hrs**
Module-III	Mechanics of metal cutting: Forces on the chips, forces in orthogonal cutting, Merchant circle diagram and analysis, Velocity relationship, Stress & shear strain in conventional shear plane, Power & Energy consumption in cutting process, Ernst & Merchant angle relationship, Lee & Shaffer principle. Measurement of Cutting Forces: Reasons for measuring cutting forces, Dynamometers for Machine Tools, Classification of cutting force dynamometers,Dynamometers for turning, drilling, and milling.	**6 Hrs**
Module-IV	Thermodynamics of chip formation: The shear plane temperature-interface temperature from dimensional analysis-Experimental determination of chip tool interface temperature. Cutting fluids: Theory of cutting fluid action at the chip tool interface, techniques for application of cutting fluids, types of cutting fluids, properties of cutting fluids, selection of cutting fluids, application of cutting fluids. Tool wear & Tool life: Mechanisms of tool wear, crater wear, flank wear, causes and mechanism of tool failure, Taylor's tool life equation, Machinability & machinability index, effect of process parameters on tool life and machinability. Vibration and chatter in machining, Economics of Machining.	**6 Hrs**
Module-V	Machine tools – Definition and classifications, Generation and machining principles. Setting and operations on machines (including major units and specifications) Lathe, Milling, Shaping, Slotting, Planing, Drilling, Boring, Broaching, Grinding (cylindrical, Surface, Centreless).	**6 Hrs**
Essential Reading	1. Metal cutting Theory & Practice- A. Bhattacharya, C.B. Publisher 2. Textbook of Production Engineering by Jain and Chitale. PHI Publication 3. A course in workshop technology" Vol-II (Machine Tool)- B.S. Raghuwanshi. Dhanpat Rai & Co.	
Supplementary Reading	1. Fundamentals of Metals machining & machine Tools- Boothroyd- InternationalEdition 2. Theory of Metal cutting- M.C. Shaw	
Course Outcomes	At the end of the course, the student will able to: CO1 Analyze and demonstrate the basics of metal cutting and machine tool operations. CO2 Develop the theoretical derivation of equations for temperature, strain, force in metal cutting. CO3 Summarize the theory of metal cutting and compute cutting forces involved from Merchant's circle. CO4 Apply the various cooling-lubrication methods for controlling the cutting temperature. CO5 Demonstrate the application of appropriate machining processes and conditions for different metals.	

Subject Code	**PE1205**	**Total Contact Hour**	**30**
Semester	**4th**	**Total Credit**	**3**
Subject Name	**Theory of Machines**		
Pre-requisites	**Engineering Mechanics**		
Course Objective	To obtain domain knowledge on various mechanism involved in a machine		

SYLLABUS		**Contact Hours**
Module-I	Mechanism: Basic Kinematic concepts and definitions, mechanism, link, kinematic pair, classification of kinematic pairs, degree of freedom, kinematic chain, binary ternary and quaternary joints and links, degrees of freedom for plane mechanism, Grubler's equation, inversion of mechanism, four bar chains and their inversions, single slider crank chain, double slider crank chain and their inversion.	**7 Hrs**
Module-II	Velocity and acceleration Analysis of plane mechanism: Velocity of a point on a link by relative velocity method and instantaneous center method. Acceleration of a point on a link. Acceleration in the slider crank mechanism.	**7 Hrs**

Module-III	Friction of a screw and nut, square threaded crew, V-threaded screw, pivot and collar bearings, friction circle, friction axis, friction clutches, transmission of power by single plate, multiple and cone clutches. Gear trains: simple train, compound train, reverted train, epicyclic train and their application.	**6 Hrs**
Module-IV	Toothed gears: Theory of shape and action of tooth properties methods of generation of standard Tooth profiles, Standard proportions, Interference and Under-cutting, methods of Eliminating Interference, Minimum numbers of teeth to avoid interference.	**5 Hrs**
Module-V	Governors: Centrifugal Governors-Watt and Porter Governors, Spring loaded Governor- Hartnell Governor, sensitiveness, stability, Isochronism, Hunting, Governor effort and power, curves of controlling force.	**5 Hrs**
Essential Reading	1. Theory of machines – S. S. Ratan, Tata McGraw Hill. 2. Mechanism and Machine Theory- Rao and Dukkipati, Wiley Eastern Ltd	
Supplementary Reading	1. A Textbook of theory of machines (in S.I units) – R.S Khurmi& J.K. Gupta, S Chand Publication. 2. Theory of Machines –Thomas Bevan, TMH.	
Course Outcomes	At the end of the course, the student will able to: CO1 Implement and design various types of linkage mechanisms for obtaining specific motion and analyze them for optimal functioning. CO2 Analyze the velocity and acceleration of a plane mechanism. CO3 Evaluate and estimate the power of screw and clutches. CO4 Analyze and evaluate the speed ratios of gears and gear trains. CO5 Analyze and evaluate the effort and power of governor.	

Subject Code	**CH1206**	**Total Contact Hour**	**30**
Semester	**4th**	**Total Credit**	**3**
Subject Name	**Inspection & Metrology**		
Course Objective	**To obtain domain knowledge on basics of metrology, comparators, surface measurements, gear measurement and non-destructive testing.**		
	SYLLABUS		**Contact Hours**
Module-I	Introduction to metrology: Definition, Need of Inspection, Process of measurement, Precision and accuracy, Errors in Measurement, Line standard, end standard. Limits, fits and tolerances: Limits, Tolerances, Terminology for Limits and Fits, Types of Fits, Allowances, Hole & shaft basis system, Interchangeability, selective assembly, Gauges and Gauge Design; Limit gauges; Snap, plug, ring, Taylor's principle. Wear allowance.		**5 Hrs**
Module-II	Comparators: Characteristics, Relative Advantages of various types of comparators; Mechanical, Optical, Pneumatic, Fluid displacement type Linear measurement: Rules, Callipers, Height gauges, Micrometers, Depth gauge, Dial indicator, slip gaugesAngular measurement: Sine bar, Sine center, angle gauges, Autocollimator. Form measurement: straightness, flatness, roundness, runout and cylindricity		**7 Hrs**
Module-III	Surface Measurements: Roughness and waviness, Surface texture, cut off length, RMS & CLA values, Surface roughness measurement by contact (using Taylor Hobson's Talysurf) and non-contact methods. Interferometry: Introduction, optical flat, Interferometers Type.		**8 Hrs**
Module-IV	Metrology of screw thread: Errors in threads, Measurement of element of threads, 2-wire &3- wire methods, best wire size. Gear Measurement: Gear Terminology, Measurement of error, Tooth Thickness Measurement; Gear tooth Caliper, Base Tangent Comparator, Constant Chord Method, Measurement using Rollers.		**5 Hrs**
Module-V	Non-destructive Testing- X-ray examination, radiography, Ultrasonic inspection, magnetic test, machine vision system-principle, application, Laser inspection.		**5 Hrs**
Essential Reading	1. Engineering Metrology- R.K. Jain 2. Production Technology- P.C. Sharma		
Supplementary Reading	1. Engineering Dimensional Metrology- Miller, Edward Arnold publications 2. Precision Engineering in Metrology- R.L. Murty, New Age Int.		
Course Outcomes	CO1 Analyze the fundamental concepts in measurement methods and techniques. CO2 Apply the uses of various gauges and comparators. CO3 Implement the application of surface roughness measuring instruments in practical domain. CO4 Incorporate appropriate method and instruments for inspection of various gear elements and thread elements. CO4 Apply various non-destructive techniques for inspection.		

Subject Code	**PE1207**	**Total Contact Hour**	**30**
Semester	**4th**	**Total Credit**	**3**
Subject Name	**Manufacturing Technology-I**		
Pre-requisites	**Basic Manufacturing Processes**		
Course Objective	**To obtain knowledge on casting, welding, forming, powder metallurgy and coating processes and their applications.**		
	SYLLABUS		**Contact Hours**
Module-I	Fundamentals of metal casting: Overview of casting; heating & pouring; solidification & cooling. Metal casting processes: sand casting; other expandable mold casting processes; permanent mold casting processes; foundry practice; casting quality; metals for casting; product design consideration.		**7 Hrs**
Module-II	Fundamentals of welding: overview of welding technology; weld joint; physics of welding; features of fusion welded joint. Welding Processes: Arc welding; resistance welding; oxyfuel gas welding; fusion welding; solid state welding; weld quality; weldability; design consideration in welding. Brazing; soldering; adhesive bonding.		**8 Hrs**

Module-III	Fundamentals of metal forming: Overview of metal forming; material behavior in metal forming; temperature in metal forming; strain rate sensitivity; friction & lubrication in metal forming. Bulk deformation processes in metal working: Rolling; forging; open-die forging; impression-die forging; closed die forging;; Extrusion: types of extrusion; analysis of extrusion; dies and presses for extrusion; defects in extruded products. Wire and Bar drawing: analysis of wire drawing.	**6 Hrs**
Module-IV	Sheet metal working: cutting operation; bending operation; other sheet metal forming operation. Powder metallurgy: characterization of engineering powders; conventional pressing and sintering; alternative pressing and sintering techniques; materials and products for powder metallurgy. Shaping processes for polymer matrix composites: materials for PMCs; open mold processes; closed mold processes.	**6 Hrs**
Module-V	Coating and deposition processes: plating and related processes; conversion coatings; physical and chemical vapor deposition, organic coatings; proclaim enameling; thermal and mechanical coating processes.	**3 Hrs**
Essential Reading	1. Fundamentals of modern manufacturing- Mikell P. Groover, Wiley India Ed. 2. Manufacturing Technology (Vol. I)- P.N.Rao,TMH 3. Welding Engineering and Technology- R.S. Parmar, Khanna publisher	
Supplementary Reading	1. Metallurgy of Welding Technology-D. Seferian, Chapman & Hall 2. Principle of Metal Casting- P.L.Jain,TMH	
Course Outcomes	At the end of the course, the student will able to: CO1 Apply the knowledge to demonstrate casting processes and applications. CO2 Apply the knowledge to demonstrate welding processes and applications. CO3 Apply the knowledge to demonstrate forming processes and applications. CO4 Apply the knowledge to demonstrate powder metallurgy process and sheet metal operations. CO5 Apply the knowledge to demonstrate coating and deposition processes and applications.	

Subject Code	CS1209	**Total Contact Hour**	**3**
Semester	4th	**Total Credit**	**30**
Subject Name	Artificial Intelligence and Machine Learning		
Pre-requisites			

Course Objective	1.To familiarize students with the fundamental concepts, theories, and applications of Artificial intelligence& Machine learning. Students will gain insight into the various subfields of AI& ML. 2.Students will have a clear understanding of the fundamental concepts and terminology of Artificial intelligence& Machine learning, enabling them to discuss and comprehend AI-related topics. 3. Students will have a clear understanding about neural networks, Fuzzy logic. 4. Students will have a clear understanding about Clustering and related techniques. 5. Students will have a clear understanding about Classification and related techniques.	
SYLLABUS		**Contact Hours**
Module-I	Introduction to Artificial Intelligence, Applications of AI, State-space problem, Problem solving by Intelligent search: BFE, DFS, Iterative Deepening Search, Hill climbing, Heuristic search: A*, AO*, MIN_MAX Algorithm, Alpha-beta cutoff	**8 Hrs**
Module-II	Knowledge representation and reasoning: Formalized symbolic logic, propositional logic, First-order predicate logic, wff conversion to clausal form, inference rules, resolution principle.	**5 Hrs**
Module-III	Unsupervised Learning: K-means, K-Medoids, Hierarchical clustering, Density based clustering, Validation Method: LOO, K-fold cross validation.	**5 Hrs**
Module-IV	Supervised Learning: Decision Tree, Naïve Bayes classifier, K-NN, Introduction to regression. Performance matrix: Confusion matrix, Precision, Recall, Sensitivity, Specificity, MAE, MSE	**6 Hrs**
Module-V	Neural Network Artificial Neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks, Training of ANN, Back propagation, RBFNN.	**6 Hrs**
Essential Reading	1.E.Rich and K. Knight, Artificial Intelligence-TMH 2.Neuro Fuzzy and Soft Computing, J. S. R. JANG,C.T. Sun, E. Mitzutani, PHI	
Supplementary Reading	1.Artificial Intelligence, Dan W Patterson, Prentice Hall of India 2.Computational Intelligence Principles, Techniques and Applications, Amit Konar, Springer publication. 3. M. Gopal, Applied Machine Learning, McGraw Hill Education, 2018	
Course Outcomes	CO1:Understand the basics of Search techniques, Knowledge representation and reasoning in Artificial Intelligence. CO2:Understand the Supervised machine learning and Unsupervised machine learning. CO3:Analyzevarious machine learning models. CO4:Implement various Supervised machine learning techniques and analyze them. CO5:Implement various Unsupervised machine learning techniques and analyze them.	

Subject Code	**HS1201**	**Total Contact Hour**	**30**
Semester	**4th**	**Total Credit**	**2**
Subject Name	**Engineering Economics**		

SYLLABUS		**Contact Hours**
Module-I	**Basic Principles of Economics:** Definition, Nature, Scope and significance of economics for Engineers. Demand & Supply and their Determinants,Elasticity-Government policies and application. Basic Macro economics concept: National income accounting (GDP/GNP/NI/Disposable Income etc) and identities for both closed and open economies.	**6 Hrs**
Module-II	**Utility Analysis:** Cardinal and ordinal measurability of utility, Assumptions of cardinal utility analysis, law of diminishing marginal utility, Consumer's equilibrium: Principle of equi-marginal utility; Indifference curve-Concepts, properties, Budget line, Equilibrium of the consumer, Revealed preference hypothesis, Individual choice under Risk and Uncertainty: St. Petersburg paradox and Bernoulli's hypothesis, Neumann-Morgenstern method of constructing utility index, Friedman-Savage hypothesis	**6 Hrs**

Module-III	**Production, Cost and Market Structure:** Production function: short run production function and law of variable proportion; Long run production function: Isoquants, isocost line, returns to scale, Optimum factor combinations, Cost Analysis: Concepts, Classification- Short run and Long run cost curves, Analytical and accounting cost concepts; Market structure: Market classifications, Perfect competition: Characteristics, price and output determination in Short run and long run, Monopoly market: Price and output determination, price discrimination Modern theories of firms: Baumol's theory of sales revenue maximisation, Bain's limit pricing model.	**6 Hrs**
Module-IV	**Money and Banking:** Money-Function of Money, Demand for Money Theory. Quantity theory of money; Banking: Commercial Banks and their Functions, Central bank's Functions. Role of the Banks in Economic Development, Monetary and Fiscal Policy Tools and their impact on the economy.	**6 Hrs**
Module-V	**Capital Budgeting and Investment Analysis:** Time value of money: use of cash flow diagram, Annual economic worth, present worth, future worth, Internal Rate of Return (IRR), Net Present Value (NPV), Payback period method, Analysis of public projects: Cost-Benefit analysis, Cost effectiveness	**6 Hrs**
Essential Reading	1. Koutsoyiannis, A. (1979). Modern Microeconomics. The Macmillan Press Ltd., London 2. Pindyck, R. S., D. N. Rubinfeld and P. L. Meheta (2009). Microeconomics, Pearson India, New Delhi 3. Panneerselvam, R. (2007). Engineering Economics, Prentice-Hall of India, New Delhi 4. Mankiw Gregory N. (2002). Principles of Economics, Thomson Asia	
Course Outcomes	CO1- Utilise economics principles in consumption process CO2- Describe the utility measurement and measure the utility associated with risk CO3- Efficient use of resources in production and take decision regarding optimum output CO4- Describe market mechanism and analyse product market to take proper decisions CO5- Implement economic principles in company related decision making	

	SESSIONAL		
Subject Code	**PE1204**	**Total Contact Hour**	**16**
Semester	**4th**	**Total Credit**	**1.5**
Subject Name	**Metal Cutting Laboratory**		
	List of Experiments		
1	To analyse the morphology and types of chips produced in turning operation at different cutting conditions.		
2	To observe and compare the types and characteristics of chips produced during metal cutting of different materials.		
3	To determine the effect of cutting parameters (speed, feed, depth of cut) on surface finish in turning operation.		
4	To measure the cutting forces during turning operation using lathe tool dynamometer.		
5	To measure the cutting forces during drilling operation using drill tool dynamometer.		
6	To analyse the vibrations during machining operations and analyse its relationship with cutting parameters.		
7	To measure the temperature generated during machining using infrared camera.		
8	To analyze the effect of cutting parameters on temperature generated at the cutting zone.		
Course Outcomes	CO1 Obtain hands-on experience with machining equipment, learning to set up and conduct experiments, collect data, and analyze results. CO2 Demonstrate the understanding of chip formation mechanism in machining. CO3 Measure the different cutting forces in turning, drilling and milling operations. CO4 Evaluate the tool vibration and chatter formation on machined surface in cutting operation. CO5 Understand the significance of temperature in the cutting process, learning to measure and analyze the thermal effects on tools and workpieces.		