Semester-IV

Sr. No.	Category	Subject Code	Subject Title	L	T	P/D	Credits	Evaluation Scheme (Marks)		
								Internal Assessment (IA)	ESE	Subject Total
Theory:										
1	FC	MAFC-311	Probability Theory and Statistics	3	1	0	4	40	60	100
2	PC	CSPC-414*	Artificial Intelligence in Engineering	2	0	0	2	40	60	100
3	PC	MEPC-411	Fluid Machines	3	1	0	4	40	60	100
4	PC	MEPC-412	Internal Combustion Engines	3	0	0	3	40	60	100
5	PC	MEPC-413	Kinematics of Machines	3	0	0	3	40	60	100
6	PC	MEPC-414	Strength of Materials	3	1	0	4	40	60	100
7	PC	HS-311	Engineering Economics	2	0	0	2			
Labs:										
1	PC	MEPC-411P	Fluid Machines Lab	0	0	2	1	30	20	50
2	PC	MEPC-412P	Engine Technology Lab	0	0	2	1	30	20	50
3	PC	MEPC-414P	Strength of Materials Lab	0	0	2	1	30	20	50
4	PC	MEPC-415P	Machine Drawing and CAD Lab	0	0	2	1	30	20	50
Total				**19**	**3**	**8**	**26**	360	440	**900**
UG Diploma Exit Option										
1	EE	MEEE-416P	Internship-I**(Exit)****	8 Weeks/ 2 Months			**6**	50	50	100

Note:

1. * CSPC-414, the contents are designed relevant to each branch and teaching load may be assigned to concerned branch.

   ****Exit Option (as per NEP):**Those students who wish to leave the studies after completion/end of 2nd year, can exercise exit option for UG Diploma in Mechanical Engineering during registration for 4th semester (only for regular students and not applicable for lateral entry students). They will be required to obtain additional 6 credits summer internship (Internship-I (Exit)) of 8-weeks/2-months duration during summer term/summer vacations after 4th semester. The evaluation of such candidates shall be done within the first-two months of the running next semester i.e. 5th sem. The internship shall be completed by student during summer vacations after 4th semester, in local industry, government/private organization, entrepreneurs, craft and skilled persons for on-site experiential learning.

MAFC-311 Probability Theory and Statistics							
Teaching Scheme			**Credit**	**Marks Distribution**			**Duration of End Semester Examination**
L	T	P		Internal Assessment	End Semester Exam	Total	
3	**1**	**0**	**4**	**Maximum Marks: 40**	**Maximum Marks: 60**	**100**	**3 Hours**
				Minimum Marks: 16	**Minimum Marks: 24**	**40**	

Instructions for question paper setter:

Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each (each subdivided into at least two equal sub-parts) and section E has short answer type questions consisting of six parts of 02 marks each or twelve parts of 01 mark each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the Section E will be compulsory. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Course Objective:

- To understand the basic probability concepts.
- To have an in-depth knowledge of standard distribution which can describe real life phenomena.
- To unerstand and characterize phenomena which evolve with respect to time in probabilisitc manner.
- To analyse the response of random imputs to linear time invariant systems.

Course Contents:

Unit-I:
Probability Theory: Counting principles, Probability axioms, Sample space and events, Conditional probability & Baye's Theorem, Random variable, Discrete and continuous probability distribution, Expectation, Variance, Standard deviation, Joint probability distribution, Mass function, Distribution function, Marginal distribution function, Covariance. **Probability Distributions:** Discrete Probability Distributions: Uniform, Bernoulli, Binomial distribution and Poisson distribution. Continuous Probability Distributions: Normal and exponential distribution.
Unit-II:
Sampling and Testing of Hypothesis: Basic sampling models, Sampling distribution of mean and standard deviation, Testing of hypothesis, Level of significance, Confidence intervals for known and unknown means, Simple sampling of attributes, Tests of significance for large samples, Comparison of large samples, Central limit theorem, Test of significance for two large samples, Student's t-test, Chi-square test, Goodness of fit, F-distribution.
Unit-III:
Solution of System of Linear, Transcendental Equations & Interpolation: Bisection method, Regula-Falsi method, Newton Raphson's method, Gauss elimination method, LU factorization method. Introduction to interpolation, Lagrange's interpolation, Newton's divided difference interpolation, Difference operators and relations.
Unit-IV:
Numerical Differentiation & Integration: Numerical differentiation using forward difference, backward difference and central difference formula. Integration by trapezoidal and Simpson's rules $1/3^{rd}$and $3/8^{th}$rule. **Numerical Solution of Ordinary Differential Equations:** Picard's method,Taylor series method,

Euler’s method, Modified Euler’s method, Runge’s and Runge-Kutta method.

Course Outcomes (COs): After the completion of the course, the student will be able to:

1. Develop understanding of basics of probability theory.
2. Identify different distribution functions and their relevance.
3. Apply the concepts of probability theory to different problems.
4. Understand different numerical integration techniques, and numerically solve differential equations.

Text Books:

- R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics (2003), 2nd ed.
- B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.
- S.C. Gupta & V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons.
- K.E. Atkinson, An Introduction to Numerical Analysis (2nd edition), Wiley-India, 1989.
- S.S.Sastry, Introductory Methods of Numerical Analysis (5th edition), PHI Learning Pvt. Ltd.

Reference Books:

- Seymour Lipschutz, and John J. Schiller, Introduction to Probability and Statistics, Schaum's Outlines by McGraw Hill Education.
- E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, New York.
- H.K. Dass and RajnishVerma, Engineering Mathematics, S. Chand Publications.

MEPC-411 Fluid Machines							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P		Internal Assessment	End Semester Exam	Total	
3	1	0	4	MaximumMarks:40 MinimumMarks:16	MaximumMarks:60 MinimumMarks:24	100 40	3 Hours

Instructions for question paper setter:

Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Course Contents:

Unit-I:

Impact of Jets and Water Turbines: Impact of jet on flat and curved plates, Types of hydro turbines - impulse and reaction, Definition of various turbine parameters like gross head, discharge, work done, input power, output power, efficiencies etc., Euler's equation applied to a turbine, Turbine velocities and Velocity triangles, Expression for work done.

Pelton Turbine: Components of Pelton turbine, Definition of design parameters like speed ratio, jet ratio, and estimation of various parameters like head, discharge, and efficiency etc., Determination of number of buckets, Performance characteristic curves.

Unit–II:

Reaction Turbines: Types of reaction turbines – Francis Turbine, Kaplan Turbine, Inward and outward flow, Radial mixed and axial, Elements of the turbine, Estimation of various working and design parameters, Performance characteristic curves of reaction turbines.

Similarity Relations in Turbines: Definition of unit quantities and specific quantities, Selection of turbines, Cavitation in turbines - causes, effects and remedies, Thomas cavitation parameter, Specific speed graphs, Determination of safe height of installation for the turbine, Draft Tube, Types of draft tube, Governing of turbines.

Unit–III:

Centrifugal Pumps: Classification, Velocity vector diagrams and work done, Hydraulic and manometric efficiency, Vane shape, Head capacity relationship and pump losses, Pressure rise impeller, Minimum starting speed, Multi-stage pumps, Similarity relations and specific speed, Net positive suction head, Cavitation and maximum suctions lift, Performance characteristics.

Unit-IV:

Reciprocating Pumps: Construction and operational details, Discharge coefficient, Volumetric efficiency and slip, Work and power input, Effect of acceleration and friction on indicator diagram (pressure – stroke length plot), Air vessels and their utility, Centrifugal v/s reciprocating pumps.

Miscellaneous Hydraulic Systems: Hydraulic Ram, Hydraulic intensifier, Hydraulic accumulator, Hydraulic lift.

Course Outcomes (COs): After the completion of the course, the student will be able to:

1. Understand about testing of hydraulic turbines and pumps for performance at constant speed and head.
2. Demonstrate the knowledge of working, stages, performance characteristics, governing and selection of fluid machinery.
3. Solve analytical problems in fluid machines for incompressible fluid flows.
4. Evaluate how to measure pressure, discharge, and velocity of fluid flow in machines.
5. Analyze the appropriate pump based on the required flow rate and pressure rise to maximize pumping efficiency.
6. Develop a logical approach to solving engineering problems, detect the type of problems that can be solved with simple analytical processes.

Text Books:

- D.S. Kumar, "*Fluid Mechanics and Fluid Power Engineering*",S.K.Kataria and Sons.
- P.N.Modi and S.M.Seth (1999), "*Hydraulics and Fluid Mechanics including Hydraulic Machines*", (1999), Standard Book House, Naisarak, Delhi.
- S.K. Som,"*Introduction to Fluid Mechanics and Machines*", McGraw Hill.

Reference Books:

- S.M. Yahya, "*Turbines, Compressors & Fans*", Tata McGraw Hill.
- F.M. White, "*Fluid Mechanics*", McGraw Hill India.
- Irving Shames, "*Mechanics of Fluids*", McGraw Hill India,
- JagdishLal, "*Hydraulic Machinery*", Metropolitan Book Co.

MEPC-412 Internal Combustion Engines							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P		Internal Assessment	End Semester Exam	Total	
3	0	0	3	MaximumMarks:40 MinimumMarks:16	MaximumMarks:60 MinimumMarks:24	100 40	3 Hours

Instructions for question paper setter:

Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Course Contents:

Unit-I:

Introduction: Heat engines; Internal and external combustion engines; Classification of I.C. Engines; Cycle of operations in four strokes and two- stroke IC engines and their comparative study; Fuels: SI and CI engine fuels, Rating of fuels; Scavenging and scavenging blowers; Air standard cycles and Fuel air cycles, Variable specific heat and its effects, Dissociation and other losses, Actual cycles, Deviation of actual engine cycle from ideal cycle; TDC, BDC, Torque, Power.

Compression Ignition Engines: Combustion phenomenon in CI engines, Stages of combustion, Delay period, Knocking, Pressure-Crank angle diagram, Factors affecting combustion and knocking, Types of combustion chambers.

Spark Ignition Engines: Combustion, Combustion phenomenon in SI Engines, Ignition delay, Flame propagation, Pressure-Crank angle diagram, Abnormal combustion, Auto ignition, Detonation and Knocking, Factors affecting combustion and detonation, Types of combustion chambers.

Unit-II:

Fuel System – SI Engines: Theory of carburetion, Simple carburetor, Essential parts of modern carburetor, Types of carburetors, Types of fuel injection systems in SI engines, Continuous injection system, Timed injection system, Electronic Fuel Injection systems (EFIs)/MPFi, Working of Sensors, Functions of ECU in Petrol Engine. Spark Plug and its requirements, Battery, Magneto, Electronic ignition systems. GDI Technology, Turbo in Petrol Engines.

Fuel System – CI Engines: Fuel injection systems: Unit pump, Inline pump, Rotary pump, Engine governors: necessity and characteristics, Types of nozzle, Electronic diesel control, CRDi technology, System layout, Function of ECU in diesel engine, Working of sensors, Turbocharger and its types, VGT, Twin-turbo.

Unit-III:

Engine Lubrication: Types of lubricants and their properties, SAE rating of lubricants, Types of lubrication systems, Engine Cooling: Necessity of engine cooling, Disadvantages of overcooling, Cooling systems and their comparison: Air cooling, Liquid cooling, Supercharging/Turbo-charging: Objectives, Effects on power output and engine efficiency.

Engine Testing and Performance: Measurement of Brake Horse Power,Indicated Power, Fuel

Consumption, Air flow, BMEP, Performance characteristic of SI and CI Engines, Effect of load and speed on mechanical, indicated thermal, break thermal and volumetric efficiencies, Heat balance sheet.
Unit-IV:
After-Treatment Technologies: Working of catalytic converter & its types, SCR, DPF, DOC, POC, LNT. Exhaust Emissions: Homologation, Emission standards, Applicable standards in India, Future norms, and Significance of fuel in meeting emissions. Classification of segments, Emission test cycles, COP, Emission measurement techniques, On board diagnosis, OBDI, OBDII. **Alternate Fuels:** Alcohol - Hydrogen - Natural Gas and Liquefied Petroleum Gas - Biodiesel- Biogas Properties - Suitability - Engine Modifications - Merits and Demerits as fuels.

Course Outcomes (COs): After the completion of the course, the student will be able to:

1. Understand the basic thermodynamic principles and combustion processes that govern internal combustion engines, including air-fuel mixture preparation, ignition, combustion, and exhaust emissions.
2. Identify and explain the functions of major engine components and systems, including cylinders, pistons, valves, crankshaft, camshaft, fuel injection systems, and exhaust systems.
3. Analyze engine performance parameters under varying operating conditions.
4. Learn about emissions control technologies and regulations governing internal combustion engines, including strategies for reducing pollutants such as NOx, CO, and particulate matter.
5. Understand the properties of different fuels used in internal combustion engines and their impact on engine performance and emissions.
6. Apply knowledge of engine fundamentals to design considerations and optimization strategies, including improving efficiency, reducing friction losses, and enhancing performance.

Text Books:

- Ganesan V., (1999), "*Internal Combustion Engines*", (1999) Tata McGraw Hill.
- John B. Heywood, "*Internal Combustion Engine Fundamentals*", (2000) McGraw Hill.

Reference Books:

- Rowland S.Benson and N.D.Whitehouse, "*Internal combustion Engines*", Vol. I and II, (2000) Pergamon Press.
- Richard.L.Bechfold, "*Alternative Fuels Guide Book*", SAEInternational Warrendale,1997.
- "*Alcohols as motor fuels progress in technology*- Series No.19 - SAE Publication USE - 1980.
- Heisler Heinz, "*Advanced Engine Technology"*, Hodder & Stoughton Ltd.

MEPC-413 Kinematics of Machines							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P		Internal Assessment	End Semester Exam	Total	
3	0	0	3	MaximumMarks:40 MinimumMarks:16	MaximumMarks:60 MinimumMarks:24	100 40	3 Hours

Instructions for question paper setter:

Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Course Contents:

Unit-I:

Introduction: Mechanism and machines, Kinematics links, Kinematic pairs, Kinematic chains, Plane and space mechanism, Kinematic inversion, Equivalent linkages, Four link planar mechanisms, Straight line mechanisms, Steering mechanisms, Pantograph.

Kinematic Analysis of Plane Mechanisms: Displacement analysis, General plane motion, Instantaneous center of velocity, Graphical and analytical methods of velocity and acceleration analysis.

Unit-II:

Cams: Classification of cams and followers, Disc cam nomenclature, Construction of displacement, Velocity and acceleration diagrams for different types of follower motions, Analysis of follower motions, Determination of basic dimension, Synthesis of cam profile by graphical approach, Cams with specified contours, Tangent and circular arc cams.

Unit-III:

Belt, Rope and Chain drives: Introduction to belts, Ropes, Law of belting, Design of belt drives, Flat & v-belt drives, Conditions for transmission of maximum power.

Gears: Introduction, Terminology, Various types of gears and applications, Fundamental law of gearing, Gear profile, Involute, Cycloidal, Interference and undercutting. Spur gear: path of contact, arc of contact, minimum teeth to avoid interference, Introduction to helical, spiral bevel and worm gears.
Synthesis of Gear Trains: Synthesis of simple, compound and reverted gear trains, Analysis of epicyclic gear trains.

Unit-IV:

Kinematic Synthesis of Mechanisms: Type, number and dimensional synthesis, Function generation, Path generation and body guidance two and three position synthesis of four bar and slider crank by graphical and analytical methods, *Freudenstein's* equation precision position, Structural error, *Chebychev* spacing, Transmission angle.

Course Outcomes (COs): After the completion of the course, the student will be able to:

1. Understand the principles of kinematic pairs, chains and their classification, DOF, inversions, equivalent chains and planar mechanisms.
2. Analyze the planar mechanisms for position, velocity and acceleration.
3. Draw displacement diagrams and cam profile diagram for followers executing different types of motions and various configurations of followers.

4. Understand the basics of belt, rope and chain drives.
5. Apply the knowledge of gear and gear trains.
6. Demonstrate an understanding of kinematic synthesis of mechanisms.

Text Books:

- V.P. Singh, "*Theory of Machines*", Dhanpat Rai Publications, New Delhi, 2016.
- Amitabha Ghosh, Ashok Kumar Mallik, "*Theory of Mechanisms and Machines*", Third Edition Affiliated East West Press.
- S.S. Rattan, "*Theory of Machines*", McGraw Hill, (4th edition), 2014.

Reference Books:

- J.S.Rao, R.K. Dukkipati, "*Mechanism and Machine Theory*", Second Edition, New age International.
- Gordon R. Pennock, Joseph E. Shigley, John J. Uicker, "*Theory of Machines and Mechanisms*", Oxford University Press, 2014.

MEPC-414 Strength of Materials							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P		Internal Assessment	End Semester Exam	Total	
3	1	0	4	MaximumMarks:40 MinimumMarks:16	MaximumMarks:60 MinimumMarks:24	100 40	3 Hours

Instructions for question paper setter:

Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Course Contents:

Unit-I:

Simple Stresses and Strains: Stress & Strain, Types of stresses and strains, elastic limit, Hooke's law, Stress-Strain diagram for ductile and brittle, Factor of safety, Poisson's ratio, Elastic constants, Young's Modulus, Shear Modulus, and Bulk Modulus, Relationship between elastic constants. Introduction to thermal stresses and strains.

Compound Stresses & Strains: Concept of surface and volumetric strains, Two – dimensional stress system, Complementary shear stresses at a point on a plane. Principal stresses & strains and principal planes. Mohr's circle of stresses, Numerical problems.

Unit-II:

Bending Stresses in Beams: Bending stresses in Beams with derivation of bending equation and its application to beams of circular, rectangular, I & T sections, Composite beams.

Columns & Struts: Columns under axial load, Concept of instability and buckling, Slenderness ratio. Derivation of Euler's formulae for the elastic buckling load. Euler's, Rankine Gordon's formulae, Johnson's empirical formula for axial loading of columns and their applications, Eccentric compression of a short strut of rectangular & circular sections, Numerical problems.

Unit-III:

Slope & Deflection: Relationship between bending moment, Slope & deflection, Method of integration, Macaulay's method, Mohr's theorem-moment area method. Calculations for slope &deflection of (1) cantilevers and (2) simply supported beams with or without overhang, under concentrated loads, uniformly distributed loads, or combination of all of these types of loads, Numerical problems.

Unit-IV:

Theories of Elastic Failure: Various theories of elastic failure with derivations and graphical representations, Applications to problems of two-dimensional stress systems with (i) Combined direct loading and bending and (ii) Combined torsional and direct loading, Numerical problems.

Thin and Thick-Walled Pressure Vessels: Derivation of hoop & longitudinal stresses & strains in cylindrical & spherical vessels under internal pressure, Change in volume of vessel under pressure, Derivation of equations for radial & hoop stresses and strains in thick cylinders and compound cylinders.

Course Outcomes (COs): After the completion of the course, the student will be able to:

1. Differentiate between various mechanical properties, stresses, failure criteria etc.
2. Understand the concepts and theories related to bending, column & struts, slope and deflection, elastic failure and pressure vessels.
3. Analyze the member under consideration using the concepts, principles and theories of strength of materials.
4. Recommend the dimensions of the mechanical member providing the reasoned argument for the same, under given loading/stress conditions.
5. Predict the mechanical behaviour of the member under given (or real-life) conditions so as to ensure safety of design.
6. Apply concepts of strength of materials to real time engineering problems.

Text Books:

- E.J. Hearn, "*Mechanics of Materials*"-Vol.-1, & Vol. 2,Elsevier Publications.
- R.K. Rajput, "*Strengths of Materials*", S.Chand& Sons.
- R.K. Bansal, "*Strength of Materials*", Laxmi Publications.

Reference Books:

- R.C. Hibbeler, "*Mechanics of Materials*", Pearson India.
- James Goodno, "*Mechanics of Solids*", Thomson Publishers.
- Popov, "*Strength of Materials*", PHI, New Delhi.
- G.H. Ryder, "*Strength of Materials*", Third Edition in S.I. units 1969 Macmillan India.

Artificial Intelligence in Engineering (CSPC-414)

Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Exam	Total	
2	0	0	2	MaximumMarks:40	MaximumMarks:60	100	3 Hours
				MinimumMarks:16	MinimumMarks:24	40	

Instructions for question paper setter:

Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Course Contents:

Unit-I:
Fundamentals of Artificial Intelligence (AI): Introduction to AI, History of AI, General applications of AI, Need of AI in Engineering, Problem solving, Process of problem solving, breadth first search, depth first search, heuristics search techniques, best first search, Introduction to intelligent systems, Various approaches to AI: Cybernetics and brain simulation, Symbolic, Sub-symbolic, Statistical. **Ethical and Social Implications of AI:** Ethical considerations in AI development and deployment, Impact of AI on jobs and society, Regulatory and policy issues.
Unit-II:
Fundamentals of Machine Learning (ML): Introduction to Machine Learning, datasets, Forms of Learning: Supervised and Unsupervised Learning, reinforcement learning, processes involved in Machine Learning, Applications of ML in Engineering. **Data Preprocessing, cleaning and normalization Approaches in Machine Learning (ML):** Data preprocessing, Data cleaning, Feature selection and extraction, Data normalization and scaling.
Unit-III:
Artificial Neural Networks: Introduction to Artificial Neural Networks (ANNs): Definition and history of ANNs, Types of ANNs architectures ,Basic architecture of ANNs, Activation functions, Singled-Layered and Multi-Layered Perceptron, Backpropagation algorithms, Applications of ANNs in Engineering.
Unit-IV:
Fuzzy Logic and Genetic Algorithm: Introduction to Fuzzy Logic: Basic concepts, history, and fuzzy set theory. Processes in a fuzzy logic system, Applications of Fuzzy Logic in Engineering. Genetic Algorithm (GA): Basics of GA, Main operations of GA, Flowchart of GA, Working principle of GA in step by step, Applications in Engineering.

Course Outcomes (COs): After the completion of the course, the student will be able to:

1. Remember the fundamentals, history, and applications of AI in mechanical engineering.
2. Understand various AI approaches, including cybernetic, symbolic, sub-symbolic, and statistical methods, in mechanical engineering.
3. Apply data preprocessing techniques like cleaning, feature selection, and normalization in machine learning.
4. Analyze the ethical and social implications of AI, including job impacts and regulatory issues.

5. Evaluate machine learning algorithms, neural networks, and fuzzy logic systems for mechanical engineering applications.

Text Books:

- Deisenroth, Faisal, Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
- B Joshi, Machine Learning and Artificial Intelligence, Springer, 2020.
- Parag Kulkarni and Prachi Joshi, Artificial Intelligence – Building Intelligent Systems, PHI learning Pvt. Ltd., ISBN – 978-81-203-5046-5, 2015.

Reference Books:

- Solanki, Kumar, Nayyar, Emerging Trends and Applications of Machine Learning, IGI Global, 2018.
- Mohri, Rostamizdeh, Talwalkar, Foundations of Machine Learning, MIT Press, 2018.
- Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.
- Zsolt Nagy - Artificial Intelligence and Machine Learning Fundamentals-Apress (2018).
- Artificial Intelligence by Elaine Rich, Kevin Knight and Nair, TMH.

HS-311 Engineering Economics							
Teaching Scheme			**Credit**	**Marks Distribution**			**Duration of End Semester Examination**
L	**T**	**P**	**C**	**Internal Assessment**	**End Semester Examination**	**Total**	
2	**0**	**0**	**2**	**Maximum Marks: 40**	**Maximum Marks: 60**	**100**	**3 Hours**
				Minimum Marks: 16	**Minimum Marks: 24**	**40**	

Instructions to the question paper setter:

Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidate will attempt five questions in all, i.e., one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and section-E will cover whole syllabus.

Course Learning Objectives:

- Understand the basic definitions, nature, scope, and significance of economics.
- Learn about the elasticity of demand, its types, methods of measurement, and its importance in economic analysis.
- Examine price determination under different market structures, including perfect competition, monopoly, monopolistic competition, and oligopoly.
- Explore the meaning, types, theories, causes, effects, and control measures of inflation.

Unit-I
Introduction: Definition, Nature, Scope, Importance and significance of Economics, Distinction between Microeconomics and Macroeconomics. Concept of Utility and Its Types.**Demand and Supply:** Meaning, Demand Function, Law of Demand. Elasticity of Demand, Types, Measurement and importance. Demand Forecasting and its techniques. Concept of Supply, Law of supply.
Unit-II
Production Function: Concept and types, Returns to Factor and Returns to Scale, Law of Variable Proportions. **Cost and Revenue:** Concept of Cost, Short run and Lung-run Cost Curves, Relationships among various costs, Break-even Analysis. Revenue: Concept and its types.
Unit-III
Market Structure: Price Determination under Different Market Structure i.e. Perfect Competition, Monopoly, Monopolistic Competition Oligopoly. **Reserve Bank of India:** Nature, Organisation Structure, Objectives, Function of RBI.**Monetary Policy and Fiscal Policy:** Meaning, Objectives and Its tools and Techniques of Monetary and Fiscal Policy.
Unit-IV
National Income: Definition of National Income and its Aggregates, Methods of Calculating National Income. **Inflation:** Meaning, Types, Theories, Causes, Effects and Control. **Business Cycle** – Meaning- Phases of business cycle.

Course Learning Outcomes (CLOs):

After the completion of the course, the student will be able to:

- Identify the determinants of supply and demand; demonstrate the impact of shifts in both market supply anddemand curves on equilibrium price and output.
- Determine the roles that prices and markets play in organizing and directing economic activity
- Calculate and graph the short-run and long-run costs of production, supply and demand elasticities.
- Describe governmental efforts to address market failure such as monopoly power, externalities, and publicgoods.
- Examine and interpret a nation's economic performance indicators such as economic growth,unemployment and inflation from a macroeconomic perspective.
- Articulate the mechanics and institutions of international trade and their impact on the macro economy.

Textbooks:

1. Steven A. Greenlaw, David Shapiro, **"Principles of Economics",**2nd Edition, Rice UniversityOpenStax, 2020.ISBN-13: 978-1947172371.
2. Managerial Economics, 8/e, D N Dwivedi, Vikas Publishing.

Reference Books:

1. N. Gregory Mankiw, **"Principles of Economics",**8th Edition, Cengage Learning, 2016.ISBN-13:978-0357038314.
2. Niall Kishtainy, **"The Economics Book: Big Ideas Simply Explained",**1st Edition, DK Publishers,2012.ISBN-13:978-0756698270.
3. Yves Hilpisch, **"Python for Finance: Mastering Data-Driven Finance",** 2nd Edition, O'Reilly Media,2018 ISBN-13:978-1492024330.

MEPC-411P Fluid Machines Lab							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P		Internal Assessment	End Semester Exam	Total	
0	0	2	1	Maximum Marks:30	Maximum Marks:20	50	2 Hours
				Minimum Marks:12	Minimum Marks:08	20	

Guidelines: The following is the list of experiments/ jobs. Minimum 08 numbers of practical's are to be performed from following list. The additional experiments may be performed by the respective institution depending on availability of time on academic schedule and the available infrastructure.

List of Experiments:

1. To determine the coefficient of impact for vanes.
2. To study the constructional details and performance characteristics of a Pelton turbine.
3. To study the constructional details and performance characteristics of a Francis turbine.
4. To study the constructional details and performance characteristics of a Kaplan turbine.
5. To study the constructional details and performance characteristics of a Centrifugal Pump.
6. To perform experiments (assembly) with pumps, valves and fittings and pipe sections.
7. To study the operating behaviour of centrifugal pumps in individual or series - parallel operation.
8. To measure the net-positive suction head (NPSH) value of centrifugal pumps.
9. To study the constructional details and performance characteristics of a reciprocating pump.
10. To study the operating behavior of reciprocating pumps in individual or series - parallel operation.
11. To study cutaway models of valves (NRV, Gate vale, Ball valve, Butterfly valve, Angle seat valve, Safety valve, 3-way plug valve, strainer) with flange fittings.
12. To perform maintenance and repair exercises on a normally primed centrifugal pump (including shaft gland sealing, ring seal etc.).
13. To perform alignment of a standard pump and its drive motor.
14. To study the constructional details of a Hydraulic Ram and determine its various efficiencies.

Course Outcomes (COs): After the completion of the course, the student will be able to:

1. Gain practical skills in operating and handling different types of fluid machines such as pumps, turbines, and ram.
2. Understand the operational principles and performance characteristics (such as efficiency, power output, and pressure ratios) of fluid machines under different operating conditions.
3. Learn to use measurement instruments such as flow meters, pressure gauges, temperature sensors, and torque meters to collect data and analyze performance parameters of fluid machines.
4. Develop proficiency in conducting experiments to study the performance curves, characteristic curves (e.g., head-flow curve for pumps), and efficiency maps of fluid machines.
5. Document experimental procedures, results, and conclusions in technical reports, including graphical representations, calculations, error analysis, and discussions.
6. Work effectively in teams to conduct experiments, share responsibilities, and discuss findings, demonstrating professionalism, teamwork, and communication skills.

MEPC-412P Engine Technology Lab							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P		Internal Assessment	End Semester Exam	Total	
0	0	2	1	Maximum Marks:30	Maximum Marks:20	50	2 Hours
				Minimum Marks:12	Minimum Marks:08	20	

Guidelines: The following is the list of experiments/ jobs. Minimum 08 numbers of practical's are to be performed from following list. The additional experiments may be performed by the respective institution depending on availability of time on academic schedule and the available infrastructure.

List of Experiments:

1. To study the construction details of 2-stroke and 4-stroke engines.
2. To perform Morse test on engine (4 stroke petrolengine).
3. To perform speed test on engine (4 stroke petrol/diesel engine).
4. To perform load test (Rope Brake/Eddy Current/Hydraulic dynamometer) on engine (4 stroke petrol/diesel engine).
5. To perform heat balance test on engine (4 stroke petrol/diesel engine).
6. To study the difference between carburetors based fuel system & EFI.
7. To study the difference between inline pump, rotary pump &CRDi system for a four-cylinder diesel engine.
8. To study the effect of variable injection timings on combustion characteristics of a single cylinder diesel engine with exhaust gas analysis.
9. To study the effect of spark timing & lambda on single cylinder petrol engine with exhaust gas analysis.
10. To study the effect of spark timing &lambda on multi-fuel engine withexhaust gas analysis.
11. To study the construction details of ignition system (Battery, Magneto, Electronic).
12. Develop schematic block diagram of electric vehicle, and hybrid vehicle.
13. To study the speed control (forward and reverse) of electric vehicle using throttle and analyse the torque production.
14. Measurement of DC-link current, voltage and BMS data of electric vehicle/hybrid vehicle.

Course Outcomes (COs): After the completion of the course, the student will be able to:

1. Measure and analyze engine performance parameters and emissions using appropriate tools and techniques.
2. Understand the impact of different types of fuels on engine performance and emissions.
3. Examine emerging technologies and alternative fuels aimed at reducing these impacts.
4. Demonstrate knowledge of safety protocols specific to internal combustion engine laboratories, including proper handling of fluids, equipment setup, and emergency procedures.

5. Communicate experimental procedures, results, and conclusions effectively through structured lab reports, including graphical representations, calculations, and discussions of sources of error.
6. Collaborate effectively with peers in conducting experiments, sharing responsibilities, and discussing findings to enhance understanding and learning outcomes.

MEPC-414P Strength of Materials Lab							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P		Internal Assessment	End Semester Exam	Total	
0	0	2	1	MaximumMarks:30	MaximumMarks:20	50	2 Hours
				MinimumMarks:12	MinimumMarks:08	20	

Guidelines: The following is the list of experiments/ jobs. Minimum 08 numbers of practical's are to be performed from following list. The additional experiments may be performed by the respective institution depending on availability of time on academic schedule and the available infrastructure.

List of Experiments:

1. To study the Brinell and Rockwell hardness testing machine & compare hardness of at least two types of materials/alloys.
2. To study the Vickers hardness testing machine & perform Vickers hardness test& compare hardness of at least two types of materials/alloys.
3. To study the impact testing machine and perform the impact tests (Izod & Charpy).
4. To perform tensile, compression test on universal testing machine.
5. To perform bending, shear test on universal testing machine.
6. To perform the torsion test on mild steel/aluminium/metal-alloy.
7. To perform fatigue test on mild steel/aluminium/metal-alloy.
8. To find Young's Modulus of abeam (rectangular/triangular/circular section) using deflection of beam apparatus.
9. To perform investigation of the deformation of statically determinate trusses.
10. To measure forces in a statically determinate and statically indeterminate plane truss.
11. To perform investigation of stresses in a thin-walled vessel under internal pressure.
12. To perform the demonstration of 4 cases of Euler elastic buckling of columns.
13. To experimentally perform bending on symmetrical and unsymmetrical cross-sectional profiles: I, L and U.
14. To perform experimental verification of stress hypothesis (*Rankine & Tresca yield criterion*) by multi-axial loading of different test specimens.

Course Outcomes (COs): After the completion of the course, the student will be able to:

1. Identify and explain the mechanical properties of materials such as tensile strength, compressive strength, elasticity, ductility, and hardness etc.
2. Demonstrate an understanding of stress-strain relationships and be able to interpret stress-strain curves for different materials.

3. Develop practical skills in conducting experiments to test material properties, including tensile tests, compression tests, bending tests, and hardness tests etc.
4. Learn to collect, analyze, and interpret experimental data, to evaluate material behavior under different loading conditions.
5. Develop the ability to document their experimental procedures, results, and analyses in clear and concise technical reports.
6. Improve their ability to work effectively in teams, coordinating with peers to complete experiments and analyze results.

MEPC-415P Machine Drawing and CAD Lab							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P		Internal Assessment	End Semester Exam	Total	
0	0	2	1	MaximumMarks:30	MaximumMarks:20	50	2 Hours
				MinimumMarks:12	MinimumMarks:08	20	

Guidelines: The following is the list of experiments/ jobs. Minimum 08 number of practicals are to be performed from following list. The additional experiments may be performed by the respective institution depending on availability of time on academic schedule and the available infrastructure.

List of Experiments:

- *Practicals shall be conducted after* ***discussing briefly about topics*** mentioned here in 1st session and in other sessions just before each relevant practical. The topics which may be introduced to students shall include: Introduction to BIS specification sp: 46- 1988 Code of engineering drawing – limits, fits and tolerances (dimensional and Geometrical tolerance), surface finish representation. gear terminology. I.S convention of assembly of spur gears, helical gear, bevel gears, worm and worm wheel. Getting orthographic views from isometric views of machine parts / components, dimensioning on CAD software, sectioning on CAD software.
- The practicals shall be performed *after setting up of drawing environment* ***in CAD software*** by setting drawing limits, drawing units, naming the drawing, naming layers, setting line types for different layers using various type of lines in Engineering drawing, saving the file with dwg. Extension/appropriate extension.

1. Preparation of drawing of an industrial component with Limits, Fits and Tolerances on CAD software.
2. Preparation of drawing of Rivets and Riveted joints on CAD Software.
3. Preparation of related to Welds and Welded joints on CAD software.
4. Draw quarter sectional isometric view of Keys, Cotters and Shaft Joints.
5. Draw different types of bolts and nuts with internal and external threading in Acme and square threading standards. Save the bolts and nuts as blocks suitable for insertion.
6. Draw a 3D model of a machine component using 3D primitives and using commands like Union. Subtraction, Revolve, Slice, Rotate 3D etc. Calculate surface Area, Mass, Centre of Gravity and Mass moment of inertia using inquiry commands render the figure made and attach a material to the figure.
7. Draw 3D model of protected type flange coupling.
8. Draw an assembly of Jigs & Fixture in 3D.
9. Draw 3D model of Assembly of Plummer Block.
10. Draw 3D model of Assembly of Foot Step Bearing
11. Draw 3D model of Assembly of Screw Jack.
12. Draw 3D model of Assembly of Connecting Rod.
13. Draw 3D model of Assembly of Crane Hook.
14. Draw 3D model of Assembly of Lathe Tailstock.

Course Outcomes (COs): After the completion of the course, the student will be able to:

1. Develop proficiency in creating detailed technical drawings of machine components, adhering to industry standards and conventions.
2. Create and interpret various views/projections of mechanical components.
3. Gain proficiency in using CAD software to create precise 2D and 3D models of mechanical components and assemblies.
4. Create assembly drawings, showing how individual components fit together to form a complete machine or system.
5. Enhance their ability to work collaboratively in teams, communicating effectively with peers.
6. Develop the ability to document their design process and present their work clearly and professionally in technical reports.

MEEE-416P Internship-I							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P		Internal Assessment	End Semester Exam	Total	
0	0	0	6	Maximum Marks: 50	Maximum Marks: 50	100	3Hours
				Minimum Marks: 20	Minimum Marks: 20	40	

Eligibility for Exercising Exit Option and Pursuing Internship-I:

Those students without any backlogs who wish to leave the studies after completion/end of 2nd year, can exercise exit option for UG Diploma in Mechanical Engineering during registration for 4th semester (only for regular students (admitted in first year) and not applicable for lateral entry students). They will be required to obtain additional 6 credits summer internship (Internship-I (Exit)) of 8-weeks/2-months duration during summer term/summer vacations after 4th semester. The evaluation of such candidates shall be done within the first-two months of the running next semester i.e. 5th sem. The internship shall be completed by student during summer vacations after 4th semester, in local industry, government/private organization, entrepreneurs, craft and skilled persons for on-site experiential learning.

List of activities/projects to be completed by student:

1. The appropriate ***area of internship shall be identified by student in consultation with the faculty mentor and industrial supervisor*** (if any) during the course of 4th semester, ***by learning all concepts being taught in previous semesters and demonstrating hard work and genuine desire to learn.***
2. The student shall clearly state in his brief report to faculty supervisor regarding (a)What he/she intends to learn, acquire and clarify through this internship? (b) Use of try to use concrete, measurable terms in listing his/her learning objectives under each of the following categories:
   a) ***Knowledge and Understanding***
   b) ***Skills***
3. The student will clearly state and describe in his brief reports regarding
   a) ***Learning Activities*****:** How will internship activities enable him/her to acquire the knowledge/understanding, and skills listed to be acquired by students (above)?
   b) ***On the job*****:** How internship activities will enable him/her to meet his/her learning objectives. Student should include *projects, research, report writing, conversations, etc., which student will do while working, relating them to what he/she intends to learn.*
   c) ***Teaching/Mentoring Activities:*** How his/her technical knowledge can be applied at the site of the internship to create value through mentoring/help people learn new things.
   d) ***Off the job:*** List of appropriate study material for reading, writing, method to keep contact with faculty supervisor, peer group discussion, field trips, observations, etc., he/she will make and carry out which will help him/her to meet his/her learning objectives.
   e) ***Evidences:*** *Student will describe* in detail what other evidence he/she will provide to attached faculty mentor to document what was learnt (e.g. journal, analytic paper, project, descriptive paper, oral presentation, etc.) Deadline dates should be included.
   f) ***Evaluation:*** The faculty or internship supervisor will provide a written evaluation, preferably in a tabular format, and by defining rubrics used for evaluation of internship.
   g) ***The Internship Job Description*****:** Student will describe about role and responsibilities while on his/her internship. (in as much detail as possible), about list of assigned /expected duties, project to be completed, deadlines,etc., and description of contribution expected by the organization/site of internship.
4. The internship will be defended by student during 5th semester in front of appropriate committee (including faculty/ internship supervisor) as per schedule notified by academic department. The concerned department will review the Internship-I rigorously to discourage low quality internship work and to avoid exit options as an escape route, rather than a genuine learning curve.