Fourth Semester					
Theory					
Sl. No.	Category	Course Code	Course Title	L-T-P	Credit
1	HSMC	19CM3HS01T	Humanities-1/Management-1(OB/EEC)	3-0-0	3
2	ESC	19ME4ES01T	Fluid Mechanics and Hydraulics Machines	3-0-0	3
3	PCC	19ME4PC01T	Mechanics of Solids	3-0-0	3
4	PCC	19ME4PC02T	Kinematics of Machines	3-0-0	3
5	PCC	19ME4PC03T	Manufacturing Science - I	3-0-0	3
6	PEC	19ME4PE01T/ 19ME4PE02T	CIM & FMS; IC Engines & Gas Turbines	3-0-0	3
7	MC	19CM4MC01T	Mandatory(Constitution of India/ Essence of Indian Tradition Knowledge)		0
Total Credit (Theory)					18
Practical					
1	ESC	19ME4ES01L	Fluid Mechanics and Hydraulics Machines Laboratory	0-0-2	1
2	PCC	19ME4PC01L	Mechanics of Solids Laboratory	0-0-2	1
3	PCC	19ME4PC02L	Kinematics of Machines Laboratory	0-0-2	1
4	PCC	19ME4PC03L	Manufacturing Science - I Laboratory	0-0-2	1

Total Credit (Practical)	4
Total Semester Credit	22

Course Code:19CM4HS01T	**Course Name: Engineering Economics**	**L-T-P 3- 0- 0**	**Credit 3**

Module-1: **(8 Hours)**

Introduction to Economics: Definition, scope and nature of economics, consumption laws, demand & supply analysis, elasticity of demand& supply, indifference curve analysis.

Module-2: **(10 Hours)**

Production : factors of production, production function, law of variable proportion, laws of return to scale, elasticity of factor-substitution, optimal combination of factor-inputs, production efficiency, economies of scales,Cost of Production: types of costs, economic costs: fixed cost and variable costs, short-run and long-run cost functions.

Module-3: **(10 Hours)**

Market Structure: pure competition, perfect competition, imperfect market, monopoly andoligopoly. Indian Banking System, Functions and Roles of Commercial Banks and Reserve Bank of India.

Module-4: **(12 Hours)**

Time value of money and interest formulae,Nominal and effective rate of interest, Present, Annual and Future worth analysis, Rate of Return Analysis, Cost-Benefit analysis in Public sector projects.

Module- 5: (as per choice of faculty) **(8 Hours)**

Portion covered can be tested through Internal evaluation only not to be included in University examination.

Reference Books:

1. Koutsoyiannis, A., 'Modern Microeconomics', English Language Book Society, Macmillan.
2. Pindyck, R S, Rubinfeld, D L &Mehta , 'Microeconomics', 6 th Edition, Pearson Education India.
3. Varian, H R, 'Intermediate Microeconomics', 7th Edition, East West Press India.
4. Samuelson, Paul A, 'Economics', 5th Edition, McGraw Hill New York.
5. Basics of Engineering Economy; Leland Blank and Anthony Tarquin, TMH.
6. Contemporary Engineering Economics, Chan. S Park, Pearson.
7. Engineering Economics, Paneerselvam, PHI.
8. Engineering Economics; Sasmita Mishra.

Course Code:19CM4HS02T	Course Name: Organizational Behavior	L-T-P 3- 0- 0	Credit 3

Course Objectives:

Developing an understanding of the behavior of individuals and groups inside organizations by enhancing the skills in appreciating individuals, interpersonal, and group process for increased effectiveness both within and outside of organizations is the goal of any organization. Through this course students will develop theoretical and practical insights and problem-solving capabilities for effectively managing the organizational processes.

Syllabus:

Module-1: Fundamentals of OB: (6 Hours)

Definition, scope and importance of OB, Relationship between OB and the individual, Evolution of OB, Models of OB. Learning; Theories and their applications

Module 2: Foundations of Individual Behavior: (12 Hours)

Personality and values: Definition and importance of Personality for performance, The Myers-Briggs Type Indicator and The Big Five personality model, Significant personality traits suitable to the workplace (personality and job – fit theory), Personality Tests and their practical applications. Attitude; ABC Model. Perception: Meaning and concept of perception, Factors influencing perception, Selective perception, Perceptual errors.

Motivation: Definition & Concept of Motive & Motivation, The Content Theories of Motivation (Maslow's Need Hierarchy & Herzberg's Two Factor model Theory), The Process Theories (Vroom's expectancy Theory & Porter Lawler model), Contemporary Theories – Equity Theory of Work Motivation.

Module- 3: Foundations of Group Behavior: (8 Hours)

Group Dynamics, Types of Groups, The Five – Stage Model of Group Development.

Developing Work Teams, Team Effectiveness & Team Building.

Leadership: Concept, Types & Styles of Leadership, Traditional & Contemporary theories of leadership Success stories of today's Global and Indian leaders.

Module- 4: Foundations of Organizational Behavior: (10 Hours)

Organizational Culture; creating and maintenance. Organizational Change; concept and technique and theories of change. Organizational Development; concept and methods of doing development.

Course Outcomes:

1. Students will understand the essential of maintaining the inter-personal relationships in organizations.
2. Personality factors will be effectively used to understand the communication among groups.
3. The reasons for conflict will be known and prescriptive methods can be devised to enhance higher productivity in organizations.
4. Being an employee in an organization the importance of organizational change and culture can be known to all.

Text Books:

1. Organizational Behaviour, Robbins, Judge, Sanghi, Pearson.

Reference Books:

1. Organizational Behaviour, K. Awathappa, HPH.
2. Organizational Behaviour, VSP Rao, Excel.
3. Introduction to Organizational Behaviour, Moorhead, Griffin, Cengage.
4. Organizational Behaviour,Hitt, Miller, Colella, Wiley.

5. Organizational Behaviour, Suba Rao,Mishra, Himalaya.
6. Organisational Behaviour – Uma Sekharan.
7. Understanding Organizational Behaviour, Parek, Oxford.

Course Code: 19ME4ES01T	Course Name: Fluid Mechanics and Hydraulic Machines	L-T-P: 3-0-0	Credit: 3
Note: Each and every module must practice with computer program like C, C++, Matlab, etc.			

Course Objectives:

1. Analyse fluid and its usage in flow measurement, hydraulic Machines, etc.
2. Compute pressure through manometer and design and develop marine systems with the usage of hydrostatic forces and buoyancy.
3. Differentiate velocity, acceleration, rotation and deformation etc. of fluid particles
4. Establish Euler's theorem and deduce Bernoulli's equation or a ideal fluid and real fluids and examine and evaluate energy losses in fluid transmission trough pipes
5. Do the performance analysis of different turbines and pumps

Syllabus:

Module-1: **(8 Hours)**

Introduction: Scope of fluid mechanics and its development as a science Physical property of Fluid: Density, specific gravity, specific weight, specific volume, surface tension and capillarity, viscosity, compressibility and bulk modulus, Fluid classification.

Fluid statics: Pressure, Pascal's Law, Pressure variation for incompressible fluid, atmospheric pressure, absolute pressure, gauge pressure and vacuum pressure, manometer. Hydrostatic process on submerged surface, force on a horizontal submerged plane surface, force on a vertical

submerged plane surface. Buoyancy and floatation, Archimedes' principle, stability of immersed and floating bodies, determination of metacentric height.

Module-2: **(8 Hours)**

Fluid kinematics: Introduction, description of fluid flow, classification of fluid flow. Reynold's number, Acceleration of fluid particles, flow rate and continuity equation, differential equation of continuity, Mathematical definitions of irrotational and rotational motion. Circulation, potential function and stream function. Flow net

Module-3: **(8 Hours)**

Fluid dynamics : Introduction, Introduction to N-S equation, Euler's equation along a streamline, energy equation, Bernoulli's equation and its application to siphon, venturimeter, orificemeter, pitot tube. Flow in pipes and ducts: Loss due to friction, Minor energy losses in pipes Hydraulic Gradient Line (HGL), Total Energy Line (TEL), Power transmission in the fluid flow in pipes, fluid flow in pipes in series and parallel. Flow through nozzles.

Module-4: **(8 Hours)**

Hydraulic turbines: Classification, Impulse and Reaction turbine; Tangential, Radial and axial turbine. Impulse turbine, Pelton wheel, bucket dimensions, number of buckets in pelton wheel, efficiency and performance curves.

Reaction Turbines: Francis turbine and Kaplan turbine, velocity triangle and efficiencies, performance curve. Function of draft tube and casing cavitation.

Module-5: **(8 Hours)**

Centrifugal Pump: constructional features, vane shape, velocity triangles, Efficiencies, Multi stage centrifugal pumps, Pump Characteristic, NPSH and Cavitation.

Positive displacement pumps: Reciprocating Pump, Working principle, Discharge, work done and power requirement, Slip, Indicator diagram.

Course Outcomes:

1. Apply conservation laws to fluid flow problems in engineering applications.
2. Design experimental procedure for physical model studies.
3. Design the working proportions of hydraulic machines.
4. Compute drag and lift coefficients using the theory of boundary layer flows.
5. Analyze and design free surface and pipe flows
6. Formulate and solve one dimensional compressible fluid flow problems

Suggested Books:

1. Y. A. Cengel and J. M. Cimbala, Fluid Mechanics , Tata McGraw-Hill, 3rd Edition,2017, New Delhi
2. CSP Ojha and P.N. Chandramouli, Fluid Mechanics and Machinery, Oxford University Press, 4th Edition, 2010, New Delhi
3. S. K. Som and G. Biswas, Introduction to Fluid Mechanics and Fluid Machines, McGraw Hill Education, 6th Edition, 2017, New Delhi
4. R. W. Fox, A. T. McDonald and P. J. Pritchard, Introduction to Fluid Mechanics, John Wiley, 8th Edition, 2011, New Delhi
5. Piyush Kundu, Ira Cohen & David Dowling, Fluid Mechanics, Elsevier, 6th Edition, 2016, Cambridge

Digital Learning Resources:

Course Name	Fluid Mechanics and Hydraulic Machines
Course Link	https://swayam.gov.in/nd1_noc19_me55/
Course Instructor	Dr. Sankar Kumar Som, IIT Kharagpur

Course Code: 19ME4PC01T	Course Name: Mechanics of Solids	L-T-P: 3-0-0	Credit: 03
Note: Each and every module must practice with computer program like C, C++, Matlab, etc.			

Course Objectives:

1. Understand mechanics of deformable bodies and apply them in analysis and design problems
2. Analyze bodies subjected to two dimensional stress systems
3. Understand behaviour of structural members in flexure and Torsion
4. Evaluate slope and deflection in beams subjected to loading
5. Understand stability of columns and struts
6. Predict the stress distribution in beams, pressure vessels and shafts

Syllabus:

Module-I: **(8 Hours)**

Concept of Stress: Load, Stress, Principle of St.Venant, Principle of Superposition, Strain, Hooke's law, Modulus of Elasticity, Stress-Strain Diagrams, Working Stress, Factor of safety, Strain energy in tension and compression, Resilience, Impact loads, Analysis of Axially Loaded Members: Composite bars in tension and compression - temperature stresses in composite rods, Concept of Statically indeterminate problems. Shear stress, Complimentary shear stress, Shear strain, Modulus of rigidity, Poisson's ratio, Bulk Modulus, Relationship between elastic constants

Module-2: **(8 Hours)**

Biaxial State of Stress: Analysis of Biaxial Stress. Plane stress, Principal plane, Principal stress, Mohr's Circle for Biaxial Stress. Stresses in thin cylinders and thin spherical shells under internal pressure, wire winding of thin cylinders; Biaxial State of Strain: Two dimensional state of strain, Principal strains, Mohr's circle for strain, Calculation of principal stresses from principal strains, Strain Rossette.

Module-3: **(8 Hours)**

Shear Force and Bending Moment Diagrams: Shear force and bending moment. Types of load and Types of support. Support reactions, Relationship between bending moment and shear force, Point of inflection. Shear Force and Bending Moment diagrams.

Bending of Beams: Theory of simple bending of initially straight beams, Bending stresses, Shear stresses in bending, Distribution of normal and shear stress, Composite beams

Module-4: **(8 Hours)**

Deflection of Beams: Differential equation of the elastic line, Slope and deflection of beams by integration method and area - moment method; Theory of Columns: Long columns, Euler's column formula, Lateral buckling, Critical Load, Slenderness ratio, Eccentric loading of short column

Module-5: **(8 Hours)**

Torsion: Torsion in solid and hollow circular shafts, Twisting moment, Strain energy in shear and torsion, strength of solid and hollow circular shafts. Strength of shafts in combined bending and twisting, Close - Coiled helical springs.

Course Outcomes:

After completing the course, the students will be able to

1. Identify the different engineering materials, describe their properties and predict their behaviour under different types of loading.
2. Compute the stresses, strains, moments, deflections, etc. and derive the expressions used from the fundamentals.
3. Select materials, sizes and sections for various applications such as beams, shafts, pressure vessels, columns, etc. and justify the selection.
4. Determine mechanical properties by destructive and non-destructive methods.

Suggested Books:

1. S.P.Timoshenko and D.H.Young, Elements of Strength of Materials, Affiliated East West Press, 5th Edition, 2003, New Delhi
2. G. H. Ryder, Strength of Materials by Macmillan Publishers India Limited, 3rd Edition, 2002, Chennai
3. S.S.Rattan, Strength of Materials by Tata Mc Graw Hill, 3rd Edition, 2017, New Delhi
4. R.Subramaniam, Strength of Materials, Oxford University Press, 3rd Edition, 2016, New Delhi

Digital Learning Resources:

Course Name	Mechanics of Solids
Course Link	https://nptel.ac.in/courses/112/102/112102284/
Course Instructor	Prof. Ajeet Kumar, IIT Delhi

Course Code:19ME4PC02T	Course Name: Kinematics of Machines	L-T-P:3-0-0	Credit: 03
Note: Each and every module must practice with computer program like C, C++, Matlab, etc.			

Course Objectives:

1. Describe the concept of machines, mechanisms and inversion
2. Analyze planar mechanism for displacement, velocity and acceleration both by graphical and analytic method
3. Analyze planar mechanism for displacement, velocity and acceleration both by graphical and analytic method
4. analyze the function of different types of drive
5. Understand techniques for studying motion of machines and their components.

Syllabus:

Module-1: **(8 Hours)**

Kinematic fundamental: Basic Kinematic concepts and definitions, Degrees of freedom, Elementary Mechanism : Link, joint, Kinematic Pair, Classification of kinematic pairs, Kinematic chain and mechanism, Gruebler's criterion, Inversion of mechanism, Grashof criteria, Four bar linkage and their inversions, Single slider crank mechanism, Double slider crank mechanism and their inversion. Transmission angle and toggle position, Mechanical advantage.

Kinematic Analysis: Graphical analysis of position, velocity and acceleration of four bar and Slider crank mechanisms. Instantaneous centre method, Aronhold-Kennedy Theorem, Rubbing velocity at a Pin-joint. Coriolis component of acceleration.

Module-2: (8 Hours)

Mechanism Synthesis: Graphical methods of synthesis, Chebychev spacing for precision positions, Freudenstein's equation applicable to four bar linkages.

Mechanism Trains: Gear Terminology and definitions, Analysis of mechanism Trains: Simple Train, Compound train, Reverted train, Epicyclic train and their applications.

Module-3: (8 Hours)

Combined Static and Inertia Force Analysis: Inertia forces analysis, velocity and acceleration of slider crank mechanism by analytical method, engine force analysis - piston effort, force acting along the connecting rod, crank effort. Dynamically equivalent system, compound pendulum, correction couple.

Module-4: (8 Hours)

Friction Effects: Screw jack, friction between pivot and collars, single, multi-plate and cone clutches, anti friction bearing, film friction, friction circle, friction axis.

Flexible Mechanical Elements: Belt, rope and chain drives, initial tension, effect of centrifugal tension on power transmission, maximum power transmission capacity, belt creep and slip.

Module-5: (8 Hours)

Brakes &Dynamometers: Classification of brakes, Analysis of simple block, Band and internal expanding shoe brake, Braking of a vehicle. Absorption and transmission dynamometers, Prony brake, Rope brake dynamometer, belt transmission, epicyclic train, torsion dynamometer.

Course Outcomes

Suggested Books:

1. Thomas Bevan, Theory of Machines, CBS Publications, 3rd Edition, 2005, New Delhi
2. Charles E. Wilson and J. Peter Saddler, Kinematics and Dynamics of Machinery, Pearson Education, 3rd Edition, 2008, Chennai
3. J. S. Rao and R. V. Dukipatti, Mechanism and Machine Theory, New Age International, New Delhi, 1992
4. A. Ghosh & A. K. Mallick, Theory of Mechanisms and Machines, East West Press, 3rd Edition, 2008, New Delhi

Digital Learning Resources:

Course Name	Kinematics of Machines
Course Link	https://nptel.ac.in/courses/112/105/112105268/
Course Instructor	Prof. Anirvan Dasgupta, IIT Kharagpur

Course Code: 19ME4PC03T	Course Name: Manufacturing Science - I	L-T-P: 3-0-0	Credit: 03

Course Objectives:

1. To understand basic manufacturing processes like casting, welding and metal forming.
2. To learn various aspects of different manufacturing techniques such as various casting methods, welding methods and metal forming methods
3. To decide which manufacturing technology can be implemented for a specific product

Syllabus:

Module-1: **(10 Hours)**

Foundry: Typesofpatterns,patternmaterialsandpatternallowances: MoldingMaterials: sandmolding,metalmolding,investmentmolding,shellmolding, Compositionofmoldingsand,Silicasand,Zirconsand,binders,additives,Binders-clay, bindersforCO2sand,binderforshell molding,bindersforcoresand, Propertiesofmoldingsandandsandtesting; Meltingfurnaces: cupola,resistancefurnace,inductionandarcfurnace;

Solidification of castings, design of risers and runners, feeding distance, centre line freezing resistance chills andchaplets; Degasification and inoculation ofmetals; Castingmethodslikecontinuouscasting,centrifugalcasting,disc; casting; Castingdefects.

Module-2: **(8 Hours)**

Welding and cutting: Introduction to gas welding, cutting, Arc welding and equipment's. TIG (GTAW) and MIG (GMAW) welding, resistance welding and Thermit welding;

Modern Welding methods like plasma Arc, Laser Beam, Electron Beam, Ultrasonic, Explosive and friction welding; Edge preparation in butt welding. Brazing and soldering, welding defects; Destructive and non-destructive testing of castings and welding.

Module-3: **(8 Hours)**

Brief introduction to powder metallurgy process; Plastic deformation of metals: Variables in metal forming and their optimization. Dependence of stress strain diagram on Strain rate and temperature. Hot and cold working of metals, classification of metal forming processes; Forging: Smith Forging, Drop and Press forging, M/c forging, Forging defects;

Module-4: **(8 Hours)**

Extrusions: Direct, Indirect, Impact and Hydrostatic extrusion and their applications, Extrusion oftubes; Briefintroductiontosheetmetalworking:Bending,Forminganddeepdrawing,shearing;

Briefintroductiontoexplosiveforming,coatinganddepositionmethods;

Module-5: **(8 Hours)**

Wire drawing methods and variables in wire-drawing, Optimum dies shape for extrusion anddrawing; Rolling:PressureandForcesinrolling,typesofrollingmills,rollingdefects;

Course Outcomes:

On completion of the course, students will be able to

1. Recognize the different types of casting process.
2. Select suitable manufacturing process for typical components.
3. Describe the various welding process.
4. Explain the concept of forging, rolling process and drawing.

Suggested Books:

1. P. N. Rao, Manufacturing technology, Volume 1, Tata McGraw Hillpublication, 4th Edition, 2013, New Delhi
2. R. A. Little,Welding Technology , Tata McGraw Hill publication, 2017, New Delhi
3. A. GhoshandA.K.Malick, ManufacturingScience, EWP, 2nd Edition, 2010, New Delhi
4. P. C. Sharma,AText BooksofProductionEngineering, S. Chand Publishing, 11th Edition, 2019, New Delhi

Digital Learning Resources:

Course Name	Manufacturing Science - I
Course Link	https://nptel.ac.in/courses/112/107/112107219/
Course Instructor	Prof. D.K. Dwivedi, IIT Roorkee

Course Code: 19ME4PE01T	Course Name: Computer Integrated Manufacturing and Flexible Manufacturing System (CIM & FMS)	L-T-P: 3-0-0	Credit: 03

Course Objectives:

1. To learn the application of computers in manufacturing sectors.
2. To learn about NC part programming and robot programming
3. To learn application of computer in quality inspection, process planning, design.

Syllabus:

Module-1: (8 Hours)

FundamentalsofManufacturingandAutomation:Productionsystems,automationprinciplesand its strategies; Manufacturing industries; Types of production function in manufacturing; Automation principles and strategies, elements of automated system, automation functions and level of automation.

Module-2: (8 Hours)

Product/production relationship, Production concept and mathematical modelsforproductionrate,capacity,utilizationandavailability;Cost-benefitanalysis. Computer Integrated Manufacturing: Basics of product design, CAD/CAM, Concurrent engineering, CAPP and CIM.

Module-3: (14 Hours)

Industrial Robotics: Robot anatomy, control systems, end effectors, sensors and actuators; fundamentalsofNCtechnology,CNC,DNC,NCpartprogramming;Roboticprogramming,Robotic languages,workcellcontrol,Robotcleftdesign,typesofrobotapplication,Processingoperations, ProgrammableLogiccontrollers:PartsofPLC,OperationandapplicationofPLC,Fundamentalsof Net workings; Material Handling and automated storage and retrieval systems, automatic data capture,identificationmethods,barcodeandothertechnologies.

Module-4: (6 Hours)

Introduction to manufacturing systems: Group Technology and cellular manufacturing, Part families,Partclassificationandcoding,Productionflowanalysis,Machinecelldesign,Applications and Benefits of GroupTechnology.

Module-5: (8 Hours)

Flexible Manufacturing system: Basics of FMS, components of FMS, FMS planning and implementation, flexibility, quantitative analysis of flexibility, application and benefits of FMS. ComputerAidedQualityControl:objectivesofCAQC,QCandCIM,CMMandFlexibleInspection systems.

Course Outcomes:

1. Will be able to apply computer to manufacture industrial components.
2. Will understand the elements of an automated manufacturing environment.
3. Will able to make NC part programming and robot programming.

Suggested Books:

1. M.P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, Pearson Publication, 4th Edition, 2016, Chennai
2. P. Radhakrishnan, S. Subramanyam and V. Raju, CAD/CAM/CIM, New Age International,

4th Edition, 2018, New Delhi

3. J. Talavage and R. G. Hannam, Flexible Manufacturing Systems in Practice, Marcell Decker, US, 1987

Digital Learning Resources:

Course Name	Computer Integrated Manufacturing and Flexible Manufacturing System (CIM & FMS)
Course Link	https://nptel.ac.in/courses/112/104/112104289/
Course Instructor	Prof. Janakarajan Ramkumar,Prof. Amandeep Singh IIT KAnpur

Course Code: 19ME4PE02T	Course Name: Internal Combustion Engines & Gas Turbines; (ICE & GT)	L-T-P: 3-0-0	Credit: 03
Note: Each and every module must practice with computer program like C, C++, Matlab, etc.			

Course Objectives:

1. To understand the operation and performance of internal combustion engines.
2. To perform theoretical calculations and do practical to obtain different efficiencies for internal combustion engines.
3. To analyze the combustion process of fuels (gasoline and diesel).
4. To know of the roles of coolants and lubricants in engine operation.
5. To acquire the knowledge of various alternate fuels, engine emissions, measuring and control techniques.

Syllabus:

Module-1: (8 Hours)

Introduction : Classification, Engine nomenclature, engine operating and performance parameters, Valve timing diagram of SI & CI Engines, Comparison of SI and CI engine.

Thermodynamic Analysis of cycles : Significance of Fuel-Air & Actual cycles of I.C. engines. Comparison with Air Standard Cycles. Analysis of Fuel-Air & Actual cycles (Effect of chemical equilibrium and variable specific heats. Effect of air fuel ratio and exhaust gas dilution. Time

Loss Factor, Heat Loss Factor, Exhaust Blow down, Loss Due to Gas Exchange Processes, Volumetric Efficiency, Loss due to Rubbing Friction).

Fuels :Fuels of SI and CI engine, Fuel additives, Properties, potential and advantages of alternative liquid and gaseous fuels for SI and CI engines (biofuels, LPG and CNG), Fuel Induction Techniques in IC engines : Fuel induction techniques in SI and CI engines, Mixture Requirements at Different Loads and Speeds.

Module-2: **(10 Hours)**

Carburetion: Factors Affecting Carburetion, Principle of Carburetion, Simple Carburetor and its drawbacks, Calculation of the Air–Fuel Ratio, Modern Carburetors;

Fuel Injection: Functional Requirements of an Injection System, Classification of Injection Systems, Fuel Feed Pump, Injection Pump, Injection Pump Governor, Mechanical Governor, Pneumatic Governor, Fuel Injector, Nozzle, Injection in SI Engine, Electronic Injection Systems, Multi-Point Fuel Injection (MPFI) System, Functional Divisions of MPFI System, Injection Timing, Group Gasoline Injection System, Electronic Diesel Injection System; Ignition :Energy requirement for ignition, requirements of an ignition system, conventional ignition systems, modern ignition systems (TCI and CDI), firing order, Ignition timing, Spark advance mechanism;

Module-3: **(10 Hours)**

Combustion : Stages of combustion in SI and CI engines, effects of engine variables on flame propagation and ignition delay, Abnormal combustion, Preignition & Detonation, Theory of Detonation. Effect of engine variables on Detonation, control of Detonation. Diesel Knock & methods to control diesel knock, Requirements of combustion chambers. Features of different types of combustion chambers system for S.I. engine. (I-head, F-head combustion chambers), C.I. engine combustion chambers -Open and divided type, Air swirl turbulence-M. type combustion chamber. Comparison of various types of combustion chambers.

Super Charging &Scavenging : Thermodynamics Cycles of supercharging. Effect of supercharging, Efficiency of supercharged engines. Methods of super charging, supercharging and scavenging of 2- stroke engines.

Module-4: (8 Hours)

Testing and Performances :Power, fuel & air measurement methods, Performance characteristic curves of SI & CI engines, variables affecting performance and methods to improve engine performance;

Cooling & Lubricating Systems, Engine Emission &Controls :Air cooling & water cooling systems, Effect of cooling on power output & efficiency, Properties of lubricants and different types of lubricating system;

Modern developments in IC Engines, EGR, MPFI, CRDI, GDI, HCCI, dual fuel engine, Lean burn engine, Stratified engine (basic principles);

Engine Emission and control : Mechanism of pollutant formation and its harmful effects. Methods of measuring pollutants and control of engine emission.

Module-5: (8 Hours)

Axial Flow & Centrifugal Compressor : Basic construction of centrifugal and axial flow compressor, Velocity diagram, performance characteristics of centrifugal and axial flow compressor, effects of slip, surging and stalling on compressor.

Course Outcomes:

1. Demonstrate the working and performance of IC Engines through thermodynamic cycles
2. Interpret different fuels and their inductions in internal combustion engines.
3. Describe the ignition and combustion of a fuel in a combustion chamber with supercharging and scavenging.
4. Analyze the testing, performance and emission of an IC engine.
5. Discuss the function of cooling and lubrication system of an IC engine.
6. Explain the working of axial flow and centrifugal compressor.

Text Books:

1. Mathur & Sharma, Internal Combustion Engines, 18th Edition, Dhanpat Rai Publication, 2008, New Delhi
2. V. Ganesan, Internal Combustion Engines, 4th Edition, Tata McGraw Hill Publication, ,2016, New Delhi
3. V.Ganesan, Gas Turbines, 3rd Edition,Tata McGraw Hill publication, , 2016, New Delhi

References:

1. J. B. Heywood, Fundamentals IC Engines, Indian Edition , Tata McGraw Hill Publication, 2017, New Delhi
2. H.N. Gupta, Fundamentals of Internal Combustion Engines, 2nd Edition, Prentice Hall India Learning Private Limited(PHI), 2012, New Delhi
3. K. K. Ramalngam, Internal Combustion Engines, 3rd Edition, Scitech Publications, 2007, Chennai
4. R. K. Rajput, Internal Combustion Engines, 2nd Edition, Laxmi Publication, New Delhi

Digital Learning Resources:

Course Name	Internal Combustion Engines & Gas Turbines
Course Link	https://nptel.ac.in/courses/112/103/112103262/
Course Instructor	Prof. Pranab K. Mondal, Prof. Vinayak N. Kulkarni Department of Mechanical Engineering, IIT Guwahati

Course Code: 9ME4ES01L	Course Name: Fluid Mechanics and Hydraulics Machines	L-T-P: 0-0-2	Credit: 1

Course Objectives:

The students able to

1. known about basic concept of buoyancy force with the flow device.
2. impart training on flow measuring devices such as orifice.
3. provide practice in estimating friction losses.
4. get basic information about fluid flow and its mechanism
5. gain basic knowledge about fluid machine such as pump and turbine with basic concept of impact jet.

Syllabus:

List of the Experiments:

1. Determination of Metacentric Height and application to stability of floating bodies.
2. Determination of Cv and Cd of Orifices.
3. Experiments on impact of Jets
4. Experiments on performance of Pelton Turbine.
5. Experiments on performance of Francis Turbine
6. Experiments on performance of Kaplan Turbine
7. Experiments on performance of centrifugal pump

8. Experiments on performance of reciprocating pump
9. Experiments on Reynold's Apparatus
10. Experiments on Flow through pipes
11. Experiments on performance of Gear pump
12. Verification of momentum equation

Course Outcomes:

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

1. Compute coefficients of orifice.
2. Calibrate flow discharge measuring device used in pipes channels and tanks.
3. Determine fluid and flow properties of buoyancy.
4. Characterize laminar and turbulent flows.
5. Test the performance of pumps and turbines

Course Code:19ME4PC01L	Course Name: Mechanics of Solids Laboratory	L-T-P: 0-0-2	Credit: 01

Course Objectives:

The students able to

1. Determine material properties.
2. Understand fatigue phenomena.
3. Determine Surface material properties.
4. Understand spring properties
5. Determine strain and load relationship

Syllabus:

List of the Experiments:

1. Determination of tensile strength of materials by Universal Testing Machine
2. Determination of compressive strength of materials by Universal testing Machine
3. Determination of bending strength of materials by Universal Testing Machine
4. Double shear test in Universal Testing Machine
5. Determination of Impact strength of material (Charpy and Izod)
6. Determination of Hardness strength of materials (Brinnel, Rockwell and Vickers)
7. Determination of Rigidity modulus of material
8. Determination of Fatigue strength of material
9. Estimation of Spring Constant under Tension and Compression.
10. Load measurement using Load indicator, Load Cells.

11. Strain measurement using Strain Gauge.
12. Stress measurement using strain rosette.

Course Outcomes:

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

1. Evaluate fatigue strength of materials under different loading conditions
2. Evaluate material properties under different loading conditions
3. Determine surface hardness of materials
4. Determine spring constant under different loading condition
5. Evaluate strain vs load relationship under different loading condition

Course Code:19ME4PC02L	Course Name: Kinematics of Machines Laboratory	L-T-P: 0-0-2	Credit: 01

Course Objectives:

The students will able to

1. Understand the motion resulting from a specified set of linkages and to synthesize the mechanism.
2. Understand the effect of screw jacks, bearings and clutch.
3. Understand the basic concepts of toothed gearing and kinematics of gear trains.
4. Determine friction in brakes and dynamometer.

Syllabus:

List of Experiments:

1. Radius of gyration of compound pendulum
2. Radius of gyration of connecting rod
3. TRI –FILAR / BI-FILAR System
4. Experiment on Screw Jack
5. Experiment on Journal Bearing Apparatus
6. Experiment/Study on clutches
7. Experiment on Epicyclic Gear Train
8. Experiments on Simple/Compound/Reverted Gear trains
9. Experiment on Dynamometer

10. Experiment on Brake
11. Experiment on Coriolis component of acceleration

Course Outcomes:

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

1. Analyze the velocity and acceleration of links of different mechanisms.
2. Evaluate the effect of friction in screw jacks, bearings and clutch.
3. Design and develop a gear train as per power transmission & gear terminologies and can calculate velocity of gears.

Course Code: 19ME4PC03L	Course Name: Manufacturing Science - I Laboratory	L-T-P: 0-0-2	Credit: 01

Course Objectives:

1. To determine the grain size of the sand, clay content in the sand sample, permeability of the test sample and to find out tensile, compressive and shear strength of the moulding sand
2. To familiar with foundry practices.
3. To determine the strength of brazed and soldered joint
4. To familiar with different types rolling mills and extrusion processes
5. To make job using sheet metals.
6. To learn how to make wood pattern for making mould.

Syllabus:

List of Experiments:

1. Determination of grain size, clay content, permeability and green compressive strength of molding sand. (2 to 3 experiments)
2. Foundry Practices
3. Preparation of a wood pattern.
4. Determination of strength of brazed and solders joints
5. Practice and preparation of job in sheet metal using processes like forming and deep drawing.

6. Demonstration of different rolling mills
7. Demonstration of Extrusion processes

Course Outcomes:

Students are able to

1. Determine the grain size of the sand, clay content in the sand sample, permeability of the test sample and are able to determine the tensile, compressive and shear strength of the moulding sand.
2. know the foundry practices and are able to make patterns
3. determine strength of brazed and soldered joint
4. get familiar with different types of rolling mills and extrusion process.
5. are able to make job with sheet metals