ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY
GUWAHATI

Course Structure and Syllabus

(From Academic Session 2018-19 onwards)

B.TECH
MECHANICAL ENGINEERING
8th SEMESTER

ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY
Guwahati
Course Structure

(From Academic Session 2018-19 onwards)

B. Tech 8th Semester: Mechanical Engineering

Semester VIII/ B. TECH/ME

Sl. No.	Sub-Code	Subject	Hours per Week			Credit	Marks	
			L	T	P	C	CE	ESE
Theory								
1	ME181801	Manufacturing Methods	3	0	0	3	30	70
2	ME1818PE2*	Program Elective - 2	3	0	0	3	30	70
3	ME1818PE3*	Program Elective - 3	3	0	0	3	30	70
4	ME1818OE2*	Open Elective - 2	3	0	0	3	30	70
Practical								
1	ME181822	Project -2	0	0	12	6	100	50
2	ME181823	Grand Viva Voce-II	0	0	0	1	-	50
TOTAL			**12**	**0**	**12**	**19**	**220**	**380**
Total Contact Hours per week : 24								
Total Credits: 19								

Program Elective-2 Subjects		
Sl. No.	**Subject Code**	**Subject**
1	ME1818PE21	Air Conditioning
2	ME1818PE22	Mechatronics
3	ME1818PE23	Robotics and Applications
4	ME1818PE24	Compressors and Gas Turbines
5	ME1818PE25	Computational Fluid Dynamics
6	ME1818PE2*	Any other subject offered from time to time with the approval of the University

Program Elective-3 Subjects		
Sl. No.	**Subject Code**	**Subject**
1	ME1818PE31	Computer Integrated Manufacturing
2	ME1818PE32	Operations Management
3	ME1818PE33	Internal Combustion Engines
4	ME1818PE34	Composite Materials
5	ME1818PE35	Tribology
6	ME1818PE3*	Any other subject offered from time to time with the approval of the University

Open Elective-2 Subjects		
Sl. No.	**Subject Code**	**Subject**
1	ME1818OE21	Noise and Vibration Control
2	ME1818OE22	Industrial Safety Engineering
3	ME1818OE23	Engineering Economic Analysis
4	ME1818OE24	Automotive Mechanics
5	ME1818OE25	Machining and machine tools
6	ME1818OE2*	Any other subject offered from time to time with the approval of the University

Course Code	Course Title	Hours per week L-T-P	Credit C
ME181801	**Manufacturing Methods**	**3-0-0**	**3**

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

1. Determine mould filling time, total solidification time and design riser for vertical and bottom gating sand moulds.
2. Determine the maximum draft possible in a single pass rolling, number of stages (passes) required and rolling torque and power for given roll diameter, reduction required and coefficient of friction in cold working operation.
3. Determine the forging force required in a forging operation for a given material (defined by a flow curve) and reduction.
4. Determine the ram pressure (force) using Johnson equation in an extrusion process for a given reduction and given material (defined by a flow curve).
5. Determine the drawing force in a wire drawing operation for a given reduction and material (defined by a flow curve).
6. Design blanking and piercing die and punch for a given sheet metal.
7. Determine blank size, number of draws, die and punch size for a given sheet metal in a drawing operation.

MODULE 1: Melting of metals, gases in metals

Different furnaces used in melting. Gating system, Design for sand Casting –Vertical and bottom gating moulds, total solidification time, riser design, aspiration effect.

Solidification behaviour of pure metals and alloy metals, Centerline shrinkage. Special casting methods – Permanent mould casting – Pressure Die casting – Hot chamber, Cold chamber and Air blown methods – Low-pressure die casting, Continuous casting. Non-metallic mould casting – Centrifugal casting, Investment casting.

Casting defects, their causes and remedies, Fettling of casting and Inspection.

MODULE 2: Behaviour of metal in metal in forming

Flow curve and average flow stress, Hot, Cold and Warm working – Variables affecting mechanical working process.

Rolling – Principle – Condition for continuous rolling and maximum draft possible, Forces and power in rolling – Methods for reduction of roll separating force – Rolling mills – Roll pass design – Thread rolling, ring rolling, gear rolling and Roll Piercing – rolling defects.

Forging – Forge ability – Metallurgy of Forging – Open die forging operations, analysis of open die forging, forging force, forging hammers and presses, closed die forging – Drop forging, Press forging, machine forging – Forging die design factors – Forging Defects.

Extrusion – Classification – Analysis of extrusion process, determination ram pressure – Variation of ram pressure with ram travel – Principle of operations of Hydrostatic extrusion, side extrusion, impact and Hooker's extrusion – Defects in extrusion.

Wire, Rod and Tube drawing – Principle and Operation – drawing equipment, drawing die – preliminary operations – tube drawing methods – Analysis of drawing, drawing force, maximum reduction per pass.

MODULE 3: High Energy Rate Forming

Reasons that prompted transition to HERF – Classification – Principles and operations of Explosive Forming, Electro-hydraulic Forming, and Electromagnetic Forming – High Velocity Forming, Principles and Operations of Petro-forging, Dynapak.

MODULE 4: Press working and sheet metal operations

Classification, forming limit diagram – Different types of Press and Selection of Presses – Pattern layout and allowances – Various cutting and forming operations – Principles and Operations of Cutting/Shearing, design for blanking and piercing operations – Methods of reduction of cutting forces. Deep drawing operations – Design for deep drawing – Methods for redrawing – Defects in sheet metal formed parts.

MODULE 5: Surface Finishing Operations

Classification – Principle and Operations of Lapping, Honing, Super finishing, Polishing, Buffing, Tumbling and Burnishing.

MODULE 6: Manufacture of threads and gears

Threads manufacturing – Different methods – Casting, Thread Chasing, Thread Rolling, Die and Tapping, Milling and grinding.

Gear manufacturing - Different Methods – Casting, Forming and Metal removal. Gear Cutting and Gear Generation Processes. Gear Finishing Operations.

MODULE 7: Powder Metallurgy

Advantages and applications of P/M – Powder Characteristics – Powder production methods – Mixing and Blending, Briquetting techniques – Sintering and presintering – Secondary Processes, Infiltration and Impregnation – Production of Cemented carbides.

Textbooks/ Reference Books:

1. Elements of Workshop Technology (Vol. I & II) – S.K. Hajra Choudhury and A.K. Hajra Choudhury.
2. Manufacturing Science–Amitabha Ghosh and Ashok Kumar Mallick, East West Press
3. Production Engineering – P.C. Sharma, S. Chand & Company Ltd.
4. Metal Forming Technology – Dr. R. Narayanasamy, Ahuja Book Co. Pvt. Ltd
5. Mechanical Metallurgy – G.E. Dieter, McGraw Hill

Course Code	Course Title	Hours per week L-T-P	Credit C
ME1818PE21	**Air Conditioning**	**3-0-0**	**3**

Course Outcomes(COs):

1. Given any three psychrometric properties of air students will be able to calculate all other psychrometric properties using equations and/or psychrometric chart.
2. Students will able to define human thermal comfort, its indices and comfort charts and also able to demonstrate the relationship between thermal comfort and human health based on thermodynamics of human body.
3. Students will be able to illustrate different psychrometric processes on the psychrometric charts. Students will be able to calculate the psychrometric properties of air after undergoing a psychrometric process or a combination of more than one psychrometric process.
4. Students will be able to design an air conditioning system for a room for given indoor and outdoor design conditions.
5. Students will be able to design a duct system using any one of the different duct design methods namely equal friction method, velocity reduction and static regain method.

MODULE 1: Psychrometry

Psychrometric properties, representations of properties in charts, preparation of charts

MODULE 2: Psychrometric processes

Constant sensible heat and latent heat processes, adiabatic saturation and enthalpy deviation. Adiabatic mixing of air stream. Humidification, Dehumidification water spray processes, sensible heat factors, grand sensible heat ratio lines, apparatus dew points, Bypass factors, Air washer-humidifying efficiency

MODULE 3: Comfort A/C

Air temperature, human health, body temperature regulation, comfort indices, comfort charts and their limitations

MODULE 4: Load analysis

Inside and outside design conditions, load classification, summer cooling loads, solar heat gain and transmission and radiation. Flywheel effect of building materials, equipment temperature differential loads due to human beings, load due to electric light, equipment and appliances. Infiltrator and ventilator loads, product loads, miscellaneous loads such as duct heat gain, duct air leakage, fans, pumps etc. Winter heat load – computation of loads

MODULE 5: Duct design and Air distribution

Different methods of duct design such as velocity reduction, equal friction and static regain, aspect ratio duct losses, distribution of air in rooms, nature and supply grill; duct arrangement and air handling system

MODULE 6: A/C System

Unitary control system, special features of residential, commercial and industrial A/C system, Year round a/c zoning

MODULE 7: Equipment

(1) Fans – types of fans, characteristics, curves, fan selection. (2) Air filter and cleaner. (3) Cooling towers, evaporators, condensers (4) Cooling coils and water capacity, (5) Chemical dehumidifiers, (6) Heaters, radiators, Convection coils

MODULE 8: Instruments and controls

Temperature, humidity, air velocity measuring instruments, Thermostat, humidistat. By pass and damper control. Dew point control, noise control, Pneumatic control

Textbooks/ Reference Books

1. Refrigeration and Air-Conditioning by Ahmedul Ameen, PHI
2. Refrigeration and Air-Conditioning by C.P.Arora, Tata McGraw Hill Publication.
3. Refrigeration and Air-Conditioning by M.Prasad

Course Code	Course Title	Hours per week L-T-P	Credit C
ME1818PE22	**Mechatronics**	**3-0-0**	**3**

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

1. Critically evaluate components of integrated systems
2. Design complete systems by justifying the use of sensors, actuators, control circuits
3. Code logics into PLC and develop closed loop control processes.
4. Utilize Computer Numerical Control to automate manufacturing processes.
5. Learn about Robot hardware and functioning

MODULE 1: Basic concepts
Definition of Mechatronics, Mechatronics in manufacturing, products and design.

MODULE 2: Review of fundamentals of electronics
Data conversion devices, sensors, transducers, signal processing devices, relays, microprocessors, and PLCs.

MODULE 3: Drives
Stepper motors, servo drives, ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, and transfer systems.

MODULE 4: Hydraulic systems
Flow, pressure and direction control valves, actuators, hydraulic pumps, design of hydraulic circuits.

MODULE 5: Pneumatics
Production, distribution and conditioning of compressed air, system components and graphic representations, design of systems.

MODULE 6: Controllers
Description of proportional, integral and derivative (PID) controllers.

MODULE 7: CNC machines and part programming

MODULE 8: Industrial Robotics

Textbooks/ Reference Books:

1. Mechatronics-Electronic Control Systems in Mechanical and Electrical Engineering, W. Bolton, Pearson Education Ltd, 2006.
2. Mechatronics-Principles and Applications, Godfrey and Onwubolu, Butterworth-Heinemann, 2006.
3. Computer Automation in Manufacturing - an Introduction, T. O. Boucher, Chapman and Hall, 1996

Course Code	Course Title	Hours per week L-T-P	Credit C
ME1818PE23	**Robotics and Applications**	**3-0-0**	**3**

Course Outcomes (COs):

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

1. Relate basic concepts of robotics for robot classification, anatomy, coordinate systems, degrees of freedom, work envelope, and robot specification to understand its operation.
2. Apply the knowledge of drive systems, actuators, sensors, and control methods to understand the design and working of robots.
3. Model forward and inverse kinematics of robot manipulators and analyze forces in links and joints of a robot.
4. Develop the knowledge of robot vision for image processing, analysis and object recognition.
5. Develop robot programming to perform tasks in industrial applications and extend the knowledge of artificial intelligence (AI) in robotics.

MODULE 1: Overview of Robotics

Definition and classification of robot manipulators, coordinate frames, robot configuration, motion and degrees of freedom, work envelope, uses, field of applications, robot specifications.

MODULE 2: Structure and Control of Robotic System

Robot anatomy, mechanical design of robot end-effectors (grippers), gripper mechanism and fingers, robot drive systems, electric drives and servo control in robotics, hydraulic and pneumatic actuators.

MODULE 3: Robot Arm Kinematics

Introduction to direct and inverse kinematics, geometric representation of rotation matrices, Euler angle representation, links and joints parameters, homogeneous transformation and D-H representation, arm matrix and kinematic equation for robot manipulator.

MODULE 4: Robot Arm Dynamics

Jacobian and force vectors, joint velocities, kinetic energy and potential energy of a robot manipulator, Lagrange-Euler formulation for motion, dynamic equation of a robot manipulator, planning of manipulator trajectory.

MODULE 5: Introduction to Sensors and Robot Vision

Classification of sensors and their functions, overview of computer vision and robotic applications of vision, elements of a vision system, lighting techniques and devices, image processing and analysis, object recognition.

MODULE 6: Robot Programming

Introduction to robot programming, application of robot programming for simple functions, introduction to artificial intelligence in robotics, mobile robotics and distributed robotics.

Textbooks/ Reference Books:

1. Robotics: Control, Sensing, Vision and Intelligence – K.S. Fu, R.C. Gonzalez and C.S.G. Lee, McGraw-Hill.
2. Introduction to Robotics – J. J. Craig, Addision-Wesley.
3. A Textbook on Industrial Robotics – Ganesh S. Hegde, University Science Pres

Course Code	Course Title	Hours per week L-T-P	Credit C
ME1818PE24	Compressors and Gas Turbines	3-0-0	3

Course Outcomes(COs):

1. Explain different parts of compressors, gas turbines and jet engines
2. Explain basic details of Turboprop, Turbofan, Turbojet and Ramjet systems.
3. Analyze turbomachines by applying Euler's equation.
4. Perform thermodynamic analysis for turbines and compressors.
5. Choose appropriate blading material for particular applications of turbine and compressor.

MODULE 1: Introduction

Classification of Turbo machines, Application of Euler equation to radial and axial flow turbomachines.

MODULE 2: Centrifugal Compressors

Impeller, blade shape, diffuser, velocity diagram, inlet guide vane and pre-whirl, slip, work done, pressure rise, temperature rise, enthalpy-entropy diagram, efficiency, characteristics, surging.

Axial-flow Compressors: Stage, stage blading arrangement, velocity diagram, blade angles, thermodynamics of the compressor stage, enthalpy-entropy diagram, efficiency, degree of reaction, stage pressure and temperature rise, work done factor, stage loading, pressure ratio of a multistage compressor, surging and stall, characteristics curve.

MODULE 3: Axial-flow Turbines

Impulse Turbines: Single stage and multi stage turbine, blading, velocity diagram, blading efficiency, Thermodynamics of stage, stage enthalpy-entropy diagram, efficiency.

Reaction Turbine: Stage, blading, stage velocity diagram, Thermodynamics of the stage, enthalpy-entropy diagram, efficiency, degree of reaction, free vortex design, variation of degree of reaction with radius, flow characteristics of multistage turbine.

Gas Turbine: Combined cycles, compounding and governing of gas turbine.

MODULE 4: Combustion system

Types of combustion chambers, the combustion chamber performance.

Blading material: Influence of blading material on the maximum temperature of the cycle, desirable properties of a gas turbine blading material, various blading material and their strength and weakness

MODULE 5: Jet Propulsion

Turboprop, turbofan, turbojet and ramjet systems, matching of turbine and compressor.

Textbooks/ Reference Books:

1. Gas Turbine Theory – H.Cohen, G.F.C. Rogers and H.T.H. Saravanemuttoo (Longman Scientific and Technical)
2. Turbines, Compressors and Fans- S.M.Yahava (Tata McGraw-Hill)
3. Gas Turbines and Propulsive system- P.P. Khajuria and S.P. Dubey (Dhanpat Rai and Sons)

Course Code	Course Title	Hours per week L-T-P	Credit C
ME1818PE25	**Computational Fluid Dynamics**	**3-0-0**	**3**

MODULE 1: The Basic Equations of Fluid Dynamics
General form of a Conservation law: equation of mass conservation, conservation law of momentum, conservation equation of Energy.

MODULE 2: The dynamic levels of approximation
The Navier-Stokes(NS) equation: The Reynold's averaged NS equation, The thin layer NS approximation, The parabolized NS approximation, The boundary layer approximation The distributed loss model, The inviscid flow model, Euler equations, steady inviscid rotational flow, The potential flow model, small disturbance approximation of the potential equation, Linearised potential flow, singularity methods, mathematical nature of flow equations.

MODULE 3: Basic discretization techniques
(a)The finite difference method, (b)The finite volume method and conservative discretization.

MODULE 4: Analysis and application of Numerical schemes
Consistency, stability, convergence, Fourier and Von Neumann stability analysis, modified equation, application of finite difference methods, to wave, heat. Laplace and Burger's equation.

MODULE 5: Solution methods
Solution of 1D heat conduction equation, wave equation, Laplace equation using various schemes.

MODULE 6: Heat Transfer
Basics of finite difference and finite element methods: Numerical methods for conduction heat transfer, Numerical methods for convection heat transfer, Numerical methods for radiative heat transfer.

Textbooks/ Reference Books:

1. Computational Fluid Mechanics and Heat Transfer—Hemisphere-Anderson, Tannehill, Pletcher.
2. Computational Heat Transfer-Hemisphere and Springer-Verlag-Jaluria and Torrance
3. Computational techniques for Fluid Dynamics-Verlag-Fletcher and Springer

Course Code	Course Title	Hours per week L-T-P	Credit C
ME1818PE31	**Computer Integrated Manufacturing**	**3-0-0**	**3**

Course Outcomes (COs):

At the completion of the course the student will be able to:

1. Apply the concept of CIM in automated manufacturing systems.
2. Apply the concept of computer aided design in manufacturing and assembly.
3. Apply the knowledge of production and process planning in manufacturing systems.
4. Design flexible manufacturing cell by applying concept of Group Technology and FMS.
5. Apply data management for decision making in CIMS.

MODULE 1: Introduction

Introduction to Automation: Automated Manufacturing system; Need of automation, Basic elements of automation, Levels of automation, Advantages & disadvantages of automation, Concept of CIM, information flow in CIM, elements of CIM, benefits and limitations.

MODULE 2: CAD/CAM

Product Design and CAD, application of computers in design, scope of CAD / CAM and CIM, concurrent engineering, design for manufacturing and assembly.

MODULE3: Production Planning and Control

Process planning – Computer Aided Process Planning (CAPP), Logical steps in Computer Aided Process Planning, Aggregate Production Planning and the Master Production Schedule, Material Requirement planning, Capacity Planning, Control Systems, Shop Floor Control, Inventory Control, manufacturing resource planning and enterprise resource planning.

MODULE 4: Group Technology

Concept, design and manufacturing attributes, part families, composite part, methods of grouping, PFA, classification and coding system- OPITZ– Relevance of GT in CIM, GT and CAD, benefits and limitations of GT.

MODULE 5: Flexible Manufacturing Systems

Flexible & rigid manufacturing cell and FMS structure, types, components of FMS, Building Blocks of FMS, Flexible Assembly System

MODULE 6: Data Acquisition and Database Management Systems

Data acquisition system, type of data, automatic data identification methods, bar code technology, Data and database management system, database design requirements, types of DBMS models-hierarchical, network and relational models and their applications.

Textbooks/ Reference Books:

1. CAD/CAM (Dhan Pat Rai & Sons.) ------ S. Kumar and A.K. Jha
2. Computer Integrated Manufacturing (PHI) ------ S. K. Vajpayee.
3. Mechatronics, HMT Ltd., (Tata Mc Graw Hills)

Course Code	Course Title	Hours per week L-T-P	Credit C
ME1818PE32	Operations Management	3-0-0	3

Course Outcomes (COs):
This course aims to improve students understanding of the concepts, principles, problems, and practices of operations management. After completing this course, students should be able to:

1. To anticipate the importance of productivity and competitiveness to both organizations and nations.
2. To recommend the various production and operations design decisions and to relate them for the overall strategies of organizations.
3. To analyze the relationship of the various planning practices of capacity planning, project planning and scheduling.
4. To summarize the roles of inventories and basics of managing inventories in various demand settings.
5. To relate the contemporary operations and manufacturing organizational approaches and the supply-chain management activities in organizational strategy.

MODULE 1: Operations Management
Introduction, Operations Management and Strategy, Tools for Implementation of Operations.

MODULE 2: Forecasting
Introduction, The Strategic Importance of Forecasting, Benefits, Cost implications and Decision making using forecasting, Classification of Forecasting Process, Methods of Forecasting, Forecasting and Product Life Cycle, Selection of the Forecasting Method, Qualitative Methods of Forecasting, Quantitative Methods, Accuracy of Forecasting

MODULE 3: Inventory Management
Need for holding stock, Planning and controlling stock levels, Product Classification, Demand analysis, ABC analysis, Product Coding. Inventory Cost and Service, Lead Time, Management of Stock Levels, Replenishment Methods

MODULE 4: Layout Planning
Introduction, Objectives of Layout, Classification of Facilities, Why Layout decisions are important, Nature of layout problems, redesigning of a layout, Manufacturing facility layouts, Types of Layouts, Layout Planning, Evaluating Plant Layouts

MODULE 5: Total Quality Management
Introduction, Meaning and Dimensions of Quality, Quality Control Techniques, Quality Based Strategy, Total Quality Management (TQM), Towards TQM – ISO 9000 as a Platform

MODULE 6: Supply Chain Management
Introduction, Domain Applications, Views on Supply Chain, Bullwhip Effect in SCM, Collaborative Supply Chain, Inventory Management in Supply Chain, Financial Supply Chain

MODULE 7: Operations Scheduling
Introduction, Purpose of Operations Scheduling, Factors Considered while Scheduling, Scheduling Activity under PPC, Scheduling Strategies, Scheduling Guidelines,

MODULE 8: Value Engineering
Introduction, Value Engineering/Value Analysis, Relevance of VE in Modern Manufacturing, Process of Value Analysis, VE– Approaches and Aim, Providing Value to the Customers, Benefits

MODULE 9: Project Management
Planning Process: Introduction, need, Project Management Principles, Essentials of Project Management Philosophy, Project Planning, Project Process Flows.

Textbooks/ Reference Books:

1. Heizer, Render, Principles of Operations Management 7th Edition, Prentice Hall, 2008.
2. Heizer, Render, Principles of Operations Management 8th Edition, Prentice Hall, 2011.
3. David Collier and James Evans, OM, 2nd Edition. Upper Saddle River, NJ: South-Western Cengage Learning, 2010/2011. ISBN-13: 978-0538745567
4. Jacobs, F.R. & R. B. Chase. Operations and Supply Chain Management 13th Edition, Boston: McGraw-Hill Irwin, 2010.

Course Code	Course Title	Hours per week L-T-P	Credit C
ME1818PE33	**Internal Combustion Engines**	**3-0-0**	**3**

Course Outcomes (COs):

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

1. Analyze and compare the real cycles with ideal air standard cycles to estimate the losses occurring during the run of an I.C. Engine.
2. Apply the properties of fuels and analyses the combustion processes in automotive IC engines including the state-of-the-art technologies of MPFI, CRDI and DGI engines to understand their effect on engine efficiency and emissions.
3. Estimate the primary design parameters, namely, stroke, bore, compression ratio, air-fuel ratio and rated speed of components of internal combustion engines from required performance parameters.
4. Critically examine the causes of unwanted exhaust emissions, their effects on the environment and measures to reduce such emissions from the study of chemistry of combustion and emission control technologies.
5. Estimate the performance of I C engines under various load conditions and throttle positions in a suitable test rig and compare the results for single cylinder and multi-cylinder of I.C. engines, namely SI and CI engines.

MODULE 1:

Fuel Air cycle – effect of variation of specific heats, fuel-air ratio, compression ratio and dissociation. Actual cycle – losses in actual cycle.

MODULE 2:

Exhaust gas analysis – its interpretation and use in determination of combustion characteristics; Pollution norms

MODULE 3:

I C engines fuels - - Petrol, Diesel, natural gases and some other alternative fuels and their characteristics and use in engines. Combustion process in S. I. And C. I. engines, abnormal combustion, detonation and fuel knock – additives. Rating of I. C. engine fuel.

MODULE 4:

Design features of combustion chambers used in S I and C I engines, some important types of combustion chambers.

MODULE 5:

Carburetion – desirable characteristics – compensation for simple jet carburetor, calculation for air-fuel ratio.

MODULE 6:

Injection processes – requirements and methods –mechanical, electronic and MPF injection system.
Ignition processes in petrol engines – requirements and types – battery magneto and electronic.

MODULE 7:
Performance characteristics of petrol and Diesel engines. Part load and full load characteristics in respect to thermal efficiency, mechanical efficiency, fuel consumption, bmep and torque. I C engine ratings and volume capacity compression ratio and weight to power output ratio and its trends in power – weight characteristics. Supercharging of I C engines – effect of supercharging on Diesel and petrol engines – performance characteristics for supercharged engines.

MODULE 8:
Supercharger – types, principles of duel-fuel and multi-fuel engines and Stratified combustion engines.

Textbooks/ Reference Books:

1. A course in Internal Combustion engines, M. L. Mathur and R. P. Sarma, 5th edn, 2014
2. Internal Combustion Engine fundamentals, John B. Heywood, 5th edn, McGraw-Hill international edition, 1988.
3. Internal Combustion Engines, V Ganesan, Tata McGraw Hill Publication, 2nd edn, 2003.
4. Engineering Fundamentals of Internal Combustion Engine, W W Pulkrabek, Pearson Education, 5th Edn. 2013.
5. Fundamentals of Internal Combustion Engine, H.N.Gupta, 2nd Edn, PHI Pvt Ltd, 2013.
6. A textbook of Internal Combustion Engines, S S Thipse, 2nd Rev Edn, Jaico Publishing house, 2014.

Course Code	Course Title	Hours per week L-T-P	Credit C
ME1818PE34	**Composite Materials**	**3-0-0**	**3**

Course Outcomes (CO's): After completion of the course, students will be able to

1. Identify different materials to design composites structures.
2. Compare the set of technological properties of the advanced materials with the conventional materials.
3. Use different techniques to process different types of composites and know the limitations of each process.
4. Understand various applications of composite materials in modern industries such as aerospace, automotive, bio-medical etc.
5. Understand different composite testing methods to obtain its material properties.

MODULE 1: Introduction to Composites

Fundamentals of composites, need for composites, enhancement of properties classification of composites, Reinforcement, particle reinforced composites, Fibre reinforced composites. Applications of various types of composites. Fiber production techniques for glass, carbon and ceramic fibers

MODULE 2: Polymer Matrix Composites

Polymer resins- thermosetting resins, thermoplastic resins, reinforcement fibres- various types of fibres. PMC processes- hand layup, spray up, compression moulding, injection moulding, resin transfer moulding, Pultrusion, Filament winding. Fibre reinforced plastics (FRP), Glass Fibre Reinforced Plastics (GFRP), Laminates- Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Applications of PMC in aerospace, automotive industries

MODULE 3: Metal Matrix Composites

Characteristics of MMC, various types of metal matrix composites, advantages of MMC, limitations of MMC, Reinforcements – particles – fibres. Effect of reinforcement – volume fraction – rule of mixtures. Processing of MMC – powder metallurgy process, diffusion bonding, stir casting, squeeze casting, a spray process, Liquid infiltration In-situ reactions-Interface-measurement of interface properties. applications of MMC in aerospace, automotive industries

MODULE 4: Testing of Composites

Mechanical testing of composites, tensile testing, Compressive testing, Intra-laminar shear testing, Inter-laminar shear testing, Fracture testing etc.

Textbooks/ Reference Books:

1. Bhargava, A. K., Engineering Materials: Polymers, Ceramics and Composites, Prentice Hall India.
2. Chawla K. K., "Composite materials", Second Edition, Springer.

Course Code	Course Title	Hours per week L-T-P	Credit C
ME1818PE35	**Tribology**	**3-0-0**	**3**

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

1. Understand the fundamentals of tribology and associated parameters.
2. Apply concepts of tribology for the performance analysis and design of components experiencing relative motion.
3. Analyze the requirements and design hydrodynamic and hydrostatic journal and plane slider bearings for a given application.
4. Select proper bearing materials and lubricants for a given tribological application.
5. Apply scientific information and knowledge about tribological problems and solutions to industry.

MODULE 1: Introduction

Introduction, history of tribology, Viscosity, flow of fluids, viscosity and its variation absolute and kinematic viscosity, temperature variation, viscosity index determination of viscosity, different viscometers, Tribological considerations, Nature of surfaces and their contact

MODULE 2: Friction and Wear

Role of friction and laws of static friction, causes of friction, theories of friction, Laws of rolling friction; Friction of metals and non-metals; Friction measurements, Friction Instability. Definition of Wear, mechanism of Wear, types and measurement of wear, friction affecting wear, Theories of wear; Wear of metals and non-metals.

MODULE 3: Hydrodynamic theory of lubrication

Principle of hydrodynamic lubrication, Various theories of lubrication, Petroff's equation, Reynold's equation in two dimensions, Effects of side leakage, Reynolds equation in three dimensions, Friction in sliding bearing, hydro dynamic theory applied to journal bearing, minimum oil film thickness, oil whip and whirl, anti-friction bearing, hydrodynamic thrust bearing.

MODULE 4: Hydrostatic lubrication

Principle of hydrostatic lubrication, General requirements of bearing materials, types of bearing materials., Hydrostatic step bearing, application to pivoted pad thrust bearing and other applications, Hydrostatic lifts, hydrostatic squeeze films and its application to journal bearing, optimum design of hydrostatic step bearing.

MODULE 5: Lubrication and Lubricants

Importance of Lubrication, Boundary Lubrication, Mixed Lubrication, Full Fluid Film Lubrication, Hydrodynamic, Elasto-hydrodynamic lubrication, Types & Properties of Lubricants, Lubricants Additives, bearing materials, bearing constructions, oil seals, shields and gaskets

Textbooks/ Reference Books:

1. Basu, Sengupta and Ahuja, "Fundamentals of Tribology", PHI
2. Majumdar, B. C, "Tribology", S. Chand Co.

Course Code	Course Title	Hours per week L-T-P	Credit C
ME1818OE21	**Noise and Vibration Control**	**3-0-0**	**3**

MODULE 1: Noise and Its Measurement
Wave Propagation, Decibel level, Frequency Analysis, Sound pressure level and its measurement, Noise Pollution regulation and control rules, Sound Level Meter.

MODULE 2: Vibration and Its Measurement
Vibration of single and multiple degree(s) of freedom system, Transmissibility, Critical Speed, Dynamical Analogies, Vibration of Beams and plates, Vibration Measurement

MODULE 3: Vibration Control
Vibration control at source, vibration Isolators, Dynamic vibration Absorber

MODULE 4: Acoustics of Rooms, Partitions, Enclosures ad Barriers
Sound field in a room, Acoustics of a Partition wall ad enclosures

MODULE 5: Noise Control Strategies
Control of Noise at source, Control of Noise in the path Control of Noise at the receiver end, Control of Noise of an existing facility

Textbooks/ Reference Books:

1. "Noise and Vibration Control", by M L Munjal, IISc Press, World Scientific Publishing Co. Pte Ltd., Singapore.
2. "Engineering Noise Control" by D.A. Bies, C.H. Hansen, Spon press London
3. Industrial Noise and Vibration Control, by J.D. Irwin, E.R. Graf, Prentice Hall, Englewood Cliffs
4. Notifications issued, time to time, by of GOI regarding Noise/Sound and vibrations

Course Code	Course Title	Hours per week L-T-P	Credit C
ME1818OE22	Industrial Safety Engineering	3-0-0	3

Course Outcomes (COs):

On successful completion of this course the student should be able to:

1. Understand the basic concepts and terminologies in industrial safety engineering.
2. Apply various techniques to analyses failure modes.
3. Assess industrial risk and losses.
4. Identify unsafe components in industry and conduct safety audit.
5. Develop fire protection systems in industry.

MODULE 1: Key concepts and basic terminologies

History of Industrial Safety Movement in India and abroad. Basic concepts and importance of industrial safety, key concepts and basic terminologies like safety, risk, accidents, incidents, mishaps, hazards, hazard-mishap entity, examples of hazard components and its description, hazard theory, hazard triangle and hazard analysis, causal factors, hazard actuation, hazard causal factors. Fundamental concepts in safety domain ontology and accident causation.

MODULE 2: Failure modes and effects analysis

Failure modes and effects analysis (FMEA), its history and importance, identification of failure modes, system breakdown concept, methodology and example of a case study of identifying failure modes of compressor sub system.

MODULE 3: Failure tree analysis

Failure tree analysis (FTA), its history and importance, different measures, primary failures, secondary failures, command failures, event symbols, gate symbols with application, failure tree construction concept, P-S-C concept of failure analysis, example of fault tree construction and analysis of gas oven burner system.

MODULE 4: Industrial risk and losses

Concept and definition of industrial risk, risk profile, risk assessment process, risk contour map, individual risk assessment, industrial losses, identification and classification of losses, framework for consequence assessment, loss estimation, safety function deployment and steps of stakeholders concerns about safety.

MODULE 5: Safety audit

Introduction, Components of safety audit, types of audit, audit methodology, non conformity reporting (NCR), audit checklist and report – review of inspection, remarks by government agencies, consultants, experts – perusal of accident and safety records, formats – implementation of audit indication - liaison with departments to ensure co-ordination – check list – identification of unsafe acts of workers and unsafe conditions in the shop floor.

MODULE 6: Industrial Fire Prevention and Protection

Sources of ignition – fire triangle – principles of fire extinguishing – active and passive fire protection systems – various classes of fires – A, B, C, D, E – types of fire extinguishers – fire stoppers – hydrant pipes – hoses – monitors – fire watchers – layout of stand pipes – fire station-fire alarms and sirens –

maintenance of fire trucks – foam generators – escape from fire rescue operations – fire drills – notice-first aid for burns.

Textbooks/ Reference Books:

1. NPTEL course on "Industrial safety engineering" by Prof. J. Maiti, Department of Industrial and systems engineering, IIT, Kharagpur.
2. Derek, James, "Fire Prevention Hand Book", Butter Worths and Company, London, 1986.
3. R.K.Jain and Sunil S.Rao , Industrial Safety, Health and Environment Management Systems, Khanna publishers , New Delhi (2006).
4. Risk Assessment and Environmental Management: D. Kofi Asvite-Dualy, John Willey & Sons, West Sussex, England (1998).
5. Gupta, R.S., "Hand Book of Fire Technology" Orient Longman, Bombay 1977.
6. GREEN, A.E., "High Risk Safety Technology", John Wiley and Sons,. 1984.
7. Lees, F.P. "Loss Prevention in Process Industries" Butterworths and Company, 1996.

Course Code	Course Title	Hours per week L-T-P	Credit C
ME1818OE23	Engineering Economic Analysis	3-0-0	3

Course outcomes (COs):

After completion of the course, the students will be able to

1. Apply the concept of time value of money in managerial decision making
2. Make decisions on economic equivalence of physical assets for selection of alternatives
3. Make decisions on economic replacement of physical assets for acquiring new ones
4. Apply the concept of depreciation for economic decisions on the life of an asset
5. Make decisions on economically viable optimum quantity of production for manufacturing

MODULE 1: Introduction

Introduction to Engineering Economy, Physical & Economic Environment, Phases in Engg. process, Some economic concepts, Value and utility; Interest and Interest rate, Time value of money; Interest formulas: - Simple and compound interest, Cash flow diagrams, Interest formulas for discrete compounding and discrete payments: Single payment (CAF & PWF), Interest formulas for discrete compounding and discrete payments: Equal payment series (CAF, CRF & PWF).

MODULE 2: Problem solving by compounding

Problem solving on discrete compounding, discrete payment; Interest formulas for Uniform gradient series; Interest formulas for geometric gradient series; Compounding frequency of Interest: Nominal and Effective interest rates; Problem solving on frequency compounding of interest and gradient series factors.

MODULE 3: Economic equivalence

Economic equivalence: Meaning and principles of equivalence; Equivalence calculations involving cash flows; Methods of comparison of alternatives: Present worth, Annual equivalent, Future worth, Internal rate of return; Comparison of alternatives: - Capitalized equivalent amount, Capital recovery with return Problem solving on equivalence and comparison of alternatives.

MODULE 4: Replacement analysis

Replacement analysis: Reason, Concept of defender and challenger; Proper treatment of sunk cost in replacement; Replacement because of improved efficiency, inadequacy, demand etc.; Problem solving on replacement analysis; Economic life of the asset.

MODULE 5: Depreciation

Depreciation: Definition, Reasons, Types of property, Value time function and book value; Basic depreciation methods: S-L method, declining balance method; Depreciation: Declining balance switching to S-L, SOYD Method; Modified accelerated cost recovery system (MACRS) method of depreciation, Depletion; Depreciation: Units of production method, Depletion.

MODULE 6: Break even and EOQ

Breakeven analysis, Effect of fixed and variable cost on BEP; Economic order quantity; Problem solving based on Break-even analysis and EOQ.

Textbooks/ Reference Books:

1.Engineering Econmics – H GThuesen and W J Fabryky and G J Thuesen
2.Panneer Selvam, R, ―Engineering Economics‖, Prentice Hall of India Ltd, New Delhi, 2001.
3.Degarmo, E.P., Sullivan, W.G and Canada, J.R, ―Engineering Economy‖, Macmillan, New York, 1984

Course Code	Course Title	Hours per week L-T-P	Credit C
ME1818OE24	Automotive Mechanics	3-0-0	3

Course Outcomes (COs): At the completion of the course the student will be able:

1. To apply the concept of internal combustion of fuel air mixture for energy production and subsequent controlled use.
2. To apply various types of engines and sub-systems with respect to desired objective and performance.
3. To examine various, dis-assembled components and assess their condition of components for replacement/repair.
4. To choose primary and peripheral components of an automobile needed for control, safety, comfort, economy and efficiency.
5. To apply new technology in automotive systems for environmental sustainability.

MODULE 1: Introduction

- History of automotive systems and operations, components of an automobile, Basic Engine terminology, Classification of different types of engines.

MODULE 2: Power Unit

Principles of Engine operation, Engine parts and their functions, Multiple cylinder Engines, Engine trouble and repairs.

MODULE 3: Fuel Systems

Fuel used systems for delivery of fuel to the engine, carburetor, fuel pump and injector, common rail system for diesel injection, CRDI.

MODULE 4: Intake and Exhaust Systems

Cylinder head and valves, valve actuation & lubrication, manifold for intake and exhaust, connecting rod, piston, piston rings, gudgeon pin, crankcase, crankshaft and bearings, camshaft and OHC, Timing chains and actuations of valves, VVT engine.

MODULE 5: Power Transmission System

Manual and automatic transmission systems; meaning and functioning. **The clutch**- construction and operation, mechanical versus hydraulic clutch. **Gear box:** types, gear system and gear box, process of speed changing and reversing. **Propeller shaft:** strength consideration and coupling used. **Differential gear box:** need, construction and operation. **Axle and Wheel assembly**: solid/liquid lubrication in bearings, wheel alignment and balancing (castor/camber/toe/ offset). **Tyres-** types, specification, rotation of tyres.

MODULE 6: Chassis and Suspension system

Position of Engine; balance and road holding. Springs (coil and leaf) and dashpots. Steel and rubber bushes and mountings for engine. Chassis construction and types.

MODULE 7: Steering systems

Rack and pinion system, tie rod and wheel pivot, turning radius & safety arrangement. Types: Mechanical system versus hydraulic systems (power steering), Electronic Power Steering (EPS).

MODULE 8: Braking system
Types of Brakes: drum and disc. Brake system: mechanical, pneumatic and hydraulic, and their operation. Components: shoe materials, size and replacement, drum/disc repair and replacement, Antilock Braking system (ABS)

MODULE 9: Recent trends in automobile engineering

Textbooks/ Reference Books:

1. Automotive Mechanics by Crouse and Anglin
2. I C Engines by V Ganeshan
3. Automotive electronics handbook by Ronald K Jurgen, McGraw Hill Professional Publication.
4. Understanding Automotive Electronics by William B. Ribbens, Butterworth-Heinemann, 225 Wildwood Avenue, Woburn, MA 01801-2041.
5. Automobile Electrical and Electronic Systems by Tom Denton, Elsevier Publication

Course Code	Course Title	Hours per week L-T-P	Credit C
ME1818OE25	Machining and Machine Tools	3-0-0	3

Course outcomes (COs):

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

1. Apply cutting tool reference systems in determining tool signatures
2. Apply mechanics of machining as well as chip formation for determination of force, power, toque etc.
3. Evaluate tool life as well as suggest strategies for economic tool life
4. Apply concept of kinematic analysis in machine tool applications
5. Apply design considerations in machine tool applications.

MODULE 1: Introduction and Reference Systems

Machining, definition and objectives. Geometry of cutting tools; turning, milling and drilling - in different reference systems like machine reference system, tool reference system and work reference system.

MODULE 2: Chip Formation and Mechanics

Mechanism of chip formation, Types of chips and their characteristics, Effective rake. Mechanics of machining

MODULE 3: Materials and Failure of Cutting Tools

Cutting tools materials and methods of failure; Assessment of tool life

MODULE 4: Measurement by Dynamometry

theoretical estimation and experimental determination of cutting forces and power consumption. Dynamometers; types, design, construction and use.

MODULE 5: Economics of Machining

Economics of machining and its principal objectives;
Main parameters and their role on cutting forces, cutting temperature, tool life and surface quality, selection of optimum combination of parameters.

MODULE 6: Kinematics of Machine Tools

Basic considerations in the design of drives – Speed and structure program, Ray diagram. Transmission in the systems of stepped regulation. Spindle speed and design of all geared headstock – intermediate shaft diameter calculation. Stepless drives and hydraulic drive. Feed gear boxes.

MODULE 7: Design Considerations

Various types of beds and columns, their materials, construction and design features and principles.
Guides, spindle materials and their lubrication Temperature deformation.
Static and Dynamic rigidity, forced damped, self, excited and stick slip vibration., Vibration isolators.

Textbooks/ Reference Books:

1. Metal cutting: Theory & Practice by Amitabha Bhattacharyya
2. Manufacturing Science by Ghosh and Mallik
3. Metal cutting by E. M. Trent
4. Fundamentals of machining and machine tools**:** Geoffrey Boothroyd
5. Principles of Machine Tools: Sen and Bhattacharya.
6. Design of Machine tools: S. K. Basu.
7. Machine Tool Engineering: G. R. Nagpal.
8. The Design and construction of M/C tools: H. C. Town.
9. Machine Tools Design Hand Books: C.M.T.I.

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