



NIST UNIVERSITY
INSTITUTE PARK, PALUR HILLS, BERHAMPUR, ODISHA - 761008

Fifth Semester					
Theory					
Sl. No.	Category	Course Code	Course Title	L-T-P	Credit
1	PCC	22ME5PC01T	Dynamics of Machines	3-0-0	3
2	PCC	22ME5PC02T	Heat Transfer	3-0-0	3
3	PCC	22ME5PC03T	Manufacturing Science-II	3-0-0	3
4	PEC	22ME5PE01T/ 22ME5PE02T/ 22ME5PE03T/ 22ME5PE04T	Mechanics of Composite materials; Advanced Mechanics of Solid; Hybrid vehicles; Production and Operation Management	3-0-0	3
5	OEC	22ME5OE01T/ 22ME5OE02T	Engineering Managements/ Micro Electro-Mechanical Systems (MEMS)	3-0-0	3
6	OEC	22ME5OE03T/ 22ME5OE04T	Engineering materials Nano Technology	3-0-0	3
7	MC	22CM5MC01T	Mandatory(Constitution of India/ Essence of Indian Tradition Knowledge)	1-0-0	0
Total Credit (Theory)					18
Practical					
1	PCC	22ME5PC01L	Dynamics of Machines Lab	0-0-2	1
2	PCC	22ME5PC02L	Heat Transfer Lab	0-0-2	1
3	PCC	22ME5PC03L	Manufacturing Science – II Lab	0-0-2	1
4	PSI	22CM5MC01L	Summer Internship/Training	0-0-2	1
Total Credit (Practical)					4
Total Semester Credit					22



Course Code: 22ME5PC01T	Course Name: Dynamics of Machines	L-T-P 3- 0- 0	Credit 3
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Course Objective:

To make the student to:

1. Understand theory involved in the analysis of clutches, brakes and dynamometers.
2. Recognize the engineering features of flywheel and governors.
3. Develop knowledge on balancing of rotary and reciprocating masses.
4. To study the gyroscope effect and its application.
5. Understanding of vibrations and its significance on engineering design

Syllabus

Module- I [8 hours]

Cams: Types of cams, Types of followers, Types of follower motions - Simple Harmonic, Uniform Velocity and Constant Acceleration & Retardation Types, Analysis for Displacement, velocity and Acceleration of Follower, Generation of Cam Profiles by Graphical Method, Introduction on Cams with specified contours.

Module-II [8 hours]

Flywheels: Engine force analysis, turning moment of crankshaft, dynamically equivalent system, inertia of connecting rod. Turning moment diagrams, fluctuation of energy, flywheels, dimensions of flywheel rim, applications.

Governors: Watt, Porter, Proell, Hartung. Wilson-Hartnell, spring-controlled gravity governor, inertia governor. Sensitiveness, hunting, isochronism, stability, power, effort, controlling force of a governor.

Module-III [8 hours]

Balancing: Static and dynamic balancing of rotating masses, force balancing of four bar linkage, Primary and Secondary balancing of reciprocating engine, balancing inline engine (2,4,6, cylinders), V-engines, W-engines and radial engines, direct and reverse crank method, balancing machines – static, dynamic theory of field balancing.

Module-IV [8 hours]

Gyroscopes: Angular velocity, angular acceleration, gyroscopic couple, gyroscopic effect on

airplanes, ships. Static and dynamic force analysis of planar mechanisms, Stability of four-wheel and two-wheel automobiles, rigid disc at an angle fixed to a rotating shaft.

Module-V

[8 hours]

Natural/Free **Vibrations of Single Degree Freedom Systems:** Definitions, types, basic features, degrees of freedom, free longitudinal, transverse, and torsional vibrations – equilibrium method, energy method, displacement, velocity, acceleration, effect of mass of spring, damped vibration, logarithmic decrement.

Course Outcomes

The student will be able to:

1. Design the basic cam systems and its application.
2. Evaluate the performance of Flywheels, governors and their application.
3. Analyze the theory involved in balancing of rotating and reciprocating members.
4. Examine the effect of a gyroscope on ships, airplanes and automobile.
5. Analyze mechanical systems subjected to vibrations under different boundary conditions.

Text Books:

1. Theory of Machine by S. S Rattan, Third Edition, Tata McGraw Hill, New Delhi..
2. Kinematics and Dynamics of Machinery by R. L. Norton, Tata MacGraw Hill
3. Theory of Machines and Mechanisms by John J. Uicker Jr., Gordon R. Pennock and Joseph E. Shigley, Oxford University Press

Reference Books:

1. Theory of Machines and Mechanisms by J.J. Uicker , G. P. Pennock , and J. E. Shigley, 4th Edition, International Version, Oxford University Press, New Delhi.
2. The Theory of Machines: A textbook for Engineering students by Thomas Bevan Pearson, New Delhi.
3. Kinematics and Dynamics of Machinery by R.C. Norton, Third Edition in SI Modules, Tata McGraw Hill Education Pvt Ltd.



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4. Mechanism and Machine Theory by J. S. Rao and R. V. Dukipatti, New Age International.
5. Theory of Mechanisms and Machines by A. Ghosh & A. K. Mallick, East West Press.



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Course Code: 22ME5PC01L	Course Name: Dynamics of Machines Lab	L-T-P: 0- 0- 2	Credit: 1
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Course Objectives:

1. To study the various type of gear drives and its applications.
2. To understand the principles of gyroscope and governors.
3. Able to examine mode shapes of rotating shaft and vibration.
4. To understand the concepts of balancing of mass and cam profile.
5. To study working principle of Journal bearing.

List of Experiments:

1. Experiment on Epicyclic gear train
2. Determination of gyroscopic couple using gyroscopic test rig.
3. Performance characteristics of a spring loaded governor
4. Determination of critical speed of rotating shaft
5. Experiment on static and dynamic balancing apparatus
6. Determination of natural frequencies of un-damped as well as damped vibrating systems.
7. Study of interference and undercutting for gear drives
8. Experiment on Cam Analysis Apparatus.
9. Experiment on Journal Bearing Apparatus.

Course Outcomes

1. Evaluate the velocity ration of the epicyclic gear train and study the interference and undercut of gear drives.
2. Analyze the performance of gyroscope and governor.
3. Inspect the critical speed of shaft and determine natural frequency of damped and un-damped vibrating system.
4. Able to perform the balancing of rotating system and draw the Cam profile.
5. Evaluate the pressure head in journal bearing under various speeds.



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Course Code: 22ME5PC02T	Course Name :Heat Transfer	L-T-P: 3- 0- 0	Credit: 3
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Course Objectives:

1. Analyze problems involving steady and unsteady state heat conduction in simple geometries applies the same in solving real life problem.
2. Understand the mechanism of convective heat transfer through different geometry.
3. To quantify radiative heat transfer for black, grey body and among different bodies interacting with each other.
4. Design and analyze the heat exchanger based on LMTD (Logarithmic Mean Temperature Difference) and Number of Transfer Units (NTU).
5. Heat transfer with phase change boiling and condensation.

Syllabus:

Module-I

[8 hours]

Modes of heat transfer: conduction, convection, and radiation, Mechanism & basic laws governing conduction, convection, and radiation heat transfer; Thermal conductivity, Thermal conductance; Thermal resistance, Contact resistance, convective heat transfer coefficient, radiation heat transfer coefficient , Electrical analogy, combined modes of heat transfer

Heat Conduction:

The General heat conduction in Cartesian, polar-cylindrical and polar-spherical coordinates, Simplification of the general equation for one and two dimensional steady conduction with/without heat generation.

Module-II

[8 hours]

Heat Conduction Applications: Solution of the one dimensional steady state heat conduction problem in case of plane walls, cylinders and spheres for simple and composite cases. Critical insulation thickness, Heat transfer in extended surfaces (pin fins) without heat generation, Long fin, short fin with insulated tip and without insulated tip and fin connected between two heat sources. Fin efficiency and fin effectiveness. Conduction in solids with negligible internal temperature gradient (Lumped heat analysis).

Module-III

[10 hours]

Convective Heat Transfer: Introduction to convective flow - forced and free. Dimensional analysis of forced and free convective heat transfer. Application of dimensional analysis, physical significance of Grashoff, Reynolds, Prandtl, Nusselt and Stanton numbers.

Conservation equations for mass, momentum and energy for 2-dimensional convective heat transfer in case of incompressible flow, Hydrodynamic and thermal boundary layers for flow over a flat plate. Thermal boundary layer; general expression for local heat transfer coefficient; Average heat transfer Coefficient; Nusselt number. Mechanism of heat transfer during natural convection

Module-IV

[8 hours]

Radiative Heat Exchange: Introduction, Radiation properties, definitions of various terms used in radiation heat transfer; Absorptivity, reflectivity & transmissivity. Emissive power & emissivity, Kirchoff's identity, Planck's relation for monochromatic emissive power of a black body, Derivation of Stefan-Boltzmann law and Wien's displacement law from Planck's relation, Radiation shape factor, Relation for shape factor and shape factor algebra. Heat exchange between black bodies through non-absorbing medium. Gray bodies and real bodies, Heat exchange between gray bodies. Radiosity and Irradiation, Electrical analogy and radiation network for 2-body and 3-body radiations exchange in non-absorbing medium, Radiation shields.

Module-V

[8 hours]

Heat transfer for boiling liquids and condensing vapours: Types of condensation, use of correlations for condensation on vertical flat surfaces, horizontal tube and; regimes of pool boiling, pool boiling correlations. Critical heat flux, concept of forced boiling.

Heat Exchangers: Introduction, Types of heat exchanger, The overall heat transfer coefficient and fouling factors, LMTD and ϵ - NTU analysis of heat exchangers.

Text Books:

- 1 Heat Transfer, Incropera and Dewitt, Willey publications, 6th edition, 2018.
- 2 Heat Transfer, J. P. Holman, TMH Publications, 10th edition, 2009.

Reference Books:

- 1 Heat Transfer, P. K. Nag, TMH, 3rd edition, 2011
- 2 Heat and Mass Transfer: A Practical Approach, Y. A. Cengel, TMH, 3rd edition, 2005.
- 3 A Textbook on Heat Transfer, S. P. Sukhatme, University Press India Ltd., 4th edition 2005.

Online Resources:

- 1 Online course on “Heat and Mass transfer” by Prof. Pradip Dutta, IISc Bangalore available on NPTEL at <https://nptel.ac.in/courses/112/108/112108149/>
- 2 Video course on “Heat and Mass transfer” by Prof. S.P Sukhatme and Prof. U.N Gaitonde, IIT Bombay available on NPTEL at <https://nptel.ac.in/courses/112/101/112101097/>

Course Outcomes:

- 1 Compute temperature distribution in steady-state and unsteady-state heat conduction.
- 2 Understand and analyze heat transfer through extended surfaces.
- 3 Interpret and analyze forced and free convection heat transfer.
- 4 Understand the principles of radiation heat transfer.
- 5 Design heat exchangers using LMTD and NTU methods.



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Course Code: 22ME5PC02L	Course Name: Heat Transfer Lab.	L-T-P: 0- 0- 2	Credit: 1
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Course Objectives:

- 1 To understand the concept of composite slab and extended surface
2. Gain the knowledge of natural and Forced convection
3. How emissivity of a surface and Stefan Boltzmann law effects radiation
4. Flow through heat exchanger is a important device for gaining heat transfer concept
5. Understand the boiling heat transfer

Syllabus:

- 1 Determination of Thermal conductivity of composite slab
2. Determination of Thermal conductivity of composites
3. Determination of heat transfer coefficient in forced convention.
4. Determination of heat transfer coefficient in natural convention.
5. Determination of surface emissivity
6. Performance test on parallel flow heat exchanger
7. Performance test on counter flow heat exchanger
8. Efficiency and effectiveness of fins (Natural / Forced convection)
9. Determination of Critical heat flux during boiling heat transfer.
10. Verification of Stefan Boltzman's law.

Course Outcomes:

- 1 Concept of conduction understandable from composite slab and fins.
2. Able to understand natural and forced convection
3. Radiation concept understand with the help of emissivity and Stefan Boltzmann constant
4. Effectiveness of the heat exchanger can be determined.
5. Critical heat flux of fluid during boiling heat transfer can be evaluate



Course Code: 22ME5PC03T	Course Name: Manufacturing Science - II	L-T-P: 3- 0- 0	Credit: 3
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Course Objectives:

The students will able to

1. Learn basic metal removal processes and different tools used in them
2. Learn mechanics and mechanism of machining, tool life, tool materials, heating effect in machining, machining time and economy of machining process
3. Learn about different machine tools.
4. Learn about different mechanisms in machine tools.
5. Learn about non- traditional machining processes and their application in machining specific material

Syllabus

Module-I: [6 hours]

Machine Tools: Geometry of cutting tools in ASA system, Mechanics of chip formation, Merchant's theory, Force relationship and velocity relationship, Cutting tool materials.

Module-II: [6 hours]

Tool life: Tool life and Taylor's equation, Effect of variables on tool life and surface finish, Flank wear, Crater wear, Cutting fluid and its effect, Machinability Criteria, Economics of machining

Module-III: [10 hours]

Conventional machining process and machine tools: Turning, Drilling, Shaping, Planning, Milling, Grinding. Machine tools used for these processes, their specifications and various techniques used.

Module-IV: [8 hours]

Mechanism in machining: Indexing mechanism and thread cutting mechanism, Quick return mechanism, mechanism for feed motion.

Production Machine tools: Gear shaper and Gear hobbing machines, Copying lathe.

Module-V: [8 hours]

Non-traditional Machining processes: Ultrasonic Machining, Laser Beam Machining, Plasma Arc Machining, Electro Chemical Machining, Electro Discharge Machining, Wire EDM , Abrasive Jet Machining.

Course Outcomes:

1. Explain the features and applications of lathe, milling, drilling and broaching machines.
2. Discuss features and applications of reciprocating machine tools like shaper, planer and slotting machine.
3. Explain economics of machining.
4. Explain different mechanisms in machine tools.
5. Explain different types of non- traditional machining processes.

Text Books:

1. Fundamentals of Machining and Machine Tools, G. Boothroyd and W. A. Knight, CRC Press
2. Metal Cutting Principles, M. C. Shaw, Oxford University Press
3. Metal Cutting Theory and Practice, A. Bhattacharya, Central Book Publishers

Reference Books:

1. Manufacturing Technology – by P. N. Rao, Tata McGraw Hill publication.
2. Manufacturing Science, Ghosh and Mallik, East West Press.
3. Metal Cutting and Machine Tools, G. T. Reddy, Scitech
4. Modern Manufacturing Processes, P. C. Pandey, H. S. Shan, Tata McGraw Hill
5. Metal Cutting Theory and Practice, D. A. Stephenson and J. S. Agapiou, CRC Press
6. Machining Technology; Machine Tools and Operation, H. A. Youssef and H. El-Hofy, CRC Press
7. Introduction to Machining and Machining Fluids: NPTEL-noc19-me32



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Course Code: 22ME5PE01L	Course Name: Manufacturing Science - II Lab	L-T-P: 0- 0- 2	Credit: 1
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Course Objective:

1. Learn about the different types of cutting tools & its geometry
2. Get the knowledge about various types of conventional machining operation, principle of machine tools
3. Learn to calculate cutting forces during machining.
4. Learn about the CNC lathe and milling machines.
5. Learn about the various non-traditional machining processes and their importance.

List of Experiments:

1. Job on lathe with taper turning, thread cutting, knurling and groove cutting (3 experiments).
2. Gear cutting (with index head) on milling machine
3. Working with shaper, Planner and slotting machine.
4. Working with surface and cylindrical grinding.
5. Determination of cutting force using Lathe tool dynamometer.
6. Determination of cutting force in drilling using drill tool dynamometer.
7. Study of Non-traditional machining processes.(USM, AJM, EDM, ECM)
8. Study of CNC Lathe and demonstration of making job in CNC lathe.
9. Study of CNC Milling machine and demonstration of making job in CNC Milling machine

Course Outcomes:

1. Students have learned about the use of cutting tools for various operations
2. Students have learned to conduct various machining operations on conventional machining
3. Students were able to calculate cutting forces during machining using dynamometer
4. Students were able to operate and conduct the machining on CNC machines
5. Students have learned the importance of the non-conventional machining processes



Course Code: 22ME5PE01T	Course Name: Mechanics of Composite Materials	L-T-P: 3- 0- 0	Credit: 3
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Course Objective:

The objective of the course is to

1. understand the concept of composite material
2. know the processes involved in the manufacturing of composite materials
3. understand the various types of composite materials and their compositions
4. know the micro and macro mechanical properties of composite materials
5. Know the concept of lamination theory.

Syllabus

Module-I: [7 hours]

Introduction to Composite Material: Classification and characteristics of composite materials, mechanical behavior of composites, constituents, Reinforcements, Matrices, Fillers, Additives, Applications and advantages of composites.

Module-II: [7 hours]

Manufacturing Procedures of composites: Constituent Materials, Initial form of constituent materials,. Testing of Composites, Evaluation of Engineering Constants and Strengths.

Module-III: [7 hours]

Macro-mechanical behavior of composites: Stress strain relations of anisotropic materials - Engineering constants for orthotropic materials, Stress strain relations for specially orthotropic lamina. Transformation relationships for a lamina of arbitrary fibre orientation.

Module-IV: [7 hours]

Micro-mechanical Analyses of orthotropic lamina: Evaluation of Engineering Constants using Micro-mechanical principles, Rules of Mixtures, Kelly Davis Model for Minimum and Critical Volume Fractions.

Module-V: [7 hours]

FRP Composite: Laminate designation and codes, Macro-mechanical Behavior of FRP Composite Laminates, Classical Lamination Theory. General Design Consideration and Suitable laminating Scheme.

Course Outcomes:

The student will be able to

1. Understand and describe the basic concept and classification of the composite.
2. Acquire the knowledge in polymer matrix composites and its processing methods.
3. Understand the micro-mechanical properties of composites.
4. Understand the macro mechanical of composites.
5. Use of Mathematical techniques to predict the macroscopic properties of different Laminates

Text Books:

1. Mechanics of Composite Materials, Second Edition, Robert M. Jones, CRC press
2. Composite Materials: Engineering and Science, F. L. Matthews and Rees D. Rawlings, Wood head publishing limited.
3. Mechanics of composite materials and structures, Madhujit Mukhopadhyay, Universities Press.

Reference Books:

1. Fibre - Reinforced composites: - Materials, manufacturing and Design, Third Edition, P. K. Mallick, CRC Press.
2. Engineering Mechanics of Composite Materials, Second Edition, Isaac M. Daniel and Ori Ishai, Oxford University Press.
3. Composite materials, Lawrence J. Broutman & Richard H. Krock, Academic Press Inc. (1 Jan 1974).
4. Principles of Composite Material Mechanics, 4th Edition, Ronald F. Gibson, CRC Press.
5. An Introduction to composite material, D. Hull and T. W. Clyne, Cambridge University press



Course Code: 22ME5OE01T	Course Name: Advanced Mechanics of Solid	L-T-P 3- 0- 0	Credit 3
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Course Objective:

1. To solve solid mechanics problems using theory of Elasticity.
2. Understand the advanced concept of stress-strain behavior of materials.
3. To solve solid mechanics problems using energy methods.
4. To estimate the stress and strain in thick cylinders.
5. Recognize the basics mode of failure criteria and fracture analysis.

Syllabus

Module-I: [9 hours]

Concept of elasticity: stresses in three dimensions, Principal Stresses, Stress Invariants, Mohr's Circle for 3-D state of stress, Octahedral Stresses, State of pure shear. Differential equations of equilibrium, compatibility conditions, plane stress.

Module-II: [8 hours]

Analysis of strain: State of strain at a point, Strain Invariant, Principal Strains, Plane state of strain, Strain measurements. Theories of Failure, Various yield criteria

Module-III: [10 hours]

Energy Methods: Work done by forces and elastic strain energy stored. Reciprocal relations, Theorem of virtual work, Castigliano's theorems, Bending of beams: Asymmetrical bending, Shear centre, Bending of curved beams, Stress distribution in beam with rectangular, circular and trapezoidal cross section, stresses in crane hooks, ring and chain links. Deflection of thick curved bars.

Module-IV: [6 hours]

Thick cylinder: Thick walled cylinder subjected to internal and external pressures, Compound cylinders, Shrink fit.

Module-V: [10 hours]

Fatigue and Fracture Analysis: Repeated stresses and fatigue in metals, Fatigue tests and fatigue design theory, Goodman, Gerber and Soderberg criteria, Concept of stress concentration, Notch sensitivity.

Introduction to Fracture Mechanics: Basic modes of fracture, Fracture toughness evaluation.

Course Outcomes:

1. To understand the elastic and plastic behavior of material and evaluate stress invariants, principal stresses and their directions.
2. Develop constitutive relationships between stress and strain for linearly elastic solid.
3. Analyze solid mechanics problems using energy methods
4. Examine the properties of ideally plastic solid and apply the concepts of energy methods in solving structural problems.
5. Analyze theories of failure and design components for safe operation.

Text Books:

1. Elements of Strength of Materials by S P Timoshenko and D H Young, Affiliated East West Press
2. Strength of Materials by G. H. Ryder, Macmillan Press
3. Strength of Materials by S S Rattan, Tata Mc Graw Hill

Reference Books:

1. Mechanics of Materials by James M Gere, Thomson Learning
2. Engineering Mechanics of Solids by Egor P Popov, Prentice Hall of India
3. Advanced Mechanics of Solids, L.S. Srinath, Tata McGraw Hill
4. Advanced Mechanics of Materials : Boresi and Schmidt, Willey
5. Advanced Mechanics of Materials : Siley and Smith
6. Mechanics of Materials by Beer and Johnston, Tata McGraw Hill
7. Mechanics of Materials by R.C.Hibbeler, Pearson Education
8. Mechanics of Materials by William F.Riley, Leroy D.Sturges & Don H.Morris, Wiley Student.
9. Engineering Machanics of Solids by Egor P. Popov, Prentice Hall of India



Course Code: 22ME5PE03T	Course Name: Hybrid Vehicle	L-T-P 3- 0- 0	Credit 3
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Course Objective:

1. know the architecture of hybrid drive trains
2. Calculate different resistances act upon the Hybrid vehicle & power related to it.
3. Know the design of transmission system & load acting on axles.
4. Know about different energy sources & its storage for Hybrid vehicle.
5. Apply their ideas on HEV project work & related industrial sector for future development of EV.

Syllabus

Module-I: [8 hours]

Introduction to Hybrid Vehicles: Fundamentals of hybrid vehicles (internal combustion engines and electrical system); Classification of Hybrid electric vehicles; the architecture of hybrid drive trains-Series, Parallel, Series-Parallel hybrid; Design principles of HEVs; Basic components of Hybrid electric systems; Design of HEV drivetrain: Series, parallel, series-parallel, mild and plug-in; Key Benefits and Challenges of Hybrid Vehicles, Different types of frame, chassis and body, Main parts of Engine.

Module-II: [8 hours]

Performance of Vehicles: Resistance to motion, rolling resistance, air resistance, gradient resistance, power required for propulsion, tractive effort and traction, road performance curves.

Power brakes, . Braking of vehicles when applied to rear, front and all four wheel, theory of internal shoe brake, description of brake shoe, brake lining and brake drum,

Module-III: [8 hours]

Transmission Systems: Layout of the transmission system, main function of the different types of clutches such as singleplate, multiplate, cone, centrifugal, semicentrifugal, Diaphragm, Electromagnetic , Cone & vacuum clutch

Gear box: Sliding mesh, constant mesh and synchromesh gearbox

Module-IV: [8 hours]

Design of 3 speed and 4 speed gear box, over drive, , semi and fully automatic transmission.

CVT. Hookes joint, propeller shaft, differential, rear axles, types of rear axles, semi floating, there quarter floating and full floating types. Hotchkiss and torque tube drives

Module-V: [8 hours]

Types of Batteries Used in Hybrid Vehicles (Lithium-Ion, Nickel Metal Hydride, Lead Acid), Battery Management Systems (BMS), Energy Storage Technologies: Flywheels, Ultracapacitors, Hydrogen as a Fuel Source in Hybrid Vehicles, Charging Systems and Infrastructure

Course Outcomes:

1. Explain the basics of electric and hybrid electric vehicles, their architecture, technologies and fundamentals.
2. Analyze the use of different power electronics devices and electrical machines in hybrid electric vehicles.
3. Explain the use of different energy storage devices used for hybrid electric vehicles, their technologies and control and select appropriate technology
4. Interpret working of different configurations of electric vehicles and its components, hybrid vehicle configuration, performance analysis and Energy Management strategies in HEVs.

Text Books:

1. Automobile Mechanics , N.K.Giri, Khanna publishers, 8th Edition 2011.
2. Automobile Engineering, K.M. Gupta, VolI & II, Umesh Publication, 14th Edition 2018
3. Electric Vehicle Technology Explained, James Larminie and John Lowry, Wiley publication, 2nd Edition 2012.
4. Electric Vehicles: A Comprehensive Guide for Engineers and Technicians, Rajiv Jain PHI Learning publisher, 1st edition 2015.
5. Electric Vehicles and their Impact on Indian Society, Ankit Sharma Notion Press publication, 5th edition 2021.



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Reference Books:

1. The Electric Vehicle Technology and Expectations in the Automobile Age, Gijs Mom Johns Hopkins University Press publication, 4th edition 2020.
2. Electric Vehicle Engineering, John F. R. Clark, CRC Press publication, 5th edition.
3. Electric Vehicles: Opportunities and Challenges for India, Dr. S. R. Kothar. Cambridge Scholars Publishing., 7th edition 2021.
4. Automobile Engineering, Vol. I & II, Kirpal Singh, Standard Publications 8th edition 2020.



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Course Code: 22ME5PC01T	Course Name: Production and Operation Management	L-T-P: 3- 0- 0	Credit: 3
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Course Objectives:

1. Acquire a working understanding of the roles/functions of production management in the context of business enterprise.
2. Develop skills in solving production management problems.
3. Recognize, appreciate, and perform the job of a competent production or operation manager

Syllabus

Module-I:

[8 hours]

Introduction: Operations Function in an Organization, Manufacturing Vs. Service Operations, System view of Operations, Strategic Role of Operations, Operations Strategies for Competitive Advantage, Operations Quality and Productivity Focus, Meeting Global Challenges of Production and Operations Imperatives.

Designing Products, Services and Processes: New Product Design- Product Life Cycle, Product Development Process, Process Technology: Project, Job shop, Batch, Assembly Line, Continuous Manufacturing; Process Technology Life Cycle, Process Technology Trends, FMS, CIM, CAD, CAM; Design for Services, Services Process Technology.

Module-II:

[8 hours]

Work Study: Methods Study- Techniques of Analysis, recording, improvement and standardization; Work Measurement: Work Measurement Principles using Stopwatch.

Time Study: Predetermined Motion Time Standards and Work Sampling, Standard Time Estimation.

Module-III

[8 hours]

Location and Layout Planning: Factor Influencing Plant and Warehouse Locations, Impact of Location on cost and revenues.

Facility Location Procedure and Models: Qualitative Models, Breakeven Analysis, location Model, centroid method.

Layout Planning: Layout Types: Process Layout, Product Layout, Fixed Position Layout Planning, block diagramming, line balancing, computerized layout planning- overview.

Forecasting: Principles and Method, Moving Average, weighted Moving Average, Exponential, Smoothing, Winter's Method for Seasonal Demand, Forecasting Error.

Module-IV **[8 hours]**

Manufacturing Planning and Control: The Framework and Components: Aggregate Planning, Master Production Scheduling, Rough-cut-Capacity Planning, Material Requirements Planning, Capacity Requirements Planning.

Sequencing and Scheduling: Single Machine Sequencing: Basics and Performance Evaluation Criteria, Methods for Minimizing Mean Flow Time, Parallel Machines: Minimization of Makespan, Flowshop sequencing: 2 and 3 machines cases: Johnson's Rule and Jobshop Scheduling: Priority dispatching Rules.

Module-V **[8 hours]**

Inventory Control: Relevant Costs, Economic Batch Quantity, Basic EOQ Model, Model with Quantity discount, Periodic and Continuous Review Systems, Safety Stock, Reorder Point and Order Quantity Calculations. ABC Analysis.

Modern Trends in Manufacturing: Just in Time (JIT) System: Shop Floor Control By Kanbans, Total Quality Management, Total Productive Maintenance, ISO 9000, Quality Circle, Kaizen, Poka Yoke, and Supply Chain Management, Group Technology.

Course Outcomes:

1. Identify the elements of operations management and various transformation processes to enhance productivity and competitiveness.
2. Analyze and evaluate various facility alternatives and their capacity decisions, develop a balanced line of production & scheduling and sequencing techniques in operation environments
3. Develop aggregate capacity plans and MPS in operation environments.
4. Plan and implement suitable materials handling principles and practices in the operations.
5. Plan and implement suitable quality control measures in Quality Circles to TQM.

Text Books:

1. R. Panerselvam, "Production and Operations Management, Prentice Hall of India.



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2. Aswathappa & Bhatt – Production & Operations Management, HPH.
3. S.N.Chary, “Production and Operations Management”, Tata McGraw Hill.

Reference Books:

1. Gaither & Frazier - Operations Management, Cengage Publication
2. Russell & Taylor - Operations Management, PHI Publication
3. Chase, Aquilanno, Jacob & Agarwal - Operations Management, TMH Publication.
4. E.E. Adam and R.J. Ebert “Production and Operations Management”, Prentice Hall of India



Course Code: 22ME5OE01T	Course Name: Engineering Management	L-T-P: 3- 0- 0	Credit :3
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Course Objectives:

1. To provide an introduction to Engineering Management and exposure to forecasting methods, namely qualitative & quantitative methods .
2. Impart knowledge on the Aggregate Planning and Materials Requirement Planning?
3. Understand the principles/methods of Scheduling and Sequencing.
4. Understand the Maintenance Planning and Control and the methods for reliability improvement?
5. Impart knowledge on the Modern concepts/ techniques in operations management and Supply Chain management

Syllabus

Module – I [8 hours]

Management and Organizations: Definition, planning organizing, directing, controlling, coordinating, types of management. Organization Definition, planning, design and development, types of organizations.

Module – II [8 hours]

Management process: General Management, scientific management, engineering, management, systems management. Control: Setting of reference or standards, appraisal or evaluation, monitoring and controlling, types of control. Introduction to standard forms of financial statements i.e. Fixed and current asset items. Fixed and current liability items.

Module – III [7 hours]

Human resource planning and management: selection, recruitment, training, retraining, skill development, competence development, promotion and career development, participative management, trade unions, and collective bargaining, Management of Physical Resources Plant: site selection procedures, factors affecting selection. Layout-types and relative merits and demerits, Maintenance-Objectives, different types of associated decisions, strategies for effective maintenance, computer applications.

Module – IV [7 hours]

Quality management: Quality definition, quality planning, quality control and quality management, Total quality management, ISO 9000 systems, simple quality control techniques like control charts and acceptance sampling.

Module – V

[10 hours]

Project management: Introduction. Concept of a project, project management concepts, project simulation, cost or project and means of financing, economic evaluation criteria of the project, project implementation, project planning, scheduling and monitoring, project control (PERT, CPM techniques including crashing). Project evaluation.

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Course Outcomes:

1. Acquire a sound knowledge on the principles of Operations Management .
2. Use forecasting methods, principles/methods of scheduling and Sequencing, methods of maintenance planning and control, concepts/ technique supply chain management for Engineering Management .
3. Select and use an appropriate principles/methods/ techniques/ modern concepts with reference to given application/situation in the mechanical systems/ project management and finance
4. Develop and implement new ideas/ modern concepts with reference to given application/situation for best manufacturing practices.
5. Preparation and ability to engage in independent and lifelong learning in the context of technological change in Engineering Management

Text Books:

1. Engineering Management by A K Gupta, S. Chand Publishing
2. Engineering Management: Meeting the Global Challenges, Second Edition by C. M. Chang, CRC Press, Taylors & Francis Group

Reference Books:

1. Engineering Management by A. S. Chauhan, R. S. Vaishwanar, Neetu Jain, Jain Brothers Publications



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2. Engineering Management by Fraidoon Mazda, Pearson Edition
3. The Practice of Engineering Management by Patrick D. T. O'Connor, Wiley–Blackwell



Course Code: 22ME5OE03T	Course Name: Micro Electro-Mechanical Systems (MEMS)	L-T-P 3- 0- 0	Credit 3
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Course Objectives:

1. Learning fundamental concepts for design of micro-electromechanical devices (MEMS), including mechanical and thermal behavior of materials and structures, transduction principles, transducer design, and modeling.
2. Learn about the current and future trends of MEMS in the industry. Types of MEMS devices, their application areas.
3. Acquire comprehensive knowledge of microfluidic devices.
4. Learn different techniques for fabrication of MEMS devices, materials used and their properties.
5. Learn analytical/mathematical modeling of a MEMS device. Gain knowledge on capabilities of different tools used in the industry.

Syllabus

Module-I **[7 hours]**

Introduction to MEMS: History of micro system technology, overview of commercial MEMS products, future trends, Case study, Micro-fabrication basics and materials used. Miniaturization : Moore's law, Effects of scaling: on mechanical strength, heat transfer, vibrational and magnetic characteristics. Benefits and limitations of the materials and miniaturization.

Module-II **[8 hours]**

MEMS types, application areas: Mechanical Transducer: Inertial Sensors (Accelerometer, Gyroscope), Pressure Sensors, Flow Sensors, Force Sensors (SPM), Magnetic Transducers: Magnetic Field Sensors, Magnetic Actuators, Proximity sensor; Chemical/Biological Transducers : Gas sensor, Thermal Transducers: Thermometers, IR Sensors; Applications of MEMS: smart homes, electrical systems, material transport, condition monitoring, biomedical prosthesis.

Packaging of MEMS devices: Standard Packages, Packaging Concepts, Packaging Examples

Module-III **[7 hours]**

Microfluidics: Fundamentals of fluid mechanics, Basic components of a micro-fluidic system, Micro flows, Micro pumps, Capillarity and Surface Tension, Micro pumping methods, Micro dispensers, Micro nozzles

Module-IV [7 hours]

Materials and Fabrication techniques of MEMS:

Properties of materials used in MEMS fabrication : silicon, polymers, metals, ceramics. Their structure and properties. Structure of silicon and other materials (polymers), Silicon wafer processing, Bulk micro machining and Surface micro machining, Wafer-bonding. Thin-film deposition, Lithography, wet etching and dry etching.

Module-V [9 hours]

Modeling of MEMS structures:

System modeling of MEMS : Analytical vs Numerical Modeling, Lumped Element modeling, Finite element modeling; MEMS simulation packages : MEMS pro, MEMS+, SUGAR, Coventor, SoftMEMS, COMSOL etc. Demonstration of MEMS pro-Ansys integration

Course Outcomes:

1. Understand the operation of micro devices, micro systems and their applications.
2. Select whether the particular situation requires the use of a MEMS device. If required, select an appropriate device.
3. Analyze a chemical/biological system to select the right microfluidic device.
4. Apply knowledge of physical, chemical and biological principles to engineer MEMS devices using different materials and techniques. Select appropriate MEMS fabrication techniques for a particular design and application.
5. Apply knowledge of MEMS analysis to evaluate suitability of MEMS designs for particular applications. Select a suitable tool for a

Text Books:

1. Smart Material Systems and MEMS: Design and Development Methodologies, Vijay K. Varadan, K. J. Vinoy, S. Gopalakrishnan, Wiley, 2006



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2. Tai Ran Hsu, “MEMS & Micro systems Design and Manufacture” Tata McGraw Hill, New Delhi, 2002

Reference Books:

1. MEMS Sensors, Design and Application, Siva Yellampalli, IntechOpen, 2018
2. MEMS : Design and Fabrication, Mohamed Gad-el-Hak, CRC Press, 2005
3. Microsystem Design, Stephen D. Senturia, Springer US, 2001



Course Code: 22ME6OE02T	Course Name: Engineering Materials	L-T-P: 3:0:0	Credit: 3
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Course Objectives:

- 1 To acquaint students with the basic concepts and properties of Material Science
- 2 To impart a fundamental knowledge of Engineering materials.
- 3 Understand the structure-property relationship in materials.
- 4 To understand some of the binary phase diagrams of commonly used alloy systems.
- 5 To develop futuristic insight into Materials used in construction, electronics and biomedical engineering domains.

Syllabus:

Module - I **[8 Hours]**

Properties and Characteristics of Engineering Materials: properties of materials. Characteristic property of metals, bonding in solids, primary bonds like ionic, covalent and metallic bond, crystal systems, common crystal structure of metals, representations of planes and directions in crystals, atomic packing in crystals, calculation of packing density.

Module - II **[8 Hours]**

Alloy formation: Concept of alloy formation, types of alloys, solid solutions, factors governing solids solubility viz. size factor, valency factor, crystal structure factor and chemical affinity factor.

Module - III **[8 Hours]**

Binary phase diagrams of common alloy systems: (a) Isomorphism system, (b) Eutectic system, (c) Peritectic system, (d) Eutectoid system.

Allotropic transformation. Lever rule and its application, Interpretation of solidification behaviors (Fe-Fe₃C, Pb-Sn).

Module - IV **[8 Hours]**

Materials for specific uses: High melting and low melting solder and brazing filler, conductive ink, conductive tape, masking layers, paints and coatings for oxidation and UV protection (Red oxide, silicone, wax, resin, thermal barrier coatings, Shape memory alloys.

Module - V **[8 Hours]**

Polymer: Uses, thermosetting and thermoplastics.

Ceramics: Types, structure, Mechanical properties,



Composite materials: properties and application of composite materials.

Bio Materials: Biomaterials for implants, prosthesis, biosensors, artificial muscles, etc.

Course Outcomes:

On completion of the course, learner will be able to

- 1 Understand the basic concepts and properties of Material.
- 2 Select proper metal, alloys, nonmetal and powder metallurgical component for specific requirement
- 3 Detect the defects in crystal and its effect on crystal properties.
- 4 Evaluate the different properties of material by studying different test
- 5 Recognize how metals can be strengthened by cold-working and hot working

Text Books:

1. Materials Science and Engineering, W. D. Callister, Wiley and Sons Inc, 2nd edition, 2013.
2. Introduction to Physical Metallurgy, Sidney, H. Avner, TMH Publications, 2nd edition, 2017.

Reference Books:

- 1 Physical Metallurgy: Principles and Practice, Ragahvan, PHI Learning Private limited, 3rd edition, 2015.

Online Resources:

- 1 Online course on “Material Science” by Prof. Satish V Kailas, IISc Bangalore available on NPTEL at <https://nptel.ac.in/courses/112/108/112108150/>



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Course Code: 22ME5OE04T	Course Name: Nanoscience and Technology	L-T-P: 3-0-0	Credit: 3
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Course Objectives:

1. Learn about the background on Nanoscience and nanomaterials.
2. Understand the synthesis of nanomaterials and their application and the impact of nanomaterials on environment
3. Recognize the different functionalities of nonamaterials.
4. Understand the fundamentals of Biomimetic nanomaterials and its application.
5. Understand the different applications of nanomaterials.

Syllabus:

Module – I [10 hours]

General introduction and theory of nanomaterials- History of nanomaterials; Size and shape dependant properties and their uniqueness; Energy at nanoscale - surface characteristics and electrostatic and steric stabilization - Quantum confinement - zero dimensional, one dimensional and two dimensional nanostructures

Module – II [8 hours]

Synthesis of nanomaterials- Introduction to nanoparticle synthesis – top-down and bottom up approaches - physical nanofabrication techniques (PVD, MBE, CVD, self-assembly, lithographic techniques etc.) and wet chemical methods for the synthesis of zero dimensional one dimensional and two dimensional nanostructures-metal nanoparticles, quantum dots, nanoclusters, nanowires and rods, thin films

Module – III [12 hours]

Functional nanomaterials- Synthesis, properties and applications of organic, inorganic, hybrid nanomaterials – core-shells, nanoshells, self-assembled nanostructures, superlattices, nanoceramics metallic, polymeric and ceramic nanocomposites, nanoporous materials, nanofluids, nanolayers and carbon based nano materials - Occurrence, production, purification, properties and applications of fullerene, carbon nanotube, graphene, carbon onion, nanodiamond and films

Module – IV [8 hours]

Biomimetic nanomaterials - introduction to biomimetics, mimicking mechanisms found in nature, synthesis and applications of bioinspired nanomaterials and self-assemblies

Module – V

[8 hours]

Applications of nanomaterials- Application of nanomaterials in healthcare, biosensors, coatings environment, catalysis, agriculture, automotives, sensors, electronics, photonics, information technology, quantum computing, energy and aerospace sectors.

Course Outcomes:

1. To develop a foundational knowledge of the Nanoscience and related fields.
2. Apply their learned knowledge to develop Nanomaterial's.
3. Evaluate the different functional properties of nanomaterials.
4. Understand the details about Biomimetic nanomaterials and its application.
5. Utilize the knowledge of nanomaterial in solving engineering problems.

Text Books:

1. K. J. Klabunde and R.M. Richards (Eds.), Nanoscale Materials in Chemistry, 2nd Edn., John Wiley & Sons, 2009.
2. T. Pradeep, Nano: The Essentials, McGraw-Hill (India) Pvt Limited, 2008.
3. Bharat Bhushan, (Ed.), Handbook of Nanotechnology, Springer, 2007.

Reference Books:

1. Carl C. Koch (Ed.), Nanostructured Materials: Processing Properties and Applications, William Andrew Inc., 2007.
2. Anke Krueger, Carbon Materials and Nanotechnology, Wiley-VCH Verlag GmbH & Co. KGaA, 2010.
3. Cao, G., Nanostructures and Nanomaterials Synthesis, Properties, and Applications, Imperial College Press, 2004.
4. Wang, Z. L., (Ed.), Characterization of nanophase materials, Wiley-VCH Verlag GmbH, 2000.

5. Garcia-Martinez, J., (Ed.), Nanotechnology for the Energy Challenge. Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, 2009.
6. Goddard III W. A., et. al.,(Ed.), Handbook of Nanoscience, Engineering, and Technology, Taylor & Francis Group, 2007.
7. B. P. S. Chauhan (Ed), Hybrid Nanomaterials: Synthesis, Characterization, and Applications, Wiley-VCH Verlag GmbH, 2011.
8. J. Lei and F. Lin, Bioinspired Intelligent Nanostructured Interfacial Materials, World Scientific Publishing Company, 2010.
9. Challa S. S. R. Kumar (Ed.) Biomimetic and Bioinspired Nanomaterials, Wiley-VCH Verlag GmbH, 2010.