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INSTITUTE PARK, PALUR HILLS, BERHAMPUR, ODISHA - 761008



Fifth Semester					
Theory					
Sl. No.	Category	Course Code	Course Title	L-T-P	Credit
1	PCC	19ME5PC01T	Dynamics of Machines	3-0-0	3
2	PCC	19ME5PC02T	Applied Thermodynamics	3-0-0	3
3	PCC	19ME5PC03T	Manufacturing Science-II	3-0-0	3
4	PEC	19ME5PE01T/ 19ME5PE02T/ 19ME5PE03T/ 19ME5PE04T	Mechanics of Composite materials; Advanced Mechanics of Solid; Automobile Engineering; Production and Operation Management	3-0-0	3
5	OEC	Open Elective – 1 (for Non-ME Students)			
		19ME5OE01T	Engineering Management	3-0-0	3
		19ME5OE02T	Micro Electro-Mechanical Systems (MEMS)	3-0-0	3
		Open Elective – 1 (for ME Students)			
		19IT5OE01T	Java Programming	3-0-0	3
		19EC5OE01T	VLSI Design	3-0-0	3
		19CE5OE01T	Building Services and Maintenance	3-0-0	3
		19EE5OE01T	Renewable Energy Systems	3-0-0	3
6	OEC	Open Elective – 2 (for Non-ME Students)			
		19ME5OE03T	Smart and Intelligent Materials	3-0-0	3
		19ME5OE04T	Nanoscience and Technology	3-0-0	3
		Open Elective – 2 (for ME Students)			
		19IT5OE02T	Computer Networks	3-0-0	3
		19EE5OE03T	Smart Grids	3-0-0	3
		19CE5OE03T	Geo-Environmental Engineering	3-0-0	3
		19EC5OE04T	Radar System Engineering	3-0-0	3
7	MC	19CM5MC01T	Essence of Indian Tradition Knowledge	3-0-0	0



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		19CM5MC02T	Constitution of India	3-0-0	0
Total Credit (Theory)					18
Practical					
1	PCC	19ME5PC01L	Dynamics of Machines Lab	0-0-2	1
2	PCC	19ME5PC02L	Applied Thermodynamics Lab	0-0-2	1
3	PCC	19ME5PC03L	Manufacturing Science-II Lab	0-0-2	1
4	PSI	19CM5MC01L	Summer Internship/Training Lab	0-0-2	1
Total Credit (Practical)					4
Total Semester Credit					22

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Course Code: 19ME5PC01T	Course Name: Dynamics of Machines	L-T-P 3- 0- 0	Credit 3
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Course Objectives:

To make the student to:

1. Recognize the engineering features of flywheel and governors.
2. Develop knowledge on balancing of rotary and reciprocating masses.
3. To study the gyroscope effect and its application.
4. Understand theory involved in the analysis cam.
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]

Vibrations: Definitions, types, basic features, degrees of freedom, free longitudinal vibration – equilibrium method, energy method, displacement, velocity, acceleration, effect of mass of spring, damped vibration, logarithmic decrement.

Forced longitudinal vibrations: Harmonic excitation, magnification factor, vibration isolation and transmissibility. Transverse vibrations, Single concentrated load, uniformly distributed load, several loads, Dunkerley’s method, whirling of shafts.

Text Books:

1. Theory of Machine, S.S Rattan, Tata McGraw Hill, 3rd Edition, 2017
2. Kinematics and Dynamics of Machinery, R L Norton, Tata MacGraw Hill, Special Indian Edition, 2017

Reference Books:

1. The Theory of Machines: A textbook for engineering students, Thomas Bevan, Pearson, 3rd Edition, 2009
2. Theory of Machines, Sadhu Singh, Pearson Education, 3rd Edition, 2011

3. Theory of Mechanisms and Machines, A. Ghosh & A. K. Mallick, East West Press, 3rd Edition, 2008
4. Theory of Machines and Mechanisms, John J. Uicker Jr., Gordon R. Pennock and Joseph E. Shigley, Oxford University Press, Fourth Edition, 2014

Course Outcome:

The student will be able to:

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

Course Code: 19ME5PC01L	Course Name: Dynamics of Machines Lab	L-T-P 0-0-2	Credit 1
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Course Objectives:

1. Learn the principles involved gyroscope.
2. Educate about the fundamental principles involved in governors.
3. Examine mode shapes of rotating shaft and vibration.
4. Understand the concepts of balancing of mass and cam profile.
5. Analyze the behavioral characteristics of damping in vibration.

List of Experiments:

1. To study gyroscopic effects through models.
2. Determination of gyroscopic couple using gyroscopic test rig.
3. Performance characteristics of a spring loaded governor
4. Performance characteristics of a dead weight load governor
5. Determination of critical speed of rotating shaft

6. Experiment on static and dynamic balancing apparatus
7. Experiment on Cam Analysis Apparatus.
8. Damping force vibration of an equivalent spring mass system.
9. Undamped free vibration of an equivalent spring mass system
10. To study dynamic equivalent system.

Course Outcome:

1. Understanding of the effect of gyroscopic couple..
2. Analyze the performance of governor.
3. Perform the balancing of rotating system and rotating shaft.
4. Evaluate the concept of Cam and draw the Cam profile.
5. Inspect the critical speed of shaft and determine natural frequency of damped and un-damped vibrating system.

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Course Code: 19ME5PC02T	Course Name: Applied Thermodynamics	L-T-P 3- 0- 0	Credit 3
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Course Objectives:

The student will be able to

1. Understand thermodynamics relations and its usage in deriving properties of substances
2. Understand the behavior of ideal gas and real gas.
3. Estimate the properties of real gases.
4. Utilize the knowledge of thermodynamic cycles in design of air compressor.
5. Understand the air craft propulsion using the knowledge of gas turbine cycles.

Syllabus

Module-I [9 hours]

Ideal Gas and Real Gas: Ideal gas, relation among the specific heats, internal energy, enthalpy. Analysis of isochoric, isobaric, isothermal, isentropic, isenthalpic processes, representation of the above processes on P-v, T-s planes. Determination of work, heat, entropy and enthalpy changes during the above processes, problems. Characteristic gas equations of a real gas, virial coefficients, law of corresponding states, compressibility factor, generalized compressibility chart, problems

Module-II [9 hours]

Properties of Gases and Gas Mixtures: Equations of State, changes in internal energy, enthalpy and entropy for an ideal gas, Equations of state for a real gas, Virial Expansions, Law of Corresponding States, Generalized Compressibility Chart, Reduced coordinates, Other Equations of state, Dalton's Law of Partial Pressures, Internal Energy, Enthalpy and Entropy and Specific Heats of Gas Mixtures, Gibbs Function of a Mixture.

Module-III [9 hours]

Thermodynamic Relations:

Some Mathematical Theorems, Maxwell's Relations, T-ds Equations, Difference in Heat Capacities, Ratio of Heat Capacities, Energy Equation, Clausius-Clapeyron Equation, Joule-Thomson Coefficient, Evaluation of Thermodynamic Properties from Equation of State, Mixtures of Variable Composition, Conditions of Equilibrium for a Heterogeneous System, Gibbs Phase Rule, Types of Equilibrium, Conditions of Stability, Third Law of Thermodynamics

Module-IV

[8 hours]

Reciprocating Air Compressors: Introduction (Uses of compressed air), The reciprocating cycle neglecting and considering clearance volume, Volumetric efficiency and its effect on compressor performance, Limitations of single stage compression, Multistage compression and intercooling, Optimum intercooler pressure, Performance and design calculations of reciprocating compressors, Air motors.

Module-V

[9

hours]

Gas Turbines: Introduction, Open and closed cycle gas turbines, Analysis of practical gas turbine cycle.

Air Craft Propulsion: Analysis of Turbo Jet, Turbo Prop, Turbo fan & Ram jet engines.


Course Outcome:

Students will able to

1. Derive different properties using the thermodynamic relations.
2. Use the ideal gas and real gas effects in solving real life problems
3. Compute the thermodynamic properties of gas mixture..
4. Design the air compressor based on the thermodynamics analysis of compressor
5. Use the knowledge of gas turbine cycles in analyzing the air-craft propulsion.

Text Books:

1. Basic and Applied Thermodynamics, P.K.Nag, 2nd Ed, TMH.

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2. Fundamentals of Thermodynamics, Sonntag, Borgnakke, Van Wylen, John Wiley & Sons
3. Fundamentals of Engineering Thermodynamics, E. Rathakrishnan, PHI

Reference Books

1. Thermodynamics and Thermal Engineering, Kothandaraman & Domkundwar, Dhanpat Rai.
2. Applied Thermodynamics, P.L.Ballaney, Khanna Publishers
3. Thermodynamics-An Engineering Approach, Y.A. Cengel, M.A. Boles, 8th Ed, TMH.
4. Molecular Thermodynamics, Mcquarrie, D.A., and Simon, J.D Viva Books, 2010.
5. Gas Turbines, Cohen and Roser

Course Code: 19ME5PC02L	Course Name: Applied Thermodynamics Lab	L-T-P 0- 0-2	Credit 1
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Course Objectives:

1. Able to get brief knowledge about Compressor
2. Understand the basic concept of expansion of a gas through Joule experiment.
3. Basic knowledge of gas turbine and jet propulsion system.
4. Gaining knowledge about load carrying system of petrol and diesel engine.
5. Understand about various performance analysis of load test, heat balance and Morse test of various engine.

List of Experiments:

1. Performance analysis of reciprocating air-compressor.
2. Performance analysis of Centrifugal / Axial Flow compressor.
3. Verification of Joule-Thomson coefficient.
4. Performance analysis of gas turbine.
5. Model study of Jet propulsion system
6. Abel's apparatus: Determination of flash and fire points of a given oil sample

7. Redwood Viscometer: Determination of kinematic and absolute viscosities of an oil sample given
8. Load test on 4-stroke single cylinder C.I. engine.
9. Load test on 4-stroke single cylinder S.I. engine.
10. Morse Test on multi-cylinder S.I. or C.I. engine
11. Load test on variable compression ratio S.I. engine
12. Load test and Heat balance on 2 stroke S.I. Engine

Course Outcomes

1. Brief description about various types of compressor and its components with characteristics analysis.
2. Describe about aircraft system and its working principle.
3. Determine the properties of gases, mixture.
4. Evaluate the performance of petrol and diesel engine.
5. Evaluate the various accept of load test, heat balance of variable 2-stroke and 4-stroke engine.

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Course Code: 19ME5PC03T	Course Name: Manufacturing Science-II	L-T-P 3- 0- 0	Credit 3
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Course Objectives:

The students will be 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 Jigs and fixtures and their application in different machine tools.
5. learn about non- traditional machining processes and their application in machining specific material

Syllabus

Module-I [12 hours]

Machine Tools: Geometry of cutting tools in ASA and ORS, Mechanics of chip formation, Merchant's theory, Force relationship and velocity relationship, Cutting tool materials. Flank wear, Crater wear, Wear measurement, Cutting fluid and its effect; Machinability Criteria, Tool life and Taylor's equation, Effect of variables on tool life and surface finish, Measurement of cutting force, Lathe tool dynamometer, Drill tool dynamometer.

Module-II [9 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. Principles of machine tools: Kinematics of machine tools, speed transmission from motor to spindle, speed reversal mechanism, mechanism for feed motion, Tool holding and job holding methods in different Machine tools.

Module-III [9 hours]

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

Module-IV

[8 hours]

Production Machine tools: Engine lathe, Speed lathe, Capstan and turret lathes, single spindle and multi spindle semiautomatics, Gear shaper and Gear hobbing machines, Copying lathe and transfer machine

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 Jigs and fixtures and their application.
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 , P.N.Rao, Tata McGraw Hill publication.
2. Fundamentals of Machining and Machine Tools, G.Boothroyd and W.A.Knight, CRC Press
3. Manufacturing Science, Ghosh and Mallik, East West Press.
4. Metal Cutting and Machine Tools, G.T.Reddy, Scitech
5. Modern Manufacturing Processes, P.C.Pandey, H.S.Shan, Tata McGraw Hill
6. Metal Cutting Theory and Practice, D.A.Stephenson and J.S.Agapiou, CRC Press
7. Machining Technology; Machine Tools and Operation, H.A.Youssef and H. El-Hofy, CRC Press
8. Machine Tools and Manufacturing Technology, Krar, Rapisarda and Check, Cengage
9. Introduction to Machining and Machining Fluids: NPTEL-noc19-me32

Course Code: 19ME5PE01L	Course Name: Manufacturing Science-II Lab	L-T-P 0- 0- 2	Credit 1
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Course Objectives:

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)

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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.

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Course Code: 19ME5PE01T	Course Name: Mechanics of Composite materials	L-T-P 3- 0- 0	Credit 3
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Course Objectives:

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]

Micromechanical Analyses of orthotropic lamina: Evaluation of Engineering Constants using Micromechanical 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 Behaviour 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 micromechanical 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, R.M. Jones, Mc. Graw Hill Book Co.
2. Composite Materials: Engineering and Science, Matthews and Rawlings, CRC Press.
3. Mechanics of composite materials and structures, M Mukhopadhyay, Universities Press.

Reference Books:

1. Fibre - Reinforced composites: - Materials, manufacturing and Design, P.K. Mallick, CRC Press.
2. Engineering Mechanics of Composite Materials, I.M.Danel, O.Issai, Oxord University Press
3. Composite materials, Broutman & Crock,
4. Principles of Composite Material Mechanics, R.F.Gibson, CRC Press



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5. An Introduction to composite material, D.Hull and T.W. Clyne, Cambridge University press
6. Fundamentals of Metal Matrix Composites, S.Suresh, A.Martensen, and A.Needleman, Butterworth, Heinemann
7. Metal Matrix Composites, Thermo mechanical Behavior, M.Taya, and R.J.Arsenault, Pergamon Press, Oxford.

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Course Code: 19ME5PE02T	Course Name: Advanced Mechanics of Solid	L-T-P 3- 0- 0	Credit 3
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Course Objectives:

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 [8 hours]

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

Module-V [9

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

Reference Books:

1. Mechanics of Materials, James M Gere, Thomson Learning
2. Engineering Mechanics of Solids, 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, Beer and Johnston, Tata McGraw Hill
7. Mechanics of Materials, R.C.Hibbeler, Pearson Education
8. Mechanics of Materials, William F.Riley, Leroy D.Sturges & Don H.Morris, Wiley Student.
9. Engineering Machanics of Solids, Egor P. Popov, Prentice Hall of India

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Course Code: 19ME5PE03T	Course Name: Automobile Engineering	L-T-P 3- 0- 0	Credit 3
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Course Objectives:

1. Identify the different parts of engine & know the construction of chassis & body.
2. Calculate different resistances act upon the vehicle & power related to it.
3. Know the steering geometry & related mechanism.
4. Know about electrical vehicle & electrical circuit diagram of electrical system of vehicle.
5. Apply their ideas on Automobile project work & related industrial sector for future development of Automobile.

Syllabus

Module-I [8 hours]

Introduction

Main Modules of automobile chassis and body, different systems of the automobile, description of the main parts of the engine, motor vehicle act.

Alternative Energy Sources-Use of Natural Gas, LPG, Biodiesel, Gasohol and Hydrogen in Automobiles, Electric and Hybrid Vehicles, Fuel Cells.

Module-II [8 hours]

Types of Resistance

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

Hydraulic braking system, braking of vehicles when applied to rear, front and all four wheel, theory of internal shoe brake, design of brake lining and brake drum, different arrangement of brake shoes, servo and power brakes.

Module-III [8 hours]

Transmission Systems, Layout of the transmission system, main function of the different components of the transmission system, transmission system for two wheels and four wheel drives. Hotchkiss and torque tube drives.

Module-IV [8 hours]

Gear box: Sliding mesh, constant mesh and synchromesh gearbox, design of 3 speed and 4 speed gear box, over drive, torque converter, semi and fully automatic transmission.

Hookes joint, propeller shaft, differential, rear axles, types of rear axles, semi floating, there quarter floating and full floating types.

Front wheel Geometry and steering systems : Camber, castor, kingpin inclination, toe-in and toeout, centre point steering condition for true rolling, components of steering mechanism, power steering.

Module-IV [8 hours]

Electrical system of an automobile: Starting system, charging system, ignition system, other electrical system.

Electrical vehicles: History, electrical vehicles and the environment pollution, description of electric vehicle, operational advantages, present EV performance and applications, battery for EV, Battery types and fuel cells, Solar powered vehicles, hybrid vehicles.

Course Outcomes:

1. Understand the basic lay-out of an automobile.
2. Understand the operation of engine cooling, lubrication, ignition, electrical and air conditioning systems.
3. Understand the principles of transmission, suspension, steering and braking systems.
4. Understand automotive electronics.
5. Study latest developments in automobiles.



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Text Books:

1. Automobile Mechanics, N.K.Giri, Khanna publishers
2. Automobile Engineering, K.M. Gupta, VolI & II, Umesh Publication
3. Automobile Engineering, Vol. I & II, Kirpal Singh, Standard Publications

Reference Books:

1. Automotive mechanics: William h. Crouse and Donald L. Anglin, TMH
2. The motor vehicle, Newton and Steeds
3. Automobile Mechanics, J. Heitner, East West Press
4. Automobile Engineering, Jain and Asthana, Tata McGraw Hill
5. Automobile Engineering, K.K.Ramalingam, Scitech
6. A Text Book of Automobile Engineering, R.K.Rajput, Laxmi Publishers

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Course Code: 19ME5PE04T	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.

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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. Production and Operations Management, R. Paneerselvam, Prentice Hall of India.
2. Production & Operations Management, Aswathappa & Bhatt, HPH.
3. Production and Operations Management, S.N.Chary, Tata McGraw Hill.

Reference Books:

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

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Other Elective Subject

Course Code: 19ME5OE01T	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, Management process: Definition, planning organizing, directing, controlling, coordinating, types of management. Organization Definition, planning, design and development, types of organizations. Management planning and control: Classical, new classical and modern principles. General Management, scientific management, engineering, management, systems management. Planning: Procedures, resources and constraints, objectives, goals, policies and procedures. Control: Setting of reference or standards, appraisal or evaluation, monitoring and controlling, types of control.

Module – II

[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. Material : Functions, objectives, planning and control

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including inventory models with or without storage costs, price break(excluding dynamic and probabilistic considerations). Different classes of inventory. Material Requirement Planning (MRP).

Module – III

[8 hours]

Financial management: Introduction to standard forms of financial statements, i.e., balance-sheet, profit and loss, and income statement. Fixed and current asset items. Fixed and current liability items. Linkage of two successive balance-sheets through income or profit and loss statement. Funds flow statement. Financial ratios and their implications. Managerial economics: Concepts, theory of production, marginal productivity and cost. Introduction to theory of firm.

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. Marketing management consumer behavior, market research, product design and development pricing and promotion.

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.

Information technology and management. Role of information, management information system and decision support system, Information technology-introduction to e-business, e-commerce and integration tools like enterprise resource planning (ERP).

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

Reference Books:

1. Engineering Management, A. S. Chauhan, R. S. Vaishwanar, Neetu Jain, Jain Brothers Publications
2. Engineering Management, Fraidoon Mazda, Pearson Edition
3. The Practice of Engineering Management, Patrick D. T. O'Connor, Wiley–Blackwell

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Course Code: 19ME5OE02T	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;

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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
2. MEMS & Micro systems Design and Manufacture, Tai Ran Hsu, 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

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SubjectCode: 19IT5OE01T	Subject Name: JAVA Programming	L-T-P 3- 0- 0	Credit 3
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Course Objectives:

1. Learn the syntax, semantics and idioms of the Java Programming language
2. Gain confidence in object oriented programming principles through lots of practical examples that provides full exposure to the core Java class libraries

Syllabus

Module-I

[8 hours]

Introduction to Java and Java Programming Environment, Object Oriented Programming Concepts, Encapsulation, Abstraction, Inheritance, Polymorphism

Fundamental Programming Structure: Data Types variables, key words, type casting, Arrays, operators, and their precedence.

Control Flow: Java's control Statements (if, switch, iteration, statement, while, do-while, for, Nested loop) . Concept of Object and Classes, Using existing Classes building your own classes, constructor over loading, static, final, this keyword.

Module-II

[8 hours]

Inheritance: Introduction, types of inheritance, use of super keyword, Method overriding, Dynamic method Dispatch, Using Abstract Classes, Using final with inheritance. The Object Class.

Packages & Interfaces: Packages, Access Protection, Importing Package, Interface, Implementing Interfaces, variable interfaces, Interfaces can be extended.

Module-III

[7 hours]

Exception Handling: Fundamentals, Types Checked, Unchecked exceptions, Using try and catch, Multiple catch, throw, throws, finally Java's Built-in exceptions, user defined exception.

String Handling: String constructors, String length, Character Extraction, String Comparison, Modifying a String,

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Module-IV

[7 hours]

Java I/O: Classes & Interfaces, Stream classes, Byte streams, Character Streams, Serialization

Multi Threading: Java Thread Life Cycle, Thread Priorities, Synchronization, Creating a thread, runnable interfaces, creating multiple threads, Using is Alive() and join(), wait() & notices().

Module-V

[9 hours]

Wrapper Classes and Collection Framework: Wrapper classes and its methods, Introduction, Interfaces, List, Set, Map etc.

Event Handling: Event Delegation Model, Event Classes, Event listener Interfaces, Adapter classes

AWT: AWT Classes window fundamentals, component, container, panel, Window, Frame working, with Graphics, Control Fundamentals, Layout Managers, Handling Events by Extending AWT Components.

Course Outcomes:

1. Implement and apply various Object Oriented Programming concepts
2. Applying Collection Classes and Files, Multiple Threads, & handle Exceptions in developing a java applications
3. Developing a Java standalone application having front end design and back end.

Text Books:

1. Java; One step Ahead, Anita Seth, B. L. Juneja, Oxford University Press.
2. Head First Java, Kathy Sierra and Bert Bates, 2nd edition
3. JAVA Complete Reference, Herbert Schildt, 9th Edition

Reference Books:

1. <https://www.udemy.com/java-the-complete-java-developer-course/>
2. Java Programming Masterclass for Software Developers Created by Tim Buchalka, Tim Buchalka's Learn Programming Academy, Goran Lochert



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Digital Learning Resources:

Course Name	Foundation Engineering
Course Link	http://nptel.ac.in/courses/105/105/105105176/
Course Instructor	Prof. Koushik Deb, Department of Civil Engineering, IIT Kharagpur

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Course Code: 19EC5OE01T	Course Name: VLSI Design	L-T-P 3- 0- 0	Credit 3
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Course Objectives:

1. To understand the concept of VLSI Design Methodology, Design Flow, fabrication steps of NMOS as well as CMOS process and MOSFET the static and switching behavior of MOS Inverter.
2. To understand the design and working of combinational and sequential MOS circuits.
3. To understand the concept of semiconductor memories.
4. To understand the concept of Layout of CMOS Digital Circuits, DRC, LVS and RCX

Syllabus

Module-I [8 Hours]

Introduction, Historical perspective, VLSI Design methodologies, VLSI Design Flow, Design Hierarchy, Design Styles, CAD Technology .

Fabrication of MOSFETS, Fabrication processes, NMOS Fabrication, CMOS n-well process, Layout Design rules, Stick Diagrams, Full Custom Mask Layout Design.

MOS Transistor, Review of structure and operation of MOSFET (n-MOS enhancement type), CMOS, MOSFET V-I characteristics, MOSFET scaling and small geometry effects, MOSFET capacitances.

Module-II [10 Hours]

MOS Inverters:

Basic NMOS inverters, characteristics, inverters with resistive load and with n-type MOSFET load, CMOS inverter and characteristics.

MOS inverters: Switching characteristics and interconnect effects: Delay time definitions and calculation, inverter design with delay constraints, estimation of parasitic switching power dissipation of CMOS inverters.

Module- III [8 Hours]

Combinational MOS logic circuits: CMOS logic circuits, state style, complex logic circuits, pass transistor logic.

Sequential logic circuit – Introduction, SR latch, clocked latch & flip-flop circuits, CMOS D latch and edge triggered flip-flop.

Module-IV **[6 Hours]**

Semiconductor Memories: Introduction, Read Only Memory Circuits, Static Read-Write Memory (SRAM) Circuits, Dynamic Read-Write Memory (DRAM) Circuits.

Module-V **[8 Hours]**

Layout concepts and examples of CMOS Inverter, 2-Input NAND Logic Gate, 2-Input NOR Logic Gate, 2:1 Multiplexer using Transmission Gate, D-Latch using Transmission Gate, Concept of DRC, LVS and RCX.

Course Outcomes:

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

1. Analyze the characteristic of MOSFET, understand the fabrication steps, design CMOS inverters, calculate the dimension of MOSFETs for delay and inverter threshold voltage.
2. Design combinational and sequential circuits using CMOS technology and verify their functionalities.
3. Analyze the memory cells and verify its functionality
4. Analyze the layout and verification of CMOS integrated circuits.

Text Books:

1. CMOS Digital Integrated Circuits: Analysis and Design, Sung-Mo Kang, Yusuf Leblebici and Chul Woo Kim, 4th Edition, Tata McGraw-Hill Publishing Company Limited, 2015.
2. VLSI Design, Debaprasad Das, 2nd Edition, Oxford University Press, 2015, New Delhi.

REFERENCE BOOKS:

1. CMOS VLSI design a circuits and systems perspective, Neil H. E. weste, David Harris and Ayan Banerjee, 4th Edition, Pearson Education, 2015.

2. Digital Integrated Circuits– A Design Perspective, Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, 2nd Edition, PHI Learning, 2016, New Delhi
3. Basic VLSI Design, Douglas A. Pucknell and K. Eshraghian, 3rd Edition, PHI Learning, 2009, New Delhi

Digital Learning Resources:

Course Name	CMOS Digital VLSI Design
Course Link	https://nptel.ac.in/courses/108/107/108107129/
Course Instructor	Prof. Sudeb Dasgupta IIT Roorkee

Course Name	Digital VLSI Design
Course Link	https://nptel.ac.in/courses/108/103/108103108/
Course Instructor	Prof. Chandan Karfa IIT Guwahati

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Course Code: 19CE5OE01T	Course Name: Building Services and Maintenance	L-T-P 3- 0- 0	Credit 3
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Course Objectives:

1. To explain the activities involved in maintenance of a building
2. To know **services** of an anti-termite treatment and repair of pipes , sanitary works and joints.
3. To analyses the strengthening technique of foundations
4. To understand the strengthening technique of beams, columns, slabs and masonry walls
5. To understand water supply systems in a building and its maintenance

Syllabus

Module-I

[8 hrs]

Maintenance of Building: White washing, color washing and dis-tempering, painting, replacement of glass panels, re-polishing of terrazzo and mosaic, replacement of decayed timber, easing of doors and windows, repairs to damaged part of the flooring.

Module-II

[8 hrs]

Removal of stains from concrete and terrazzo floor, anti termite treatment in building, foundations, floors and wood work, repairing of plumbing, drain and sanitary works. Repair of water storage sumps and tanks

Module-III

[8 hrs]

Special Repairs: Strengthening of foundation and foundation soils, rectification of leaking roof and concrete covers palled roof, repairs to crack in masonry wall, repairs to leakage at window sill, special repairs to joinery work at roof level, providing D.P.C. to the exciting buildings, repairs to expansion and contraction joints, repair storamped floors.

Module-IV

[6 hrs]

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Strengthening of beams, Strengthening of columns, Strengthening of slab Strengthening of masonry wall

Module-V

[10 hrs]

Water quality, Purification and treatment- water supply systems-distribution systems in small towns- types of pipes used, laying jointing, testing- testing for water tightness plumbing system for building- internal supply in buildings- municipal bye laws and regulations - Rain Water Harvesting - Sanitation in buildings-arrangement of sewerage systems in housing -pipe systems storm water drainage from buildings-septic and sewage treatment plant – collection, conveyance and disposal of town refuse systems.

Course Outcome:

After completion of the course the student is able to

1. Analyses the activities involved in maintenance of a building
2. Evaluate various anti-termite treatments and repair of pipes, sanitary works and joints
3. Design the strengthening technique of foundations
4. Analyses the strengthening technique of beams, column slab and masonry walls
5. Design water supply systems in a building and its maintenance

Text Books:

1. Building Construction, V. N. Vazirani and S. P. Chandola, Khanna Publishers, NewDelhi, India.

Reference Books:

1. Building Maintenance Management, B. Chanter and P. Swallow, Second Edition, Wiley-Blackwell, 2017, New Jersey, United States.
2. General Specification for Building Maintenance Works in Residential Buildings, prepared by Building Surveying Division, HKIS



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Digital Learning Resources

CourseName	Fire Protection, Services and Maintenance Management of Building
CourseLink	https://nptel.ac.in/courses/105/102/105102176/
CourseInstructor	Dr. B. Bhattacharjee, Department of Civil Engineering, IIT Delhi

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Course Code: 19EE5OE01T	Course Name: Renewable Energy Systems	L-T-P 3- 0- 0	Credit 3
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Course Objectives:

The program is expected to enable the students to

1. Design and develop innovative products and services in the field of Renewable Energy.
2. Keeps abreast with the latest technology and tool set.
3. Communicate effectively to propagate ideas and promote team work
4. Attain intellectual leadership skills to cater to the changing needs of power industry, academia, society and environment

Syllabus

Module-I

[4 Hours]

Introduction: Causes of Energy Scarcity, Solution to Energy Scarcity, Factors Affecting Energy Resource Development, Energy Resources and Classification, Renewable Energy – Worldwide Renewable Energy Availability, Renewable Energy in India.

Quality of Energy: Measure of Quality of energy, Identification of potential energy resources in terms of their quality. Dependency of Efficiency of energy conversion on Quality of energy. Cogeneration, Dispersed or Distributed generation.

Module-II

[8 Hours]

Energy from Sun: Sun- earth Geometric Relationship, Solar radiation geometry, Layer of the Sun, Earth – Sun Angles and their Relationships, Solar Energy Reaching the Earth’s Surface, Sunpath diagram and evaluation of insolation quality at a location using Sunpath, Solar Thermal Energy Applications.

Solar Thermal Energy Collectors: Types of Solar Collectors, Configurations of Certain Practical Solar Thermal Collectors, Material Aspects of Solar Collectors, Concentrating Collectors, Parabolic Dish – Stirling Engine System, Working of Stirling or Brayton Heat Engine, Solar Collector Systems into Building Services, Solar Water Heating Systems, Passive Solar Water Heating Systems, Applications of Solar Water Heating Systems, Active Solar

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Space Cooling, Solar Air Heating, Solar Dryers, Crop Drying, Space Cooling, Solar Cookers, Solar pond.

Module-III

[7 Hours]

Solar Photovoltaic Cells: Components of Solar Cell System, Elements of Silicon Solar Cell, Equivalent Circuit of a PV Cell, Impact of parameters of PV cell performance, Solar Cell materials, Practical Solar Cells, I – V Characteristics of Solar Cells, Maximum Power Point Tracking (MPPT), MPPT algorithms: P&O, Incremental Conductance, Efficiency of Solar Cells, Photovoltaic Panels, Shading & Mitigation techniques, Applications of Solar Cell Systems.

Module-IV

[10 Hours]

Wind Energy Conversion System (WECs): Energy content in wind, extractable content of energy through WECs. Types of wind turbines with respect to axis of rotation (Horizontal & vertical axis wind turbine), working principle (lift and drag type) etc.

Airfoil terminology - Blade element theory - Blade design - Rotor performance and dynamics- Balancing technique (Rotor & Blade), significant parameters determining efficiency of WECs, Pitch angle, No of blades, solidity, Tip Speed ratio.

Constant speed Constant frequency - Variable speed variable frequency - Up wind-Down wind - Stall control-Pitch control - Gear coupled generator type - Direct generator drive/PMG/Rotor excited sync generator.

Module-V

[10Hours]

Integrated Energy Systems: Systems aspects of Integration: voltage effect, thermal effects, fault level, islanding. Stand alone systems: Network voltage and system efficiency, Case studies of standalone system. Hybrid energy systems and its economic evaluation. Technological aspects of power electronic systems connection to the grid. Hybrid and integrated energy systems, total energy concepts and waste heat utilization, Energy modeling to optimize different systems

Course Outcomes:

1. Appraise the need and possibility of extracting solar energy and converting into electrical energy using PV cell.
2. Design and analyze stand-alone and grid connected PV system.
3. Describe the dynamics of wind turbine and electrical generator.
4. Select and design suitable configuration of the wind energy conversion system based on application.
5. Suggest, design and analyze hybrid energy systems.

Text Books:

1. Non-conventional Energy Sources by G. D. Rai, Khanna Publishers.
2. Renewable Energy by Boyle, Godfrey Oxford University Press.
3. Renewable Energy Systems Design and Analysis with Induction Generators, by M. Godoy Simoes, Felix A. Farret, CRC press.
4. Micro-grid: A Conceptual Solution, Robert Lasseter, Paolo Piagi, PESC2004, June 2004.

Reference Books:

1. Renewable Energy Resources by John Twidell and Tony Weir, Taylor Francis Group.
2. Renewable Energy Sources for fuels and Electricity by Laurie Barrtom, Island Press.

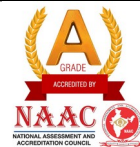
Digital Learning Resources:

Course Name	Solar, Wind and Biomass Energy Systems
Course Link	https://nptel.ac.in/courses/103/103/103103206/
Course Instructor	Prof. R. Anandalakshmi Prof. Vaibhav Vasant Goud, Department of Chemical Engineering, IIT Guwahati
CourseName	Solar & WindEnergy
CourseLink	https://nptel.ac.in/courses/103/107/103107157/




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CourseInstructor	Prof. P. Mondal, Department of Chemical Engineering, IIT Roorkee
CourseName	Energy Resources
CourseLink	https://www.youtube.com/watch?v=cZSYukWvpsE
CourseInstructor	Prof. Rangan Benarjee, Department of Energy Science & Technology, IIT Bombay
CourseName	Design of Photo voltaic system
CourseLink	https://www.youtube.com/watch?v=hr2sId412zU&list=PLuv3GM6-gsE2KyXoBTQ6lbrwn22Z3SiVm&index=2
CourseInstructor	Prof. L. Umanand, Department of Electronic System Engineering, IISc, Bangalore

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Course Code: 19ME5OE03T	Course Name: Smart and Intelligent Materials	L-T-P 3- 0- 0	Credit 3
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Course Objectives:

1. To study different type of smart material and its application.
2. Understand in details on the shape memory material and Chromogenic materials.
3. Understand the details of smart polymer and its application.
4. To study about smart hydrogels and its properties.
5. Understanding of smart material and its application in aerospace engineering.

Syllabus

Module-I

[7 hours]

Smart materials and structures: System intelligence- components and classification of smart structures, common smart materials and associated stimulus-response, Application areas of smart systems
Ferroelectric materials: Piezoelectric materials- piezoelectric effect, Direct and converse, parameter definitions, Piezoceramics, Piezopolymers, Piezoelectric materials as sensors, Actuators and bimorphs

Module-II

[7 hours]

Shape memory materials: Shape memory alloys (SMAs), Shape memory effect, Martensitic transformation, One way and two-way SME, training of SMAs, binary and ternary alloy systems, Functional properties of SMAs

Chromogenic materials: Thermochromism, Photochromism, Electrochromism, Halochromism, Solvatochromism- principle and design strategies

Module-III

[7 hours]

Smart polymers: Thermally responsive polymers, Electroactive polymers microgels, Synthesis, Properties and Applications, Protein-based smart polymers, pH-responsive and photo-responsive polymers, Self-assembly, Molecular imprinting using smart polymers, Approaches to molecular imprinting, Drug delivery using smart polymers

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Module-IV

[7 hours]

Smart hydrogels: Synthesis, Fast responsive hydrogels, Molecular recognition, Smart hydrogels as actuators, Controlled drug release, Artificial muscles, Hydrogels in microfluidics

Module-V

[7 hours]

Smart systems for space applications: Elastic memory composites, Smart corrosion protection coatings, Self-healing materials, Sensors, Actuators, Transducers, MEMS, Deployment devices, Molecular machines

Course Outcomes:

1. On successful completion of this course students will be able:
2. Characterize and evaluate smart materials for specific applications.
3. Inspect the theory of shape memory alloy material and chromogenic materials.
4. Understand the structure of smart polymer and its application to engineering problems.
5. Examine the properties of smart hydrogels.
6. Design advanced materials for aerospace, biological, nuclear and high temperature applications.

Text Books:

1. Engineering Analysis of Smart Material Systems, D.J. Leo, Wiley 2007.
2. Smart Materials and New Technologies in Architecture, M. Addington, D.L. Schodek, Elsevier 2005.
3. Shape Memory Materials, K. Otsuka, C.M. Wayman (Eds.), Cambridge University Press, 1998.
4. Smart Materials and Structures, M.V. Gandhi, B. S. Thompson, Chapman & Hall, 1992.

Reference Books:

1. Processes, and Methods Technology, M. Schwartz, New Materials, CRC Press, 2006.
2. Made to Measure: Materials for the 21st Century, P. Ball, Princeton University Press, 1997.



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3. Smart Polymers: Applications in Biotechnology and Biomedicine, Galaev, B. Mattiasson (Eds.), 2nd ed., CRC Press, 2008.
4. Reflexive Polymers and Hydrogels: Understanding and Designing Fast Responsive Polymeric Systems , N. Yui, R. J. Mrsny, K. Park (Eds.), CRC Press, 2004.

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Course Code: 19ME5OE04T	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 dependent 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. Nanoscale Materials in Chemistry, K. J. Klabunde and R.M. Richards (Eds.), 2nd Edn., John Wiley & Sons, 2009.
2. Nano: The Essentials, T. Pradeep, McGraw-Hill (India) Pvt Limited, 2008.
3. Handbook of Nanotechnology, Bharat Bhushan, Springer, 2007.

Reference Books:

1. Nanostructured Materials: Processing Properties and Applications, Carl C. Koch (Ed.), William Andrew Inc., 2007.
2. Carbon Materials and Nanotechnology, Anke Krueger, Wiley-VCH Verlag GmbH & Co. KGaA, 2010.

3. Nanostructures and Nanomaterials Synthesis, Cao, G., Properties, and Applications, Imperial College Press, 2004.
4. Characterization of nanophase materials, Wang, Z. L., (Ed.), Wiley-VCH Verlag GmbH, 2000.
5. Nanotechnology for the Energy Challenge. Garcia-Martinez, J., (Ed.), Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, 2009.
6. Handbook of Nanoscience, Engineering, and Technology, Goddard III W.A., et. al.,(Ed.), Taylor & Francis Group, 2007.
7. Hybrid Nanomaterials: Synthesis, Characterization, and Applications, B.P.S. Chauhan (Ed), Wiley-VCH Verlag GmbH, 2011.
8. Bioinspired Intelligent Nanostructured Interfacial Materials, J. Lei and F.Lin, World Scientific Publishing Company, 2010.
9. Biomimetic and Bioinspired Nanomaterials, Challa S. S. R. Kumar (Ed.) Wiley-VCH Verlag GmbH, 2010.

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Course Code: 19IT5OE02T	Course Name: Computer Networks	L-T-P 3- 0- 0	Credit 3
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Course Objectives:

1. Understand the concepts of data communication, layered model, wireless devices in computer networks.
2. Explain the various techniques used to access a shared channel in the network and IEEE specifications for LANs.
3. List types of networking devices, back bone networks and Internet Protocol (IP) addressing.
4. Explain the responsibilities of network, transport and application layers.

Syllabus

Module-I

[12 hours]

Overview of Data Communication Networks, Protocols and standards, OSI Reference model, TCP/IP Protocol.

Physical Layer: Analog Signals, Digital Signals, Data Rate Limits, Transmission Impairment, Data rate limit, Digital Transmission: Digital to Digital conversion, Analog to Digital conversion, Transmission modes, Analog Transmission: Digital-to-Analog conversion, Analog-to-Analog conversion, Multiplexing: Frequency Division Multiplexing (FDM), Wave Division Multiplexing (TDM), Transmission Media: Guided Media (Twisted-Pair Cable, Coaxial Cable and Fiber-Optic Cable) and unguided media (wireless), Switching: Circuit Switched network, Datagram Network, Virtual-Circuit Network.

Module-II

[12 hours]

Error Detection and Correction

Types of Error, Error Detection mechanism (Linear codes, CRC, Checksum), Error Correction mechanism: Hamming Encoding. Data Link Control and Protocols,: Flow and Error Control, Stop-and-Wait ARP. Go-Back-N ARO, Selective Repeat ARO, HDLC and Point-to-Point Protocol Multiple Access: Random access (ALOHA, CSMA, CSMA/CD, CSMA/ CA), Controlled Access (Polling, Reservation, Token Passing)

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Module-III

[6 hours]

Wireless LANS

IEEE 802.11 and Bluetooth Connecting Devices: Passive Hub, Repeater, Active Hub, Bridge, Two layers Switch, Router, Three layers Switch, Gateway. Virtual Circuit Networks: Frame Relay, Architecture and layers, ATM: Design goals, Architecture and layers.

Module-IV

[8 hours]

Network Layer: IPV4 addresses, IPV6 addresses, Internet Protocol: Internetworking. IPV4 datagram, IPV6 packet format and advantages, network Layer Protocols: ARP, RARP, IGMP and ICMP, Routing: Unicast Routing Protocols and Multicast Protocols.

Transport Layer: Process to Process Delivery, User Datagram Protocol (UDP) and Transmission Control Protocol (TCP).

Module- V

[8 hours]

Domain Name System (DNS)

Name Space, Domain Name Space, DNS in Internet, Resolution and Dynamic Domain name System (DDNS), Remote loggong, Electronic mail (SMTP) and file transfer (FTP), WWW: Architecture and Web document.

Course Outcomes:

1. Explain computer network reference models, networking devices and different transmission techniques.
2. Reason the need for flow and error control at the data link layer and explain the associated protocols; enumerate the shared channel access methods, associated protocols and Wired LAN standards and implementations.
3. Explain how network layer, transport layer and application layer facilitates the transfer of message from one node to another in a global network.

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Text Books:

1. Data Communication and Networking , Behrouz A. Forouzan, Tata McGraw-Hill, 5th Edition (2013).
2. Computer Networks, A. S. Tannenbum, D. Wetherall, Pearson Education, 5th Edition (2014).
3. Data and Computer Communications, William Stallings, pearson Education, 10th Edition (2018).

Reference Books:

1. Computer Networking, A Top-Down Approach, James F. Kurose, Keith W. Ross, Pearson publication, 6th Edition (2017).
10. <http://www.nptelvideos.in/2012/11/computer-networks.html>, Prof. Sujoy Ghosh, IIT, Kharagpur.
11. <https://nptel.ac.in/courses/106105183/>, Prof. Soumya Kanti Ghosh, IIT, Kharagpur.
12. <https://www.classcentral.com/course/stanford-openedx-introduction-to-computer-networking-1578>, Prof. Philip Levis and Professor Nick McKeown, Stanford University.

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Course Code: 19EE5OE03T	Course Name: Smart Grids	L-T-P 3- 0- 0	Credit 3
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Course Objectives:

The objectives of the course are to make the students,

1. To understand the basic concepts, components and architecture of smart grid
2. To understand the various measurement technologies in smart grid
3. To educate the importance of renewable energy in smart
4. To know about battery technology and energy storage
5. To brief about role of Electric Vehicles in smart grids

Syllabus

Module-I [12 hours]

Introduction to Smart Grid:

Basics of power systems, definition of smart grid, need for smart grid, smart grid domain, enablers of smart grid, smart grid priority areas, regulatory challenges, smart-grid activities in India, differences between traditional grid and smart grid.

Module-II [7 hours]

Concept of Microgrids:

Introduction to the concept of microgrid, the overview of the structure and architecture of microgrid with brief control, operational aspects. Recent pilot microgrid projects and their outcomes.

Module-III [8 hours]

Control of Smart Power Grid System:

Load Frequency Control (LFC) in Micro Grid System – Voltage Control in Micro Grid System – Reactive Power Control in Smart Grid

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Module-IV

[7 hours]

Energy Storage Systems:

Batteries, Super Conducting Magnetic Energy Storage System, Pumped Hydro, Compressed Air Energy Storage, Flywheel, Ultra capacitors.

Module- V

[8 hours]

Domain Name System (DNS)

Phasor Measurement Units Importance of PMUs, Phasor Measurement Units and Phasor Data Concentrators Wide Area Monitoring: WAMS concept, data collection, WAMS architecture, Advanced data processing, optimal placement of PMUs.

Course Outcomes:

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

1. Understand the features of Smart Grid.
2. Understand the basic concepts of micro grid and characteristics of energy storage devices.
3. Understand the concepts of Phasor measurements in power system.
4. Analyze the power system behavior using synchronized phasor measurements.

Text Books:

1. Smart Grids, Infrastructure, Technology and Solutions, S. Borlase, CRC Press, 1st Edition, 2013.
2. Microgrids Architecture and control, N. D. Hatziargytiu, IEEE Press Series, John Wiley & Sons Inc, 1st Edition, 2013.
3. Wide Area Monitoring of Interconnected Power Systems, A. R. Messina, IET publisher, 1st Edition, 2015.

Reference Books:

1. Synchronized Phasor Measurements and Their Applications, Arun G. Phadke, James S. Thorp, Springer International Publishing AG 2008, 2nd Edition, 2017.

2. Design of Smart power grid renewable energy systems, Ali Keyhani, Wiley IEEE,2011.
3. The Smart Grid: Enabling Energy Efficiency and Demand Response, Clark W. Gellings, CRCPress, 2009.
4. Smart Grid: Infrastructure, Technology and solutions, Stuart Borlase, CRC Press.
5. Smart Grid: Technology and Applications, Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, Wiley.
6. The Advanced Smart Grid: edge Power Driving, Andres Carvallo, John Cooper, Artech House Publishers July 2011.

Digital Learning Resources:

Course Name	Introduction to Smart Grid
Course Link	https://nptel.ac.in/courses/108/107/108107113/
Course Instructor	Prof. N P Padhy & Prof. Premalata Jena, Department of Electrical Engineering, IIT Roorkee

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Course Code: 19CE5OE03T	Course Name: Geo-Environmental Engineering	L-T-P 3- 0- 0	Credit 3
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Course Objectives:

1. To know the sub-surface contamination, geo- synthetics types and its application.
2. To gain comprehensive knowledge solid and hazardous waste management.
3. To provide knowledge on contaminant transport.
4. To understand about the remediation techniques.
5. To know the basic concept of Landfill design.

Syllabus

Module-I **[8 hours]**

Introduction: Scope, importance, waste generation, subsurface, contamination, Geo-synthetics: Types of manufacturing functions, applications and economics.

Module-II **[8 hours]**

Solid and Hazardous Waste Management: Classification of waste, Characterization solid wastes, Environmental Concerns with waste, waste management strategies.

Module-III **[8 hours]**

Contaminant Transport: Transport process, Mass-transfer process, Bioremediation, Phytoremediation.

Module-IV **[8 hours]**

Remediation Techniques: Objectives of site remediation, various active and passive methods, Soil washing, Emerging Remediation Technologies.

Module- V **[8 hours]**

Landfills: Types of landfills, Site Selection, Waste Containment Liners, Leachate collection system, Cover system, Gas collection system

Course Outcomes:

After completion of the course the student can

1. Understand surface contamination, geo-synthetic types and its function.
6. Analyze the classification of waste and waste management strategies.
7. Identify contaminant transport mechanisms in soils.
8. Understand the principles of soil treatment techniques
9. Get idea about different landfill concepts.

Text Books:

1. K. R. Reddy and H D Sharma, “*Geoenvironmental Engineering: Site Remediation, waste containment, and emerging waste management technologies*”, John Willey , New Jersey, USA
2. R N. Yong, “*Geo Environmental Engineering: Contaminated Ground: Fate of Pollutions and Remediation*” ., Thomson Telford , London, UK

Reference Books:

1. L N Reddy and H.I. Inyang, “*Geoenvironmental Engineering: Principles and Applications*”, Marcel Dek , New York, USA
2. R. W. Sarsby, “*Environmental Geotechnics*”, Thomson Telford , London, UK

Digital Learning Resources:

Course Name	Geo-Environmental Engineering
Course Link	https://nptel.ac.in/courses/105/102/105102160/
Course Instructor	Prof. Manoj Datta, Department of Civil Engineering, IIT Delhi

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Course Code: 19EC5OE04T	Course Name: Radar System engineering	L-T-P 3- 0- 0	Credit 3
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Course Objectives:

6. To learn the basics of the RADAR fundamentals and familiarization with various components of Transmitter and receiver.
7. To understand the concept of radar signal and its processing techniques under ambiguity conditions.
8. To learn about different types of RADARs and their operational principles.
9. To understand basic detection theory and tracking principles of a Radar systems.

Syllabus

Module-I

[10 hours]

Introduction to Radar:

Basic radar, maximum unambiguous range, building blocks of radar, simple form of radar equation, Block diagram of Radar transmitter, Radar frequencies, Applications to radar and related Problems.

Radar Equation : Prediction of Range Performance, Minimum Detectable Signal, Receiver Noise and SNR, Integration of Radar Pulses, Radar Cross Section of Targets (simple targets - sphere, cone-sphere), Transmitter Power, PRF and Range Ambiguities, System Losses (qualitative treatment). Related Problems.

Module-II

[8 hours]

CW and Frequency Modulated Radar:

Range and Doppler Measurement, Block Diagram and Characteristics (Approaching/ Receding Targets), FM-CW altimeter, Measurement Errors, Multiple Frequency CW Radar.

Module-III

[10 hours]

MTI and Pulse Doppler Radar:

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Introduction, Principle, MTI Radar with - Power Amplifier Transmitter and Power Oscillator Transmitter, Delay Line Cancellers – Filter Characteristics, Blind Speeds, Double Cancellation, Staggered PRFs. Range Gated Doppler Filters. MTI Radar Parameters, Limitations to MTI Performance. Non-coherent MTI, MTI versus Pulse Doppler Radar.

Module-IV

[7 hours]

Tracking Radar:

Tracking with Radar- Types of Tracking Radar Systems, Monopulse Tracking- Amplitude Comparison Monopulse (one-and two-coordinates), Phase Comparison Monopulse. Sequential Lobbing, Conical Scan Tracking, Block Diagram of Conical Scan Tracking Radar, Tracking in Range, Comparison of Trackers.

Module- V

[8 hours]

Radar Receiver:

Block Diagram of Radar Receiver & Radar Displays- A-scope and PPI.

Modern Radars:

Height Finding Radars, Synthetic Aperture Radar, Air borne Radar, Secondary surveillance Radar

Course Outcomes:

1. After completion of the course, the student will be able to
2. Demonstrate the understanding of radar fundamentals and various factors affecting the detection process.
3. Differentiate between various types of radar based on their working principles and field of application.
4. Familiarize with different displays and their applications on real time basis.
5. Analyze radar signals and various building blocks affecting it and also the detection process by applying different target centric tracking principles.
6. Understand the concepts of Phasor measurements in power system.

Text Books:

1. Merrill I. Skolnik, Introduction to Radar Systems, Third Edition, Tata McGraw-Hill, 2001, New Delhi.

Reference Books:

1. Radar Principles, Byron Edde, Technology, Applications, First Edition, Pearson Education, 2007, New Delhi.
2. Radar Design Principles, Nathanson, Second Edition, Mc-Graw Hill, 1991, New York.
3. Radar Principles, Peyton Z. Peebles, First Edition, Wiley, 1998, New York.
4. Principles of Modern Radar: Basic Principles, Mark A. Richards, James A. Scheer, William A. Holm. Yesdee, P First Edition, Scitech Publishing, 2013, Raleigh, North California

Digital Learning Resources:

Course Name	Radar System Engineering
Course Link	https://nptel.ac.in/courses/108/107/108107113/
Course Instructor	Prof. N P Padhy & Prof. Premalata Jena, Department of Electrical Engineering, IIT Roorkee

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Course Code: 19CS5MC02T	Course Name: Essence of Indian Tradition Knowledge	L-T-P 1- 0- 0	Credit 0
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Course Objectives:

1. To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.
2. To make the students understand the traditional knowledge and analyze it and apply it to their day to day life.

Syllabus

Module-I **[8 hours]**

Introduction to traditional knowledge: Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, Indigenous Knowledge (IK), characteristics, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge

Module-II **[6 hours]**

Protection of traditional knowledge: The need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.

Module-III **[8 hours]**

Legal framework and TK: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016.

Module-IV **[8 hours]**

Traditional knowledge and intellectual property: Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge



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Module-V

[10 hours]

Traditional Knowledge in Different Sectors: Traditional knowledge and engineering, Traditional medicine system, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.

Course Outcomes: At the end of the Course, Student will be able to:

1. Identify the concept of Traditional knowledge and its importance.
2. Explain the need and importance of protecting traditional knowledge.
3. Illustrate the various enactments related to the protection of traditional knowledge.
4. Interpret the concepts of Intellectual property to protect the traditional knowledge.
5. Explain the importance of Traditional knowledge in Agriculture and Medicine.

Text Books:

1. Traditional Knowledge System in India, by Amit Jha, 2009.
2. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002.
3. Knowledge Traditions and Practices of India" Kapil Kapoor1, Michel Danino2.