Bachelor of Technology
5th Semester
Detailed Syllabus

Department of Civil Engineering

National Institute of Science and Technology (Autonomous), Institute Park, Pallur Hills, Berhampur

B. Tech Programme Structure					
Fifth Semester					
Theory					
Sl. No.	Category	Subject Code	Subject Name	L-T-P	Credit
1	PCC	19CE5PC01T	Hydrology and Water Resources Engineering	3-0-0	3
2	PCC	19CE5PC02T	Foundation Engineering	3-0-0	3
3	PCC	19CE5PC03T	Design of Concrete Structures	3-0-0	3
		Professional Elective 2			
4	PEC	19CE5PE01T	Advanced Transportation Engineering	3-0-0	3
		19CE5PE02T	Environmental Impact Assessment and Life Cycle Analyses		
		19CE5PE03T	Building Services and Maintenance		
		19CE5PE04T	Repair and Rehabilitation of Structures		
5	OEC	Open Elective – 1 (for Non-CE Students)			
		19CE5OE01T	Building Services and Maintenance	3-0-0	3
		19CE5OE02T	Green Technology		
		Open Elective – 1 (for CE Students)			
		19IT5OE01T	Java Programming		
		19CS5OE01T	Introduction to Python Programming		
		19EE5OE04T	Introduction to Electrical Properties of Materials		
		19EE5OE01T	Renewable Energy Systems		
		19ME5OE03T	Micro Electro-Mechanical Systems (MEMS)		
		19EC5OE01T	VLSI Design		
		19EC5OE02T	Microprocessor and Interfacing		
6	OEC	Open Elective – 2 (for Non-CE Students)		3-0-0	3
		19CE5OE03T	Geo-Environmental Engineering		
		19CE5OE04T	Fluid Mechanics		

		Open Elective – 2 (for CE Students)			
		19IT5OE02T	Computer Networks		
		19CS5OE02T	Database Management System		
		19EE5OE03T	Smart Grids		
		19EE5OE02T	Sensor and Instrumentation		
		19ME5OE04T	Nanoscience and Technology		
		19EC5OE03T	Embedded System Design		
		19EC5OE04T	Radar System Engineering		
7	MC	19CM5MC01T/ 19CM5MC02T	Constitution of India/ Essence of Indian Tradition Knowledge	3-0-0	0
Total Credit (Theory)					18
Practical					
1	PCC	19CE5PC01L	Water Resources Engineering Lab.	0-0-2	1
2	PCC	19CE5PC02L	Foundation Engineering Lab.	0-0-2	1
3	PCC	19CE5PC03L	Design of Concrete Structures Lab.	0-0-2	1
4	PSI	19CM5PS01L	Summer Internship/Training.	0-0-2	1
Total Credit (Practical)					4
Total Semester Credit					22

5th Semester	Subject Code: 19CE5PC01T	Subject Name: Hydrology and Water Resources Engineering	L3-T0-P0	Credit:3

Course Objective:

1. To study occurrence movement and distribution of water that is a prime resource for development of a civilization.
2. To know diverse methods of collecting the hydrological information, which is essential, to understand surface and ground water hydrology.
3. To know the basic principles and movement of ground water and properties of ground water flow.
4. To know various hydraulic structure used in water resources engineering and their importance.

Module: I **(8 hrs)**

Introduction: Hydrologic cycle, Climate and water availability, Water balances, Precipitation: Forms, Classification, Variability, Measurement, Data analysis, Evaporation and its measurement, Evapo-transpiration and its measurement, Penman Monteith method. Infiltration: Factors affection infiltration, Horton's equation and Green Ampt method.

Module: II **(8 hrs)**

Stream flow Measurement: Discharge measuring structures, approximate average slope method, area-velocity method, and stage-discharge relationship. Hyetograph and Hydrograph Analysis: Hyetograph, Runoff: drainage basin characteristics, Hydrograph concepts assumptions and limitations of unit hydrograph, Derivation of unit hydrograph S hydrograph, Synthetic unit hydrograph: Snyder's approach, Introduction to Instantaneous Unit Hydrograph (IUH), Flow duration curve

Module: III **(8 hrs)**

Hydrologic Analysis and Design: Design flood, Flood estimation, Frequency analysis, Flood routing through reservoirs and open channels, Storm drainage design. Flood control measures. Reservoir: Types, Investigations, Site selection, Zones of storage, Safe yield, Reservoir capacity, Reservoir sedimentation and control.

Module: IV **(8 hrs)**

Groundwater & Well Hydraulics: Occurrence and movement of groundwater, Darcy's law, governing ground water flow equations, Factors governing ground water flow, Types of aquifers, porosity, specific yield, specific retention, storage coefficient, permeability, hydraulic conductivity, hydraulic transmissibility, Conjunctive use and it's necessity.

Module: V **(8 hrs)**

Distribution systems**:** Canal types and section, design of canal using Lacey's and Kennedy's method, Canal fall, Cross drainage work, diversion headwork, Dams and Spillway: Gravity dam, forces acting on gravity dam, High and low gravity dam,Stability analysis of gravity dam, earthen dam types and failure, Spillway

Course Outcome:

After completion of the course the student can

1. Ability to develop a simulation model related to water resources.
2. Ability to predict flood by using different techniques
3. Ability to explain reservoir operation, planning and management of water resources projects.
4. Ability to analyse and design the various types of hydraulic structures such as canal, weir, canal fall, dams and spillways.

Text Books:

1. K. Subramanian, "*Engineering Hydrology*", Fourth edition, McGraw Hill Education, 2017, New York, New York, United States
2. S. K. Garg, "*Irrigation Engineering and Hydraulic Structures*", First Edition, Khanna Publication, 2006, India

Reference Books:

1. B. C. Punmia, B. B. L. Pande, A.K. Jain, A. K. Jain, "*Irrigation and Water Power Engineering*", Laxmi Publication, 1992, New Delhi, India.
2. K. C. Patra, "*Hydrology and Water Resources Engineering*", First Edition, Published by Narosa Publishing House Pvt. Ltd., 2015, New Delhi, India
3. V.P Singh, "*Elementary Hydrology*" Facsimile Edition, Prentice Hall Publication, 1991, Hoboken, New Jersey, United States
4. V.T. Chow, "*Handbook of applied hydrology*" First Edition, McGraw Hill Education, 2017, New York, New York, United States.

Digital Learning Resources

Course Name	Hydrology and Water Resources Engineering
Course Link	https://nptel.ac.in/courses/105/104/105104103/
Course Instructor	Prof. Rajesh Srivastav, Department of Civil Engineering, IIT Kanpur

5th Semester	Subject Code: 19CE5PC01L	Subject Name: Water Resources Engineering Lab	L0-T0-P2	Credit:1

Course Objective:

1. To know about design principles of various types of hydraulic structures.
2. To gain knowledge about the design of canal sections by using various method.
3. To give a practical knowledge about the design of various segments of a canal work like lined channel section, diversion head work, canal fall and weir section.

EXPERIMENT NAME

1. Determination of average precipitation over an area.
2. Flood predication using different techniques.
3. Layout of canal sections in cutting, filling and partially cutting and filling
4. Design of Channel section using Lacey's and Kennedy's method
5. Design of Lined Channel section
6. Layout of Diversion head work.
7. Design of Canal falls
8. Design of Weir section
9. Design of Gravity Dam
10. Design of Earthen Dam.

Course Outcome:
After completion of the course the student can

1. Ability to determine average precipitation over an area.
2. Ability to predict flood by using different techniques.
3. Ability to analyse and design the various types of hydraulic structures such as canal, weir,canal fall, dams.

5th Semester	Subject Code 19CE5PC02T	Subject Name Foundation Engineering	L3-T0-P0	Credit: 3

Course Objective:

1. To know about the earth pressure on retaining wall and its analysis.
2. To calculate the bearing capacity of soil.
3. To calculate the load carrying capacity and settlement on deep foundation.
4. To impart knowledge to plan and execute a detail site investigation programme.
5. To explain about subsoil exploration.

Module: I **(8 hrs)**

Lateral Earth Pressure and Retaining Structures: Concept of earth pressure, Earth pressure at rest, active and passive earth pressure for both cohesionless and cohesive soils, Earth pressure theories: Rankine's theory, Coulomb's Wedge theory, Graphical methods: Rebhan's and Culmann's graphical solutions, Stability conditions for retaining walls.

Module: II **(8 hrs)**

Bearing Capacity of Shallow Foundations: Types of shear failure in foundation soil, Terzaghi's bearing capacity equation its validation and limitations, Meyerhof's, Vesics's, Brinch-Hansen, IS code method of bearing capacity theory, Effect of water table on bearing capacity, Field Methods: Plate load test and its limitations

Module: III **(8 hrs)**

Deep Foundations: Difference between shallow and deep foundations, Types of deep foundations. Pile Foundations: Types of piles, pile driving, load carrying capacity of piles-static and dynamic formulae, Pile load test and its limitations, Pile group analysis, Settlement analysis of pile.

Module: IV **(8 hrs)**

Subsoil Exploration: Necessity and planning for subsoil exploration, Methods -direct (test pits and trenches), indirect (sounding, penetration tests and geophysical methods).Soil sampling – types of samples, standard penetration test, static and dynamic cone penetration test, in-situ.

Module: V **(8 hrs)**

Rock Mechanics: Introduction, problems, defects in rock mass, joints, faults, folds, methods of geophysical prospecting, seismic and electrical method. Stability of Slopes: Stability of infinite slopes, the stability of finite slopes

Course Outcome:

After completion of the course the student can

1. Determine the earth pressure of retaining walls and stability analysis of retaining wall.
2. Determine the bearing capacity of soil and explain different testing methods.
3. Determine the load carrying capacity and settlement on deep foundation.
4. Distinguish the different methods of subsoil exploration.
5. Demonstrate the site investigation, methods and sampling.

Text Books:

1. B. M. Das, *Principles of Geotechnical Engineering*, First Edition, Thompson Learning, 2002, Boston, Massachusetts, United States.
2. G. Ranjan and A. S. R. Rao, *Basic and Applied Soil Mechanics*, Second Edition, New Age International, 2007, New Delhi.

Reference Books:

1. S. K. Gulhati and M. Datta, *Geotechnical Engineering*, First Edition, McGraw Hill Education, 2017, New York, United States.
2. V. N. S. Murthy, *Principles of Soil Mechanics and Foundation Engineering*, First Edition, UBS Publishers and Distributors, 2002. New Delhi.

Digital Learning Resources

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

5th Semester	Subject Code: 19CE5PC02L	Subject Name: Foundation Engineering Lab	L0-T0-P2	Credit: 1

Course Objective:

1. To know the compressibility characteristics soil by consolidation test
2. To know the bearing capacity of soil by using different field method.
3. To know shear parameter of soil by using shear test apparatus.
4. To know the swelling characteristics of the soil.

EXPERIMENT NAME

1. Determination compressibility characteristics of fine-grained soil by consolidation test
2. Determination of bearing capacity by Standard Penetration test
3. Determination of bearing capacity by Cone Penetration test
4. Determination of shear strength of saturated soil by Trixial Shear Test.
5. Determination of Shear Strength of Saturated soil by Drained Trixial Shear Test.
6. Determination of Free Swell and Swelling Potential.

Course Outcome:

After completion of the course the student can

1. Able to find out the compressibility parameters.
2. Analyse the bearing capacity of soil by using different field method.
3. Find out the shear strength parameter.
4. Understand the swelling characteristics of the soil.

5th Semester	Subject Code: 19CE5PC03T	Subject Name: Design of Concrete Structures	L3-T0-P0	Credits: 3

Course Objective:

1. To know the basic concepts, properties and design philosophies of reinforced Cement Concrete with application of Limit State Method for rectangular beams
2. To analyse and design doubly reinforced beams T and L beams. Design of simple beams for shear, bond and torsion
3. To design one way, two way slabs
4. To design short and long columns with axial and eccentric loadings
5. To design of isolated square and rectangular footings.

Module: I **(8 hrs)**

Properties of concrete and reinforcing steel; philosophy, concept and methods of reinforced concrete design; introduction to limit state method: limit state of collapse and limit state of serviceability, application of limit state method to rectangular beams for flexure.

Module: II **(8 hrs)**

Design the beams for shear; bond; and torsion. Design of doubly reinforced beams; T and L beams.

Module: III **(8 hrs)**

Structural behaviour of one way and two way slabs under uniformly distributed load, Types of end supports, Design and reinforcement detailing of one way slab: cantilever and simply supported .one way continuous slab Design and reinforcement detailing of Two-way slab: Corners are not held down, Corners are held down: All the Four edges discontinuous case only.

Module: IV **(8 hrs)**

Design of compression members for axial loads and axial load plus, Uni-axial moment ,Short columns under axial compression, Short columns under axial compression with uni-axial bending, Short columns under axial compression with bi-axial bending. Slender columns.

Module: IV **(8 hrs)**

Foundation types, Types of footings, Design of isolated square and rectangular footings.

Course Outcome:

After completion of the course the student able to

1. Understand the properties of the materials used in R.C.C. and various philosophies used in design of concrete structures. Perform analysis of a R.C.C. beam.
2. Analyse and design doubly reinforced and T beams. Design the beams for shear and torsion
3. Design one way, two way slabs
4. Design long and short columns with axial and eccentric loadings
5. Design of isolated square and rectangular footings

Text Books:

1. S. Pillai and D.Menon, “Reinforced Concrete Design” Third Edition, McGraw Hill Education, 2017, New York, New York, United States.

Reference Books:

2. B.C.Punmia, A.K.Jain and A.K.Jain “*RCC Design*”, Tenth edition, Laxmi Publications, 2015, New Delhi, India.

Digital Learning Resources

Course Name	**Design of Reinforced Concrete Structures**
Course Link	https://nptel.ac.in/courses/105/105/105105105/
Course Instructor	Prof. Nirjhar Dhang, Department of Civil Engineering, IIT Kharagpur

5th Semester	Subject Code: 19CE5PC03L	Subject Name: Design of Concrete Structures Lab	L0-T0-P2	Credit: 1

Course objective:

1. Students will able to know different properties of concrete
2. Students will able to find the properties of aggregates of concrete
3. Students will able to find the workability of concrete
4. Students will able to know about the properties of concrete
5. Students will able to know the mix design procedure for different types of concrete.

EXPERIMENT NAME

1. Workability test of concrete: Slump test
2. Workability test of concrete: Compaction factor test
3. Workability test of concrete: Flow table test
4. Cube Test of Concrete(Nominal Mix)
5. Cylinder Test for Concrete(Nominal Mix)
6. Split Tensile Strength Test of Concrete
7. Prism test for determining modulus of rupture of concrete
8. Design of Concrete Mix (As per Indian Standard Method)
9. Two Field visits for detailing of reinforcements.

Course outcomes:

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

1. Outline the importance of testing of concrete and its properties
2. Assess the different properties of aggregate in concrete
3. Summarize the concept of workability and testing of concrete
4. Describe the properties of hardened concrete
5. Describe the preparation of green concrete using IS code

5th Semester	Subject Code: 19CE5PE01T	Subject Name: Advanced Transportation Engineering	L3-T0-P0	Credit: 3

Course Objective:

1. To give the basic idea about Indian railway system.
2. To explain different components of railway track.
3. To design the different geometric element of railway track.
4. To explain the components of runway design and understand the control system of air transport system.
5. To explain the components of harbour and docks engineering.

Module: I **(8 hrs)**

History of Indian railways, component parts of railway track, selection of gauges, uniformity of gauges, problems of multi gauge system, coning of wheels, alignments and survey

Module: II **(8 hrs)**

Permanent way track components, type of rail sections, creep of rails, wear and failure in rails, ballast requirements, sleeper requirements, types of sleepers, and various train resistances

Module: III **(8 hrs)**

Geometric design: Gradients and grade compensation, various speeds on a railway track, super- elevation, horizontal and vertical curves, Points and crossings, Design of simple turn-out, Signalling and interlocking.

Module: IV **(8 hrs)**

Airport site selection, Air craft characteristics, various surface of an airport, Wind rose diagram, Geometric elements of run way and taxiway, holding apron, parking configuration , terminal building , visual aids, air traffic control, airport marking and lighting.

Module: V **(8 hrs)**

Harbour Engineering: Classification of Harbour basin, general layout of harbours, Docks, Different components of docks.

Course Outcome:

After completion of the course the student can

1. Understand the fundamentals of railway system.
2. Understand the components of railway track.
3. Design and analyze the geometric features of Railway track.
4. Analyze geometric components of runway, taxiway and airport and the traffic control management.
5. Synthesize the features of harbour and Dock engineering.

Text Books:

1. S.C.Saxena and M.G.Arora, "*A Text Book of Railway engineering*" Dhanpat Rai Publications, 2010, New Delhi, India.
2. S.K.Khanna and M.G.Arora, "*Airport Planning and Design*" Nem Chand, 1999, Roorkee, Uttarakhand.

Reference Books:

1. C. Venkatramaih, "*Transportation Engineering: Volume-II*" Orient Blackswan Private Limited, 2018, Hyderabad, India
2. S. Chandra and M.M Agrawal "*Railway Engineering*" Oxford University Press, 2007, Oxford, United Kingdom.
3. R. Srinivasan, "*Harbour dock and Tunnel Engineering*" 28th Edition, Charotar Publishing House Pvt. Ltd. 2016, Gujarat.

Digital Learning Resources

Course Name	Advanced Transportation Engineering
Course Link	https://nptel.ac.in/courses/105/104/105104098/
Course Instructor	Prof. A. Das, Prof. Partha Chakraborty, Department of Civil Engineering, IIT Kanpur

5th Semester	Subject Code: 19CE5PE02T	Subject Name: Environmental Impact Assessment and Life Cycle Analyses	L3-T0-P0	Credit: 3

Course Objective:

1. To introduce the basic knowledge of current environmental management systems applied in both public and private sectors.
2. To discuss various stages of environmental impact assessment and its evaluation.
3. To gain knowledge about different environmental auditing process.
4. To know the basic concept of life cycle assessment.
5. To gain comprehensive knowledge of environmental management system and standards.

Module: I **(8 hrs)**

Principles of Environmental Management, Ecosystem Concepts, Environmental Concerns in India, Policy and Legal Aspects of Environmental Management, Introduction to Environmental Policies, Environmental Laws and Legislations, Environmental Legislations in India.

Module: II **(8 hrs)**

Environmental Impact Assessment (EIA), Impact Prediction, Evaluation and Mitigation, Forecasting Environmental Changes, Strategic Environmental Assessment (SEA), Environmental Clearance Procedure in India, EIA Documentation and Processes, EIA Monitoring and Auditing.

Module: III **(8 hrs)**

Environmental Auditing, Elements of Audit Process, Waste Audits and Pollution Prevention Assessments, EA in Industrial Projects.

Module: IV **(8 hrs)**

Life Cycle Assessment (LCA): Stages in LCA of a Product, Procedures for LCA, Different Applications of LCA. Sustainable approach towards Environment Management, Environmental Protocols.

Module: V **(8 hrs)**

Environmental Management System Standards, Implementation of EMS Conforming to ISO 14001. Environmental Economics: Introduction, economic tools for evaluation, Green GDP, Cleaner development mechanisms and their applications.

Course Outcome:

Upon successful completion of this course, students will be able to

1. Understand different policies and legal aspects of environmental management.
2. Analyze the different procedure to predict environmental impact assessment.
3. Overview the application of different environmental auditing process.
4. Comprehend different stages and procedure of life cycle assessment.
5. Get idea about environmental management system and environmental economics.

Text Books:

6. V. Kulkarni and T.V. Ramachandra, "*Environmental Management*", Commonwealth Of Learning, Canada and Indian Institute of Science, Bangalore, Printed by TERI Press, New Delhi.
7. L.W. Canter, "*Environmental Impact Assessment"*, Second Edition, McGraw-Hill Higher Education, 1996, New York, New York, United States.

Reference Books:

1. Paul, A Erickson, "*A Practical Guide to Environmental Impact Assessment*" Academic Press Inc, 1994, Cambridge, Massachusetts, United States.
2. B. N. Lohani "*Environmental Quality Management*", South Asian Publishers, 1984, New Delhi.
3. Chanlett "*Environmental Protection*", McGraw Hill Publication, 1979, Newwork.
4. G.E. Danoy and R.F. Warner "*Planning and Design of Engineering Systems*" Unwin Hyman Publications.
5. ISO 14001:2004 Environmental management systems - Requirements with guidance for use

Digital Learning Resources

Course Name	Environmental Impact Assessment and Life Cycle Analyses
Course Link	https://nptel.ac.in/courses/120/108/120108004/ https://nptel.ac.in/courses/105/105/105105157/
Course Instructor	Prof. Brajesh Kumar Dubey , Department of Civil Engineering, IIT Kharagpur

5th Semester	Subject Code: 19CE5PE03T	Subject Name: Building Services and Maintenance	L3-T0-P0	Credits: 3

Course Objective:

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

Module: I **(8 hrs)**

Maintenance of Building: White washing, colour washing and distempering, 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 cover spalled 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, repairs to ramped floors.

Module: IV **(6 hrs)**

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. analyse 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. analyse the strengthening technique of beams, column slab and masonry walls
5. design water supply systems in a building and its maintenance

Text Books:

1. V. N. Vazirani and S.P. Chandola, "*Building Construction*", Khanna Publishers, New Delhi, India.

Reference Books:

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

Digital Learning Resources

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

5th Semester	Subject Code: 19CE5PE04T	Subject Name: Repair and Rehabilitation of Structures	L3-T0-P0	Credit: 3

Course Objective:

1. To understand the importance of maintenance and various aspects of assessment of damage with their causes of deterioration
2. To give a brief knowledge about the durability aspects and types of cracks with their effects.
3. To explain the benefits of various concretes used in repair works
4. To introduce the methods of repair and corrosion protection.
5. To make them able to rehabilitate, retrofit and demolish the structures using proper methods.

Module: I **(8 hrs)**

Maintenance and repair strategies: Maintenance, repair and rehabilitation, facts of maintenance, importance of maintenance, various aspects of inspection, assessment procedure for evaluating damaged structure, causes of deterioration.

Module: II **(8 hrs)**

Strength and durability of concrete: Quality assurance for concrete, strength and durability. Cracks, different types, causes–effects due to climate, temperature, sustained elevated temperature, corrosion

Module: III **(8 hrs)**

Special concretes: Polymer concrete, Sulphur infiltrated concrete, fiber reinforced concrete, high strength concrete, high performance concrete, Vacuum concrete, self-compacting concrete, geopolymer concrete, Reactive powder concrete, concrete made with industrial wastes.

Module: IV **(8 hrs)**

Techniques for repair and protection methods: on-destructive testing techniques, Load test for stability-epoxy injection, shoring, underpinning, corrosion protection techniques–corrosion inhibitors, corrosion resistant steels, coatings to reinforcement, cathode protection

Module: V **(8 hrs)**

Repair, rehabilitation and retrofitting of structures: strengthening of structural elements, repair of structures distressed due to corrosion, fire, leakage, earthquake-transportation of structures from one place to other – structural health monitoring- demolition techniques-Engineered demolition methods-Case studies.

Course Outcome:

After completion of the course the student can

1. Understand the importance of maintenance and assessment methods of distressed structures.
2. Analyze the types of cracks with their causes and effects.
3. Distinguish the merits and demerits of concretes used in rehabilitation
4. Explore the techniques for repair and rehabilitation methods
5. Appraise rehabilitation and retrofitting of structures and demolition techniques.

Text Books:

1. M.S. Shetty "*ConcreteTechnology-Theory and Practice*", Eighth Edition, S. Chand Publishing, 2019, New Delhi.
2. B. Vidivelli "*Rehabilitation of Concrete Structures*" First Edition, Standard Publishes Distribution, 2019, Delhi.

Reference Books:

1. D. Kominetzky "*Design and Construction Failures*", Galgotia Publications Pvt. Ltd, 2001, New Delhi.
2. P.C. Varghese "*Maintenance Repair and Rehabilitation and Minor works of building*", Prentice Hall India Pvt. Ltd, 2014, Delhi.

Digital Learning Resources

Course Name	Repair And Rehabilitation Of Structures
Course Link	https://nptel.ac.in/courses/105/106/105106202/
Course Instructor	Radhakrishna G. Pillai, Department of Civil Engineering, IIT Madras

5th Semester	Subject Code: 19CE5OE01T	Subject Name: Building Services and Maintenance	L3-T0-P0	Credits: 3

Course Objective:

6. To explain the activities involved in maintenance of a building
7. To know services of the anti termite treatment and repair of pipes, sanitary works and joints.
8. To analyse the strengthening technique of foundations
9. To understand the strengthening technique of beams, column slab and masonry walls
10. To understand water supply systems in a building and its maintenance

Module: I **(8 hrs)**

Maintenance of Building: White washing, colour washing and distempering, 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 cover spalled 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, repairs to ramped floors.

Module: IV **(6 hrs)**

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

6. analyse the activities involved in maintenance of a building
7. evaluate various anti termite treatments and repair of pipes, sanitary works and joints
8. design the strengthening technique of foundations
9. analyse the strengthening technique of beams, column slab and masonry walls
10. design water supply systems in a building and its maintenance

Text Books:

4. V. N. Vazirani and S.P. Chandola, "*Building Construction*", Khanna Publishers, New Delhi, India.

Reference Books:

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

Digital Learning Resources

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

5th Semester	Subject Code: 19CE5OE02T	Subject Name: Green Technology	L3-T0-P0	Credit: 3

Course Objective:

1. Study of global warming and its effect and also to choose the proper way for planning of future to reduce the global warming.
2. To analyze the opportunities in control of carbon emission and accumulation.
3. To gain knowledge about the various use of green technologies for energy production.
4. To understand the personal, citywide and specific applications of green technologies.
5. To know some high-tech measures for the reduction of carbon emission and recommended plan of action.

Module: I **(8 hrs)**

Global Warming and its effect:- Introduction and physical definition of global warming, the New Carbon Problem: Accumulation, Long Half-Life, Heating Potential, Carbon Emission Factors, Carbon Absorption in Nature, The Global Emission Situation and its effect in India, The Kyoto and Other Protocols and its view in India, Effect of climate change and its impact.

Planning for the Future to reduce global warming:- Steps taken to Control Carbon Emissions universally, Use of Promotional and Punitive Mechanisms for Reducing Carbon in Atmosphere, The General Approach in Planning for the Future, Developing Countrywide Adaptive Measures for Safety of Local People, Developing Mitigative Measures for Global Reduction of Carbon, India's National Action Plan on Climate Change (NAPCC) till date, National Mission for a Green India, The MRV Debate.

Module: II **(8 hrs)**

Opportunities in Control of Carbon Emissions and Accumulation:- Essential Steps for Control of Carbon Emissions and Accumulation, Procedure to develop own Priorities and Business Opportunities in India for control of carbon emissions and accumulation, Needs a Mix of Green and Traditional Power Sources in India, A Logical Approach for Carbon Reduction, Need in India —More Forests, Less Deforestation and payment rates procedure for controlling carbon emissions and its Promotional Mechanisms at India.

Module: III **(8 hrs)**

Green Technologies for Energy Production :- Various Technologies Available for Energy Production, Cost Comparison of a Few Typical Systems for Power Generation, Sources of Energy Production Already in Use, Alternative Methods Ready for Use, Green Technologies Needing some Prior R&D Work.

Module: IV **(8 hrs)**

Green Technologies for Personal and Citywide Application :- Measures to be taken for Green city, Carbon Emission Reduction at Personal Level, Carbon Emission Reduction at Local Authority and Citywide Level, Carbon Emissions from Imports.

Green Technologies for Specific Applications:- Promotion of 'Green' Buildings, Guidelines, The Energy Conservation Building Code (ECBC),Green Hotels and Hospitals, Green Technologies for Transport, Green Roads, Ports and Harbors, Industries, Carbon, Carbon Emissions from a Few Selected Industries in India, The Changing Scenario in Cities, Need for Wider Application to Town Planning and Area Re-Development Projects ,'Green' Infrastructure for Municipal Services, Bringing up Indian Villages, Green Services for Crematoria, Spreading Message to all Stakeholders.

Module: V **(8 hrs)**

Some High-tech Measures for Reducing Carbon Emissions :- Use of Solar Power with Satellite-Based Systems ,Use of Carbon Capture and Storage (Sequestration) ,Microorganisms, A Quick SWOT Analysis.
Recommended Plan of Action :- India's National Action Plan Take Us to a Low-Carbon Path, The Missions Help Develop Awareness, Few case studies on Projects undertaken by Various Countries, Adaptive Measures Essential for Indian People to Cope with Climate Change

Course Outcome:

After completion of the course the student can

1. To understand the global warming effect and the planning of future to reduce the global warming.
2. Ability to determine the control of carbon emissions and accumulation.
3. Identify the various technologies available for energy production.
4. Apply some green technologies specific application for carbon emission reduction like personal level, local authority, and citywide level.
5. Able to analyse some high-tech measures for carbon emission and recommended plan of action.

Text Books:

1. Soli J. Arceivala "*Green Technologies*", First Edition, McGraw Hill Education (India) Private Limited, 2014, New Delhi.

Reference Books:

1. R. Singh and S. Kumar "*Green Technologies and Environmental Sustainability*" First Edition, Springer International Publishing, 2017.

Digital Learning Resources

Course Name	Sustainable Materials and Green Buildings
Course Link	https://nptel.ac.in/courses/105/102/105102195/
Course Instructor	Dr. B. Bhattacharjee, Department of Civil Engineering, IIT Delhi

5th Semester	Subject Code: 19CE5OE03T	Subject Name: Geo-Environmental Engineering	L3-T0-P0	Credit: 3

Course Objective:

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.

Module: I **(8 hrs)**

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

Module: II **(8 hrs)**

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

Module: III **(8 hrs)**

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

Module: IV **(8 hrs)**

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

Module: V **(8 hrs)**

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

Course Outcome:

After completion of the course the student can

1. Understand surface contamination, geo-synthetic types and its function.
2. Analyze the classification of waste and waste management strategies.
3. Identify contaminant transport mechanisms in soils.
4. Understand the principles of soil treatment techniques
5. 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

5th Semester	Subject Code: 19CE5OE04T	Subject Name: Fluid Mechanics	L3-T0-P0	Credit: 3

Course Objective:

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

Module: I **(8 hrs)**

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

Fluid statics: Pressure, Pascal's Law, Pressure variation for incompressible fluid, atmospheric pressure, absolute pressure, gauge pressure and vacuum pressure, manometer. Hydrostatic process on submerged surface, force on a horizontal submerged plane surface, force on a vertical submerged plane surface. Buoyancy and floatation, Archimedes' principle, stability of immersed and floating bodies, determination of metacentric height.

Module: II **(8 hrs)**

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

Module: III **(8 hrs)**

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

Module: IV **(6 hrs)**

Hydraulic turbines: Classification, Impulse and Reaction turbine; Tangential, Radial and axial turbine. Impulse turbine, Pelton wheel, bucket dimensions, number of buckets in pelton wheel, efficiency and performance curves. Reaction Turbines: Francis turbine and Kaplan turbine, velocity triangle and efficiencies, performance curve. Function of draft tube and casing cavitation.

Module: V **(8 hrs)**

Centrifugal Pump: constructional features, vane shape, velocity triangles, Efficiencies, Multi stage centrifugal pumps, Pump Characteristic, NPSH and Cavitation. Positive displacement pumps: Reciprocating Pump, Working principle, Discharge, work done and power requirement, Slip, Indicator diagram.

Course Outcome:

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

Text Books:

3. Y. A Cengel and J. M. Simbala "*Fluid Mechanics*", McGraw-Hill Higher Education, New York, United States.
4. C. S. P Ojha, P.N. Chandramouli, and R. Berndtsson "Fluid Mechanics and Machinery", First Edition, Oxford University Press. 2010, Oxford, United Kingdom.

Reference Books:

1. S.K. Som and G. Biswas "Introduction to Fluid Mechanics and Fluid Machines", Third Edition, -Hill Higher Education, 2017, New York, United States

Digital Learning Resources

Course Name	Fluid Mechanics
Course Link	https://nptel.ac.in/courses/105/103/105103192/
Course Instructor	Dr. Subhashisa Dutta , Department of Civil Engineering, IIT Guwahati

Course Name	Principle of Hydraulic Machines and System Design
Course Link	https://nptel.ac.in/courses/112/103/112103249/
Course Instructor	Prof. Pranab K. Mondal, Department of Civil Engineering, IIT Guwahati

5th Semester	Subject Code: 19CM5MC01T	Subject Name: Constitution of India	L3-T0-P0	Credit: 3

Course Objective:

1. This course acquaints students with the constitutional design of state structures and institutions, and their actual working over time.
2. The course traces the embodiment of some of these conflicts in constitutional provisions, and shows how these have played out in political practice.

Module: I **(10 hrs)**

Preamble & its Philosophy, Salient Features of Indian Constitution

Module: II **(10 hrs)**

Citizenship- Methods of acquiring & loosing, Fundamental Rights & Fundamental Duties, Directive Principles of State Policy

Module: III **(10 hrs)**

Legislature: Union Parliament, Executive: President, Vice-President, Prime Minister and Council of Ministers, Judiciary: Supreme Court

Module: IV **(10 hrs)**

State Legislature- Composition & Powers, State Executive: Governor, Chief Minister & Council of Ministers – powers & functions, State Judiciary: High Court- Composition & Powers

Course Outcome:

1. Able to understand historical background of the constitutional making and its importance for building a democratic India, the structure of Indian government, the structure of state government, the local Administration.
2. Able to apply the knowledge on directive principle of state policy, the knowledge in strengthening of the constitutional institutions like CAG, Election Commission and UPSC for sustaining democracy.

3. Able to analyze the History, features of Indian constitution, the role Governor and Chief Minister, role of state election commission, the decentralization of power between central, state and local self-government. Able to evaluate Preamble, Fundamental Rights and Duties, Zilla Panchayat, block level organization, various commissions of viz SC/ST/OBC and women

Text Books:

1. D.D. Basu "*An Introduction to the Constitution of India*", Twenty Second Edition, Lexis Nexis
2. M.V. Pylee, "*An Introduction to The Constitution of India*" Fifth Edition, Vikas Publishing, 1998, New Delhi.

Reference Books:

1. V.D. Mahajan, "*Constitutional Development and National Movement in India*" First Edition , S Chand and Co., 1986, New Delhi.
2. G. Noorani "*Constitutional Questions in India: The President, Parliament and the States*", Oxford University Press, 2000, Delhi.
3. J.C. Johari, "*Indian Political System*", Anmol Publishers, 1996, New Delhi.

5th Semester	Subject Code: 19CM5MC02T	Subject Name: Essence of Indian Tradition Knowledge	L3-T0-P0	Credit: 3

Course Objective:

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 analyse it and apply it to their day to day life

Module: I **(8 hrs)**

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 hrs)**

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 hrs)**

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 hrs)**

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

Module: V **(10 hrs)**

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 Outcome:

1. Identify the concept of Traditional knowledge and its importance.
2. Explain the need and importance of protecting traditional knowledge.
3. Illlustrate 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. A. Jha "*Traditional Knowledge System in India*", Atlantic, 2002, Chennai, Tamil Nadu.

Reference Books:

1. K. Kapoor, M. Danino, "Knowledge Traditions and Practices of India" Central Board of Secondary Education, 2021

Open Elective Courses for CE Students offered by other Branches

Open Elective-1

Subject Code: 19IT5OE01T	Subject Name: JAVAPROGRAMMING	L3-T0-P0	Credit: 3

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 exposer 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 Bulletin exceptions, user defined exception.

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

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 Creared by Tim Buchalka, Tim Buchalka's Learn Programming Academy, Goran Lochert

5th Semester	Subject Code: 19CS5OE01T	Subject Name: Introduction to Python Programming	L3-T0-P0	Credit: 3

Course Objective:

1. Identify/characterize/define a problem.
2. Design a program to solve the problem.
3. Create executable code.
4. Read most Python code and write basic unit tests

Module: I **(10 hrs)**

Features and History of Python: Literal constants, variables and identifiers, data types, Input operations, comments, reserve words, indentation, operators and expressions, operations on strings, other data types, conditional branching statements, loop structures, break, continue, pass, else. Functions in python

Module: II **(10 hrs)**

Concatenating, appending and multiplying strings: string formatting operator, built in string methods and functions, slice operation, ord() and chr(), in and not in operations, comparing strings, iterating strings, string module, match(), search() and sub(), findall() and finditer().

Data structures: sequence, lists, functional programming, tuple, sets, dictionaries,

Module: III **(10 hrs)**

Class Objects: class methods and self arguements, the _init_(), class variable and object variable, _del_(),public and private data members, calling a class method from another class method, builtin funcitons to set,get and delete class attributes

Inheritance, types, composition or containership, abstract classes or interfaces
Operator overloading: implementing Operator overloading, reverseadding, overriding _getitem_() and _setitem_() methods, overriding the in operator, overloading the misc functions

Module: IV **(10 hrs)**

Error and exception handling: handling exceptions, multiple exception blocks, multiple exceptions in a single block, except block without exception, else clause, raising exception, instantiating exceptions, handling exceptions in invoked functions, builtin and user defined exceptions, the finally block, predefined cleanup action.

Course Outcome:

1. To understand why Python is a useful scripting language for developers.
2. To learn how to design and program Python applications.
3. To learn how to use lists, tuples, and dictionaries in Python programs.
4. To learn how to identify Python object types.

Text Books

1: Python programming, Reema Thareja, Oxford publications

2: learning python , Mark lutz, oreilly

Reference Books:

3: Statistics and Machine Learning in Python Release 0.1, Edouard Duchesnay, Tommy Löfstedt

4: Python data Analytics , Fabio Nelli, Apress.

Digital Learning Resources

Course Name	Programming Data Structures and Algorithm in Python
Course Link	https://nptel.ac.in/courses/106/106/106106145/
Course Instructor	Prof. Madhavan Mukund, Chennai Mathematical Institute

Subject Code: 19EE5OE04T	Subject Name: Introduction to Electrical Properties of Materials	L3-T0-P0	Credit: 3

Course Objectives

1. To understand the conducting properties of metal.
2. To give knowledge about semiconductor materials.
3. To give knowledge about the insulating materials and their applications.
4. To acquire the knowledge about the dielectric materials.
5. To have knowledge about magnetic materials.
6. To have knowledge about special purpose materials.

SYLLABUS

Module-I (8 Hours)

Conductivity of Metal: Introduction, factors affecting the resistivity of electrical materials, motion of an electron in an electric field, Equation of motion of an electron, current carried by electrons, mobility, energy levels of a molecule, emission of electrons from metals, thermionic emission, photo electric emission, field emission.

Module-II (6 Hours)

Dielectric Properties: Introduction, effect of a dielectric on the behaviour of a capacitor, polarization, the dielectric constant of monatomic gases, frequency dependence of permittivity.

Module-III (9 Hours)

Dielectric losses, significance of the loss tangent, dipolar relaxation, frequency and temperature dependence of the dielectric constant. Dielectric properties of polymeric system, ionic conductivity in insulators, insulating materials, Ferro-electricity, piezoelectricity.

Module-IV (8 Hours)

Magnetic properties of Materials: Introduction, Classification of magnetic materials,

diamagnetism, para-magnetism, ferromagnetism, magnetization curve, the hysteresis loop, factors affecting permeability and hysteresis loss, common magnetic materials, magnetic resonance. Superconductivity and its origin, Zero resistance and Meissner Effect, critical current density.

Module-V (8 Hours)

Semiconductors: energy band in solids, conductors, semiconductors and insulators, types of semiconductors, Intrinsic semiconductors, impurity type semiconductor, diffusion, the Einstein relation, hall effect, thermal conductivity of semiconductors, electrical conductivity of doped materials.

Course Outcomes

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

1. Understand the various kinds of materials and their applications in ac and dc fields.
2. Understand the conductivity of superconductivity of materials.
3. Explain the electrical properties of different materials and metallic behavior of materials on the basis of band theory.
4. Explain the properties and applications of all kind of magnetic materials.
5. Explain the properties of electrical conducting and insulating materials.
6. Assess a variety of approaches in developing new materials with enhanced performance to replace existing materials.

Text Books

1. C. S. Indulkar and S. Thiruvengadam, S., “An Introduction to Electrical Engineering
2. Kenneth G. Budinski, “Engineering Materials: Prentice Hall of India, New Delhi
3. ELECTRICAL PROPERTIES OF MATERIALS, 9th Edition (L. Solymer, Donald Walsh,R. R .A. Syms)

4. Electrical and Electronic Engineering Materials by SK Bhattacharya, Khanna Publishers, New Delhi.

Reference Books:

1. Electrical Engineering Materials Adrianus J Dekker, Phi Learning Publishers.
2. Introduction to Electrical Engineering Materials 4th Edn. 2004 Edition by Indulkar C, S. Chand & Company Ltd-New Delhi.

Digital Learning Resources:

Course Name	Processing of Semiconducting Materials
Course Link	http://nptel.ac.in
Course Instructor	Dr. Pallab Banerji,Department of Metallurgy and Material Science,IITKharagpur.

Course Code: 19ME5PC01T	Course Name: Renewable Energy Systems	L-T-P 3- 0- 0	Credit 3

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 Space Cooling, Solar Air Heating, Solar Dryers, Crop Drying, Space Cooing, 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, extractible 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 ans 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 byJ ohn 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/
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=PLuv3GM6gsE2KyXoBTQ6lbrwn22Z3SiVm&index=2
CourseInstructor	Prof. L. Umanand, Department of Electronic System Engineering, IISc, Bangalore

Course Code:	Course Name:	L-T-P 3- 0- 0	Credit 3
19ME5OE03T	Micro Electro-Mechanical Systems (MEMS)		

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
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

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

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

Subject Code: 19EC5OE02T	Subject Name: Microprocessor and Interfacing	L-T-P: 3-0-0	Credit : 3

Course Objective:

1. Understand the main components and working principle of the Intel 8086 microprocessor and its programming
2. Understand the Memory organization, interfacing and the interrupt concept of 16-bit microprocessor
3. To make the interfacing of the I/O devices using programmable interfacing devices
4. To enable the students to understand the basic components and working principle of the Intel 32-bit processor 80386

SYLLABUS

Module-1 **(10 Hours)**

8086 Microprocessor:

Introduction: Overview of Microcomputer organization.

Intel 8086 Microprocessor: Introduction, 8086 Programmer's model: Register organization, **Hardware Architecture**: Bus interface unit (BIU), Execution unit (EU), Pipelined operation, physical address generation and Memory segmentation.

8086 Pin description: Common, Minimum and maximum mode Pin and Signals, Bus cycle and System configuration.

Module-2 *(8 Hours)*

8086 Memory Interfacing and Interrupt technique:

8086 Memory Interfacing: External Memory addressing, EPROM and RAM interface with 8086.

8086 Interrupt: Interrupt Processing, sources of interrupt in 8086, Interrupt Instructions, Interrupt types, IVT, Hardware Interrupts and Interrupt priorities.

Module-3 *(8 Hours)*

8086 Instruction set and programming:

8086 Addressing modes, Instruction set: data transfer, arithmetic, bit manipulation, branch and processor control, assembler directives and programming

Module-4 *(10 Hours)*

Peripheral interfacing and its programming:

Introduction to basic I/O interface, I/O interfacing techniques in 8086.

Interfacing devices: 8255 PPI, 8254 Timer, 8251 USART, ADC-0808/0809, and DAC-0800 interfacing using PPI.

Module-5 *(8 Hours)*

32-bit Microprocessor 80386:

Salient features of 80386, Architecture and Signal Description of 80386. Register Organization of 80386, Hardware Memory organization 80386 Memory management: Real mode, Segment translation, protected mode, Memory paging mechanism and Virtual 8086 Mode

Course Outcome:

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

1. Gain deep knowledge on 8086 microprocessor architecture and pin and signals and demonstrate the memory interfacing and illustrate the use of interrupts.
2. Identify the addressing modes and illustrate the different classification and functions of 8086 microprocessor instructions and apply the knowledge in assembly language programming.
3. Illustrate the design aspect of I/O interface and Design and development of interfacing various I/O devices using programmable peripheral devices with the 8086

microprocessor.

4. Study and understand the architecture and memory management system of 80386 advanced microprocessors.

Text Books:

1. A. K. Ray and K. M. Bhurchandi, **"***Advanced Microprocessors and Peripherals***",**3rd Edition, Tata McGraw Hill Education,2000, New Delhi.
2. Walter A Triebel and Avtar Singh, "*The 8088 and 8086 Microprocessors, Programming, Interfacing, Software, Hardware and Applications*", 4th edition, Pearson Education, 2014, Noida

Reference Books:

1. Barry B. Brey, *The Intel Microprocessors, Architecture, Programming and Interfacing*, 8th Edition, Pearson Education, 2009, Noida
2. Doughlas.V.Hall, *Microprocessor and Interfacing : Programming and Hardware*, 2nd Edition, McGraw Hill, 1992, Noida
3. Yu-chengliu and Glenn a. Gibson, *Microcomputer Systems: The 8086/8088 Family Architecture, Programming & Design*-, 2ndEdition, Prentice Hall of India, 2007, New Delhi

Digital Learning Resources:

Course Name	Microprocessors and interfacing
Course Link	https://nptel.ac.in/courses/108/103/108103157/
Course Instructor	Prof. Shaik Rafi Ahmed, Department of Electronics and ElectricalEngineering, IIT Guwahati

Open Elective-2

5th Semester	Subject Code: 19IT5OE02T	Subject Name: Computer Networks	L3-T0-P0	Credit:3

Course Objective

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, backbone networks and Internet Protocol (IP) addressing.
4. Explain the responsibilities of network, transport and application layers.

Module: I **(8 hrs)**

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 (WDM), Time 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 hrs)**

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

Module: III **(6 hrs)**

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 & layers, ATM: Design goals, Architecture &layers.

Module: IV **(6 hrs)**

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 Routing Protocols.

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

Module: V **(8 hrs)**

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

Course Outcome

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 facilitate the transfer of message from one node to another in a global network.

Text Books:

1. Data Communications 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).
2. http://www.nptelvideos.in/2012/11/computer-networks.html, Prof. Sujoy Ghosh, IIT, Kharagpur.
3. https://nptel.ac.in/courses/106105183/, Prof. SoumyaKantiGhosh, IIT, Kharagpur.
4. https://www.classcentral.com/course/stanford-openedx-introduction-to-computer-networking-1578, Prof. Philip Levis and Professor Nick McKeown, Stanford University.

5th Semester	Subject Code: 19CS5OE02T	Subject Name: Database Management System	L3-T0-P0	Credit:3

Course Objective

1. To learn data models, conceptualize and depict a database system using ER diagram
2. To understand the internal storage structures in a physical DB design
3. To know the fundamental concepts of transaction processing techniques

Module: I **(5 hrs)**

Introduction: Purpose of Database System: Views of data – data models, database management system, three-schema architecture of DBMS, components of DBMS. E/R Model - Conceptual data modelling - motivation, entities, entity types, attributes relationships, relationship types, E/R diagram notation, examples.

Module: II **(12 hrs)**

Rational Model:

Relational Data Model - Concept of relations, schema-instance distinction, keys, referential integrity and foreign keys, relational algebra operators, SQL - Introduction, data definition in SQL, table, key and foreign key definitions, update behaviours. Querying in SQL, notion of aggregation, aggregation functions group by and having clauses, embedded SQL

Module: III **(6 hrs)**

Database Design:

Dependencies and Normal forms, dependency theory - functional dependencies, Armstrong's axioms for FD's, closure of a set of FD's, minimal covers, definitions of 1NF, 2NF, 3NF and BCNF, decompositions and desirable properties of them, algorithms for 3NF and BCNF normalization.

Module: IV **(6 hrs)**

Transactions:

Transaction processing and Error recovery - concepts of transaction processing, ACID properties, concurrency control, locking based protocols for CC, error recovery and logging, undo, redo, undo-redo logging and recovery methods.

Module: V **(8 hrs)**

Implementation Techniques:

Data Storage and Indexes - file organizations, primary, secondary index structures, various index structures - hash-based, dynamic hashing techniques, multi- level indexes, B+ trees.

Course Outcomes

1. Ability to Install, configure, and interact with a relational database management system
2. Ability to master the basics of SQL and construct queries using SQL
3. Ability to design and develop a large database with optimal query processing

Text Book

1. Silberschatz, Henry F. Korth, and S. Sudharshan, "Database System Concepts", 7thEd,Tata McGraw Hill, 2019.
2. C. J. Date, A. Kannan and S. Swamynathan, "An Introduction to Database Systems", 8thed,Pearson Education, 2006

Reference Books:

1. RamezElmasri and Shamkant B. Navathe, "Fundamentals of Database Systems",7thEdition, Pearson/Addisionwesley, 2016
2. Raghu Ramakrishnan, "Database Management Systems", Third Edition, McGraw Hill, 2003

Digital Learning Resources

Course Name	Database Systems Course
Course Link	https://nptel.ac.in/courses /106/104/106104135/
Course Instructor	Dr. Arnab Bhattacharya, IIT,Kanpur

Course Name	Introduction to Database Systems
Course Link	https://nptel.ac.in/courses/106 /106/106106220/
Course Instructor	Prof. P.Sreenivasa Kumar, IIT,Madras

5th Semester	Subject Code: 19EE5OE03T	Subject Name: Smart Grids	L3-T0-P0	Credit:3

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 grid6.

SYLLABUS

Module-1 **(6Hours)**

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-2

Concept of Microgrids **(7 Hours)**

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-3

Control of Smart Power Grid System **(8 Hours)**

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

Module-4 ***(7 Hours)***

Energy Storage Systems

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

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

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 storagedevices.
3. Understand the concepts of Phasor measurements in power system.
4. Analyze the power system behavior using synchronized phasor measurements.

Text Books:

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

Reference Books:

1. Arun G. Phadke, James S. Thorp, "Synchronized Phasor Measurements and Their Applications", Springer International Publishing AG 2008, 2nd Edition, 2017.
2. Ali Keyhani, "Design of Smart power grid renewable energy systems", Wiley IEEE,2011.
3. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and DemandResponse", CRCPress, 2009.
4. Stuart Borlase, "Smart Grid: Infrastructure, Technology and solutions " CRC Press.
5. Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama,"Smart Grid: Technology and Applications", Wiley.
6. Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving", 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 ElectricalEngineering, IIT Roorkee

Subject Code:	Subject Name:	L-T-P:	Credit:
19EE5OE02T	Sensor and Instrumentation	3-0-0	3

Course Objectives:

The students will

1. Understand the concepts of measurement technology.
2. They learn the various sensors used to measure various physical parameters.
3. They will learn the fundamentals of signal conditioning and data acquisition.
4. Learn how to use virtual instrumentation for measurement.

Syllabus

Module-1 **(8 Hours)**

Sensors & Transducer: Definition, Classification & selection of sensors, Elements of a general measurement system: Static Characteristics: systematic characteristics, statistical characteristics, calibration; Dynamic characteristics of measurement systems: transfer functions of typical sensing elements, step and frequency response of first and second order elements, and dynamic error in measurement systems.

Module-2 *(8 Hours)*

Measurement of displacement using Potentiometer, LVDT & Optical Encoder, Measurement of force using strain gauge, Measurement of pressure using LVDT based diaphragm & piezoelectric sensor

Module-3 *(8 Hours)*

Signal Conditioning Elements: Deflection bridges: design of resistive and reactive bridges,push-pull configuration for improvement of linearity and sensitivity. Amplifiers:Operational amplifiers-ideal and non-ideal performances, inverting, non-inverting and differential amplifiers, instrumentation amplifier, filters. A.C. carrier systems, phasesensitive demodulators and itsapplications in instrumentation

Module-4 *(10 Hours)*

Virtual Instrumentation: Graphical programming techniques, Data types, Advantage of Virtual Instrumentation techniques, Concept of WHILE & FOR loops, Arrays, Clusters & graphs,Structures: Case, Sequence & Formula nodes, need of software based instruments for industrial automation.

Module – 5 *(4 Hours)*

Data Acquisition Methods: Basic block diagram, Analog and Digital IO, Counters, Timers, Types of ADC: successive approximation and sigma-delta, Types of DAC: Weighted Resistor and R-2R Ladder type, Use of Data Sockets for Networked Communication

Course Outcomes:

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

1. Apply the use of sensors for measurement of displacement, force and pressure.
2. Employ commonly used sensors in industry for measurement of temperature, position, accelerometer, vibration sensor, flow and level.
3. Demonstrate the use of virtual instrumentation in automation industries.
4. Identify and use data acquisition methods.
5. Comprehend intelligent instrumentation in industrial automation.

Text Books:

1. J.P. Bentley, Principles of Measurement Systems- 3rd edition, Pearson Education, New Delhi,2007.

2. Jovitha Jerome,Virtual Instrumentation Using LabVIEW,PHI Learning Pvt. Ltd., New Delhi-1100012010

REFERENCE BOOKS:

3. Introduction to Measurement and Instrumentation- A.K. Ghosh (3/e), PHI Learning,New Delhi, 2009.

4. Patranabis D, Sensors and Transducers, 2nd Edition, PHI, New Delhi, 2010

Digital Learning Resources:

Course Name	Sensor and Transducer
Course Link	https://nptel.ac.in/courses/108/108/108108147/ https://nptel.ac.in/courses/108/105/108105064/
Course Instructor	Dr. Hardik Jeetendra Pandya, Department of Electronic Systems Engineering, IISc Bangalore Prof. Alok Barua, Department of Electrical Engineering, IIT Kharagpur.

Course Code: 19ME5OE04T	Course Name: Nanoscience and Technology	L-T-P 3- 0- 0	Credit 3

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, biosenors, 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 Propertiesand 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 andF.Lin, World Scientific Publishing Company, 2010.
9. Biomimetic and Bioinspired Nanomaterials, Challa S. S. R. Kumar (Ed.) Wiley-VCH Verlag GmbH, 2010.

Subject Code: 19EC5OE03T	Subject Name: Embedded System Design	L-T-P: 3-0-0	Credit: 3

COURSE OBJECTIVES:

1. To get the knowledge of the Embedded technology and its utility to the society.
2. Understanding the architecture and programming of embedded processor (ARM or FPGA) or microcontroller
3. Familiarization with the embedded computing platform design and analysis.
4. To acquire the knowledge in interfacing protocols and related Hardwires.

SYLLABUS:

Module-1 **(10 Hours)**

Introduction to Embedded Systems:

Hardware and Software Concepts: Embedded Systems, Application and characteristics of Embedded System, Overview of Processor and Hardware Units in Embedded System, Embedded Software into a system, Introduction to Embedded SystemDesign,Introduction to Embedded System Architecture.

System-on-Chip, NoC, Embedded Hardware Modeling and Design: System-on-chip (SoC),Network-on-chip (NoC), Levels of Hardware modeling, Embedded Hardware Design and Development.

Module-2 *(8 Hours)*

8051, AVR ATmega and ARM Microcontrollers:

Microcontrollers, AVR Microcontrollers, ARM processor –based system Design

Sensors, A/D–D/A Converters, Actuators and Interfacing:

Sensors, A/D–D/A Converters, Actuators, interfacing Techniques, Network Embedded System, Internet-Enable Systems-Network Protocols, Wireless and Mobile System Protocols

Module- 3 *(8 Hours)*

Real-Time Operating System (RTOS) and Real-Time task scheduling:

RTOS: concepts, types of Real time Task and their characteristics, task scheduling, Feature of RTOS, device driver, interrupts and Service mechanism

Module – 4 *(8 Hours)*

IoT System- System Architecture and Design:

IoT, Internet connectivity and IoT connectivity, Edge computing Architecture and Application, IoT communication module Protocols, Rapid prototype designing using open source Boards.

Module – 5 *(8 Hours)*

EMBEDDED AI- System Architecture and Design:

Artificial Intelligence Embedded AI hardware and Software Development, Embedded AI Application

Course Outcome:

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

1. Design an embedded system application
2. Implement the peripheral interfacing.
3. Use system design techniques to develop firmware
4. Develop embedded system solution to automation and IoTs Application.

Text Books:

1. K. V. SHIBU, *Introduction to Embedded Systems*, McGraw Hill Publication Company Limited, 2009, New Delhi.

Reference Text Books:

1. Raj Kamal, *Title Embedded Systems*, 4th Edition, McGraw Hill Publication Company Limited, 2020, New Delhi.

2. David E. Simon, Addition Wesley, *An Embedded Software Primer*, Wiley, 1999, New Delhi.
3. K. Short, *Embedded Microprocessor Systems Design: An Introduction Using the Intel 80C188EB*, Prentice Hall,1998, ISBN-10 : 0132494671,ISBN-13 : 978-0132494670.

Digital Learning Resources:

Course Name	Embedded System Design
Course Link	https://nptel.ac.in/courses/106/105/106105159/
Course Instructor	Prof. Anupam Basu, Department of Computer Science and Engineering,IIT Kharagpur

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Subject Code:	Subject Name:	L-T-P:	Credit
19EC5OE04T	Radar System Engineering	3-0-0	: 3

Course Objective:

1. To learn the basics of the RADAR fundamentals and familiarization with various components of Transmitter and receiver.
2. To understand the concept of radar signal and its processing techniques under ambiguityconditions.
3. To learn about different types of RADARs and their operational principles.
4. To understand basic detection theory and tracking principles of a Radar systems.

SYLLABUS:

Module-1 **(10 Hours)**

Introduction to Radar:

Basic radar, maximum unambiguous range, building blocks of radar, simple form of radarequation, 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-2 *(8 Hours)*

CW and Frequency Modulated Radar:

Doppler Effect, CW Radar – Block Diagram, Isolation between Transmitter and Receiver, Non- zero IF Receiver, Receiver Bandwidth Requirements, Applications of CW radar.

FM-CW Radar:

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

Module-3 *(10 Hours)*

MTI and Pulse Doppler Radar:

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-4 *(8 Hours)*

Tracking Radar:

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

Module-5 *(6 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 Outcome:

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

1. Demonstrate the understanding of radar fundamentals and various factors affecting thedetection process.

2. Differentiate between various types of radar based on their working principles and fieldof application.
3. Familiarize with different displays and their applications on real time basis.
4. Analyze radar signals and various building blocks affecting it and also the detectionprocess by applying different target centric tracking principles.

Text Book:

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

Reference Books:

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

Digital Learning Resources:

Course Name	Radar System Engineering
Course Link	https://nptel.ac.in/courses/108/105/108105154/
Course Instructor	Prof. Amitabha Battacharya, Department of Electronics and ElectricalCommunication Engineering, IIT Kharagpur

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

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

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. IIllustrate 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.