6^{th} Semester B. Tech. (CE) Detailed Syllabus

National Institute of Science and Technology (Autonomous)

Institute Park, Pallur Hills, Berhampur, Odisha - 761008

Sixth Semester					
Theory					
Sl. No.	**Category**	**Subject Code**	**Subject Name**	**L-T-P**	**Credit**
1	BSC	19CM6BS01T	Optimization Engineering	4-0-0	4
2	PCC	19CE6PC01T	**PCC-9:** Irrigation Engineering	3-0-0	3
3	PCC	19CE6PC02T	**PCC-10:** Advanced Structural Analysis	3-0-0	3
4	PEC	19CE6PE01T/ 19CE6PE02T/ 19CE6PE03T/ 19CE6PE04T/	**Professional Elective-3:** Advanced Mechanics of Materials / Ground Improvement Techniques/ Construction Practice / Building and Town planning	3-0-0	3
5	PEC	19CE6PE05T/ 19CE6PE06T/ 19CE6PE07T/ 19CE6PE08T/	**Professional Elective-4:** Estimation and Project Management / Open Channel Flow/ Pavement Materials and Traffic control / Environmental Geotechnics	3-0-0	3
6	OEC	19ECOE01T/19EC6OE02T/19EE6OE01T /19EE6OE02T /19IT6OE01T/19CS6OE01T	**Open Elective-3 (For CE Branch)** Fundamental of Satellite Communication/Image Processing Techniques/ Introduction to Robotics and Autonomous Vehicles / Electrical Energy Utilization/ Introduction Operating System/Data Analytics	3-0-0	3
7	OEC	**19CE6OE01T/ 19CE6OE02T**	**Open Elective-3 (For Non-CE Branch) Plastic Waste Management Environment and Safety Engineering**	3-0-0	3
8	MC	19CE6MC01T	Mandatory (Constitution of India/ Essence of Indian Tradition Knowledge)	1-0-0	0
Total Credit (Theory)					19
Practical					
1	HSMC	19CM6HS01L	Business Communication & Interview Skills	0-0-2	2
2	PSI	19CE6PS01L	Research/Lab based Project	0-0-2	2
3	PCC	19CE6PC01L	**PCC Lab-9:** Irrigation Engineering Sessional	0-0-2	1
4	PCC	19CE6PC02L	**PCC Lab-10:** Advanced Structural Analysis Sessional	0-0-2	1
Total Credit (Practical)					6
Total Semester Credit					25

6th Semester	**Subject Code 19CE6PC01T**	**Subject Name Irrigation Engineering**	**L3-T0-P0**	**Credit: 3**

Course Objective:

1. To make understand the basic types of irrigation, irrigation standards and crop water assessment
2. To develop knowledge about different canal system and their methods of design
3. To develop knowledge about different methods used for Reclamation of water-logged area
4. Idea about the river system
5. To provide knowledge on various hydraulic structures such as weir and barrage, head and cross regulators, canal falls, spillway, cross drainage works, various types of dams

Module: I (08 hrs)

Introduction to irrigation: Necessity of Irrigation in India, Advantages and disadvantages of Irrigation, Systems of irrigation: Lift irrigation, Flow irrigation, Techniques of distribution of water to farm. Quality of irrigation water.

Water requirement of crops, factors affecting water requirement, crop season, crop period, base period, delta and duty, consumptive use of water, frequency of irrigation, irrigation efficiency.

Module: II (08 hrs)

Canal Irrigation: Classification of canals, Canal losses, Alignment of canals, Design of stable channels using Kennedy's and Lacey's theory, Garret's diagram, Cross section of irrigation canals *Lining of Irrigation Canals*: Advantages and economics of lining, Various types of lining, Design of lined canals.

Reclamation of Water Logged and Saline Soils: Causes and control of water logging. Reclamation of saline and alkaline land, Surface and Sub-surface drainage, Design

Module: III (07 hrs)

Behaviour of river control and training: Importance of rivers and Necessity of controlling them, Types of rivers and their characteristics, Indian rivers and their classification, Behaviour of rivers, Control and training of rivers

Module: IV (09 hrs)

Types of Cross-Drainage Works: Types of CD works, Selection of a suitable type to suite a particular condition, Design consideration of Aqueduct design. *Diversion Head works*: Weirs and Barrages, Types of weirs and barrages, Layout of a diversion head works, Introduction to different components of a diversion head works. *Design of weirs and barrages*: Bligh's creep theory, Design of weir using Bligh's theory, Lane's weighted creep theory, Khosla's theory, Khosla's method of independent variables, Exit gradient. *Canal Falls*: Necessity, Proper location, Types, Design and detailing of one type of fall.

Module: V (08 hrs)

Gravity Dams: Typical cross section, Various forces acting on gravity dam, Combination of forces for design, Modes of failure and criteria for structural stability, High and low gravity dam, Design of high dam, Typical section of low gravity dam. Earth Dams: Types, Causes of failure, Preliminary section of an earth dam, Seepage control in earth dams. Spillways: Descriptive study of various types of spillways.

Course Outcome:

After completion of the course the student can

1. Assess the irrigation techniques and irrigation needs of crops.
2. Able to gain knowledge the canal system and their design.
3. Assess about the methods adopted to control water logged in an irrigated area
4. Develop knowledge on about different hydraulic structures such as canal, weir, cross drainage works, different dams, spillways, canal falls and their functions
5. Design of different hydraulic structures such as canal falls, weir, gravity dam, earthen dam, etc

Text Books:

1. S. K. Garg, *Irrigation Engineering and Hydraulic Structures*, First Edition, Khanna Publication, New Delhi, 1976
2. B.C. Punmia, A. K. Jain, A. K. Jain and B. B. L. Pande, *Irrigation and Water Power Engineering*, Seventh Edition, Laxmi Publication, New Delhi, 2021.

Reference Books:

1. Birdie and Das, *Irrigation Engineering - Including Water Power Engineering*, Third Edition, Dhanpat Rai Publication Company, New Delhi, 2014
2. S.K. Sharma, *Irrigation Engineering and Hydraulic Structures*, First Edition, S. Chand Publishing. Cuttack, Odisha, 2017.

Digital Learning Resources

Course Name	Irrigation and Drainage
Course Link	https://nptel.ac.in/courses/126/105/126105010/
Course Instructor	Prof. D.R. Maillapalli, Department of Agricultural and Food Engineering, IIT Kharagpur

6th Semester	**Subject Code 19CE6PC01L**	**Subject Name Irrigation Engineering Sessional**	**L0-T0-P2**	**Credit: 1**

Course Objective:

1. Understand the methods various type of irrigation method
2. Able to design of both lined and unlined canals.
3. Able to design various types of hydraulic structures such weir, barrage, spillways, cross drainage structures, canal falls, Gravity dams

Irrigation Engineering Sessional

1. Design and Layout of Sprinkler and Drip irrigation Method
2. Design of Cross section of Canals in Cutting, filling, partly in cutting and filling
3. Design of Alluvial canal using Lacey's and Kennedy's method.
4. Design of Lined Canal.
5. Design of Canal Falls.
6. Design of Cross drainage work.
7. Layout of Diversion of Headwork
8. Deign of weir and barrage
9. Study different type of Spillway
10. Analysis and Design of Gravity dam

Course Outcome:

1. Ability to know different technique of irrigation method
2. Ability to design lined and unlined canal irrigation method.
3. Ability to design the hydraulic structures such as canal falls, weirs, dams, cross drainage structures etc.

6th Semester	**Subject Code 19CE6PC02T**	**Subject Name Advanced Structural Analysis**	**L3-T0-P0**	**Credit: 3**

Course Objective:

1. To learn the concepts of moving loads and its effect on structures.
2. To analyze indeterminate structures such as beams and portal frames, trusses.
3. To study behavior of arches and their methods of analysis.
4. To analyze the beams using matrix method.
5. To study the concepts of Plastic analysis for simple beams and portal frames.

Module: I (09 hrs)

Rolling loads and influence lines for determinate beam. ILD for reaction, shear force and bending moment at a section, ILD for wheel loads, point loads and udl, Absolute maximum bending moment and shear force.

Module: II (08 hrs)

Analysis of continuous beams and plane frames by Kani's Method. Analysis of indeterminate plane trusses

Module: III (07 hrs)

Analysis of two hinged arches, Suspension cables with two hinged stiffening girders.

Module: IV (08 hrs)

Matrix methods of analysis: flexibility and stiffness methods; Application to simple beams.

Module: V (08 hrs)

Plastic Design: Plastic modulus, shape factor, plastic moment of resistance, Load factor, Plastic analysis of continuous beam and simple rectangular portals

Course Outcome:

After completion of the course the student can

6. Apply the influence line diagram for moving loads to analyze structural members
7. Analyse, formulate equilibrium and compatibility equations for structural members
8. Analyse arches and two hinged stiffening girders.
9. Analyse the forces in continuous beams using stiffness and flexibility method
10. Analyse beams and portal frames using concepts of Plastic analysis

Text Books:

1. C. S. Reddy, *Basic Structural Analysis*, Third Edition, McGraw Hill Education, 2017
2. S. S. Bhavikatti, *Structural Analysis* I&II", Fifth Edition, Vikas Publishing House, Noida, 2011.

Reference Books:

1. Norris and Wilber*, Elementary Structural Analysis*, Fourth Edition, McGraw Hill, Inc., USA, 1991
2. A. Kassimali, *Structural Analysis*, Fifth Edition, Cengage Learning India Private Limited, 2015

Digital Learning Resources

Course Name	Advanced Structural Analysis

Course Link	https://nptel.ac.in/courses/105105180/
Course Instructor	Prof. Amit Shaw & Prof. Biswanath Banerjee, IIT KGP

6th Semester	**Subject Code 19CE6PC02L**	**Subject Name Advanced Structural Analysis Sessional**	**L0-T0-P1**	**Credit: 1**

Course Objective:

1. To know the deflections of a frame using different type of loads.
2. To know the member forces of indeterminate truss structures.

3. To know the concept of moving load using influence line diagram for different type of loadings.
4. To analyse the two hinged and three hinged arches.
5. To know the behavior of portal frame using STAAD Pro.

ADVANCED STRUCTURAL ANALYSIS SESSIONAL

1. Study of multi-storeyed frame with different types of loading.
2. Study of truss with multi degree of indeterminacy.
3. Study on Influence line diagram for determinate beams.
4. Calculation of horizontal thrust in three hinged and two hinged arches.
5. Study the behavior of a portal frame under different end conditions using STAAD Pro.

Course Outcomes:

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

1. To determine the deflections of indeterminate frames for different type of loadings.
2. To determine the member forces for indeterminate trusses.
3. To draw the influence line diagram for beams subjected to different moving loads.
4. To determine the reactions of the three hinged and two hinged arches.
5. To analyze the frame structures using STAAD Pro. Software.

6^{th} Semester	Subject Code 19CE6PE01T	Subject Name Advanced Mechanics of Materials	L3-T0-P0	Credit: 3

Course Objective:

1. To make a relation between uniaxial loading (experiments done in the laboratory) and biaxial or triaxial loading (in real structures)
2. Stresses in thin and thick cylinders and Distribution of radial and circumferential stresses for different boundary conditions.
3. To solve for stresses and deflections of beams under unsymmetrical loading and to locate the shear center of thin wall beams.
4. To calculate stresses in beams with large initial curvature

5. Be able to analyses stresses in three dimensions, repeated stresses, stress concentration and find the strain using strain rosette.

Module –I (08 hrs)

Determination of principal stresses and principal strains, strain rosettes. Theories of failure: Maximum principal stress theory, maximum shear stress theory, maximum strain theory, total strain energy theory, maximum distortion theory, octahedral shear stress theory graphical representation and comparison of theories of failure.

Module- II (08 hrs)

Stresses in thin cylinders, thin spherical shells under internal pressure. Thick cylinders subjected to internal and external pressures, compound cylinders

Module -III (08 hrs)

Unsymmetrical bending: Properties of beam cross selection, slope of neutral axis, stresses and deflection in unsymmetrical bending, shear center.

Module -IV (08 hrs)

Curved Beam: Bending of beam with large initial curvature, Stress distribution in beam with rectangular, circular and trapezoidal cross section, stresses in crane hooks, ring and chain links.

Module –V (08 hrs)

Elementary concept of theory of elasticity, stresses in three dimensional, equations of equilibrium and compatibility, plane stress, Stress tensor at a point, stress invariants.
Advanced topics in mechanics of materials: Repeated stresses and fatigue in metals, concept of stress Concentration, notch and stress concentration factors.

Course Outcomes

1. Students are able to find the factor of safety of a material when it used in real structure.
2. Stresses in thin and thick cylinders and Distribution of radial and circumferential stresses for different boundary conditions.
3. To calculate stresses and deflections of beams under unsymmetrical loading and to locate the shear center of thin wall beams.
4. Stresses in crane hooks, rings and chain links
5. Be able to analyses stresses in three dimensions, repeated stresses, stress concentration.

Text Book:

1. K. Kumar and R.C. Ghai, *Advanced Mechanics of Materials*, Seventh Edition, Khanna Publisher. 1976.
2. L.S. Srinath, *Advanced Mechanics of Solids*, Third Edition, Tata McGraw Hill Education Private Limited. 2010.

Reference Books:

1. R. Subramaniam, *Strength of Materials*, Third Edition, Oxford University Press, 2016
2. S. S. Ratan, *Strength of Material*, Third Edition, McGraw Hill Education, 2017.

Digital Learning Resources

Course Name	Advanced Solid Mechanics
Course Link	https://nptel.ac.in/courses/105/106/105106049
Course Instructor	Dr. U. Saravanan, Department of Civil Engineering, IIT Madras

6th Semester	**Subject Code: 19CE6PE02T**	**Subject Name: Ground Improvement Techniques**	**L3-T0-P0**	**Credit: 3**

Course Objective:

1. Understanding the engineering behaviour of various natural and man-made soil deposits
2. Understanding the concept of various ground improvement techniques
3. Selection of site-specific method of improvement and its design
4. Exposure to recent ground improvement techniques through various case studies

Module: I **(08 hrs)**

Need for Ground Improvement, Different types of problematic soils, Emerging trends in ground Improvement, Rock cycle, classification of rocks and rock forming minerals. Weathering process and formation of soil. Engineering properties of the soft, week and compressible deposits, Natural on land, off-shore and Man-made deposits. Role of ground improvement in foundation engineering, methods of ground improvement, Selection of suitable ground improvement techniques

Module: II (08 hrs)

Mechanical Modification: Shallow and deep compaction requirements, Principles and methods of soil compaction, Factors affecting compaction, Effect of compaction on various soil properties. Shallow compaction and methods. Properties of compacted soil and compaction control, Deep compaction, and Vibratory methods Dynamic compaction.

Module: III (07 hrs)

Hydraulic Modification: Ground Improvement by drainage, Dewatering methods. Design of dewatering systems, Preloading, Vertical drains, vacuum consolidation, Electro-kinetic dewatering, design and construction, Cement stabilization and cement columns, Lime stabilization and lime columns. Stabilization using bitumen and emulsions, Stabilization using industrial wastes Construction techniques and applications.

Module: IV (09 hrs)

Grouting: Permeation grouting, compaction grouting, jet grouting, different varieties of grout materials, grouting under difficult conditions. In-situ treatments methods: In-situ densification soils, Dynamic compaction and consolidation, Vibro-floation, Sand pile compaction, preloading with sand drains and fabric drains, Granular columns, Micro piles, Soil nailing, Ground Anchors, Lime piles, Grouting technique, Thermal, Electrical and Chemical methods, Electro osmosis, Soil freezing

Module: V (08 hrs)

Reinforced Soil: The mechanism, Reinforcement materials, Reinforcement - Soil Interactions, Geosynthetics, Analysis and Design of Reinforced Retaining Structures, Embankments and Slopes. Case studies of ground improvement projects.

Course Outcome:

After completion of the course the student will able to

1. Explain the engineering behaviour of various natural and man-made soil deposits and identify the problems related to ground improvement techniques
2. Explain the concept of various ground improvement techniques
3. Propose appropriate method of ground improvement and its design
4. Exposure to recent ground improvement techniques through various case studies

Text Books:

1. N. V. Nayak, *Foundation Design Manual*, Dhanpat Rai and Sons, Delhi.
2. G. V. Rao and G. V. S. Rao, *Text Book On Engineering with Geotextiles*, Tata McGraw Hill

Reference Books:

1. B. M. Das, *Principles of Foundation Engineering*, Thomson, Indian Edition
2. R. M. Korner, *Design with Geosynthetics*, Prentice Hall, New Jersy, 3rd Edn .

Digital Learning Resources

Course Name	Ground Improvement Techniques
Course Link	https://nptel.ac.in/courses/105/108/105108075/
Course Instructor	Prof. G.L. Sivakumar Babu, Department of Civil Engineering, IISc Bangalore

6th Semester	**Subject Code 19CE6PE03T**	**Subject Name Construction Practice**	**L3-T0-P0**	**Credit: 3**

Course Objectives:

1. To Know the different construction techniques and structural systems
2. To understand various techniques and practices on masonry construction.
3. To maintain and repair of buildings
4. To justify choice of construction equipment for earthwork.
5. To identify and understand the working of various equipment for different construction process

MODULE I **[08 hours]**

Construction Practices**:** Specifications, details and sequence of activities and construction co-ordination, Site Clearance, Marking, Earthwork, masonry, Bond in masonry. Foundation: Types of foundation

MODULE II **[08 hours]**

Brick Masonry**:** Types of bonds, Brick laying, Joints in brickwork, Reinforced brickwork, Joint between old and new masonry, Maintenance of brick work.

Stone Masonry**:** Types of stone masonry-Rubble and Ashlar, General principles of construction, Joints of stone, maintenance of stone work.

MODULE III **[08 hours]**

Damp Proofing**:** Causes and effects, materials used for damp proofing, methods of preventing dampness, Damp Proof Course.

Plastering: Definition. Materials used for plastering, types of plastering, methods of plastering, defects and remedial measures in plastering.

Maintenance of Buildings**:** Causes and prevention of cracks in building, Leakage of buildings, special repair of buildings, annual maintenance.

MODULE IV **[08 hours]**

Construction Equipment: Conceptual planning of new project, site access and services, mechanical v/s manual construction

Earth moving Equipment: Fundamentals of earth moving and earth moving equipment Types of Earth Work Equipment -Tucks, bulldozers, power shovels, Scrapers, frond end loaders, Excavators.

MODULE V **[08 hours]**

Types of pumps used in Construction, Foundation and Pile Driving Equipment, lifting equipment, Concreting equipment. Plants for grading, batching, mixing, types of mixers, concrete pumps, bitumen plants.

Course Outcome:

After completion of the course the student can

1. know the different construction techniques and structural systems
2. Understand various techniques and practices on masonry construction.
3. maintain and repair of buildings.
4. Identify and understand the working principle of earthwork equipment's
5. Identify and understand the working of various equipment for different construction process

Text Books:

1. B.C.Punmia, A. K. Jain and A. K. Jain, "*Building Construction*, Laxmi Publications (P) ltd., New Delhi
2. R.L. Peurifoy, "*Construction Planning and Equipment*" -McGraw-Hill Publishing Co.; 6th edition, 2001.

Reference Books:

1. Mahesh Verma, "*Construction Equipment and Its Planning and Application*", Metropolitan Book Co; 2nd edition, 1975.

2. U. K. Shrivastava, "*Construction Planning and Management*", Galgotia Publications Pvt Ltd, 2000.
3. S.C Sharma, "*Construction Equipment and Management*", Khanna Publishers New Delhi, 1988.

Digital Learning Resources

Course Name	Civil Engineering - Building materials and Construction
Course Link	https://nptel.ac.in/courses/105/102/105102088/
Course Instructor	Dr. B. Bhattacharjee , IIT Delhi

Course Name	Construction method and equipment management
Course Link	https://nptel.ac.in/courses/105/103/105103206/
Course Instructor	Dr. Indu Shiva Ranjani Gandhi , IIT Guwahati

6th Semester	Subject Code 19CE6PE04T	Subject Name Building and Town Planning	L3-T0-P0	Credit: 3

Course objectives:

1. To understand the town and country plan act and building by-laws.
2. Planning and design of buildings.
3. To understand the trend of urbanization and planning process, identify the stages of planning process and surveys in planning.
4. Understand principles of the regional, master, structural and detailed development plans.
5. To know how to implement the plan for slum clearance and road aesthetics.

Module: I **[08 hrs]**

Functional planning of buildings: Planning, designing and construction, General building requirements as per the National building Code, Principles of building planning, Orientation of building, building by–laws as per National Building Code, Building by–laws of local authority, Standards for Residential, Public, Commercial, Industrial and Institutional Buildings Planning, Planning of Earth Quake Resistant Building, Principles of architecture composition.

Module: II **[08 hrs]**

Elements of Building Drawing, Planning and Preparing working drawing of Residential Building with scale proportion, Layout of Public Building, Industrial Building etc., Methods of making line drawing and detailed drawing. Site plan, floor plan, elevation and section drawing of small residential buildings. Foundation plan. Roof drainage plans. Provision of Building services (like water supply, drainage, electrification, etc.

Module: III **[08 hrs]**

Town Planning; Evolution of towns: History and trends in town planning: origin and growth, Historical development of town planning in ancient India; Indus Valley Civilization. Objects and necessary of town planning; Surveys and analysis of a town.

Module: IV
[08hrs]

New Concepts in town planning: Garden city movement, Linear city and Satellite city concepts, Neighbourhood Planning. Elements of City plan, Estimating future needs, Planning standards, Zoning: definition, procedure and districts, height and bulk zoning, F.A.R., Master Plan; Concepts of urban planning, design and landscaping.

Module: V
[08hrs]

Slums, causes of slums, effect of slums, slum clearance, prevention of slum formation. The Indian slum. Urban Roads: Objects, classification, outer and inner ring roads, expressways, freeways, road aesthetics

Course outcomes:

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

1. Apply the town and country plan act and building by-laws.
2. Planning and design of buildings as per National Building Code.
3. Identify the stages of planning process and surveys in planning.
4. Apply the principles of the regional, master, structural and detailed development plans.
5. Implement the plan for slum clearance and road aesthetics.

Text Books:

1. S. C. Rangwala and K. S. Rangwala, *Town Planning*, First Edition, Charotar Publishers House Pvt. Ltd, Gujrat, India, 2009
2. Y.S. Sane, *Planning and Designing Building*, First Edition, Allies Book Stall, Gujrat, India, 1964

Reference books:

1. G. K. Hiraskar, *Fundamentals of Town Planning*, First Edition, Dhanpat Rai Publication, New Delhi, India, 2018.

2. S. C. Agarwal, *Architecture and Town Planning*, Second Edition, Dhanpat Rai & Co , New Delhi, India, 2013.
3. National Building Code of India, 2005, New Delhi.

Digital Learning Resources

Course Name	Introduction to Urban Planning
Course Link	https://onlinecourses.nptel.ac.in/noc21_ar12
Course Instructor	Prof. Harshit Sosan Lakra , IIT Roorkee (Swayam course)

6th Semester	Subject Code 19CE6PE05T	Subject Name Estimation and Project Management	L3-T0-P0	Credit: 3

Course Objective:

1. To know about principles of working out quantities for estimates.
2. To analyse the bar scheduling and earthwork estimates.
3. To determine construction projects based on costs.
4. To gain knowledge about Construction project planning.
5. To explain about construction project planning, CPM, PERT analysis.

Module: I (08 hrs)

General items of work in Building – Standard Units Principles of working out quantities for detailed and abstract estimates – Approximate method of Estimating. Detailed Estimates of Buildings, Culverts and bridges.

Module: II (08 hrs)

Specifications-Types, requirements and importance, detailed specifications for buildings, roads, minor bridges and industrial structures. Rate analysis-Purpose, importance and necessity, factors affecting Analysis of rates, Prime cost, Schedule rates, Analysis of rates for various types of works.

Module: III (08 hrs)

Tender- Types of Tenders, Preparation of tender documents, inviting tenders, general and special conditions, contract types. termination of contracts, penalty and liquidated charges, Settlement of disputes, Arbitration, R.A. Bill & Final Bill, Payment of advance, insurance, claims, price variation, Introduction to e-tendering.

Module: IV (08 hrs)

Construction project planning- Stages of project planning: pre-tender planning, pre-construction planning, detailed construction planning, role of client and contractor, level of detail. Process of development of plans and schedules, work break-down structure, activity lists, assessment of work content, concept of productivities, estimating durations, sequence of activities, activity utility data;

Module: V (08 hrs)

Techniques of planning- Bar charts, Gantt Charts. Networks: basic terminology, types of precedence relationships, preparation of CPM networks: activity on link and activity on node representation, computation of float values, critical and semi critical paths, calendaring networks. PERT- Assumptions underlying PERT analysis, determining three-time estimates, analysis, slack computations, calculation of probability of completion

Course Outcome:

After completion of the course the student can

1. Understand the technical specification for various works to be performed for a project and how they impact the cost of a structure.
2. Quantify the worth of a structure by evaluating quantities of constituents, derive their cost rates and build up the overall cost of the structure
3. Understand how competitive bidding laws and how to submit a competitive bid proposal.
4. Get an idea of construction of project planning.
5. Get an idea of Techniques of planning, CPM, PERT

Text Books:

1. B.N. Dutta, "*Estimating and Costing in Civil Engineering*", UBS Publishers' Distributors Ltd; 25th edition, 2002.
2. G.S. Birdie, "*A Text Book of Estimating and Costing for Civil Engineering*", Dhanpat Rai Publishing Company Private Limited-New Delhi; Sixth edition,2014.
3. B.C. Punmia, K.K. Khandelwal, "*Project Planning with PERT and CPM*", Laxmi Publications, 2016.
4. K. K. Chitkara, "*Construction Project Management*", Tata McGraw-Hill Education, 2014.

Reference Books:

1. Standard schedule of rates and standard data book by public works department

2. I.S:1200 (Part I toXXV-1974/method of measurement of building and civil engineering works-B.I.S.)
3. M. Chakraborthi, "*Estimation, costing and specification*", Laxmi Publications.
4. R.L. Peurifoy, "*Construction Planning, methods of Equipment*", McGraw hill, 2011
5. S.W. Nunnally, "*Construction methods and management*", Prentice Hall,2006
6. Neeraj Kumar Jha, "*Construction Projects Management, Theory and Practice*", Pearson Education India,2015.

Digital Learning Resources

Course name:	**Estimation and Project Management**
Course Link:	https://nptel.ac.in/courses/105/103/105103093/

6th Semester	**Subject Code 19CE6PE06T**	**Subject Name Open Channel Flow**	**L3-T0-P0**	**Credit: 3**

Course Objective:

1. To develop an understanding of continuity, momentum and energy equations to uniform and non-uniform open channel flows
2. To learn to apply conservation laws to gradually varied and rapidly varied unsteady flows
3. To analyse hydraulics of mobile bed channel

Module: I (08 Hrs.)

Open Channel Flow**:** Kinds of open channel flow, channel geometry, types and regimes of flow, Velocity distribution in open channel, wide open channel, specific energy, critical flow and its computation, Energy in non-prismatic channel, momentum in open channel flow, specific force.

Energy and Momentum Principles Critical depth, concepts of specific energy and specific force, application of specific energy principle for interpretation of open channel phenomena, flow through vertical and horizontal contractions

Module: II **(08 Hrs.)**

Uniform Flow: Qualification of uniform flow, velocity measurement, Mannings and Chezy's formula, Determination of roughness coefficients, determination of normal depth and velocity Most economical sections, nonerodable channels, flow in a channel section with composite roughness, flow in close conduit with open channel flow.

Module: III **(08 Hrs.)**

Varied Flow: Dynamic equations of gradually varied flow, assumptions and characteristics of flow profiles. Classification of flow profile, draw down and back water curves, profile determination, graphical integration, direct step and standard step method. Numerical methods, flow through transitions, dynamic equation of spatially varied flow, analysis of spatially varied flow profile, computation of spatially varied flow using numerical integration.

Module: IV **(09 Hrs.)**

Hydraulic Jumps**:** Hydraulic jump, types of jumps, basic characteristics of jump, length and location of jump, jump as energy dissipation, control of jump, surges, surge channel transitions.

Module: V **(07 Hrs.)**

Flow Through Non-Prismatic Channel Section**:** Sudden transition, sub-critical flow through sudden transition, flow through culverts, flow through bridge piers, obstructions, channel junction

Course Outcome:

After completion of the course the student

1. Ability to apply continuity, momentum and energy equations to uniform and non-uniform open channel flows
2. Ability to apply conservation laws to gradually varied and rapidly varied unsteady flows
3. Ability to analyse hydraulics of mobile bed channel
4. Ability to know about bridge hydraulics.

Text Books:

1. C.S.P. OJha, R. Berndtsson, and P.N. Chadramouli, "*Engineering Fluid Mechanics"* Oxford University Press, 2009
2. P.N. Chanrdamouli, C.S.P.Ojha and K.M.Singh, "*Hydraulic Machines*" Oxford University Press, June 2010.

Reference Books:

1. K Subramanya ,"Flow through open channels" Tata McGraw Hill.

Digital Learning Resources

Course Name	Advanced Hydraulics
Course Link	https://nptel.ac.in/courses/105/107/105107059/#
Course Instructor	

6th Semester	Subject Code 19CE6PE07T	Subject Name Pavement Materials & Traffic Control	L3-T0-P0	Credit: 3

Course Objective:

1. To do the characterization of subgrade soil.
2. To evaluate Characterization of road aggregates.
3. To know the Characterization of paving grade bitumen, Compare and Characterize modified bitumen.
4. To explain traffic movements, types of intersections, islands, crossings, and their design.
5. To illustrate the design of signals and explain the redesigning of existing signals

Module: I (10 hrs)

Sub-grade Soil Characterization: Soil Classification; Index & Engineering properties of soil, Properties of sub-grade; in-situ procedures for evaluating the mechanical properties of soils viz CBR, Plate Load test, resilient modulus, DCPT, Suitability of different type of soil for the construction of highway embankments and pavement layers; Field compaction and control.

Introduction to Soil Stabilization: Physical and Chemical modification: Stabilization with admixtures like cement, lime, calcium chloride, fly ash and bitumen.

Module: II (08 hrs)

Aggregate Characterization: Origin, Classification, Types of aggregates; Sampling of aggregates; Mechanical and shape properties of aggregates, Aggregate texture, and skid resistance, polishing of aggregates; Proportioning and Blending of aggregates.

Module: III (08 hrs)

Properties of Bituminous Mixes: Elastic modulus, Dynamic modulus; stiffness modulus; visco-elastic and fatigue, creep test; Resilient modulus, Complex (Dynamic) Moduli of Bituminous Mixes.

Modified bitumen: Crumb Rubber Modified bitumen, Natural rubber modified bitumen, polymer modified bitumen; Long term and short-term ageing and its effect on bitumen performance.

Module: IV (08 hrs)

Traffic Regulations and Control: General regulations: Regulations on Speed, Vehicles, drivers, and flow; other regulations and control. Traffic management; noise and air pollution due to road traffic and methods of control.

Module: V (08 hrs)

Traffic Control Devices: Traffic signs, markings, islands, and signals. Different methods of signal design; redesign of existing signal including case studies. Signal system and co-ordination. Evaluation and design of road lighting.

Course Outcome:

After completion of the course the student can

1. Able to Characterize the subgrade soil, aggregate and bitumen.
2. Study rheological properties of modified Bitumen.
3. Capable of designing traffic signals.
4. Able to explain traffic movements, types of intersections, islands, crossings, and their design.
5. Be able to understand of signal coordination and road lighting.

Textbooks:

1. L.R Kadiyali, “Traffic Engineering and Transport Planning”, Khanna Publishers.1999
2. Das and P. Chakraborty, “Principles of Transportation Engineering”, 1st Edition, PHI Publication.
3. S.K. Khanna, C.E.G. Justo, “Highway Engineering”, Nem Chand & Bros., Roorkee,1990.

Reference Books:

1. L.R Kadiyali, “Principles & Practice of Highway Engineering”, Khanna Publishers,2017.
2. T M Matson, F W Hurd, W S Smith, “Traffic engineering”, McGraw-Hill Book Co., New York, N.Y., 1955.

Digital Learning Resources

Course Name	Traffic Engineering and Management
Course Link	https://nptel.ac.in/courses/105/101/105101008/
Course Instructor	Dr. Tom V Mathew, Department of Civil Engineering, IIT Bombay

6th Semester	Subject Code: 19CE5PE08T	Subject Name: Environmental Geotechnics	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 about on ash disposal facilities.
4. To understand about the remediation techniques.
5. To know the basic concept of Landfill design.

Module: I (05 hrs)

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

Module: II (11 hrs)

Solid Waste Management: Source, Classification and Composition of Solid Wastes, Properties, Separation, Storage and Transportation, MSW Management, Waste Minimization of MSW, Reuse and Recycling of MSW Fractions, Biological MSW Treatment, Thermal Treatment-Combustion, Incineration, Pyrolysis, Land Farming, Solid Waste Disposal, Open dumping, Land Filling, Integrated Waste Management.

Hazardous Waste Management: Types of Hazardous Waste, Exposure and Risk Assessment, Environment Legislation, Characterization, Hazardous Waste Generation, Treatment Systems for Hazardous Waste.

Module: III (08 hrs)

Selection of waste disposal sites: Site selection –Factor affecting site selection, Solid waste disposal: Ash Disposal facilities- Dry disposal, Ash Pond layout, Method of raising the dyke height, Geotechnical issues for the construction of ash pond, Environmental issues for construction of Ash Pond, Maintenance of ash dyke, Design of ash disposal system.

Module: IV (08 hrs)

Ash ponds and mine tailing impoundments: Components of ash pond impoundment, Criteria for starter dam and ash dyke raising, Minimum guideline design for starter dam. Remediation Techniques: Principle- planning, source control, soil washing, bioremediation.

Module: V (08 hrs)

Landfills: Difference between landfill and dump, Site selection of landfill, Types of landfills, Bioreactor landfill, Essential components of landfill, Function of landfill, Impervious barrier for liner and covers, Leachate collection, Landfill gas collection system, Reason for LFG control, Factors affecting LFG generation, Method of collection LFG, Serious causes of landfills, Drastic effects of landfills, impressive solutions of landfills.

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. Understand the facilities of ash disposal as well as geotechnical and environmental issues for construction of ash pond.
4. Understand the principles of soil treatment techniques.
5. Get idea about different landfill concepts.

Text Books:

1. B.B. Phillip, H. S. Refai, andC. J. Newell "*Ground Water Contamination*" Prentice HallPublications.
2. H. D. Sharma and K. R. Reddy "*Geoenvironmental Engineering*", John Wiley & Sons

Reference Books:

3. R. K. Rowe "*Geotechnical and Geoenvironmental Engineering Handbook*" Kluwer Academic.
4. L. N. Reddi and H. I. Inyang "*Geoenvironmental Engineering Principles and Applications*",Marcel. Dekker, Inc., New York.
5. M. D. LaGrega, P. L. Buckingham, and J. C. Evans,–"*Hazardous Waste Management*", McGraw-Hill.

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

6th Semester	Subject Code 19CE6OE01T	Subject Name Plastic Waste Management	L3-T0-P0	Credit: 3

Course Objective:

1. To know the sources of plastics
2. To know plastic waste management system
3. To know the recycling of waste plastic.
4. To know the plastic waste management practices.
5. To know about the biodegradable plastics.

Module: I (08 hrs)

Plastics – What it is? Types, Uses and Global Statistics, Plastic Waste – Sources, Production, Global and Indian Contex, Plastic Waste Management Rules 2016 (India) and Global Rules and Regulations

Module: II (08 hrs)

Plastics waste management-4 R & I approach viz. Source reduction, Reuse, Repair, Recycling, and Incineration with examples. Plastics recycling, Classification Code of practice-Primary, secondary, territory and quaternary recycling with examples-Coextrusion and co-injection moulding-Waste plastics as fillers.

Module: III (08 hrs)

Mechanical recycling of commonly used plastics, such as PP, PE. PET, etc. mixed waste recycling-co-extruded films waste, commingled waste extrusion flow moulding for production of plastics lumbers, chemical recycling/feed Stoch recycling processes for recovery of oil, monomer and energy-thermolytic processes. Solvolysis-process outline for PMMA, PET, etc.

Module: IV (08 hrs)

Plastic Waste Management Practices – Use of Plastic waste in roads, issues and challenges, Possible Alternate Materials to Plastics –Greener Alternatives, Plastics Resource Recovery and Circular Economy, Plastic Bans including China Sword Policy implication on global plastic waste management, Impact of Plastics on Marine Life, Effect on Wildlife, Human Health and Environment.

Module: V (08 hrs)

Biodegradable plastics-an overview. Environmental issues, policies and legislation in India. Plastics-Energy saving, Eco-Friendly-Case studies. Life cycle analysis-a model.

Course Outcome:

After completion of the course the student can

1. Students will able to explain the sources of plastics.
2. Students will be able to explain the plastic waste management.
3. Students will be able to explain the recycling process of plastic.
4. Students will able to explain waste management practices.
5. Students will able to explain biodegradable plastics.

Text Books:

1. R. J. Brandrup, *Recycling and recovery of plastics*, First Edition, Hanser Publishers, 1996 New York
2. N. Mustafa, *Plastics Waste Management*, Disposal Recyding and Reuse, First Edition, Marcel Dekker, Inc. 1993, New York.

Reference Books:

1. A. L. Andrady, *Plastics and the Environment*, First Edition Wiley Inter science, 2003, New York.
2. R.J. Ehrig, *Plastics Recycling, Products and Processes*, First Edition Hanser Publishers, 1992, New York.
3. *Technologies in Plastics Recycling*, American Chemical Society, Washington, DC 1992.

Digital Learning Resources

Course Name	Plastic Waste Management
Course Link	https://nptel.ac.in/courses/105/105/105105184/#
Course Instructor	Prof. B. K. Dubey, Department of Civil Engineering, IIT Kharagpur

6th Semester	Subject Code 19CE6OE02T	Subject Name Environment and Safety Engineering	L3-T0-P0	Credit: 3

Course Objective:

1. Convey ideas of the interdisciplinary nature of environment
2. Characterization of water and wastewater including basic design
3. To aware of the basic concepts of safety
4. Ability to assess safety in various places

Module: I (08 hrs)

Environmental Engineering: Introduction to Environmental engineering Nature and scope of environment problems Ecosystem effects through bio-geochemical cycles Local, regional and global environmental challenges, Basic concepts of biodiversity and its significance, human behavior and values for a sustainable society Water Pollution Fundamentals and Control Strategies

Module: II (08 hrs)

Water quality-physical, chemical & biological characteristics, drinking water standards Effluent quality requirements Water and wastewater treatment processes-treatment train, physical, chemical and biological unit operations Air Pollution Fundamentals and Control Strategies: Air pollution - sources, classifications and regulations indoor air pollution, air pollutants and their effects, Monitoring Principles and instrumentation for particulate and gaseous pollutant measurements

Module: III (08 hrs)

Waste Minimization: Concept, Principles in Waste Management, LCA, Benefits of Waste Minimization, Elements of a Waste minimization Programme, Waste Reduction Technique. Environment Impact Assessment: Origin, Aims and Procedure of EIA, Project Screening for EIA, Preparation and Review of EIS, Limitation of EIA.

Module: IV (08 hrs)

Industrial Safety: Introduction, key concepts, terminologies, and safety quantification, safety by design, Hazard identification techniques, Fault tree and event tree analysis (qualitative & quantitative), Safety function deployment, Occupational Safety and Health Acts, Industrial Safety Improvement Audit as per IS 14489 – Code of Occupational Safety and Health, Safety procedures,

Module: V (08 hrs)

Type of Accidents, Chemical and Heat Burns, Prevention of Accidents involving Hazardous substances, Human error and Hazard Analysis. Hazard Control Measures. Fire Prevention – Detection, Extinguishing Fire, Electrical Safety, Product Safety. Safety. Management- Safety Handling and Storage of Hazardous Materials, Corrosive Substances, Gas Cylinders, Hydro Carbons and Wastes. Personal Protective Equipment. Road Safety Audit

Course Outcome:

After completion of the course the student can

1. Capable to assess environmental pollution level
2. Can design water treatment units
3. Identify and solve occupational safety and health problems
4. Ability to apply the fundamental knowledge of environmental engineering to assess environmental and risk Demonstrate the site investigation, methods and sampling.

Text Books:

1. H. S. Peavy, D. R. Rowe, and G.Tchobanoglous, *Environmental Engineering*, First Edition McGraw Hill Education, 2017.
2. Noel de nevers, *Air Pollution Control Engineering*, SecondEdition, McGraw Hill. Education, 1999.
3. Environmental Engineering & Safety by Prof B.K. Mohapatra, Seven Seas Publication, Cuttack

Reference Books:

1. W Eckenfelder, Jr, *Eckenfelder Industrial Water Pollution Control*, McGraw-Hill Science
2. G Kiely, *Environmental Engineering*, McGraw Hill Education

Digital Learning Resources

Course Name	Environmental Engineering
Course Link	https://nptel.ac.in/courses/103/107/103107084/
Course Instructor	

Course Name	Industrial Safety Engineering
Course Link	https://nptel.ac.in/courses/110/105/110105094/
Course Instructor	Dr. Jhareswar Maiti, Professor, IIT Karagpur

Subject Code:	Subject Name:	L-T-P:	Credit:
19EC6OE01T	FUNDAMENTAL OF SATELLITE COMMUNICAITON	3-0-0	3

COURSE OBJECTIVE:

The purpose of this course is to introduce students to

1. Make the students understand the basic concept in the field of Satellite Communication
2. Understand the design of satellite links
3. Gain knowledge about the Satellite Access schemes.
4. Comprehend the details of earth stations design and various useful satellite applications

SYLLABUS

Module-1 **(10 Hours)**

Introduction to satellite communication: Overview of satellite communications, General structure of satellite communication, Satellite frequency allocation and band spectrum, Satellite orbits – Performance characteristics of different altitude satellites (GEO, MEO and LEO satellite systems)

Orbital mechanics: Introduction, Kepler's laws of planetary motion, Orbital parameters, look angle determination, Launches and Lunch vehicle, Orbital effects in communication system performance.

Satellite subsystem: Attitude and Orbit Control System(AOCS), Telemetry, Tracking and Command System(TT&C), Power System, Satellite antennas, Communications subsystem, Transponders

Module-2 **(8 Hours)**

Satellite Link Design: Basics of transmission theory, system noise temperature and G/T ratio, Uplink and Downlink design, design of satellite links for specified (C/N) performance.

Module-3 **(8 Hours)**

Multiple Accesses: Multiplexing techniques for satellite links, Comprehensive study on FDMA, TDMA and CDMA; Spread Spectrum Transmission and Reception

Propagation on satellite: Earth paths and influence on link design; Quantifying attenuation and depolarization, hydrometric & non hydrometric effects, ionosphere effects, rain and ice effects.

Module-4 **(6 Hours)**

Satellite Antennas: Types of antenna and relationships; Basic Antennas Theory – linear, rectangular & circular aperture; Gain, pointing loss.

Earth station Technology: Earth station design; Design of large antennas – Cassegrain antennas

Module-5 **(6 Hours)**

Application of Satellite communication: Overview of VSAT systems, Network architectures, direct broad casting TV.

Other Satellite services: Fundamentals of mobile communication satellite.

COURSE OUTCOME:

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

1. Explain the basic concepts of orbit mechanics and satellite Launching
2. Analyze the design of satellite links for specified C/N with system design examples
3. Understand the various multiple access schemes for satellite communication systems, as well as the satellite link propagation impairments
4. Explain the fundamentals of earth station technology and the role of satellites in various applications

TEXT BOOKS:

1. T. Pratt, C. Bostian, *Satellite Communication,* 2nd Edition John Wiley Co.,2003,India
2. R.N.Mutagi, *Satellite Communication: Principles & Applications*, 1st Edition, Oxford University Press, 2016,India

REFERENCE BOOKS:

1. Dennis Roddy, *Satellite Communications*, 2nd Edition, McGraw Hill, 1996,India
2. M. Richcharia, *Satellite Communications: Design Principles*, 2nd Edition, BSP, 2003,India
3. Tri T. Ha, *Digital Satellite Communication*, Special Indian Edition, Tata McGraw- Hill, 2009, India

DIGITAL LEARNING RESOURCES:

Course Name	Satellite Communication Systems
Course Link	https://nptel.ac.in/courses/117/105/117105131/
Course Instructor	**Prof. Kalyankumar Bandyopadhyay**

Subject Code: 19EC6OE02T	Subject Name: IMAGE PROCESSING TECHNIQUES	L-T-P 3-0-0	Credits 3

COURSE OBJECTIVE:

The program is expected to enable the students to

1. Gain an insight into the various analytical methods used in image processing.
2. Familiarize with image enhancement and restoration techniques.
3. Mathematical modeling of different image compression techniques and their applications.
4. Understand the Concept of color image processing and morphological operations on gray image.

SYLLABUS

Module- 1 **(8 Hours)**

Introduction: Introduction: Background of image processing, Fundamental steps in image processing, Elements of digital image processing systems. Digital image representation, Sampling and quantization, Relationship between pixels: Neighbours, adjacency, connectivity, regions, boundaries and distance measure, Image geometry: translation, rotation, perspective transformation.

Module- 2 **(8 Hours)**

Image Enhancement: Enhancement in spatial domain: Point Processing: Log, Power law, Image Negatives, Piecewise linear transformation, Spatial correlation and convolution Histogram processing. Smoothing and Sharpening of Spatial Filters.

Enhancement in frequency domain: Introduction to filtering in frequency domain, Smoothing and Sharpening of frequency domain filters.

Module-3 **(8 Hours)**

Image Restoration and Reconstruction: Image Restoration: Degradation model, Restoration in presence of noise only – spatial filtering, Linear position invariant degradations, Estimating degradation functions, Inverse filtering, Wiener filtering.

Color Image Processing: Color fundamentals, Conversion of color image to gray scale image, Color model (RGB, HSI, HSV, HLS, CMK, CMYK).

Module- 4 **(6 Hours)**

Image compression: Introduction and motivation, Fundamental concepts: Data redundancy (coding redundancy, inter pixel redundancy and psycho visual redundancy), Fidelity criteria, Image compression models, Image compression standards, Elements of information theory. Image compression methods: Huffman coding, Arithmetic coding, LZW coding, Run-Length Coding, Bit plane coding.

Module-5 **(6 Hours)**

Morphological Image Processing: Morphological Image Processing: Preliminaries, Erosion, Dilation, Opening and Closing, hit or Miss transformation, Boundary extraction, Hole filling, Extraction of connected components, Thinning, Thickening.

COURSE OUTCOMES:

On Completion of this course, the students should be able to:

[1]. Understand the need for different types of image transforms and their properties for processing of gray and color image data.

[2]. Implement the signal processing algorithms and techniques in image enhancement, image restoration, Morphology and Image Compression.

[3]. Implement basic image processing algorithms in MATLAB.

[4]. Understand practical scope of digital image processing for most of the work currently underway in this field.

TEXT BOOKS:

1. R.C. Gonzalez, R.E. Woods, Digital Image Processing, 3rd Edition, Pearson Education, 2007, New Delhi.
2. S. Sridhar, Digital Image Processing, 2nd Edition, Oxford University Press, 2016, New Delhi.

REFERENCE BOOKS:

1. Rafael C. Gonzalez, Richard E. Woods Digital Image Processing using MATLAB, Seventh Edition , Pearson Education, Inc, 2004, New Delhi.
2. William K. Pratt, Digital Image Processing, 4th Edition, Wiley, 2002, New York.
3. Anil K. Jain, 'Fundamentals of Digital Image Processing', 1st Edition, Pearson 2019, New Delhi.
4. B. Chanda, Dutta D. Majumder, Digital Image Processing And Analysis, 2nd Edition ,PHI, 2011 , New Delhi.

DIGITAL LEARNING RESOURCES:

Course Name	DIGITAL IMAGE PROCESSING
Course Link	https://nptel.ac.in/courses/117/105/117105135/
Course Instructor	Prof. P.K. Biswas , Department of Electronics & Electrical Communication Engineering, I.I.T, Kharagpur

Course Code: 19EE6OE01T	Course Name: Electrical Energy Utilization	L-T-P 3-0-0	Credit : 3

Course Objectives:

1. To understand the basic concepts of illumination systems
2. To understand the basic concept of design of lighting schemes
3. To understand the fundamental requirements of railway electrification
4. To understand the operation of refrigeration and air-conditioning control technique

Syllabus

Module-I Illumination:[8 Hours]

Production of light - lighting calculations - determination of MHCP and MSCP - Polar curves of different types of sources - Rousseau's construction - photometers - interior and exterior illumination systems - lighting schemes - Design of lighting schemes - factory lighting - flood lighting - electric lamps - gaseous discharge lamps - high pressure and low pressure neon signs - high frequency, low pressure discharge tubes.

Module-II Electric furnaces and welding:[7 Hours]

Resistance, inductance and Arc Furnaces - Construction and fields of application - control equipment, high frequency dielectric heating, resistance - welding equipment - characteristics of carbon and metallic arc welding - butt welding - spot welding.

Module-III Electro-chemical processes:[5 Hours]

Electrolysis – Electroplating – Electro deposition – Extraction of metals Current, Efficiency - Batteries – types – Charging Methods.

Module-IV Electric traction:[8 Hours]

Railway electrification – definition and analysis of traction effort – speed – time curve – traction motors - battery driven vehicles - energy efficiency drives – advanced speed control measures- tractive effort calculations - electric braking - control wire - A.C. traction - recent trend in electric traction.

Module-V Refrigeration and air-conditioning:[7 Hours]

Control of temperature - basic wiring diagram - simple heat load and motor calculations. Air- conditioning - function of complete air conditioning system - type of compressor motor and fan motor-wiring diagram for a typical air conditioning unit.

Course Outcomes:

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

1. Students will be able to understand the basic concepts of illumination systems and concept of design of lighting schemes.
2. Students will be able to understand the construction and fields of application of resistance, inductance and arc furnaces.
3. Students will be able to assess the degree of adequacy level in electro-chemical processes in Industry.
4. Students can analyze problem related to railway electrification.
5. Students will understand the operation of refrigeration and air-conditioning control techniques.

Text Books:

[1] S. C. Tripathy, *Electric Energy Utilisation and Conservation*, Tata McGraw Hill , 1991

[2] W. F. Stocker and J.W. Jones, *Refrigeration & Air Conditioning Refrigeration & Air Conditioning*, McGraw Hill , 1985

Reference Books:

[1] C. L. Wadhwa, *Generation, Distribution and Utilization of Electrical Energy*, New Age , 1989

[2] N.V. Suryanarayana, *Utilisation of Electric Power*, Wiley Eastern Ltd. , 1993

Online Learning Resources:

Course Name	Illumination Engineering
Course Link	https://nptel.ac.in/courses/108/105/108105060/
Course Instructor	Prof. N.K.Kishore, Indian Institute of Technology Kharagpur

Subject Code:	Subject Name:	L-T-P:	Credit:
19EE6OE02T	Introduction to Robotics and Autonomous Vehicles	3- 0- 0	3

Course Objective:

1. Gain basic knowledge on control and design of robotic system and it applications to solve common human society problems
2. Will able to gain knowledge on sensor technology and computer vision
3. Knowledge on autonomous vehicle technology
4. Will generate fundamental knowledge needed for the future technological advances that will able to drive the economic engines of the society.

Syllabus

Module 1:

Introduction and Overview of Robotic Systems and their Dynamics [12Hours]

Introduction. Construction of manipulators, advantages and disadvantages of various kinematic structures. Applications, Nonservo robots, motion planning. Feedback systems, encoders Kinematics, homogeneous coordinates solution of the inverse kinematic problem, multiple solutions, jacobian, workenvelopes.

Trajectory planning. Joint Interpolated Trajectory, Link joints and their Manipulatordynamics and force control. Sensors: Vision, ranging, laser, acoustic, tactile.

Module II: Evolution of Automotive Electronics [8 Hours]

Basic Control System Theory applied to Automobiles -Overview of the Operation of ECUs - Infotainment, Body, Chassis, and Powertrain Electronics-Advanced Driver Assistance Systems-Autonomous Vehicles

Module III:

Sensor Technology for Autonomous Vehicles [8 Hours]

Basics of Radar Technology and Systems -Ultrasonic Sonar Systems -LIDAR Sensor Technology and Systems -Camera Technology -Night Vision Technology -Use of Sensor Data Fusion -Kalman Filters

Module IV:

Computer Vision and Deep Learning for Autonomous Vehicles [7 Hours]

Computer Vision Fundamentals -Advanced Computer Vision -Neural Networks for Image Processing –TensorFlow -Overview of Deep Neural Networks -Convolutional Neural Networks

Module V: Autonomous Vehicle Technology [7 Hours]

Driverless Car Technology-Different Levels of Automation -Localization, Unmanned Aerial Vehicle (UAV) Technology, Navigation, Path Planning, Path Following, Obstacle avoidance technology. Controllers to Actuate a Vehicle: PID Controllers -Model Predictive Controllers.

Course Outcomes:

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

1. Gain the knowledge on robotics and its applications to operate autonomous vehicles
2. Explain the applications of controllers in the field of robotics
3. Gain depth knowledge Sensor Technology and computer vision
4. Gain knowledge in different types of motor drives
5. Explain different applications of Deep Learning for Autonomous Vehicles
6. Describe the Technology of Autonomous Vehicle including the design and path planning

Text Books:

[1] K.S Fu, R.C. Gonzalez, C.S.G. Lee, Robotics, McGraw Hill, 1987.

[2] R Kelly, D. Santibanez, LP Victor and Julio Antonio, “Control of Robot Manipulators in Joint Space”, Springer, 2005.

[3] Hong Cheng, “Autonomous Intelligent Vehicles: Theory, Algorithms and Implementatio

[4] Williams. B. Ribbens: “Understanding Automotive Electronics”, 7th Edition, Elsevier Inc, 2012.

Reference Books:

[1] Shaoshan Liu, Liyun Li, "Creating Autonomous Vehicle Systems", Morgan and Claypool Publishers, 2017.

[2] Marcus Maurer, J.ChristianGerdes, "Autonomous Driving: Technical, Legal and Social Aspects" Springer, 2016.

[3] Ronald.K.Jurgen, "Autonomous Vehicles for Safer Driving", SAE International, 2013.

[4] James Anderson, KalraNidhi, Karlyn Stanly, "Autonomous Vehicle Technology: A Guide for Policymakers", Rand Co, 2014.

[5] Lawrence. D. Burns, Chrostopher Shulgan, "Autonomy – The quest to build the driverless car and how it will reshape our world", Harper Collins Publishers, 2018.

Online Learning Resources:

Course Name	Introduction to Robotics
Course Link	https://nptel.ac.in/courses/107/106/107106090/
Course Instructor	Prof. Asokan T, Indian Institute of Technology Madras

Course Code: 19EEE6OE01T	Course Name: Electrical Energy Utilization	L-T-P 3-0-0	Credit : 3

Course Objectives:

1. To understand the basic concepts of illumination systems
2. To understand the basic concept of design of lighting schemes
3. To understand the fundamental requirements of railway electrification
4. To understand the operation of refrigeration and air-conditioning control technique

Syllabus

Module-I Illumination:[8 Hours]

Production of light - lighting calculations - determination of MHCP and MSCP - Polar curves of different types of sources - Rousseau's construction - photometers - interior and exterior illumination systems - lighting schemes - Design of lighting schemes - factory lighting - flood lighting - electric lamps - gaseous discharge lamps - high pressure and low pressure neon signs - high frequency, low pressure discharge tubes.

Module-II Electric furnaces and welding:[7 Hours]

Resistance, inductance and Arc Furnaces - Construction and fields of application - control equipment, high frequency dielectric heating, resistance - welding equipment - characteristics of carbon and metallic arc welding - butt welding - spot welding.

Module-III Electro-chemical processes:[5 Hours]

Electrolysis – Electroplating – Electro deposition – Extraction of metals Current, Efficiency - Batteries – types – Charging Methods.

Module-IV Electric traction:[8 Hours]

Railway electrification – definition and analysis of traction effort – speed – time curve – traction motors - battery driven vehicles - energy efficiency drives – advanced speed control measures- tractive effort calculations - electric braking - control wire - A.C. traction - recent trend in electric traction.

Module-V Refrigeration and air-conditioning:[7 Hours]

Control of temperature - basic wiring diagram - simple heat load and motor calculations. Air- conditioning - function of complete air conditioning system - type of compressor motor and fan motor-wiring diagram for a typical air conditioning unit.

Course Outcomes:

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

6. Students will be able to understand the basic concepts of illumination systems and concept of design of lighting schemes.
7. Students will be able to understand the construction and fields of application of resistance, inductance and arc furnaces.
8. Students will be able to assess the degree of adequacy level in electro-chemical processes in Industry.
9. Students can analyze problem related to railway electrification.
10. Students will understand the operation of refrigeration and air-conditioning control techniques.

Text Books:

[3] S. C. Tripathy, *Electric Energy Utilisation and Conservation*, Tata McGraw Hill , 1991

[4] W. F. Stocker and J.W. Jones, *Refrigeration & Air Conditioning Refrigeration & Air Conditioning*, McGraw Hill , 1985

Reference Books:

[3] C. L. Wadhwa, *Generation, Distribution and Utilization of Electrical Energy*, New Age , 1989

[4] N.V. Suryanarayana, *Utilisation of Electric Power*, Wiley Eastern Ltd. , 1993

Online Learning Resources:

Course Name	Illumination Engineering
Course Link	https://nptel.ac.in/courses/108/105/108105060/
Course Instructor	Prof. N.K.Kishore, Indian Institute of Technology Kharagpur

Subject Code: 19IT6OE01T	Subject Name: INTRODUCTION TO OPERATING SYSTEM	L-T-P 3-0-0	Credits 3

COURSE OBJECTIVES:

1. Recognize the concepts and principles of operating systems.
2. Provide comprehensive introduction to understand the underlying principles, techniques and approaches which constitute a coherent body of knowledge in operating systems.
3. To teach understanding how the various elements that underlie operating system interact and provides services for execution of application software.

Module-I: [8 Hrs]

Overview of operating systems: computer system organization, computer system architecture, operating system operations, Need of Process/Memory/Storage Management, Protection and security, Distributed systems, Real-Time Embedded Systems. Operating systems services, User-Operating System Interface, Systems calls and its types, operating system structure.

Module-II:

Process Concept; Process Scheduling; Operations on Processes; Interprocess Communication; Thread; Multithreading models;

Module-III: [8 Hrs]

Scheduling Criteria, Algorithms (FCFS, SJF, SRTF, Round Robin, Priority, Multi-level Queue and Feedback Queue), Thread scheduling.

The Critical- section problem, Peterson's Solution, Synchronization Hardware, Semaphores, Classical problems of synchronization, monitors

Module-IV: [8 Hrs]

System model; Deadlock Characterization; Methods for Handling Deadlock (Deadlock prevention, detection and Avoidance, recovery);

Swapping; Contiguous memory allocation; Paging; Structure of the page table; Segmentation;

Virtual memory, demand paging, Copy on write, page-Replacement algorithms (FIFO, LRU, LFU, Optimal Page Replacement)

Module-V: [8 Hrs]

File Concept, Access Methods, Directory Structure, File System Mounting, File Sharing and Protection, File system structure, File System Implementation, Directory Implementation, Allocation Methods. Overview of Mass-storage structure, disk structure, disk attachment, disk scheduling, swap-space management

TEXT BOOK:

1. Abraham Silberschatz, Peter Baer Galvin & Greg Gagne "Operating System Concepts", 8th edition,
2. John Wiley & SonsWilliam Stallings, "Operating Systems – Internals and Design Principles", 5/e,Pearson.
3. Charles Crowley, "Operating Systems: A Design-Oriented Approach", Tata McGraw Hill Co., 1998 edition.

4. Andrew S.Tanenbaum, “Modern Operating Systems”, 2nd edition, 1995, PHI.

Digital Learning Resources

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

Subject Code: 19CS6OE01T	Subject Name: DATA ANALYTICS	L-T-P 3-0-0	Credits 3

Course Objective:

1. To optimize business decisions and create competitive advantage with Big Data analytics
2. To explore the concepts regression and classification.
3. To learn to analyze the complexity of different techniques.
4. To understand the various additive models and boosting techniques.
5. To understand the Neural Networks, Support Vector Machines, and K-nearest Neighbor.

Module: 01 [8 Hours]

Linear Methods for Regression and Classification: Overview of supervised learning, Linear regression models and least squares, Multiple regression, Multiple outputs, Subset selection , Ridge regression, Lasso regression , Linear Discriminant Analysis , Logistic regression , Perceptron learning algorithm.

Module: 02 [8 Hours]

Model Assesment and Selection : Bias, Variance, and model complexity, Bias-variance trade off, Optimisim of the training error rate ,Esimate of In-sample prediction error, Effective number of parameters, Bayesian approach and BIC, Cross- validation ,Boot strap methods, conditional or expected test error.

Module: 03 [8 Hours]

Additive Models, Trees,and Boosting: Generalized additive models, Regression and classification trees , Boosting methods-exponential loss and AdaBoost, Numerical Optimization via gradient boosting ,Examples (Spam data, California housing , New Zealand fish, Demographic data)

Module: 04 [8 Hours]

Neural Networks(NN) , Support Vector Machines(SVM),and K-nearest Neighbor: Fitting neural networks, Back propagation, Issues in training NN, SVM for classification, Reproducing Kernels, SVM for regression, K-nearest –Neighbour classifiers(Image Scene Classification)

Module: 05 [8 Hours]

Unsupervised Learning and Random forests: Association rules, Cluster analysis, Principal Components, Random forests and analysis. (II) Inferential Statistics and Prescriptive analytics.

Text Books:

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman , The Elements of Statistical Learning-Data
2. Mining, Inference, and Prediction ,Second Edition , Springer Verlag, 2009.
3. G.James,D.Witten,T.Hastie,R.Tibshirani-An introduction to statistical learning with applications in R,Springer,2013
4. E.Alpaydin, Introduction to Machine Learning, Prentice Hall Of India,2010,(Chapter-19)

References

C.M.Bishop –Pattern Recognition and Machine Learning,Springer,2006

L.Wasserman-All of statistics.

Digital Learning Resources

Subject NameData Analytics with Python

Course Link NPTEL :: https://nptel.ac.in/courses/106/107/106107220/

Course Instructor Prof. A. Ramesh, IIT Roorkee

Course Code:	Course Name:	L-T-P	Credit
19ME6OE01T	Introduction to Hybrid Vehicle	3- 0- 0	3

Course Objective:

1. Understand the basic functional blocks of a modern vehicle, need for and degree of hybridization.
2. Analyze various drives suitable for electric and hybrid electric vehicles.
3. Learn about electric propulsion unit and design considerations of EVs and hybrids.
4. Discuss different energy storage technologies used for hybrid electric vehicles and their control.
5. Learn about Energy Management Strategies used in electric vehicles and hybrid vehicles.

Syllabus:

Module-I: **[8 Hours]**

Basics of Modern Vehicles: History of hybrid and electric vehicles. Societal and environmental importance of fuel, electric and hybrid vehicles. Degrees of hybridization.

Conventional Vehicles: Features and sub-systems in a modern vehicle, Motion and dynamics equations for vehicles, Basics of vehicle performance, vehicle power source characterization, transmission characteristics and mathematical models to describe vehicle performance.

Module-II: **[8 Hours]**

Electric vehicle drive-trains: Basic concept of electric traction, Electric drive-train topologies and power flow analysis, electric components used in EVs, Configuration and control of DC Motor drives, induction motor drives, permanent magnet motor drives, switched reluctance motor drives. Drive system efficiency.

Hybrid vehicle drive trains: Basic concept of hybrid traction, degree of hybridization, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, energy efficiency analysis.

Module-III: **[8 Hours]**

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

Design consideration for EV chassis and body: Modularity in chassis, NVH level requirements, IP rating of drive train, configuration of traction device for damping,

Module-IV: **[8 Hours]**

Energy Storage: Introduction to energy storage requirements in hybrid and electric vehicles, Battery based energy storage and its analysis (charge-discharge rate and cycles limit), Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices, Regenerative braking, AC-DC converter.

Module-V: **[8 Hours]**

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification and comparison of different energy management strategies, implementation issues of energy management strategies. Challenges in battery charging / swapping infrastructure. Grid connected energy transfer, wireless energy transfer.

Case Studies: Design of a Plug-in Hybrid Electric Vehicle (PHEV), Design of a Battery Electric Vehicle (BEV), Design of Series-Parallel HEV Drive train

Text Books:

1. Electric and Hybrid Vehicles: Design Fundamentals, I. Husain, CRC Press, 2nd edition, 2010.
2. Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, Mehrdad Ehsani, Yimin Gao, Stefano Longo and Kambiz Ebrahimi, CRC Press, 3rd edition, 2018.
3. Electric Vehicle Technology Explained, James Larminie, John Lowry, Wiley, 2nd edition, 2012.

Reference Books:

1. Vehicular Electric Power Systems, A. Emadi, M. Ehsani and Jihn M. Miller, CRC Press, 1st edition, 2003.
2. Electric Vehicles: Prospects and Challenges, James Larminie and John Lowry, Wiley, 2nd edition, 2012.
3. Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Sheldon S. Williamson, Springer, 2013.

Online Resources:

1. Online course on "Introduction to Hybrid and Electric Vehicles" by Dr. Praveen Kumar and Prof. S. Majhi, IIT Guwahati available on NPTEL at https://nptel.ac.in/courses/108/103/108103009/
2. Video Course on "Electric Vehicles" by Prof. Amit Kumar Jain, IIT Delhi available on NPTEL at https://nptel.ac.in/courses/108/102/108102121/

Course Outcomes:

1. Demonstrate the working of electric and hybrid electric vehicles.
2. Choose a suitable drive scheme for developing an electric hybrid vehicle depending on resources.
3. Design and develop the propulsion system of electric vehicles and hybrid electric vehicles.
4. Choose proper energy storage systems for vehicle applications.
5. Analyze and model the power management systems for electric and hybrid vehicles.