

Minor Stream: Structural Engineering

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241CE057	Construction & Project Management	FC	2			2	50	50	100	--
241CE025	Repair & Rehabilitation of Structures	FC	3			3	50	50	100	-
241CE026	Fire & Safety Engineering	FC	3			3	50	50	100	-
241CE027	Green Buildings	FC	3			3	50	50	100	-
241CE029	Construction Equipment & Machinery	FC	3			3	50	50	100	CM&CT
241CE028	Finite Element Methods	IC	2	1		3	50	50	100	SA
241CE031	Construction Contract Management	IC	3			3	50	50	100	-
241CE030	Pre-stressed Concrete Structures	IC	3			3	50	50	100	-
241CE032	Design of Ocean Structures & Foundation	IC	2	1		3	50	50	100	-
241CE033	Analysis & Design of Masonry Structures	IC	2	1		3	50	50	100	-
241CE034	Design of Tall Buildings	AC	2	1		3	50	50	100	-
Total			28	4		32				

Construction & Project Management

Course Code: 241CE057	L	T	P	C
	2	0	0	2

Course Outcomes:

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

CO1:	Understand and apply management principles in construction and organizational settings.
CO2:	Understand contracts, tenders, execution, and government project terminology.
CO3:	Plan, schedule, and manage construction and international project methods.
CO4:	Apply project planning, scheduling, and control using PERT/CPM.
CO5:	Ensure construction safety, labor welfare, and legal compliance practices.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2									
CO2	3	3	3			2				2	
CO3	1	1	3			2					
CO4	2	2						1		2	
CO5	1	1					1	2		2	

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	2	
CO2:	2	
CO3:	3	
CO4:	3	
CO5:	2	

UNIT – I

Principles of Management:

Definition - Importance – Functions of Management - Relevance to government and Quasi Government departments - Private Contractors - Contracting firms - Organizational structure. Construction safety measures.

UNIT – II

Contracts and Documentation:

Various features of Contract document, preparation of a tender document for the construction project, Various technical and accounting terms used in government organizations, Methods of execution of works in government organizations.

UNIT – III

Construction Planning and Projects:

Describe various planning methods for construction works, Prepare Construction schedule.

Tendering - Arbitration - International projects - Detailed Project Reports (DPR) / Build Own Operate (BOO) / Build Own Operate Transfer (BOOT) Projects / Build Operate and Transfer (BOT) - case studies.

UNIT – IV

Construction Project Management:

Project Planning, Project Scheduling, Project Controlling, Bar charts & Milestone charts, Development of Network, Network analysis, Network rules, Work Breakdown Structure, and Elements of PERT and CPM.

UNIT – V

Construction safety measures & Labor Welfare

Explain need of safety management in Construction, Describe Safety measures in Construction as per IS code.

Relationships between management and labor - Problems - Labor legislation Minimum Wages act - Industrial Psychology - Safety procedures in construction

Text Books:

Construction project management Theory and Practice, Kumar Neeraj Jha, Pearson. (ISBN: 13-978-9332542013).

Construction planning, Equipment and method, Purifoy and Schlender, Shapira, Tata McGraw-Hill. (ISBN:978-0070706996).

Reference Books:

Construction Technology, Subir K, Sarkar and Subhajit Saraswati, Oxford University press. (ISBN:13-978-0195694833)

Project planning and control with PERT and CPM, Dr.B.C.Punmia, .K.Khandelwal, Laxmi publication. (ISBN: 13-978-8131806982)

Construction Project Management, K.K.Chitkara, McGraw Hill. (ISBN: 13-978-0070680753).

Web Links:

<https://archive.nptel.ac.in/courses/105/104/105104161/>

<https://archive.nptel.ac.in/courses/105/103/105103093/>

<https://elearn.nptel.ac.in/shop/completed-courses/short-term-programs-completed/construction-technology-and-management/>

Repair & Rehabilitation of Structures

Course Code:241CE025

L T P C
3 0 0 3

Course Outcomes:

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

CO1:	Describe the concept of repair and its need.
CO2:	Classify various causes of deterioration of concrete structure and Distresses monitoring techniques.
CO3:	Identify the effect of corrosion on structures.
CO4:	Assessing the techniques for repairing.
CO5:	Apply the NDT techniques to assess the condition of the structures& explain seismic retrofitting and maintenance of heritage structures.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	3	1		2					
CO2	2		2	2		2					
CO3	2	1	2	2		2					
CO4	2		2	2		2					
CO5	2		2	2		3					

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:		1
CO2:		1
CO3:		1
CO4:		1
CO5:		

UNIT – I

Introduction:

Maintenance and Repair strategies - Maintenance, repair and rehabilitation, Facets of Maintenance, importance of Maintenance various aspects of Inspection, Assessment procedure for evaluating a damaged structure

UNIT – II

Deterioration of Structures:

Introduction, Basic terminology – Causes of deterioration, physically induced deterioration, chemically induced deterioration, Quality assurance for concrete construction concrete properties- strength, permeability, thermal properties and cracking.

UNIT – III

Corrosion of structures:

Corrosion mechanism - Effects of cover thickness and cracking - Methods of corrosion protection – Inhibitors - Coatings - Cathodic protection for reinforcements-design and construction errors - Effects of cover thickness and cracking.

UNIT – IV

Rehabilitation and retrofitting methods:

Repair: Guniting, Shotcreting, Epoxy – Cement mortar injection, Crack ceiling Rehabilitation Methods: Grouting, Imbalance of structural stability, Strengthening & Stabilization techniques, Design consideration – Beam shear capacity strengthening – Shear transfer strengthening – Stress reduction techniques – Column strengthening, Flexural strengthening – Connection stabilization & strengthening.

UNIT – V

Damage Assessment:

Repairs to Structures - Repair of structures distressed due to earthquake – Strengthening using FRP Strengthening and stabilization techniques for repair Non – Destructive testing methods – Rebound hammer, Ultrasonic pulse velocity, Rebar locator, Corrosion meter, Penetration resistance & Pullout tests. Seismic Retrofitting and Maintenance of Heritage Structures: Earthquake damages of buildings, their retrofitting and restoration. Effects of earthquakes. Methods of seismic retrofitting, restoration of buildings, Special care in repair and rehabilitation of heritage structures.

Text Books:

1. Maintenance Repair Rehabilitation & Minor works of Buildings- P.C. Varghese, PHI Publications. (ISBN: 978-81-203-4945-2)
2. Repair and Rehabilitation of Concrete Structures – P.I. Modi, C.N. Patel, PHI Publications. (ISBN : 9788120352148).

Reference Books:

1. Rehabilitation of Concrete Structures - B. Vidivelli, Standard Publishers

- Distributors (ISBN: 8180141101).
2. Rehabilitation of Concrete Structures - B. Vidivelli, Standard Publishers Distributors (ISBN : 9788180141102).
 3. Concrete Repair and Maintenance illustrated - Peter H.Emmons (ISBN-13: 978-0876292860).

Web Links:

1. https://www.academia.edu/30633495/Repair_and_Rehabilitation_of_Structures
2. <https://nptel.ac.in/courses/105/106/105106202/>

Fire & Safety Engineering

Course Code:241CE026

L T P C
3 0 0 3

Course Outcomes:

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

CO1:	Study the effect of fire on materials used for construction
CO2:	Explain the various methods of test for non-combustibility and fire resistance; and will be able to select different structural elements and their dimensions for a particular fire resistance rating of a building.
CO3:	Explain the design concept of fire walls, fire screens, local barriers and fire doors and able to select them appropriately to prevent fire spread.
CO4:	Study the various methods of fire protection to RCC, steel, and wooden structural elements and their repair methods if damaged due to fire.
CO5:	Classify the various safety techniques and improve the analytical and intelligence to take the right decision at right time.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2		1								
CO2			3								
CO3	1		2			3			1		
CO4						1					
CO5	2		1			1	1		1		1

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:		2
CO2:		2
CO3:		2
CO4:		2
CO5:	2	

UNIT – I

Eherent Safety Concepts :

Compartment fire-factors controlling fire severity, ventilation controlled and fuel controlled fires; Spread of fire in rooms, within building and between buildings. Effect of temperature on the properties of structural materials- concrete, steel, masonry and wood; Behavior of non-structural materials on fire- plastics, glass, textile fibres and other house hold materials.

UNIT – II

Plant Locations:

Compartment temperature-time response at pre-flashover and post flashover periods; Equivalence of fire severity of compartment fire and furnace fire; Fire resistance test on structural elements- standard heating condition, Indian standard test method, performance criteria.

UNIT – III

Working Conditions:

Fire separation between building- principle of calculation of safe distance. Design principles of fire resistant walls and ceilings; Fire resistant screens- solid screens and water curtains; Local barriers; Fire stopped areas-in roof, in fire areas and in connecting structures; Fire doors- Low combustible, Non-combustible and Spark-proof doors; method of suspension of fire doors; Air-tight sealing of doors.

UNIT – IV

Fire Severity And Repair Techniques:

Fabricated fire proof boards-calcium silicate, Gypsum, Vermiculite, and Perlite boards; Fire protection of structural elements - Wooden, Steel and RCC.. Reparability of fire damaged structures- Assessment of damage to concrete, steel, masonry and timber structures, Repair techniques- repair methods to reinforced concrete Columns, beams and slabs, Repair to steel structural members, Repair to masonry structures.

UNIT – V

Working at Heights:

Safe Access - Requirement for Safe Work Platforms- Stairways - Gangways and Ramps-Fall Prevention & Fall Protection - Safety Belts - Safety nets - Fall Arrestors-Working on Fragile Roofs - Work Permit Systems-Accident Case Studies.

Text Books:

1. Principles of fire safety standards for building construction , Roytman, M. Y,
- B.Tech (CE) Curriculum - 2024

- Amerind Publishing Co. Pvt. Ltd., New Delhi. (ISBN: 13-978-8120350380).
2. Fire safety engineering design of structures , John A. Purkiss, Butterworth Heinemann, Oxford, U. (2nd edn.). (ISBN: 13-978-0750664431).

Reference Books:

1. Design of buildings for fire safety , Smith, E.E. and Harmathy, T.Z. (Editors) ASTM Special Publication 685, American Society for Testing and Materials, Boston, U.S.A. (ISBN: 13-978-0803147522).
2. Butcher, E. G. and Parnell, A. C, JohnWiley and Sons Ltd., New York, U.S.A. (ISBN: 13-978-0471102397).
3. Designing of fire safety Jain, V.K New Age International(P) Ltd., New Delhi,2010. (ISBN:13-978-9389802191)

Web Links:

1. <https://archive.nptel.ac.in/courses/105/102/105102176/>
2. Industrial Safety Engineering - Course (nptel.ac.in)
3. NPTEL : NOC:Fire Protection, Services and Maintenance Management of Building (Civil Engineering) (digimat.in)
4. NPTEL : NOC:Fire Protection, Services and Maintenance Management of Building (Civil Engineering) (digimat.in)

Green Buildings

Course Code:241CE027

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Define sustainability and a green building, along with its features and benefits.
- CO2:** Describe the methods used to maintain indoor environmental quality.
- CO3:** Describe the water efficiency methods
- CO4:** Design sustainable and energy efficient civil engineering projects.
- CO5:** Select materials for sustainable built environment & adopt waste management methods.

Mapping of course outcomes with program outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	2	-	-	-	2	-	1	-	-	-
CO2	3	3	-	-	-	2	-	1	-	-	-
CO3	3	3	-	-	-	2	-	1	-	-	-
CO4	2	2	-	-	-	2	-	1	-	-	-
CO5	3	3	-	-	-	2	-	1	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	1	
CO2:	1	
CO3:	1	
CO4:	3	
CO5:		3

UNIT I

Green Building Concept:

Overview of green building movement; Concept of Green building and sustainable development; Issues and strategies of Green building and sustainable development; Objectives Principles and Benefits of Green building design; Introduction to High-performance building; integrated design process of high-performance building; Green project requirements and strategies; Overview of various green rating systems worldwide.

UNIT-II:

Green Building Materials and Indoor Environment Quality

Introduction; Low emitting materials; Building and material reuse; Construction waste management; Regional materials; Life cycle cost assessment of building materials and products; Factors affecting indoor environment quality; Ventilation and filtration; Building materials and finishes- Emittance level; Indoor Environment quality best practice.

UNIT-III:

Water:

Reduce, Reuse and Recycle: Introduction; Wastewater strategy and water reuse/recycling; Water fixtures and water use reduction strategies.

UNIT-IV:

Energy Efficiency:

Environmental impact of building constructions, Concepts of embodied energy, operational energy and life cycle energy.

Methods to reduce operational energy:

Energy efficient building envelopes, Solar Heat Gain Coefficient, U-Values for facade materials, efficient lighting technologies, energy efficient and BEE rated appliances for heating and air-conditioning systems in buildings, zero ozone depleting potential (ODP) materials, wind and solar energy harvesting, energy metering and monitoring, concept of NET ZERO buildings.

UNIT-V:

Building materials:

Methods to reduce embodied energy in building materials: (a) Local building materials. (b) Natural and renewable materials like bamboo, timber, rammed earth, stabilized mud blocks. (c) Materials with recycled content such as blended cements, pozzolana cements, fly ash bricks, vitrified tiles, materials from agro and industrial waste. (d) Reuse of waste and salvaged materials.

Waste Management:

Handling of construction & demolition waste materials, separation of household waste, handling e-waste, on-site and off-site organic waste management.

Text Books:

1. Alternative Building Materials and Technologies, K.S. Jagadeesh, B.V. Venkata Rama Reddy, and K.S. Nanjunda Rao, New Age International Publishers. (ISBN: 9788122433110)
2. Green Building Fundamentals, Mike Montoya, Pearson in the USA. (ISBN: 9780135066403)

Reference Books:

1. Green Buildings, Peter Gevorkian, published by McGraw-Hill. (ISBN: 9780071473590)
2. Green Building Handbook, Volume 1, Tom Woolley, Sam Kimmins, Paul Harrison, and Rob Harrison, E & FN Spon (an imprint of Thomson Science & Professional). (ISBN: 9780419236900)

Web Links:

1. <https://www.igbc.in/>
2. <http://www.sbtmanual.in/>
3. <https://www.grihaindia.org/>

Construction Equipment & Machinery

Course Code: 241CE029	L	T	P	C
	3	0	0	3

Course Outcomes:

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

- CO1:** Develop knowledge on planning of equipment and selection of equipment
- CO2:** Explain the knowledge on fundamentals of earth work operations, earthmoving operations and types of earth work equipment
- CO3:** Develop the knowledge on special construction equipment
- CO4:** Apply the knowledge on asphalt and concrete plants
- CO5:** Apply the knowledge and select the proper materials handling equipment

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2										
CO2	2						1				1
CO3	2										
CO4	2						1				1
CO5	2				2						

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	1	
CO2:	1	
CO3:	1	
CO4:	1	
CO5:	1	

UNIT – I

Construction Equipment:

Identification-Planning of equipment – Selection of equipment -Equipment management in projects - Maintenance management - Equipment cost - Operating cost - Cost control of equipment –Depreciation analysis-Replacement analysis-Safety management.

UNIT – II

Equipment for Earthwork:

Fundamentals of earthwork operations - Earth moving operations - Types of earthwork equipment-Tractors, motor graders, scrapers, front end loaders-Dozer, excavators, rippers, loaders, trucks and hauling equipment, compacting equipment, finishing equipment-Case studies on earthwork equipment.

UNIT – III

Other Construction Equipment:

Equipment for dredging, trenching, drag line and clamshells, tunneling - Jacking equipment -Equipment for drilling and blasting - Pile driving equipment - Erection equipment - Crane, mobile crane-Types of pumps used in construction - Equipment for dewatering, grouting and demolition.

UNIT – IV

Asphalt and Concrete Plants:

Aggregate production - Different crushers - Feeders - Screening equipment - Handling equipment -Batching and mixing equipment - Ready mix concrete equipment, concrete pumping equipment –Asphalt plant-Asphalt pavers-Asphalt compacting equipment

UNIT – V

Materials Handling Equipment:

Forklifts and related equipment - Portable material bins - Material handling conveyors – Material handling cranes-Industrial trucks –Aerial transporting equipment.

Text Books:

1. Construction Planning, Equipment and Methods, Peurifoy, R.L., Schexnayder, C., Schmitt, R.L. and Aviad Shapira., 9th Edn. Mc GrawHill, Singapore, 2018. (ISBN: 13978-1260108804)
2. Construction Equipment and Management for Engineers Estimators and Owners, Granberg G., Popescu M Taylor and Francis Publishers, New York. (ISBN:13978-1498788489)

Reference Books:

1. Construction Equipment and Job Planning, Deodhar, S.V. 4thEdn. Khanna Publishers, New Delhi, 2020. (ISBN:13978-8174091147)
Building Construction, Planning Techniques and Method of Construction,
2. Arora S.P. and Bindra S.P., B Dhanpat Rai and Sons,2018. (ISBN: 13978-8189928803)
3. Construction Equipment and Management, Sharma S.C. Khanna Publishers, New Delhi. (ISBN: 978-9382609056)

Web Links:

1. <https://archive.nptel.ac.in/courses/105/102/105102088/>

Finite Element Methods

Course Code:241CE028

L	T	P	C
2	1	0	3

Course Outcomes:

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

CO1:	Summarize the direct and formal methods for deriving finite element Equations.
CO2:	Solve engineering problems in truss elements.
CO3:	Apply FEM for analysis of beams and frames.
CO4:	Explain the principles of stress-strain behaviour of continuum
CO5:	Discuss the role and significance of shape functions in finite element formulations.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	1	1									
CO2	3	2	1									
CO3	3	2	1									
CO4	3	3	1									
CO5	2	1	1									

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	2	
CO2:		2
CO3:		2
CO4:		2
CO5:	2	

UNIT – I

Introduction:

Review of stiffness method- Principle of Stationary potential energy -Potential energy of an elastic body- Rayleigh-Ritz method of functional approximation - variational approaches- weighted residual methods.

UNIT – II

Finite Element formulation of Truss Element:

Stiffness matrix- properties of stiffness matrix – Selection of approximate displacement functions- solution of a plane truss- transformation matrix and stiffness matrix for a 3-D truss- Inclined and skewed supports- Galerkin's method for 1-D truss– Computation of stress in a truss element.

UNIT – III

Finite Element formulation of Beam Elements:

Beam stiffness- assemblage of beam stiffness matrix- Examples of beam analysis for concentrated and distributed loading- Galerkin's method - 2-D Arbitrarily oriented beam element – inclined and skewed supports – rigid plane frame examples.

UNIT – IV

Plane Stress and Plane Strain Analysis:

Derivation of CST and LST stiffness matrix and equations-treatment of body and surface forces- Finite Element solution for plane stress - comparison of CST and LST elements– convergence of solution-interpretation of stresses.

UNIT – V

Isoparametric Elements & Numerical Integration:

Introduction - Isoparametric formulation - Higher order elements - Derivation of shape functions for a four noded quadrilateral element using natural coordinates - strain displacement matrix - stress- strain relationship matrix - stiffness matrix for isoparametric element - Numerical Integration - Gauss quadrature method for rectangular elements.

Text Books:

1. Finite element Analysis in Engineering, S.Md.Jalaludeen, Anuradha Publications. (ISBN:13 978-8184722376)
2. Finite Element Analysis, S.S.Bhavakatti, New age international publisher.(ISBN: 13978-8122436716)

Reference Books:

1. An introduction to Finite Element Method, JN Reddy, McGraw-Hill.(ISBN:13978-0070607415)
2. Finite Element Method with applications in Engineering. YM esai, Eldho & Shah, Pearson Publishes. (ISBN:9788131724644)

Web Links:

1. <https://nptel.ac.in/courses/105105041/>
2. <https://nptel.ac.in/downloads/105108141/>

Construction Contract Management

Course Code:241CE031

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1: Decide suitable contracts for a given project scenario and stakeholders of the contract
- CO2: Identify the best form of contract for a specific project and design performance parameters
- CO3: Summarize tender processing and assess various contractual provisions in tender documents and develop a bidding strategy
- CO4: Understand the conditions of the contract
- CO5: Formulate contract management processes involved in construction projects

Mapping of course out comes with program outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	1									1
CO2	3	3	-	-	-	-	-	2	-	-	2
CO3	3	3	-	-	-	-	-	-	-	-	2
CO4	2	2	-	-	-	-	-	-	-	-	2
CO5	3	3	-	-	-	-	-	-	-	-	2

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	2	
CO2:	2	
CO3:	3	
CO4:	3	
CO5:	2	

UNIT I

Introduction to Contract

Definition and legal issues in contract, Essential requirement of a contract as per Indian Contract Act 1872, Characteristics of a good contract, Legal enforceability of contract, Breach & termination of contracts, Major stakeholders in construction contracts, Overview of Activities in Contract Management.

UNIT-II:

Construction Contracts

Type of construction contracts: Lump sum contracts, Fixed price contracts, Percentage rate contracts, Cost plus contracts, Target contracts, Design-Build contracts, Turn-key contracts, BOT contracts. Parties to a Contract, Contract Formation, Common contract clauses: Notice to proceed, rights and duties of various parties, Contract Duration and Price.

UNIT-III:

Tendering

Process of tendering: Tender notice, EOI, RFQ & RFP, Bid security, Prequalification process, Bidding Models and bidding strategy, Tender submission and evaluation, Tender rejection, Security deposits/performance guarantee & Defect liability, Contract agreement & contract documents

Performance Parameters

Delays, penalties and liquidated damages; Force Majeure, Suspension and Termination.

UNIT-IV:

Conditions of Contracts

General conditions & special conditions, Contract conditions for payments, Time delay, Scope changes, Extra claims, Termination of contracts, subcontracting

UNIT-V:

Contract Administration

Elements of contract management, Major stakeholders in construction contracts, Contract administration; Duties and responsibilities of parties, Stakeholder agreements, Contract risk management, Management reporting, Dispute resolution mechanisms: Negotiation, Mediation

Text Books:

1. Construction Contracts, Keith Collier, Reston Publishing Company, Inc, Reston, Virginia. (ISBN: 9780835906801)
2. Construction Contracts - Law and Management , John Murdoch & Will Hughes, Spon Press, Taylor & Francis Group. (ISBN: 9780415655247)

Reference Books:

1. Construction and Contract Management Vol.1 , V. K. Raina, Raina's (Second Edition), SPD Publishers, ISBN: 9788180141262)
2. Govt of India, Central Public Works Department, "CPWD 7/8: General Conditions of Contracts."

Web Links:

1. https://indiatradefair.com/uploads/tender/tender_led_boards_15_09_2016.PDF
2. <https://nptel.ac.in/courses/105103093/15>
3. <https://esub.com/4-types-construction-contracts/>
4. http://www.niperhyd.ac.in/Tenders/CPWD_GCC.pdf

PRE STRESSED CONCRETE

Course Code:241CE030

L T P C
3 0 0 3

Course Outcomes:

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

CO1:	Explain concepts of prestressing.
CO2:	Estimate losses in prestressed concrete.
CO3:	Calculate the flexural strength and deflection of prestressed concrete beam.
CO4:	Design prestressed concrete member for bending, shear, and torsion.
CO5:	Design of end zone reinforcement for pre tensioned and post tensioned members

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2					2				
CO2	2	2					2				
CO3	2	2					2				
CO4	2	2	3				2				
CO5	2	2	3				2				

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	2	3
CO2:	2	
CO3:	2	
CO4:	3	
CO5:	3	

UNIT – I

Basic concepts of Prestressing:

Basic concepts of Prestressing – Advantages and Applications of Prestressed Concretes – High Strength Concrete – Permissible Stresses – Shrinkage – Creep – Deformation Characteristics – High strength Steel – Types – Strength – Permissible Stresses – Relaxation of Stress – Stress Corrosion – Durability – Fire Resistance – Cover Requirements.

Prestressing Systems:

Introduction – Tensioning devices – Pre-tensioning Systems – Post tensioning Systems

– Basic Assumptions in Analysis of prestress and design – Analysis of prestress – Resultant Stresses at a section – pressure line – Concepts of load balancing – Stresses in Tendons – Cracking moment.

UNIT – II

Losses of Pre-stressing:

Losses of Pre-stressing – Loss of Pre-stress in pre-tensioned and post tensioned members – Elastic shortening of concrete – shrinkage of concrete – creep of concrete – Relaxation of steel – slip in anchorage – differential shrinkage – bending of members and frictional losses – Total losses allowed for design.

UNIT – III

Deflections and Flexure Strength:

Importance of control of deflections – Factors influencing – Prediction of short term and long term deflections – Types of flexural failure – Code procedures – Design of sections for flexure.

UNIT – IV

Design for Shear and Torsion:

Shear and Principal Stresses – Design of Shear reinforcements – Codal Provisions – Design for Torsion – Design for Combined bending, shear, and torsion.

UNIT – V

Transfer of Stresses:

Transfer of Prestress in pre tensioned members – Transmission length – Bond stresses – end zone reinforcement – Codal provisions – Anchorage zone Stresses in Post tensioned members – stress distribution in end block – Anchorage Zone reinforcement.

Text Books:

1. Prestressed Concrete, Krishna Raju N, Tata Mc.Graw Hill Publications, 6th Edition. (ISBN: 13 - 978-9387886209)
2. Prestressed Concrete, Rajagopalan. N, Narosa publications, 2nd Edition. (ISBN:13-978-8173195433).

Reference Books:

1. Prestressed concrete, srikanth, B. Vanakudu, Khanna Publications. (ISBN: 13-978-9386173317).
2. Prestressed Concrete, Ramamrutham S, Publications, 5th Edition. (ISBN:9789384378370).
3. Design of Prestressed Concrete Structures, Lin T.Y. & Ned H. Burns, John Wiley & Sons, 3rd Edition. (ISBN:13-978-9812531179).

Web Links:

1. <https://nptel.ac.in/courses/105106118/>
2. <https://lecturenotes.in/subject/245/prestressed-concrete-structures-pcs>
3. <https://nptel.ac.in/courses/105106117/>

Design of Ocean Structures & Foundations

Course Code: 241CE032	L	T	P	C
	2	1	0	3

Course Outcomes:

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

- CO1:** Describe concept of ocean structures
- CO2:** Classify various loads on offshore structures.
- CO3:** Design of steel member/joint of offshore structures.
- CO4:** Evaluate and design various types of pile foundations
- CO5:** Apply pile installation methods and understand related stresses

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	-	-	-						
CO2	3	2	-	-							
CO3	3	2	3	1							
CO4	3	2	3	1							
CO5	3	2	-	1	-						

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	1	
CO2:		
CO3:	3	
CO4:	3	
CO5:		

UNIT – I

Introduction

Fixed offshore platforms (jackets, gravity platforms, articulated towers); superstructure & foundation, floating platforms (semi-submersibles, jack-ups, TLP, FPSOs, pipe laying barges).

UNIT – II

Loads on Ocean Structures:

Wind Loads; Wave and Current Loads; Calculation based on Maximum base Shear and Overturning Moments; Design Wave heights and Spectral Definition; Hydrodynamic Coefficients and Marine growth, Seismic Loads, Allowable stresses - Various design methods and Code Provisions.

UNIT – III

Steel Tubular Member Design:

Introduction to tubular joints, Principles of WSD and LRFD; Allowable stresses and Partial Safety Factors; Tubular Members, Slenderness effects; Column Buckling, Design for Hydrostatic pressure; Design for combined axial and bending stresses-Elastic stress distribution - Punching shear Stress - Overlapping braces - Stress Concentration-Design of tubular joints as per API Code- S-N curves and fatigue damage calculations.

UNIT – IV

Pile foundation

Jacket main piles, skirt piles, driven piles, drilled and grouted piles, steel and concrete piles, axial capacity, point bearing and skin friction, factor of safety, lateral load on piles, p-y, t-z and q-z curves, pile group effect, scour around piles, seabed subsidence and design of piles against seabed movement, negative skin friction, cyclic degradation, main pile to jacket connections, skirt pile to jacket connections, API RP 2A provisions

UNIT – V

Pile Installation

Minimum pile wall thickness, pile handling stresses, static and dynamic stresses, pile stickup, stresses during stickup, wave and current loads, hammer selection, pile driving stresses, wave equation analysis, pile driving fatigue, API RP 2A guidelines.

Text Books:

1. Hydrodynamics of Offshore Structures, S.K. Chakrabarti, Springer Verlag. (ISBN-10. 0387173196)
2. Handbook of Offshore Engineering, S.K. Chakrabarti, Elseviers. (ISBN-13. 978-0080443812)

Reference Books:

1. Pile Design and Construction, M. J. Tomlinson, E & FN Spon.(ISBN-10. 9781466592636
2. Marine Technology Reference Book , Morgan, N., , Butterworths,7. B.C.(ISBN-13. 978-0408027847)

Web Links:

1. <https://archive.nptel.ac.in/courses/114/106/114106011/>
2. <https://archive.nptel.ac.in/courses/114/106/114106015/>

Analysis & Design of Masonry Structures

Course Code: 241CE033	L	T	P	C
	2	1	0	3

Course Outcomes:

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

- CO1:** Select suitable material for masonry construction by understanding engineering properties.
- CO2:** Compute loads, load combinations and analyze the stresses in masonry.
- CO3:** Design masonry under compression (Axial load) for various requirements and conditions.
- CO4:** Design masonry under bending (Eccentric, lateral, transverse load) for various requirements and conditions.
- CO5:** Assess the behavior of shear wall and reinforced masonry.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	3	1							
CO2	2		2	2							
CO3	2	1	3	2							
CO4	2		3	3							
CO5	2		2	2							

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:		3
CO2:	1	
CO3:	3	
CO4:	3	
CO5:		2

UNIT – I

Masonry Units, Materials, types and masonry construction::

Bricks, Stone and Block masonry units strength, modulus of elasticity and water absorption of masonry materials–classification and properties of mortars. Defects and Errors in masonry construction – cracks in masonry, types, reason for cracking, methods of avoiding cracks.

Strength and Stability:

Strength and stability of axially loaded masonry walls, effect of unit strength, mortar strength, joint thickness, rate of absorption, effect of curing, effect of ageing, workmanship. Compressive strength formulae based on elastic theory and empirical formulae.

UNIT – II

Permissible stresses:

Types of walls, permissible compressive stress, stress reduction and shape modification factors, increase in permissible stresses for eccentric vertical and lateral load, permissible tensile stress and shear stresses.

Design Considerations:

Effective height of wall and columns, openings in walls, effective length, effective thickness, slenderness ratio, eccentricity, load dispersion, arching action in lintels. Problems on design considerations for solid walls, cavity walls, wall with pillars.

UNIT – III

Load considerations and design of Masonry subjected to axial loads:

Design criteria, design examples of walls under UDL, solid walls, cavity walls, solid wall supported at the ends by cross wall, walls with piers.

UNIT – IV

Design of walls subjected to concentrated axial loads:

Solid walls, cavity walls, solid wall supported at the ends by cross wall, walls with piers, design of wall with openings.

Design of walls subjected to eccentric loads:

Design criteria – stress distribution under eccentric loads –Problems on eccentrically loaded solid walls, cavity walls, walls with piers.

UNIT – V

Design of Laterally and transversely loaded walls:

Design criteria, design of solid wall under wind loading, design of shear wall – design of compound walls. Introduction to reinforced brick masonry, lintels and slabs. In-filled frames: Types – modes of failures – design criteria of masonry retaining walls.

Text Books:

1. Brick and Reinforced Brick Structures , Dayaratnam P , Scientific International Pvt. Ltd. (ISBN: 13978-9386479792).
2. Building and Construction Materials, M. L. Gambhir , McGraw Hill education Pvt. Ltd. (ISBN:13-9789383286843).

Reference Books:

1. Structural Masonry, Henry, A.W., Macmillan Education Ltd. (ISBN: 13978-0333733097)
2. IS 1905–1987 Code of practice for structural use of un-reinforced masonry- (3rd revision) BIS, New Delhi.
3. SP20(S&T)–1991, Hand book on masonry design and construction(1st revision) BIS, New Delhi.

Web Links:

1. <https://archive.nptel.ac.in/courses/114/106/114106011/>
2. <https://www.engineeringtrainer.com/shop/inco1501-product-design-of-offshore-structures-438>

Design of Tall Buildings

Course Code: 241CE034	L	T	P	C
	2	1	0	3

Course Outcomes:

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

CO1:	Explain different types of concrete used in construction of tall buildings.
CO2:	Calculate different types of loads acting on buildings
CO3:	Summarize the behaviour of various structural systems
CO4:	Analyze and design of various structural systems for tall buildings.
CO5:	Analyze stability of structural members in tall buildings

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1									
CO2	2	2	1								
CO3	2	2									
CO4	2	3	2								
CO5	2	3	3								2

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:		2
CO2:	2	
CO3:	2	
CO4:	3	
CO5:	2	

UNIT – I

Design Philosophies and Materials:

Introduction-Modern concepts, High performance, concrete Fibre reinforced concrete – Lightweight concrete – Self compacting concrete.

UNIT – II

Gravity and Lateral Loading:

Dead load, live load, impact load, construction load, and sequential loading – Wind loading – Static and dynamic approach analytical method – Wind tunnel experimental methods – Earthquake loading – Equivalent lateral load analysis – Response spectrum method – Combination of loads.

UNIT – III

Behaviour of Structural Systems:

Factors affecting the growth – Height and structural form – behavior of braced frames – Rigid frames – in-filled frames – Shear walls – Coupled shear walls – Wall – Frames.

UNIT – IV

Analysis and Design:

Modelling for approximate analysis – Accurate analysis and reduction techniques – Analysis of structures as an integral unit – Analysis for member forces – Drift and twist – Computerized 3D analysis – Design for differential movement – Creep and Shrinkage effects – Temperature effects and fire Resistance.

UNIT – V

Stability Analysis:

Overall buckling analysis of frames, wall – Frames – Approximate methods – Second order effect of gravity loading $P-\Delta$ Effects – Simultaneous first order and $P-\Delta$ analysis Translational instability- Torsional instability – Effect of stiffness of members and foundation rotation in stability of structures.

Text Books:

1. Building Structures-Analysis and Design, Bryan Stafford Smith and Alex Coull, Tall, John Wiley and Sons, Inc. (ISBN: 13-978-0471512370).
2. Structural Analysis and Design of Tall Buildings, Taranath B.S, McGraw-Hill, 2021. (ISBN: 13-978-0070628786).

Reference Books:

1. Structural Concepts and Systems for Architects and Engineers, Lin T.Y. and Burry D. Stotes, John Wiley, Van Nostrand Reinhold Co Publishers. (ISBN: 13-978-0471085386).
2. Analysis of Tall & complex structures, FENG FU, BH Publications. (ISBN: 9781498706797).

3. Design of Tall Buildings, Mark Srkisian, Routledge Publishers, 2019. (ISBN: 13-9781138886711).

Web Links:

1. <http://www.madehow.com/Volume-6/Skyscraper.html>
2. <https://www.bdcnetwork.com/5-innovations-high-rise-building-design>
3. <https://theconstructor.org/structural-engg/high-rise-structures/5/>

Minor Stream: Environmental Geotechnics

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241CE041	Geoenvironmental Engineering	FC	2			2	50	50	100	ES
241CE040	Fundamentals of Soil Behaviour	FC	2	1		3	50	50	100	-
241CE039	Flow & Transport in Porous Media	FC	3			3	50	50	100	-
241CE044	Land fill Engineering & Remediation Technology	FC	3			3	50	50	100	-
241CE036	Environmental Impact & Risk Management	FC	3			3	50	50	100	-
241CE035	Climate Change and Environmental Issues	IC	3			3	50	50	100	-
241CE042	Ground Improvement Techniques	IC	3			3	50	50	100	GTE-2
241CE038	Expansive Soils	IC	3			3	50	50	100	GTE-1&2
241CE037	Environmental Management	IC	3			3	50	50	100	-
241CE045	Marine Foundations	AC	3			3	50	50	100	GTE-2
241CE073	Water Resource Management	AC	3			3	50	50	100	-
Total			31	1		32				

Geoenvironmental Engineering

Course Code:241CE041 L T P C
2 0 0 2

Course Outcomes:

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

- CO1:** Assess the contamination in the soil.
- CO2:** Study the contaminant transport process and methods for groundwater contamination control.
- CO3:** Prepare the suitable disposal system for particular waste.
- CO4:** Evaluate the methods for stabilizing waste and assess the utilization of solid waste for soil improvement.
- CO5:** Select suitable ground water remediation methods based on contamination.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	3					2				
CO2	3	3		2			3				
CO3	3	3	3				3				
CO4	3	3	2				3				
CO5	3	3	2				3				

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:		3
CO2:		3
CO3:	2	3
CO4:		3
CO5:		2

UNIT-1

Introduction:

Emergence of Geo-Environmental engineering, Types of Geo-Environmental problems, inorganic and organic toxic chemicals, composition of soils, soil properties, inorganic and organic geochemistry.

UNIT – II

Contaminant Transport and Fate :

Transport processes, chemical mass transfer processes, biological processes, contaminant transport and fate modeling, landfill and surface impoundments, in-situ barriers, ground water contamination.

UNIT – III

Subsurface Contamination and Waste Containment:

Sources and types of contamination, remediation approach, contaminated site characterization, risk assessment and remedial strategy. Vertical and bottom barriers, surface caps, ground water pumping systems, subsurface drains, liner systems.

UNIT – IV

Soil Remediation:

Soil vapour extraction, soil washing, stabilization and solidification, electrokinetic remediation, thermal desorption, vitrification, bioremediation, phytoremediation, soil fracturing.

UNIT – V

Ground Water Remediation:

Pump and treat, In-situ flushing, permeable reactive barriers, in-situ air sparing monitored natural attenuation, bioremediation.

Text Books:

1. Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies ,Sharma H.D. and Reddy K.R., John Wiley& Sons, Inc., USA. (ISBN: 978-0471415120)
2. Geoenvironmental Engineering, Contaminated Soils, Pollutant Fate, and Mitigation, Yong, R. N. CRC Press, New York. (ISBN: 978-0849334354)

Reference Books:

1. Geoenvironmental Engineering, Principles and Applications, Reddi L.N. and Inyang, H. I., Marcel Dekker Inc. New York. (ISBN: 978-0824798227)

Web Links:

1. <https://nptel.ac.in/courses/105102160>
2. <https://archive.nptel.ac.in/courses/105/103/105103025/>

Fundamentals of Soil Behaviour

Course Code: 241CE040	L	T	P	C
	2	1	0	3

Course Outcomes:

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

- CO1:** Identify the probable soil formation history
- CO2:** Analyze effective stress and evaluate permeability characteristics of soil.
- CO3:** Evaluate soil compressibility and determine consolidation parameters.
- CO4:** Asses the shear strength characteristics using appropriate laboratory and insite methods.
- CO5:** Apply critical state models to understand elastic and plastic behaviour of soils.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2					1				
CO2	3	3		2			1				
CO3	3	3	1	3							
CO4	3	3	2	3							
CO5	3	3		2	1						

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	1	
CO2:	2	
CO3:	3	
CO4:	3	
CO5:	2	

UNIT – I

Soil Formation and Composition :

Origin, nature and distribution of soil, description of individual particle, clay mineralogy, clay-water electrolytes, soil fabric and structure

UNIT – II

Effective Stress and Soil Permeability:

Effective stress principle, steady state flow in soil, effect of flow on effective stress, determination of coefficient of permeability.

UNIT – III

Soil Consolidation :

Consolidation in one, two, three and radial direction, variation of effective stress during consolidation, consolidation tests and determination of consolidation parameters.

UNIT – IV

Shear Strength of Soils:

Stress path analysis, tri-axial and direct shear tests, shear behaviour of granular soils and Fine-Grained Soils, factors affecting shear behaviour, determination of shear strength parameters, pore pressure parameters, UU, CU, CD tests, total and effective shear strength parameters, factors affecting shear strength- determination of in situ undrained strength.

UNIT – V

Critical State Model :

Introduction models and soil mechanics, use of models in engineering, elasticity, soil elasticity, plasticity and yielding, yielding of metal tubes in combined tension and torsion, elastic-plastic model for soil, elastic volumetric strains, a particular elastic-plastic model.

Text Books:

1. Soil Mechanics and Foundation Engineering, Arora K.R., Standard publisher, 2020. (ISBN: 13-978-8180141126)
2. Soil Mechanics and Foundations , Punmia, B.C., Laxmi Publications Pvt. Ltd. New Delhi. (ISBN: 13-978-8170087915)

Reference Books:

1. Text book in Fundamentals of Soil Behaviour , Mitchell, J. K., , John Wiley & Sons, New York, 2Ed. (ISBN: 13-978-0471856405)
2. Soil Behaviour and critical State Soil Mechanics , Muir Wood , Cambridge University Press. (ISBN: 13-978-0521337823).

Web Links:

1. <https://nptel.ac.in/courses/105101084>
2. <https://archive.nptel.ac.in/courses/105/101/105101201/>

Flow & Transport in Porous Media

Course Code:241CE039

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Understand the basics of groundwater flow and transport in groundwater.
- CO2:** Analyze groundwater flow and well hydraulics.
- CO3:** Understand multiple well systems, unsaturated zones, and fractured formations flow.
- CO4:** Assess saline water intrusion and develop groundwater management strategies.
- CO5:** Evaluate groundwater quality, contaminant transport, and apply predictive modelling techniques.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2		1							
CO2	3	3		3	1						
CO3	3	3		2	1						
CO4	3	3	2	2	1						
CO5	3	3		3	2						

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	2	
CO2:	1	
CO3:	2	
CO4:	3	
CO5:	2	

UNIT – I

Groundwater Basics and Hydrologic Cycle :

Groundwater and the hydrologic cycle. Occurrence and movement of groundwater -

origin, age, distribution, types of aquifers. Darcy's law, hydraulic head and fluid potential, hydraulic conductivity and permeability.

UNIT – II

Aquifer Dynamics and Hydraulic Principles:

Heterogeneity and anisotropy of hydraulic conductivity, porosity and void ratio, compressibility and effective stress, transmissivity and storativity. Steady State and transient flow - formulation of the governing equations, limitations of the Darcian approach. Groundwater and well hydraulics - steady flow to a well fully penetrating an aquifer (confined and unconfined), unsteady radial flow to a well fully penetrating an aquifer (confined, unconfined and leaky), the effect of wellbore storage.

UNIT – III

Complex Well Systems and Unsaturated Flow:

Multiple well systems, partially penetrating wells, bounded aquifers, characteristic well losses, specific capacity. Slug tests. Introduction to flow in the unsaturated zone and flow in fractured formations.

UNIT – IV

Saline Water Intrusion and Groundwater Management:

Saline water intrusion in coastal aquifers: occurrence, shape and structure of the interface, upcoming, control of saline water intrusion. Groundwater modelling, Inverse modelling in groundwater. Artificial recharge of aquifers - concepts, hydraulics and methods. Groundwater budget. Groundwater resource estimation.

UNIT – V

Groundwater Contamination and Quality:

Introduction to groundwater contamination. Quality of groundwater - measures of quality, groundwater samples, physical, chemical and biological analyses, water quality criteria, and salinity. Transport and transformation of contaminants in groundwater - processes, formulation of the governing equations and initial and boundary conditions, modelling, solutions for simple cases.

Text Books:

1. Applied Hydrogeology , C. W. Fetter, 4th ed., Prentice Hall, Inc. (ISBN: 978-0130882394)
2. Contaminant Hydrogeology , C. W. Fetter, 2nd ed., Waveland Press. (ISBN: 978-1577665830)

Reference Books:

1. Numerical Groundwater Hydrology , A.K. Rastogi, Penram International Publishing (India) Pvt. Ltd. (ISBN: 978-8187972122)

2. Applied Flow and Solute Transport Modeling in Aquifers , Vedat Batu, Taylor and Francis/CRC Press. (ISBN: 978-0849343721)

Web Links:

1. <https://archive.nptel.ac.in/courses/103/105/103105160/>

Landfill Engineering & Remediation Technology

	L	T	P	C
Course Code: 241CE044	3	0	0	3

Course Outcomes:

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

- CO1:** Acquire knowledge on waste management hierarchy and landfill basics.
- CO2:** Design of liners and various components of waste disposal units.
- CO3:** Evaluate and implement effective strategies for leachate and landfill gas management.
- CO4:** Implement landfill operation, closure, and environmental controls.
- CO5:** Apply a risk-based assessment of contaminated sites and implement site remediation technologies.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2				2	3				
CO2	3	3	3	2			3				
CO3	3	3	2	2	2		3				
CO4	3	3	2	2		3	3				
CO5	3	3	3	2		3	3				

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	1	3
CO2:	3	3
CO3:	3	3
CO4:	3	3
CO5:	3	3

UNIT – I

Landfill Basics :

Waste management Hierarchy- Need for landfills –Environmental Protection by Landfills- Landfill Classification – Sanitary and Secure Landfills - Components and Configuration - Legal framework for landfilling – Landfill Site investigation-

Regional Landfills- Environmental control using site design – Landfill Design Tasks.

UNIT – II

Landfill Liners and Cover Systems:

Landfill barrier system components – Design of Compacted clay liners: Factors affecting hydraulic conductivity , Water content-density criteria, Thickness, Desiccation - Geosynthetic Clay Liners and Geomembranes; types, manufacturing, handling, seaming and testing - Asphalt Barriers and Capillary barrier - Composite Liner system design- liner construction and quality control- Leakage through Liners- vapor transmission and chemical compatibility - Installation of Geomembranes - Liner Leakage Mechanism – Diffusion - Controls on advection through liners - Single phase flow-advection-diffusion- Landfill cover systems- Design of Cover Systems – Daily Cover – Intermediate Cover – Final Cover - Flow through Landfill Covers- Design and Analysis of Slope Stability- Anchor Trenches- Access ramps - Erosion control.

UNIT – III

Leachate and Landfill Gas Management:

Waste decomposition in landfills - Factors affecting leachate and landfill gas generation – Factors affecting Leachate Quantity in active and post closure conditions- Hydrologic Evaluation of Landfill Performance (HELP) model – Leachate Drainage Layer – Geotextile and Geonet design – Leachate Collection and Removal systems-Temporal trends in leachate composition – Design of Landfill gas collection and removal systems- Gas condensate issues & knockouts - Leachate treatment methods (biological and physico-chemical)- Leachate re-circulation & bioreactor landfills- monitoring and control of leachate and Landfill gas- Landfill Settlement.

UNIT – IV

Landfill Operation and Closure :

Landfill Construction and Operational Controls – Fill Sequencing Plans – Cell Construction- Dozer and Compactor operations-Selection of Landfill Equipment-Landfill Administration-Record Keeping - Topographic mapping-Environmental Controls – Odour, Vector and Litter Control – Landfill Safety - Fire Control – Ground and Surface water Monitoring – Methane Gas monitoring - Audits of landfill environmental performance and management – Post Closure care and use of landfills – Landfill Economics- landfill construction and operational cost estimation – establishing tipping fees.

UNIT – V

Contaminated Site Remediation:

Contaminated sites - Fate and behaviour of toxics and persistent substances in the environment – Engineering Issues in Site Remediation - Site Characterization - Framework for risk assessment at landfill sites - Remediation Principles: Source Control and Management of Migration Covers, Cut-off Walls, Solidification /

Stabilization - Pump-and-Treat Systems - Solvent Vapor Extraction, Air Sparging, Soil Flushing – Bioremediation - Natural Attenuation - Remedy Selection and Risk Assessment – Geotechnical Aspects of In Situ Remediation Technology - Specific case studies in contaminated site remediation – Rehabilitation of Open dumps- Landfill Mining.

Text Books:

1. Solid Waste Management: Principles and Practice , M. N. Rao, PHI Learning Pvt. Ltd. (ISBN: 978-8120338695)
2. Geotechnical Aspects of Landfill Design and Construction , R. M. Koerner and D. H. Gray, Prentice Hall, New Jersey. (ISBN: 978-0130125064)

Reference Books:

1. Handbook of Solid Waste Management , G. Tchobanoglous, F. Kreith, and M. E. Williams, Asian Books Pvt. Ltd. (ISBN: 978-0071356237)
2. The Handbook of Landfill Operations, Neal Bolton P.E , Blue Ridge Services Inc., Atascadero, CA – ISBN 0-9646956-0-x. (ISBN: 0-9646956-0-X)

Web Links:

1. <https://archive.nptel.ac.in/courses/105/107/105107181/>
2. <http://www.digimat.in/nptel/courses/video/105105160/L47.html>

Environmental Impact & Risk Assessment

Course Code:241CE036

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Apply basic principles of EIA
- CO2:** Illustrate the necessity to study the impacts
- CO3:** Interpret different risks that will be caused by projects or industries
- CO4:** Identify methods to overcome these impacts
- CO5:** Demonstrate the concepts of the legal requirements of Environmental and Risk Assessment for projects.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3		1			2				1	1
CO2	2	2	2	1		2					
CO3	2	2	1	1		3					
CO4	2	2	2	1		2					
CO5	2		3			3					

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	1	2
CO2:		1
CO3:		3
CO4:		1
CO5:		1

UNIT – I

Introduction :

Historical development of Environmental Impact Assessment (EIA). EIA in Project Cycle - Legal and Regulatory aspects in India – Types and limitations of EIA, EIA process, Screening, Scoping, Setting, Analysis, Mitigation - Cross sectoral issues and terms of reference in EIA – Public Participation in EIA.

UNIT – II

Impact Identification and Prediction:

Matrices – Networks – Checklists –Cost benefit analysis – Analysis of alternatives – Software packages for EIA – Expert systems in EIA - Prediction tools for EIA – Mathematical modeling for impact prediction – Assessment of impacts – air – water – soil – noise – biological, Cumulative Impact Assessment.

UNIT – III

Social Impact Assessment and EIA Documentation:

Social impact assessment - Relationship between social impacts and change in community and institutional arrangements. Individual and family level impacts. Communities in transition Documentation of EIA findings – planning – organization of information and visual display materials – Report preparation.

UNIT – IV

Environmental Management Plan :

Environmental Management Plan, Preparation, implementation and review – Mitigation and Rehabilitation Plans, Policy and guidelines for planning and monitoring programmes – Post project audit, Ethical and Quality aspects of Environmental Impact Assessment-Case Studies.

UNIT – V

Environmental Risk Assessment and Management:

Environmental risk assessment framework-Hazard identification -Dose Response Evaluation – Exposure Assessment – Exposure Factors, Tools for Environmental Risk Assessment– HAZOP and FEMA methods – Event tree and fault tree analysis – Multimedia and multipath way exposure modelling of contaminant- Risk Characterization Risk communication - Emergency Preparedness Plans –Design of risk management programs.

Text Books:

1. Environmental Impact Assessment , Canter, L.W., McGraw Hill, New York. (ISBN: 0070097674).
2. Environmental Impact Assessment – Practical solutions to recurrent problems, Lawrence, D.P., Wiley-Interscience, New Jersey. (ISBN: 978-0-471-72202-1).

Reference Books:

1. Environmental Risk and Hazards, Cutter, S.L., Prentice-Hall of India Pvt. Ltd., New Delhi, (ISBN: 0137538561)
2. Risk Assessment and Management Handbook, Kolluru Rao, Bartell Steven, Pitblado R and Stricoff , McGraw Hill Inc., New York. (ISBN: 13978-0070359871)
3. Loss Prevention in the Process Industries, Hazard Identification, Assessment and Control Sam Mannan, Lees, 4th Edition, Butterworth Heineman. (ISBN: 978-0-7506-7555-0).

Web Links:

1. <https://nptel.ac.in/courses/120108004>
2. <https://www.witpress.com/journals>
3. <https://www.researchgate.net/publication/235859306>

Climate Change & Global Environmental Issues

Course Code: 241CE035	L	T	P	C
	3	0	0	3

Course Outcomes:

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

- CO1** Identify the major global climate changes and the upstream drivers behind these changes
- CO2** Illustrate the health risks of climate variability and change, including the sources of vulnerability and exposure to those risks
- CO3** Explain highly vulnerable populations domestically and globally
- CO4** Identify key interventions to promote climate-resilient health systems
- CO5** Enumerate key issues in implementing, monitoring, evaluating, learning from, and continuously updating, adaptation policies and programs

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	-	1	-	-	2	2	-	-	-	1
CO2	2	2	2	1	-	2	2	-	-	-	-
CO3	2	2	1	1	-	2	3	-	-	-	-
CO4	2	2	2	1	-	2	2	-	-	-	-
CO5	2	-	3	-	-	2	3	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	1	2
CO2:		1
CO3:		
CO4:		1
CO5:		1

Unit-I

Global climate change:

Introduction - Climate change – Factors influencing Climate change - Stratospheric ozone depletion and public health - and health impacts due to climate change – impacts on materials

Unit-II

Global bio-geo chemical cycles Carbon cycle: The Global Carbon Cycle, the Ocean Carbon Cycle, the Terrestrial Carbon Cycle Nitrogen cycle: nitrogen fixation, nitrogen assimilation, ammonification, nitrification and denitrification

Unit-III

Greenhouse Effect:

Non-CO₂ Greenhouse Gases and Aerosols, Temp, Radiation, & Energy Health exposures, weather, climate variability, climate change, and climate change epidemiology

Unit-IV

Climate Sensitivity:

Linking Human Dimension to Climate Change; Econometric Models and GHG Emissions, Scenarios

Unit-V

Climate Projections:

Strategies to Slow & Stabilize Climate Change; Sequestrations of Atmospheric CO₂; Impacts of Climate Change; Climate change & policy options.

Text Books:

1. Climate Change synthesis report , IPCC, (ISBN 92-9169-122-4)
2. Global Warming and Climate Change, Tapeshwar Singh, Rajesh Publications, (ISBN: 978-81-85891-76-7)

Reference Books:

1. Kevin E Trenberth: Climate System Modeling, Cambridge University Press, (ISBN: 9780521128377)
2. Kendal McGuffie, Ann Henderson-Sellers: A Climate Modeling Premier, Wiley, Print (ISBN:9781119943365)

WebLinks:

1. <https://science.nasa.gov/climate-change/effects/>
2. <https://www.ipcc.ch/2021/08/09/ar6-wg1-20210809-pr/>

Ground Improvement Techniques

Course Code: 241CE042	L	T	P	C
	3	0	0	3

Course Outcomes:

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

- CO1:** Identify the suitable densification methods and dewatering techniques for different soil conditions.
- CO2:** Illustrate the appropriate stabilization techniques for a range of ground and site conditions.
- CO3:** Demonstrate an ability to design reinforced earth-retaining structure.
- CO4:** Explain the different types of grouts, their properties and applications.
- CO5:** Demonstrate different types of geosynthetics in field applications.

Mapping of Course Out comes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	1	2	1						
CO2	3	2	2	2	1						
CO3	2	2	2	2	3						
CO4	2	2	3	2	3						
CO5	3	1	1	2	1						

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	3	
CO2:		1
CO3:		1
CO4:	3	
CO5:	2	

Unit– I

In Situ Densification Methods and Dewatering:

In situ densification of granular soils -vibration at ground surface and at depth, impact at ground and at depth–in situ densification of cohesive soils–preloading–vertical drains –sand drains and geo drains–stone columns.

Dewatering: sump sand interceptor ditches –single and multi – stage well points–vacuum well points–horizontal wells–criteria for choice of filler material around drains–electro osmosis.

Unit– II

Stabilization of soils:

Methods of soil stabilization – mechanical – cement – lime- bitumen and polymer – use of industrial wastes like fly ash and granulated blast furnace slag.

Unit–III

Reinforced Earth Technology:

Concept of soil reinforcement, reinforcing materials, Back fill criteria, Design of reinforcement for internal stability, Applications of Reinforced earth structures

Unit– IV

Grout Techniques:

Types of grouts, grouting equipment and machinery, injection methods, grout monitoring, stabilization with cement, lime and chemicals, stabilization of expansive soils.

Unit– V

Geo synthetics:

Geotextiles – types – functions, properties and applications –geogrids, geo membranes and gabions-properties and applications.

Text Books:

1. Ground Improvement techniques, Purushothama Raj Laxmi Publications,1st Ed, NewDelhi. (ISBN: 13-978-8131808573).
2. An Introduction to Ground Improvement Engineering, Mittal. S, Med tech Publisher. (ISBN:13-9789381714362).

Reference Books:

1. Ground Improvement, Moseley M.P,2ndEd.,Blackie Academic and Professional, Boca Taton, Florida,USA. (ISBN:13-978-0415274555).
2. Ground Control and Improvement, Xanthakos P.P, Abramson, L.W and Brucwe,D.A, John Wileyand Sons, NewYork,USA.

Web Links:

1. <http://nptel.ac.in/courses/105108075/>
2. <https://lecturenotes.in/subject/228/ground-improvement-techniques>
3. <https://www.vidyarthiplus.com>

Expansive Soils

Course Code:241CE038

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Identify the expansive soils in the field and laboratory
- CO2:** Illustrate the methods for the identification of soil structure and clay mineralogy
- CO3:** Design a suitable foundation for expansive soils.
- CO4:** Suggest a suitable method for stabilizing the expansive soils
- CO5:** Examine the liquefaction problems related to expansive soils

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	-	2	2	-	-	-	-	-	-
CO2	2	1	-	2	-	-	3	-	-	-	-
CO3	2	2	3	1	-	-	-	-	-	-	-
CO4	3	2	-	1	-	-	-	-	-	-	-
CO5	2	3	-	-	2	-	2	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	1	
CO2:	1	
CO3:	2	
CO4:	1	
CO5:	1	

UNIT-I:

Introduction and Identification:

Expansive soils of India-related civil engineering problems – formation of expansive soils in field – identification of expansive solids in laboratory by X-ray diffraction method and differential thermal analysis.

UNIT-II:**Physical and Chemical Properties**

Soil structure and clay mineralogy of expansive soil- atomic bond and molecular bonds- honey comb structure-based exchanges capacity- clay water relation- electrolysis processes.

UNIT -III:**Foundations**

Foundations on swelling soils-swelling potential and mechanism of volume change– chemical composition of black cotton soil-construction techniques in black cotton soil-modern method of construction in under reamed piles for expansive soil.

UNIT-IV:**Improvement methods**

Stabilization of expansive soils with lime-slag (silica fume and aluminium sludge)– cement-fly ash – chemicals-reinforced earth technique –micro reinforced vegetation-vibro floatation-grouting and soil nailing.

UNIT-V:**Liquefaction Hazard Mitigation**

Factors affecting the expansive soil – method of assessment for liquefaction-effect instrumentation for monitoring –consolidation of marine clay deposits-expansive soil model of Bingham fluid bounded by porous beds

Text Books:

1. Nelson, J. D., and Miller, D.J. Expansive Soils, John Wiley and Sons, Inc., New York (ISBN: 978-0471839669)
2. Design Aids in Soil Mechanics and Foundation Engineering–S.R. Kaniraj (Tata McGraw Gill, New Delhi) 2019. (ISBN: 978-1259007834)

Reference Books:

1. Foundation Engineering (2nd Edition)– Peck, R.B., Hanson (W.E. and Thornburn. W.H. Johan Wiley, New York) (ISBN: 978-0471061794)
2. Soil Engineering in Theory and Practice (Vol.-II)– Alam Sing hand G.R. Chowdhary (Asia Publishing House, New Delhi. (ISBN: 978-8123912930)

Web Links:

1. https://onlinecourses.nptel.ac.in/noc25_ce20/preview
2. <https://nptel.ac.in/content/storage2/courses/105101083/download/lec35.pdf>

Environmental Management

Course Code:241CE037

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Explain the concept and principles of environmental management
- CO2:** Explain the role of environmental organizations of planning for sustainable development.
- CO3:** Implement the concept of environmental management plan.
- CO4:** Examine the role of environmental impact assessment in real life.
- CO5:** Defend the knowledge of environmental legislations and acts.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3					2	2				1
CO2	2	2	1		2	3	2				2
CO3	3	2	3			3		2			2
CO4	3					3		3			1
CO5	2					3	3	1			2

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	1	
CO2:	1	
CO3:	1	
CO4:	1	
CO5:	1	

UNIT – I

Principles of Environmental Management

Definition of Environmental Management - Principles of Environmental Management - Nature, Scope and Components of Environmental Management - Policies and Legal Aspect of Environmental Management.

UNIT – II

Sustainable Environmental solutions

Public Private Participation Model - ISO Certification - Environment Health & Safety (EHS) - Environment & Disaster Management (EDM) - Environmental organizations for planning and implementation of sustainable development.

UNIT – III

Environmental Management Plan

Preventive and reactive strategies for environmental pollution control - Life Cycle Assessment as Environmental Management Tool - Environmental Management Plan (EMP) - Components of EMP - Preparation of EMP - Case Study

UNIT – IV

Environmental Impact Assessment

Environmental Impact Assessment (EIA) - Need and Importance - Steps involved - Methods of EIA - Ad-hoc, checklist, network, matrix etc - Typical case studies of environmental impact assessment - Environmental impact statement and risk assessment

UNIT – V

Environmental Legislations

Environmental Legislation - Air, Water and Environmental acts - Preventive and reactive strategies for environmental pollution control - Environmental Audit.

Text Books:

1. Assessment and analysis of Environmental management, Shukla S. S., Shrivastva P. R, common wealth publishers New Delhi (ISBN: 8171692192).
An introduction to Environmental Management, Dr, Anand Bal, Himalaya
2. Publishing House, (ISBN-13 978-8183183758).

Reference Books:

1. Environmental Impact Assessment, second edition, Larry W. Canter, McGraw-Hill International editions (ISBN-13 978-0070097643).
Environmental Management 2013, Vikas Khanna, D. R. & Chopra, A. K. & Matta,
2. Gagan & Bhutiani, R. & Singh (ISBN-13 978-8170358220).

Web Links:

1. <https://enviromicro-journals.onlinelibrary.wiley.com/journal/14622920>.
2. <https://link.springer.com/book/10.1007/978-94-017-9118-2>

Marine Foundations

Course Code:241CE045

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Study the scope, classification, and characteristics of marine soils.
- CO2:** Comprehend the sedimentological characteristics and engineering behaviour of marine soils.
- CO3:** Apply offshore soil investigation techniques, such as sampling and in-situ strength determination.
- CO4:** Analyze the foundations for gravity and jacket-type structures.
- CO5:** Evaluate the design and stability of jack-up platforms and submarine infrastructure.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2					1				
CO2	3	3	1				1				
CO3	3	3	2	3	2		1				
CO4	3	3	3	2			1				
CO5	3	3	3	2			1				

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	1	
CO2:	2	
CO3:	3	
CO4:	3	
CO5:	3	

UNIT – I

Introduction To Marine Geotechnical Engineering :

Scope of marine geotechnical engineering - Marine and submarine soils - Classification of marine soils - Relative distribution of marine soils in the different marine regions - General characteristics of marine deposits in some specific locations and in the Indian subcontinent.

UNIT – II

Sedimentological Characteristics of Marine Soils:

Structure of marine soils - Cementation bonding - Morphology and genesis of marine and submarine sediments - Post- depositional changes - Effect of calcium carbonate in marine deposits. Engineering behaviour of marine soils: Fine and coarse-grained deposits - Strength and deformation behaviour of fine - and coarse-grained marine deposits - Effect of cementation - Strength and deformation behaviour under static and cyclic loading.

UNIT – III

Offshore Soil Investigation:

General characteristics of offshore soil exploration - Sampling using free corer, gravity corer, tethered systems and manned submersibles - Deep penetration sampling using wire line techniques - In-situ determination of strength of submarine soils - Penetrometer, piezocone, vane and pressure meter techniques - General reconnaissance procedure for installation of fixed structures (gravity and piled type), floating structures, sea bed anchors and submarine pipelines.

UNIT – IV

Foundations For Gravity Structures:

Types of gravity structures - Installation techniques - Movement of gravity structures - Settlement of soil beneath gravity structures - Stress distribution beneath gravity structures - Stability of gravity structures under static and cyclic loads Foundations for jacket type structures: Types - Installation techniques - Design considerations - Axial and lateral load capacity of piles - Lateral load deformation behaviour of piles - Calculation of bearing capacity of piles - Design of piles subjected to lateral loads - Reese-Matlock method & p-y curves method.

UNIT – V

Foundations For Jack Up Platforms:

Types of jack up platforms - Piles and mat supported - Spud cans - Different types - Techniques for installation and removal of jack up - Stability of jack up platforms - Determination of penetration of supports - Stability under lateral loads - Stability under

static and cyclic load effects. Sea bed anchors, submarine pipe lines: General introduction to sea bed anchors, moorings, submarine pipe line etc. - General design considerations (brief outline only) - geotechnical aspects in the design and installation of sea bed anchors, moorings, submarine pipelines etc.

Text Books:

1. Offshore Soil Mechanics, George, P and Wood, D, Cambridge University Press. (ISBN: 978-0521333612).
2. Pile Foundation Analysis and Design, Poulos, H. G and Davis, E. H., John Wiley. (ISBN: 978-0471692606).

Reference Books:

1. Marine Geotechnology and nearshore/offshore structures, Chaney, F. ASTM, STP. (ISBN: 978-0803109725).
Strength Testing of Marine Sediments - Laboratory and In-situ Measurements,
2. Chaney, R. C and Demars, K. R., ASTM, STP -883, 1985. (ISBN: 978-0803109633).

Web Links:

1. <https://archive.nptel.ac.in/courses/114/106/114106015/#>
2. <https://archive.nptel.ac.in/courses/105/106/105106144/>

Water Resources Management

Course Code:241CE073

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Illustrate the important concepts of water resource management
- CO2:** Discuss the sources of water, ground water aquifers and zones
- CO3:** Describe the vulnerability conditions of flood and drought
- CO4:** Explain the different techniques of water harvesting
- CO5:** Apply the principles of remote sensing and GIS in hydrological modelling

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	-	1	-	-	2	2	-	-	-	-
CO2	2	2	2	1	-	2	2	-	-	-	-
CO3	2	2	1	1	-	2	3	-	-	-	-
CO4	2	2	2	1	-	2	2	-	-	-	-
CO5	2	-	3	-	-	2	3	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:		
CO2:		
CO3:		
CO4:		
CO5:		

UNIT – I

Introduction

Importance of water as a natural resource – Availability on the earth - Sources of Water – classification – importance and need of management of water resources – Water quality - Principles of water management - Role of various agencies in water resource management.

UNIT – II

Hydrologic Cycle and its components:

Surface water sources and Groundwater sources, importance, type of groundwater aquifers, groundwater zones, types of wells, concept, location, and importance. Artificial recharge of groundwater, direct and indirect methods.

UNIT – III

Floods and Drought Management:

Flood damage, assessing flood risk, flood hazard assessment, flood impact assessment, flood risk reduction options.

Drought assessment and classification – drought analysis techniques – drought mitigation planning and management.

UNIT – IV

Rain water Harvesting:

Necessity of Rainwater harvesting, Importance of Rainwater harvesting - Techniques of rain water harvesting – rain water harvesting from roof top – surface flow harvesting – subsurface flow harvesting – stop dams – farm ponds and dugout ponds – percolation tanks – Case studies.

UNIT – V

Water resource Systems Modeling:

Applications of remote sensing and GIS in –delineation of surface water bodies and wetlands - hydrological modelling - Data of water resource systems for modelling – application and comparison of models – model calibration and validation – advances of water resource system models.

Text Books:

1. Sustainable Water Resources Management, Chandra S.P. Ojha , Rao Y. Surampalli , (ISBN – 9780784414767)

2. Water Resource Engineering, Wurbs R A and James R A, Prentice Hall Publishers, .
(ISBN – 13 -978-0130812933)

Reference Books:

1. Disaster Management Future Challenges and Opportunities, Jagbir Singh, K
International publishing house.(ISBN - 818986646X, 9788189866464)
2. Watershed Hydrology, Black P E, Prentice Hall. (ISBN – 1-57504-027-1)

Web Links:

1. https://www.ct.gov/deep/cwp/view.asp?a=2719&q=325622&depNav_GID=1654
2. http://agritech.tnau.ac.in/agriculture/agri_majorareas_watershed_watershedmgt.html

Minor Stream: Transportation Engineering

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241CE053	Pavement Materials & Characterization	FC	2			2	50	50	100	-
241CE047	Docks & Harbour Engineering	FC	3			3	50	50	100	-
241CE054	Railway Engineering	FC	3			3	50	50	100	-
241CE055	Road Safety Analysis	FC	3			3	50	50	100	-
241CE048	Highway Construction & Practices	FC	3			3	50	50	100	-
241CE052	Pavement Management Systems	FC	3			3	50	50	100	-
241CE051	Pavement Drainage Systems	FC	3			3	50	50	100	-
241CE046	Airport Planning & Design	IC	3			3	50	50	100	-
241CE056	Urban Transportation Planning	IC	3			3	50	50	100	-
241CE049	Intelligent Transportation Systems	AC	3			3	50	50	100	-
241CE050	Pavement Design & Evaluation	AC	3			3	50	50	100	-
Total			32			32				

Pavement Materials & Characterization

Course Code:241CE053

L	T	P	C
2	0	0	2

Course Outcomes:

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

- CO1:** Identify different pavement materials.
- CO2:** Characterization of subgrade soil for pavement design
- CO3:** Assess the suitability of aggregates used in various layers of pavement
- CO4:** Determine the optimum bitumen content by applying the bitumen mix design methods.
- CO5:** Explain various concrete properties and its applications

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	1	2							
CO2	2	3	1	2	1						
CO3		2	2	1	2	1					
CO4	3	2	2	2	1						
CO5	2	2	2	2	1						

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:		3
CO2:		2
CO3:		2
CO4:		2
CO5:		2

UNIT – I

Introduction to Pavement Materials:

Pavement structure: introduction to materials used in different layers; factors affecting pavement performance; need for material characterization; performance data collection; specification development.

UNIT – II

Subgrade Soil Characterization:

Characterization of subgrade soil for pavement design: index properties, compaction characteristics; stiffness and strength of soil, resilient modulus; deformation characteristics of subgrade soil; soil Stabilization concepts: mechanical and chemical; geosynthetic application in pavements.

UNIT – III

Aggregate Characterization:

Origin, physical characterization of aggregates; requirement of aggregate property in different pavement layers: aggregate gradations; aggregate packing characteristics; factors affecting the performance of unbound aggregate layers; non-linear behavior of granular materials.

UNIT – IV

Bitumen & Bituminous Concrete Mixes:

Chemistry of bitumen, Rheology of bitumen, Elastic modulus, Dynamic modulus, visco-elastic and fatigue properties, creep test, stiffness modulus of bitumen, long term and short-term ageing Desirable properties of bituminous mixes, Design of bituminous mixes: Modified Marshall's specifications.

UNIT – V

Cement and Concrete Mixes:

Types of cements and basic cement properties, Special cements; Quality tests on cement; Introduction to advanced concretes like self-compacted concrete, Light weight concrete, Roller Compacted Concrete for pavement application; Nano technology applications in cement concrete.

Text Books:

1. Highway Engineering, Khanna, S.K., and Justo, C.E.G., Nem Chand and Bros. Roorkee. 9th Edition. (ISBN: 9788185240633).
2. Pavement Design and Materials, Papagiannakis, A.T., Masad, E.A., Wiley, First Edition. (ISBN: 9780471214618).

Reference Books:

1. Highway Materials, Soils and Concretes , Atkins, N. Harold, Fourth Edition, Prentice-Hall. (ISBN: 9780130993045).

2. Highway Materials, Kerbs Robert D. and Richard D. Walker, McGraw-Hill. (ISBN: 9780070354654).
3. Specifications for Road and Bridge Works, Ministry of Road Transport and Highways, Indian Roads Congress, New Delhi, India, Fifth Edition. (ISBN: 9788193293201).

Web Links:

1. <https://www.pavementinteractive.org/>
2. <https://www.eng.auburn.edu/research/centers/ncat/research/other-publications.html>
3. <https://nptel.ac.in/courses/105/106/105106203/>

Docks & Harbour Engineering

Course Code:241CE047

L T P C
3 0 0 3

Course Outcomes:

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

- CO1:** Introduce history and classifications of harbors
- CO2:** Explain the fundamentals of Harbor planning
- CO3:** Explain the natural forces affecting ports and general design aspects of marine structures
- CO4:** Describe various navigational aids and dock & repair facilities
- CO5:** Describe maintenance and protection of port facilities

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2									
CO2	3	3	3			2				2	
CO3	1	1	3			2					
CO4	2	2						1		2	
CO5	1	1					1	2		2	

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	1	
CO2:	2	
CO3:	2	
CO4:	1	
CO5:	1	

UNIT – I

Harbor Planning:

Types of water transportation, water transportation in India, requirements of ports and harbors, classification of harbors, selection of site and planning of harbors, location of harbor, traffic estimation, master plan, ship characteristics, harbor design, turning basin, harbor entrances, type of docks, its location and number, Site investigations – hydrographic survey,

topographic survey, soil investigations, current observations, tidal observations.

UNIT – II

Harbor Works:

Design and construction of breakwaters, berthing structures - jetties, fenders, piers, wharves, dolphins, trestle, moles, navigational aids, requirements of signals, fixed navigation structures, the necessity of navigational aids, light houses, beacon lights, floating navigational aids, light ships, buoys, radar.

UNIT – III

Docks and Repair Facilities:

Harbor docks, use of wet docks, design of wet docks, repair docks, lift docks, dry docks, keel and bilge blocking, construction of dry docks, gates for dry docks, pumping plant, floating docks, slipways, locks, size of the lock, lock gates, types of gates.

UNIT – IV

Port facilities:

Port development, port planning, port building facilities, transit sheds, warehouses, cargo handling facilities, container handling terminal facilities, shipping terminals, inland port facilities.

UNIT – V

Dredging, Coastal Protection and Inland navigation:

Classification, types of dredgers, choice of dredger, uses of dredged materials, coastal erosion and protection, sea wall, revetment, bulkhead, coastal zone, and beach profile. Inland waterways, Inland water transportation in India, classification of waterways, the economics of inland waterways transportation, national waterways.

Text Books:

1. Dock and Tunnel Engineering, Srinivasan and S. C. Rangwala, Harbour, Charotar Pub House, Anan. (ISBN: 9788192869261).
2. Docks and Harbour Engineering, Bindra S.P. - Dhanpat Rai & Sons, New Delhi.(ISBN: 9788189928858).

Reference Books:

1. Transportation Engineering, Railways, Airports, Docks & Harbours, Srinivasa Kumar R, University Press, Hyderabad,2020. (ISBN: 9789389211160).
2. Port Design - Guidelines and recommendations, C. A. Thoresen, Tapir Publications,2018. (ISBN: 9788251908399).
3. Highway, Railway, Airport and Harbor Engineering, Subramanian K. P, Scitech Publications (India) Pvt Limited, Chennai. (ISBN:13-9788195330591).

Web Links:

1. <https://nptel.ac.in/courses/114106025>
2. <https://lecturenotes.in/s/1892-dock-harbour-and-airport-engineering/videos>

RAILWAY ENGINEERING

Course Code: 241CE054

L T P C
3 0 0 3

Course Outcomes:

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

- CO1:** Explain different components of railway track.
- CO2:** Design track gradients as per given requirements.
- CO3:** Discuss various types of tracks turnouts and crossings.
- CO4:** Explain interlocking and signaling systems.
- CO5:** Describe railway stations, site selection, classifications, facilities and yards.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1									
CO2	2	2	3								
CO3		2	3			1					
CO4		1	3			2					
CO5	1					2					

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	2	
CO2:	2	
CO3:	1	
CO4:	2	
CO5:	1	

UNIT – I

Components of Railway Engineering:

Permanent way components – Railway Track Gauge - Cross Section of Permanent Way - Functions of various Components like Rails, Sleepers and Ballast –Rail Fastenings – Creep of Rails- Theories related to Creep – Adzing of Sleepers- Sleeper density – Rail joints.

UNIT – II

Geometric Design of Railway Track:

Alignment – Engineering Surveys - Gradients- Grade Compensation- Cant and Negative Super elevation- Cant Deficiency – Degree of Curve – safe speed on curves – Transition curve – Compound curves.

UNIT – III

Turnouts & Controllers:

Track layouts – Switches – Design of Tongue Rails – Crossings – Turnouts – Layout of Turnout – Double Turnout – Diamond crossing – Scissors crossing – Inspection and maintenance of Points and Crossings.

UNIT – IV

Signalling and Interlocking:

Objectives of Signalling - Classification of Signals – Fixed Signals - Stop Signals Signalling Systems – Mechanical Signalling System - Electrical Signalling System - Systems for Controlling Train Movement – Interlocking - Modern Signalling Installations.

UNIT – V

Railway Stations and Yards:

Purpose of a Railway Station - Selection of Site for a Railway Station - Facilities Required at Railway Stations – Requirements of a Passenger Station Yard - Classification of Railway Stations - Station Platforms - Types of Yards.

Text Books:

1. Railway Engineering, Satish Chandra and M.M. Agrawal, Oxford University Press, New Delhi, 2020. (ISBN: 9780195687798).
2. Railway Engineering, Rangwala, Charotar Publishing House. (ISBN: 9788177643260).

Reference Books:

1. Roads, Railways, Bridges & Tunnel Engineering, T.D.Ahuja & G.S.Birdie. (ISBN: 9788189401337).
2. Transportation Engineering, Railways, Airports, Docks & Harbours, Srinivasa Kumar R, University Press, Hyderabad, 2020 (ISBN: 9789389211160).

Web Links:

1. <https://nptel.ac.in/courses/105/107/105107123/>
2. <http://www.nptelvideos.in/2012/11/transportation-engineering-ii.html>
3. <https://lecturenotes.in/subject/458>

Road Safety Analysis

Course Code:241CE055

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Analyze the effect of user, roadway, and environment characteristics on traffic
- CO2:** Plan and design of road safety improvement programs.
- CO3:** Analyze accident data and suggest safety measures.
- CO4:** Conduct road safety audit.
- CO5:** Build knowledge on accident mitigation measures

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	2	2	2	1					
CO2	3	2	3	2	1	2					
CO3	2	3	2	2	1	1					
CO4	2	3	1	1	1	3					
CO5	2	1	1	1		1					

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	2	
CO2:	3	
CO3:	2	
CO4:	1	
CO5:	1	

UNIT – I

Introduction of Road Safety:

Road accidents, Trends, Global and Indian level, Crash Causation, Collision diagrams; Highway safety; Human factors and road user limitations; Speed and its effect on road safety;

Vehicle factors; Highway safety in India.

UNIT – II

Statistical Analysis of Crash Data:

Before-after methods in crash analysis, Recording of crash data; Accident Investigation and Analysis; Statistical testing and the role of chance; Black Spot Identification and Investigations, Hot spot analysis, Case Studies.

UNIT – III

Road Safety Management System:

Multi-causal dynamic systems approach to safety; Crash Vs. Accident; Road safety improvement strategies; Elements of a road safety plan, Speed management, Safety data Needs; Intersection Safety, Safe vehicle design.

UNIT – IV

Road Safety Audits:

Key elements of a road safety audit, Road Safety Audits & Investigations, Work zone safety audit; Crash investigation and analysis, Methods for identifying hazardous road locations, Case Studies.

UNIT – V

Mitigation Measures:

Accident prevention by better planning, Accident prevention by better design of roads, Crash Countermeasures, Highway operation and accident control measures, Highway Safety Measures during construction, Highway geometry.

Text Books:

1. Observational Before-After Studies in Road Safety, Ezra Hauer, Pergamon Press. (ISBN: 9780080423931).
2. Traffic Safety, Leonard Evans, Science Serving Society. (ISBN: 9780945964235).

Reference Books:

1. The Handbook of Road Safety Measures, Rune Elvik, Truls Vaa, Alena Hoye, Michael Sorensen, Emerald Group Publishing. Second Edition. (ISBN: 9781849502544).
2. The Traffic Safety Toolbox: A Primer on Traffic Safety, ITE. (ISBN:

- 9780934066918).
3. Traffic Accident Reconstruction, Lynn B. Fricke, Northwestern University Center for Public Safety. (ISBN: 9780912642031).

Web Links:

1. <http://tripp.iitd.ernet.in/publication/report>
[https://atpio.org/webinar-on-addressing-road-safety-worldwide-vulnerable-road-](https://atpio.org/webinar-on-addressing-road-safety-worldwide-vulnerable-road-users-human-factors-rs-in-lmic/)
2. [users-human-factors-rs-in-lmic/](https://atpio.org/webinar-on-addressing-road-safety-worldwide-vulnerable-road-users-human-factors-rs-in-lmic/)
3. <https://ebrdelearning.com/course>

Highway Construction & Practices

Course Code:241CE048

L T P C
3 0 0 3

Course Outcomes:

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

- CO1:** Explain various construction techniques of subgrade.
- CO2:** Explain construction techniques of unbound and bound granular layer.
- CO3:** Illustrate the functions and operations of various asphalt plant types.
- CO4:** Prepare for paving operations including new construction and overlay.
- CO5:** Understand and manage the processes involved in concrete production for pavement construction.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	1	2	1	2					
CO2	2	2	2	2	1	2					
CO3	2	2	1	2	1	2					
CO4	2	3	2	3	1	2					
CO5	3	3	3	2	1	2					

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:		2
CO2:		2
CO3:		2
CO4:		1
CO5:		1

UNIT – I

Construction of Subgrade:

Earthwork grading; compaction and construction of embankments; types of subgrade material, factors affecting strength gain; compaction requirement for subgrade; subgrade stabilization: preparation, compaction equipment.

UNIT – II

Construction of Unbound and Bound Granular Layers:

Gradation and material quality requirement for granular subbase and base layers, blending and proportioning, compaction requirements; field quality control; stabilized subbase and base layers: mix design, placing, laying and compaction requirements.

UNIT – III

Asphalt Plant Operations, Transport, and Delivery:

Asphalt plant functions; batch, drum, and continuous mix plants; emission controls; mix storage; asphalt mix transport: planning, haul trucks, addressing segregation, material transfer vehicle, visual inspection of the mix, and trouble shooting.

UNIT – IV

Asphalt Paving Operation:

Preparing for paving: new construction/overlay, prime coat, tack coats: recommended applications, distribution, verifying the application rates; asphalt pavers and compaction; screed operations and control; joints; compaction mechanics; cold weather paving.

UNIT – V

Construction of Concrete Pavements:

Concrete production; preparation of subgrade and base; reinforcement presetting for JPCP and CRCP; establishing string line; PCC slab constructions: slip form paving, fixed form paving; curing process.

Text Books:

1. Bituminous Road Construction in India, Kandhal, P.S., PHI Learning Pvt. Ltd, First Edition. (ISBN: 9788120335714).
2. Specifications for Road and Bridge Works, Ministry of Road Transport and Highways, Indian Roads Congress, New Delhi, India, Fifth Edition. (ISBN: 9788185730697).

Reference Books:

1. Concrete Pavement Design, Construction and Performance, Norbert, J.D., CRC Press, Second Edition. (ISBN: 9781466589240).
2. Construction of Quality Asphalt Pavements, MS-22, Asphalt Institute, 2020, Third Edition. (ISBN: 9781556893682).

Web Links:

1. <https://pavementinteractive.org/referencedesk/construction/sitepreparation/subgrade-preparation-for-new-pavements/>
2. https://www.virginiadot.org/vtrc/main/online_reports/pdf/15-r6.pdf

Pavement Management System

Course Code:241CE052

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Identify and select suitable database strategies for a given pavement.
- CO2:** Determine the pavement condition using functional and structural methods.
- CO3:** Decide the type and timing of maintenance required for given pavement.
- CO4:** Apply ranking methods, benefit-cost ratio analysis, and mathematical optimization techniques
- CO5:** Estimate the life cycle cost of pavements and implementation strategies.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	3	2	2	1	2	2	2	2		
CO2	3	3	1					2	2		
CO3	3	3	3	3		2	2	2	2		
CO4	3	3	3	2		2	2	2	2		
CO5	2	1	1	1							

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:		3
CO2:		2
CO3:		2
CO4:		2
CO5:		1

UNIT – I

Introduction to PMS:

Historical perspectives of PMS, Evolution of PMS concepts, basic components of PMS, Network and Project levels of PMS, data needs, GIS applications, database design, inventory and monitoring databases, planning pavement investments process and benefits of pavement management.

UNIT – II

Pavement Performance Models:

General concepts, pavement evaluation with respect to user cost, pavement evaluation technologies, techniques for developing prediction models deterministic, probabilistic, expert system of PMS models; remaining service life, AASHO, CRRI, and HDM models, deterioration concepts and modeling, priority programming methods.

UNIT – III

Design Alternatives:

Design alternatives, evaluation, and selection, a framework for pavement design, design objectives and constraints, generating alternative pavement design strategies, economic evaluation methods, economic evaluation of alternative pavement design strategies, and selecting optimal design strategies.

UNIT – IV

Pavement Prioritization Techniques:

General concepts, ranking methods and procedures, prioritization based on benefit-cost ratio, mathematical optimization for prioritization of M, R&R Work Programs, Markov and heuristic approaches.

UNIT – V

Pavement management systems:

Artificial Neural Network techniques for M, R&R Work programs, pavement life cycle cost analysis, implementation of PMS, operational issues, system complexity, feedback, other institutional issues, and PMS case studies.

Text Books:

1. Pavement Management for Airports, Roads and Parking Lots, Shahin, M.Y., Chapman & Hall, New York. (ISBN: 9780412989310).
Modern Pavement Management, Haas, R., W. R., Hudson, and J. P. Zaniewski.
2. Modern Pavement Management. Krieger Publishing Company. Malabar, Florida. (ISBN:9780894646920)

Reference Books:

1. Infrastructure Management: Integrating Design, Construction, Maintenance, Rehabilitation, and Renovation. Hudson, W. R., R. Haas, and W. Uddin., McGraw Hill. New York. (ISBN: 9780070308955).
2. Southeast Michigan Council of Governments. Pavement Management System, SEMCOG. (ISBN: 9780970308955).
3. Transportation Association of Canada. Pavement Design and Management Guide. Transportation Association of Canada, Ottawa, 1997. (ISBN:9781551871141).

Web Links:

1. <https://www.youtube.com/watch?v=IDv67Eppaos>
2. <https://ocw.mit.edu/courses/civil-and-environmental-engineering/>
3. <http://www.trb.org/Publications/PubsNCHRPPProjectReportsAll.aspx>

Pavement Drainage System

Course Code:241CE051

L T P C
3 0 0 3

Course Outcomes:

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

CO1:	Assess the impact of water on pavement performance.
CO2:	Judge requirement of different cross drainage structures.
CO3:	Design surface drainage system.
CO4:	Evaluate the performance of pavement concerning sub-surface drainage methods.
CO5:	Plan sustainable drainage systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	1	2	3	2					
CO2	3	2	2	3	2	2					
CO3	3	2	2	3	3	2					
CO4	3	2	2	3	3	1					
CO5	3	2	2	3	2	2					

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	2	
CO2:	2	
CO3:	3	
CO4:	2	
CO5:	2	

UNIT – I

Pavement Drainage Structures:

Pavement types, relevant pavement materials, source and role of water, factors affecting the flow of water, hydraulic conductivity, estimation of surface runoff, typical drainage in Pavements.

UNIT – I

Cross Drainage Works:

The necessity of culverts, planning of culverts and effective drainage, types and size of culverts, ditches, side drains design considerations, common culverts problems, and solution, disposal of drainage water and maintenance of drainage system.

UNIT – III

Surface Drainage:

General, the effect of standing water on pavement performance, factors affecting the surface drainage, geometric features of pavement, maintenance of side drains, medians, culverts, the hydrological requirement of roadside drains, factors affecting runoff, and design methodologies.

UNIT – IV

Subsurface Drainage:

Permeable bases stabilized and unstabilized bases, aggregate layers, geotextiles separate layers, longitudinal drains, filter design, geocomposite design and capillary barrier drain, determination of pavement permeability, and framework for drainage systems under new concrete pavements.

UNIT – V

Sustainable Drainage:

Porous asphalt pavement design, construction, and maintenance; design of porous concrete; design of permeable interlocking concrete pavements, construction and maintenance; sustainable urban drainage systems, and applicability of specific SUDS structures.

Text Books:

1. Pavement Drainage; Theory and Practice, Sivakumar Babu G.L., Prithvi S. Kandhal, CRC Press, New Delhi, India. (ISBN: 9780367148191).
2. Principles of Pavement Design, Yoder, E.J., and Witczak, M.W., Wiley India Pvt. Ltd., New Delhi, India, Second Edition. (ISBN: 9788126530708).

Reference Books:

1. Design of Road Drainage System: A Design Reference Book, S .N. Sachdeva, 2018. (ISBN: 9789386173675).
2. An Introduction to the Principles of Pavement Drainage, J. Paul Guyer, Independently Published. (ISBN: 9788126530708).
3. Highway Drainage Guidelines, American Association of State Highway Official (AASHTO), Fourth Edition. (ISBN:978-1-56051-292-9).

Web Links:

1. <https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4986>
2. <https://freevideolectures.com/course/3352/geosynthetics-engineering-in-theory-and-practice/21>

Airport Planning & Design

Course Code:241CE046

L T P C
3 0 0 3

Course Outcomes:

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

- CO1:** Explain fundamental principles and concepts of Airport planning and design.
- CO2:** Design the airport runway and airport capacity.
- CO3:** Design airport pavement systems for various loading and conditions.
- CO4:** Analyze air travel demands.
- CO5:** Apply knowledge of air traffic controls.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1										
CO2	2	2	3			2	1				
CO3	3	2	3			2	1				
CO4	2	3				2					
CO5	2					2					

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	2	
CO2:	3	
CO3:	2	
CO4:	2	
CO5:	1	

UNIT – I

Airport Planning and Obstructions:

Growth of Air Transport, Technological Developments, Institutional Development for Planning, Aircraft characteristics related to airport planning and design, Future trends in Aircraft design and Airport Planning; Airport master plan, site selection, planning surveys. Airport Obstructions: Zoning Laws, Classification, Approach and Turning Zones.

UNIT – II

Runway and Taxiway Design:

Runway design: Runway Orientation, Wind rose diagram, Basic Runway Length and Factors affecting, Correction for elevation, temperature, and gradient as per ICAO and FAA, Runway Geometric Design, and Airport Classification. Taxiway Design: Factors, Geometric design standards, Exit Taxiways, Fillets, Separation clearance, Holding apron, Turn around.

UNIT – III

Design of Airport Pavements:

Design factors, Design methods for flexible Pavements and Rigid pavements, LCN Systems of pavement design, Joints in cement concrete pavements, Special consideration for design of pavement facilities, for V/STOL operations.

UNIT – IV

Air Traffic Controls (ATC):

Visual Aids: Marking and lighting; Need, Network and Aids for ATC, Radio equipment; Design of Heliports and STOLPORTS: Design Factors, Planning, Site selection. Geometric Designs, Visual Aids.

UNIT – V

Airport maintenance and Drainage:

Need for Maintenance, Airfield pavement failures, Maintenance and Rehabilitation of airfield pavement, Evaluation and Strengthening of airfield pavement, Airport drainage, Design data, Surface and Subsurface drainage, Special Characteristics, and requirements of airport drainage.

Text Books:

- Planning and Design of Airports, Horonjeff, R., McKelvey, F.X., Sproule, W.J., and
1. Young, S.B., McGraw-Hill, New York, USA, Fifth Edition. (ISBN: 9780071446410).
 2. Subramanian K.P., Highways, Railways, Airport and Harbour Engineering, Scitech Publications (India), Chennai. (ISBN: 9788183710843).

Reference Books:

1. Airport Planning and Design, Khanna, S.K., Arora, M.G., and Jain, S.S.; Nem Chand and Bros, Roorkee, India, Sixth Edition. (ISBN: 9788185790377).
2. Air Transportation Planning and Design; Kumar, V., and Chandra, S.; Galgotia Publications Pvt. Ltd., New Delhi, India. (ISBN: 9788175153880).

Web Links:

1. <https://archive.nptel.ac.in/courses/105/107/105107123/>
2. <https://drmcet.digimat.in/nptel/courses/video/105107123/L31.html>
<https://hits.digimat.in/nptel/courses/video/105107123/L30.html>
- 3.

Urban Transportation Planning

	L	T	P	C
Course Code: 241CE056	3	0	0	3

Course Outcomes:

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

- CO1:** Design, conduct and administer surveys to provide the data required for transportation planning.
- CO2:** Explain the process of data collection about travel behavior and analyze the data for use in transport planning
- CO3:** Develop and calibrate modal split, trip generation rates for specific types of land use developments
- CO4:** Apply the mode choice behaviour and mode split models.
- CO5:** Adopt the steps that are necessary to complete a long-term transportation plan.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	3			2	1				
CO2	2	2	1	1		2	1				
CO3	2		3			2	1				
CO4	2					2	2				
CO5	2					3	1				

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	2	
CO2:	2	
CO3:	2	
CO4:	1	
CO5:	1	

UNIT – I

Introduction:

Urbanization, urban class groups, transportation problems and identification, impacts of transportation, urban transport system planning process, modeling techniques in

planning. Urban mass transportation systems: urban transit problems, travel demand, types of transit systems.

UNIT – II

Data Collection:

Types and Sources of Data Trip generation models - Trip classification - productions and attractions – Trip rate analysis - Multiple regression models - Category analysis - Trip distribution models – Growth factor models.

UNIT – III

Trip Generation:

UTPS Approach, Trip Generation Analysis: Zonal Models, Category Analysis, Household Models, Trip Attraction models, Commercial Trip Rates; Trip Distribution by Growth Factor Methods. Problems on above.

UNIT – IV

Trip Distribution:

Gravity Models, Opportunity Models, Time Function Iteration Models. Travel demand modeling: gravity model, opportunity models, Desire line diagram. Modal split analysis. Problems on above.

UNIT – V

Traffic Assignment:

Land use transportation models – Urban forms and structures - Location models - Accessibility – Land use models - Lowry derivative models Diversion Curves; Basic Elements of Transport Networks, Coding, Route Properties, Path Building- Preparation of alternative plans - Evaluation technique.

Text Books:

1. Principles of Urban Transportation System Planning , Hutchinson B.G., McGraw Hill. (ISBN :13. 978-0070315396).
2. Introduction to Transportation Planning , J. Hutchinson, London. (ISBN: 13: 9780090986200).

Reference Books:

1. Transportation Engineering , Kent Lall, Prentice Hall of India (ISBN-13: 978-9332569706).
2. Transportation Engineering and Planning, C.S. Papacostas and P.D. Prevedouros, Prentice Hall of India Pvt. Ltd (ISBN-13:978-0130814197)
3. Highway Engineering, S.K. Khanna& C.E.G. Justo, Nemchand & Bros., 10th edition (ISBN-13:978-8185240930)

Web Links:

1. <http://nptel.ac.in/courses/105101087/29>
2. <https://novalynx.com/store/pc/What-Is-a-Wind-Rose-d55.htm>
3. <https://ircep.gov.in/>

Intelligent Transportation Systems

Course Code:241CE049

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Identify and differentiate ITS user services and their components.
- CO2:** Study the telecommunications in ITS.
- CO3:** Interpret ITS functional areas.
- CO4:** Implement suitable ITS and services for effective transportation.
- CO5:** Applications of Automated Highway Systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2			1						
CO2	3	2			1						
CO3	2	2	1	1	1						
CO4	2	2	1	1	1						
CO5	2	2	1	1	1						

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	1	
CO2:	1	
CO3:	1	
CO4:	1	
CO5:	1	

UNIT – I

Introduction:

Definition of ITS and Identification of ITS Objectives, Historical Background, Benefits of ITS - ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection.

UNIT – II

Telecommunications in ITS:

Importance of telecommunications in the ITS system, Information Management, Traffic Management Centers (TMC). Vehicle –

Roadside communication – Vehicle Positioning System.

UNIT – III

ITS functional areas:

Advanced Traffic Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS).

UNIT – IV

ITS User Needs and Services:

Travel and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management.

UNIT – V

Automated Highway Systems:

Vehicles in Platoons – Integration of Automated Highway Systems. ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries.

Text Books:

1. Fundamentals of Intelligent Transportation Systems Planning, M.A. Chowdhury and A. Sadek, Artech House, First Edition. (ISBN: 9781580534702).
2. Intelligent Transport Systems, Sarkar, Pradip Kumar, and Amit Kumar Jain, PHI Learning, 2018, First Edition. (ISBN: 9788120353001).

Reference Books:

1. Economic Impacts of Intelligent Transportation Systems: Innovations and Case Studies, Bekiaris and Y.J. Nakanishi, Elsevier/JAI. (ISBN: 9780762310320).
2. Intelligent Transport Systems Standards, Bob Williams, Artech House Publishers. (ISBN: 9781607839324)

3. Intelligent Transport Systems: Cases and Policies, Roger Stough, Edward Elgar. (ISBN:3. 978-1840644470).

Web Links:

1. https://www.civil.iitb.ac.in/tvm/nptel/591_ITS_1/web/web.html
2. https://www.civil.iitb.ac.in/tvm/nptel/592_ITS_2/web/web.html
3. <https://archive.nptel.ac.in/courses/105/101/105101008/>
<http://digital-library.theiet.org/content/journals/iet-its>
- 4.

Pavement Design & Evaluation

Course Code:241CE050

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Identify the pavement components and compare highway and airport pavements
- CO2:** Calculate the stresses and ESWL in flexible pavements.
- CO3:** Design the flexible pavement using empirical, semi empirical and IRC methods
- CO4:** Analyze the warping, friction, wheel load stress and calculate the combined stress.
- CO5:** Design rigid pavements by IRC method.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	3					3				
CO2	3	3		2			3		3		
CO3	3	3	3	3	2	3	3			3	
CO4	3	2		2			2				
CO5	3	3	3	3	2	3	3			3	

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	2	
CO2:	2	
CO3:	3	
CO4:	2	
CO5:	3	

UNIT – I

Introduction:

Pavement types and Components – Factors affecting Design and Performance of Pavements, Comparison between Highway and Airport pavements – Functions and Significance of Sub grade properties.

UNIT – II

Stresses in Flexible Pavements:

Stresses and Deflections in Homogeneous Masses – Burmister’s 2-layer, 3-layer Theories – Wheel Load Stresses, ESWL of Multiple Wheels, Repeated Loads and EWL factors.

UNIT – III

Flexible Pavement Design:

Empirical – Semi-empirical and Theoretical Approaches; Principles and procedure, Design, Advantages and applications of different Pavement Design Methods – IRC Method of Design.

UNIT – IV

Stresses in Rigid Pavements:

Types of Stresses and Causes – Factors influencing the Stresses, General conditions in Rigid Pavement Analysis, ESWL, Wheel Load Stresses, Warping Stresses, Friction Stresses, Combined Stresses.

UNIT – V

Rigid Pavement Design:

Types of Joints in Cement Concrete Pavements and their Functions, Joint Spacing, Design of Slab Thickness, Design of Joint Details for Longitudinal Joints, Contraction Joints and Expansion Joints, IRC Method of Design.

Text Books:

1. Pavement Analysis and Design, Yang H. Huang, Pearson Prentice Hall, Upper Saddle River, NJ. (ISBN: 9780134732212).
2. Principles of Pavement Engineering, Nick Thom, ICE Publishing, London. (ISBN: 9780727741832).

Reference Books:

1. Pavement Design and Materials, A. T. Papagiannakis and E. A. Masad, John Wiley & Sons, Hoboken, NJ. (ISBN: 9780471264411).
2. Highway Engineering, Paul H. Wright and Karen Dixon, John Wiley & Sons, Hoboken, NJ. (ISBN: 9780471476958).
Airport Engineering: Planning, Design, and Development of 21st Century Airports,
3. Norman J. Ashford, Saleh Mumayiz, and Paul H. Wright, John Wiley & Sons, Hoboken, NJ. (ISBN:978-0-470-39855-5).

Web Links:

1. https://www.fhwa.dot.gov/pavement/pub_details.cfm
2. <https://www.irc.nic.in/publication-main-page>.
3. <https://www.acpa.org/resources/>

Minor Stream: Integrated Design for Industrial Facilities Industry Integrated Program - L & T[#]

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241CE069	Building Information Modelling in Construction	FC			3	3	50	50	100	-
241CE067	Sustainability Practices in Design of Buildings	IC			3	3	50	50	100	-
241CE070	Formwork Engineering Practices	IC			2	2	50	50	100	-
241CE072	Design & Execution of Pile Foundations	IC			3	3	50	50	100	-
241CE061	Metro Rail Transportation Systems & Construction	IC			3	3	50	50	100	-
241CE071	Deep Excavations, Foundations & Tunnels	AC			3	3	50	50	100	-
241CE068	Bridge Engineering Design Practices	AC			3	3	50	50	100	-
241CE016	Geospatial Techniques in Practice	AC			3	3	50	50	100	-
241CE063	Pre Engineered Buildings	AC			3	3	50	50	100	-
241CE064	Precast Members & Construction	AC			3	3	50	50	100	-
241CE060	Hydropower Structures	AC			3	3	50	50	100	-
Total							32	32		