

# **SEMESTER 8**

## **CIVIL ENGINEERING**

## SEMESTER S8

### WATER AND AIR QUALITY MANAGEMENT

<b>Course Code</b>	<b>PECET861</b>	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3:0:0:0	<b>ESE Marks</b>	60
<b>Credits</b>	3	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	None	<b>Course Type</b>	Theory

#### Course Objectives:

1. To provide knowledge of aquatic ecology, water pollution, water quality standards, water quality assessment and its management
2. Students would get an insight into the dispersion of air pollution in the atmosphere, its sources, sampling techniques and control measures.

### SYLLABUS

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	Water quality: impurities (pollutants and contaminants) in water, their significance and estimation techniques; water borne diseases; standards of potable water. Impact of water pollutants on environment; self-purification of waste in streams; zones of purification; eutrophication; disposal standards	<b>7</b>
<b>2</b>	Water treatment: Aeration and types of aerators; purpose and mechanism of flocculation; coagulants used in water treatment; factors influencing coagulation; estimation of coagulant dose; types of flash mixers and flocculators; sedimentation; analysis of discrete and flocculent settling; sedimentation tanks; Filtration: types and design of filters, Disinfection: chemical and non-chemical methods	<b>9</b>
<b>3</b>	Water resources and quality management in India : Water availability; water stress index; status and trend of surface and groundwater; issues and policy	<b>9</b>

	interventions; pollution of rivers, lakes and ground water; GAP and National River Action Programme; role of national and international agencies in water health and sanitation.	
<b>4</b>	Air Pollution: Types, Sources, Effects on human health, vegetation, materials, global environmental issues. Air sampling and pollution measurement methods, principles and instruments, ambient air quality and emission standards, Air pollution indices, Air Act, legislation and regulations Control principles, Removal of gaseous pollutants by adsorption, absorption, reaction and other methods. Particulate emission control	<b>11</b>

### Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

### Continuous Internal Evaluation Marks (CIE):

<b>Attendance</b>	<b>Assignment/ Microproject</b>	<b>Internal Examination-1 (Written)</b>	<b>Internal Examination- 2 (Written )</b>	<b>Total</b>
<b>5</b>	<b>15</b>	<b>10</b>	<b>10</b>	<b>40</b>

### End Semester Examination Marks (ESE)

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

<b>Part A</b>	<b>Part B</b>	<b>Total</b>
<ul style="list-style-type: none"> <li>• 2 Questions from each module.</li> <li>• Total of 8 Questions, each carrying 3 marks</li> </ul> <p><b>(8x3 =24marks)</b></p>	<ul style="list-style-type: none"> <li>• Each question carries 9 marks.</li> <li>• Two questions will be given from each module, out of which 1 question should be answered.</li> <li>• Each question can have a maximum of 3 sub divisions.</li> </ul> <p><b>(4x9 = 36 marks)</b></p>	<b>60</b>

### Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
<b>CO1</b>	Gain insight into key concepts of water quality, water quality and health, impairment of natural water bodies	<b>K2</b>
<b>CO2</b>	Comprehend components of water treatment and schemes based on source of water, select suitable unit process and unit operation at conceptual, theoretical, methodical level	<b>K3</b>
<b>CO3</b>	Develop an integrated perspective on water resource and water quality management	<b>K3</b>
<b>CO4</b>	Design, operate and control the devices used for air quality management	<b>K3</b>

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

### CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3					2	2					
<b>CO2</b>	3					2	2					
<b>CO3</b>	3					2	1					
<b>CO4</b>	3					2	2					

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Water Supply and Sanitary Engineering	Birde G.S. and Birde J.S	7th ed., New Delhi, Dhanpat Rai Publishing	2004
2	Air pollution	M. N. Rao, H. V. N. Rao	Tata McGraw Hill Pvt. Ltd, New Delhi	1993
3	Basic Environmental Technology: Water Supply, Waste Management and Pollution Control	Nathanson J.A.	4th ed., New Delhi, PHI Learning	2009

Reference Texts				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Handbook Of Environment And Waste Management: Air And Water Pollution Control	Lawrence K Wang, Nazih K Shammaas, Yung-tse Hung	World Scientific Publishing Company	2012
2	Water and Air Effluents Treatment Handbook	NPCS Board of consultants and Engineers	ASIA PACIFIC BUSINESS PRESS Inc.	2009

Video Links (NPTEL, SWAYAM...)	
Sl. No.	Link ID
1	<a href="https://onlinecourses.nptel.ac.in/noc24_ag06/preview">https://onlinecourses.nptel.ac.in/noc24_ag06/preview</a>
2	<a href="https://archive.nptel.ac.in/courses/105/107/105107213/">https://archive.nptel.ac.in/courses/105/107/105107213/</a>

## SEMESTER S8

### VALUATION OF REAL PROPERTIES

<b>Course Code</b>	<b>PECET862</b>	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3:0:0:0	<b>ESE Marks</b>	60
<b>Credits</b>	3	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	PCCET601	<b>Course Type</b>	Theory

#### Course Objectives:

1. This course introduces the principles and methodologies involved in the valuation of real properties. It covers fundamental concepts in real estate appraisal, exploring various approaches to property valuation, market analysis, and regulatory considerations. Through theoretical discussions, case studies, and practical exercises, students will gain the skills and knowledge necessary to assess the value of different types of real estate.

### SYLLABUS

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	Role of valuer-Classification-Valuers' Functions & Responsibilities. Purpose-doctrine of estate-different form of value-factors affecting, aspects, characteristics. Supply and demand forces, factors affecting demand and supply-Cost, Price & Value Type of interest (right) in land-Free hold-Lease hold, Forms of lease, Mortgage Income, Outgoings-Type, sinking fund, Year's Purchase Numerical examples. Valuation table-use	<b>8</b>
<b>2</b>	Investment-Type-characteristics of ideal investment Appraisal technique – Net present value (NPV) by discounted cash flow method (DCF), Internal rate of return (IRR)-Numerical Example. Life of various types of buildings - Depreciation- Obsolescence-Functional & Economical -difference between depreciation and obsolescence Method of estimating cost depreciation-Numerical examples	<b>8</b>

<b>3</b>	<p>Building FSI – Plot coverage – Types of structure Method of Valuation for open land- Comparative method, Abstractive method, Belting method- Numerical examples</p> <p>Method of valuation of land with buildings- Rental method, direct comparison of the capital, Valuation based on profit- Numerical examples</p> <p>Valuation of apartment-FSI – Super built-up area, Undivided share of land</p> <p>Valuation for bank-Purposes – Security, Primary and collateral</p> <p>Report writing for various purposes of valuation-Sale, Purchase, Mortgage, Taxation, Insurance, Liquidation etc</p>	<b>10</b>
<b>4</b>	<p>Environment &amp; Valuation- Environmental factors affecting valuation</p> <p>Professional ethics- Model Code of Conduct as notified by MCA under the Companies (Registered valuers and valuation) Rules 2017 - Ethical considerations under terms of engagements</p> <p>Salient features of Real estate (regulation &amp; development) Act 2016, Transfer of property Act, Land acquisition, Indian easement Act,</p> <p>Estate Duty Act of 1953, Wealth Tax Act of 1957, Gift Tax Act of 1958, Income Tax Act of 1964, Rating Laws of 1866 (brief description only)</p> <p>Important case laws-Case study based on case laws</p> <p>CPWD Rates, Cost Index, Cost Inflation Index</p> <p>Valuation for Capital Gain Tax-Numerical examples</p>	<b>9</b>

### **Course Assessment Method**

**(CIE: 40 marks, ESE: 60 marks)**

#### **Continuous Internal Evaluation Marks (CIE):**

<b>Attendance</b>	<b>Assignment/ Microproject</b>	<b>Internal Examination-1 (Written)</b>	<b>Internal Examination- 2 (Written )</b>	<b>Total</b>
<b>5</b>	<b>15</b>	<b>10</b>	<b>10</b>	<b>40</b>

### End Semester Examination Marks (ESE)

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

Part A	Part B	Total
<ul style="list-style-type: none"><li>2 Questions from each module.</li><li>Total of 8 Questions, each carrying 3 marks</li></ul> <p>(8x3 =24marks)</p>	<ul style="list-style-type: none"><li>Each question carries 9 marks.</li><li>Two questions will be given from each module, out of which 1 question should be answered.</li><li>Each question can have a maximum of 3 sub divisions.</li></ul> <p>(4x9 = 36 marks)</p>	<b>60</b>

### Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Define the technical terms involved in valuation of Real properties	K2
CO2	Identify the return on investment on real properties	K3
CO3	Prepare valuation of land and buildings	K3
CO4	Recall the important aspects of Acts related to valuation	K1

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

### CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											
CO2	3											
CO3	3	2								2		
CO4								2				

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation



Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Valuation of real properties	Rangwala	Charotar Publishing House Pvt. Ltd.	2020
2	Basics in real estate valuation	P.T. Hardikar	P.T. Hardikar	2022
3	Estimation and costing in civil engineering	B. N. Dutta	UBS publishers	28 <sup>th</sup> Rev. Edition, 2020

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Real estate principles : A value approach	David Ling and Wayne Archer	McGraw-Hill Education	Fifth Edition, 2018
2	Fundamentals of real estate appraisal	R. Martha Williams & L. William Ventolo	Real Estate Education Co.	1998
3	Latest CPWD DAR and DSR			

Video Links	
Module No.	Link ID
2	<a href="http://www.onlinecourses.swayam2.ac.in/imb22_mg06/preview">www.onlinecourses.swayam2.ac.in/imb22_mg06/preview</a>

## SEMESTER S8

### CONTRACTS MANAGEMENT

<b>Course Code</b>	<b>PECET863</b>	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3:0:0:0	<b>ESE Marks</b>	60
<b>Credits</b>	3	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	PCCET601	<b>Course Type</b>	Theory

#### Course Objectives:

1. To provide students with a comprehensive understanding of the basic principles of contract law and their application in construction projects.
2. To ensure students can identify the essential elements required for the formation of a valid contract.

### SYLLABUS

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	Introduction to contract management-Definition & importance, Type of contracts (Lump sum, item rate, EPC, BOT etc..),  Agreement and contract  Indian Contract Act 1872 – Layout and Salient Features - Performance and Non-performance of Contract - Breach of Contract - Consequences and Remedies - Liquidated Damages, Extension of Time	<b>9</b>
<b>2</b>	Contract Documentation-Form of Agreement & Hierarchy of Terms and Conditions- Typical structure of contract- Preamble, Scope and Specifications- Preliminaries and General - Insurance policies, Bonds and Guarantees, Terms of Payment- Price adjustment- Assignments and Subcontracting	<b>9</b>

	Tendering and Bidding process-Prequalification, Invitation of tender, Bid preparation and submission, Evaluation of bid and award of contract, Negotiation.	
<b>3</b>	Standard Forms of Contracts - FIDIC form of Contract.  Performance Bond - Programme of Work – Submissions and approvals - Progress Review Meetings - Certification and Interim Payments - Quality and Safety - Variation clauses and changes to the scope of work - Claims - Delay and disruption - Force majeure and Exceptional events - Suspension & Termination - Taking over and Substantial completion - Release of Performance Bond/Security - Defect Liability and Release of Retention Money - Contract closure and Final	<b>10</b>
<b>4</b>	Conflicts, Disputes, and their causes - Conflict avoidance and tiered dispute resolution clauses - Alternative Dispute Resolution Methods & Litigation - Best practices in dispute resolution and management - General Provisions - Arbitration Agreement, Composition of Arbitral Tribunal	<b>8</b>

### **Course Assessment Method**

**(CIE: 40 marks, ESE: 60 marks)**

#### **Continuous Internal Evaluation Marks (CIE):**

<b>Attendance</b>	<b>Assignment/ Microproject</b>	<b>Internal Examination-1 (Written)</b>	<b>Internal Examination- 2 (Written )</b>	<b>Total</b>
<b>5</b>	<b>15</b>	<b>10</b>	<b>10</b>	<b>40</b>

### End Semester Examination Marks (ESE)

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

Part A	Part B	Total
<ul style="list-style-type: none"><li>2 Questions from each module.</li><li>Total of 8 Questions, each carrying 3 marks</li></ul> <p>(8x3 =24marks)</p>	<ul style="list-style-type: none"><li>Each question carries 9 marks.</li><li>Two questions will be given from each module, out of which 1 question should be answered.</li><li>Each question can have a maximum of 3 sub divisions.</li></ul> <p>(4x9 = 36 marks)</p>	<b>60</b>

### Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe the basic elements of conditions of contract.	K2
CO2	Recall provisions of Indian contract law & FIDIC	K1
CO3	Explain the various steps involved in the contract documentation	K3
CO4	Explain the process of dispute resolution in contracts	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

### CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			2								3	
CO2			2								3	
CO3			2							3		
CO4			2								3	

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

<b>Text Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
1	Law of contract and specific relief	A. Md. Samiulla	Asia Law House	2016
2	Construction project management	K.K.Chitkara	McGraw Hill Education	2010

<b>Reference Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
1	Indian Contract Act (1872)			
2	FIDIC Contracts: Law and Practice	Ellis Baker, Ben Mellors , Scott Chalmers , Anthony Lavers	Informa Law from Routledge	2009
3	Construction contract: Law and Management	John Murdoch , Ronan Champion , Will Hughes	Routledge	5th edition , 2015

<b>Video Links (NPTEL, SWAYAM...)</b>	
<b>Module No.</b>	<b>Link ID</b>
<b>1, 2</b>	NPTEL :: Law - NOC:Advanced Contracts, Tendering and Public Procurement

**SEMESTER S8**  
**ADVANCED DESIGN OF STEEL STRUCTURES**

<b>Course Code</b>	<b>PECET864</b>	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3-0-0-0	<b>ESE Marks</b>	60
<b>Credits</b>	3	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	PCCET602	<b>Course Type</b>	Theory

**Course Objectives:**

1. The proposed course is expected to enhance and strengthen the knowledge on detailed design methods for steel structures, in compliance with Indian codes

**SYLLABUS**

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	Types of bolts–Bearing and High strength bolts–Prying Force–Beam to Column connections–Design of seat angle–Unstiffened–Design of seat angle–Stiffened web angle & end plate connections, Beam and column bolted splices–Design of framed beam connection–continuous beam to beam connection	<b>9</b>
<b>2</b>	Structure and properties of weld metal. Beam to-column connections– Stiffened beam seat connection–Web angle and end plate connections– - Tubular Connections–Parameters of an in-plane joint - Welds in tubular joints–curved weld length at intersection of tubes	<b>9</b>
<b>3</b>	Design of plate girders subjected to uniformly distributed loads – design of stiffeners	<b>9</b>

	Design of gantry girders–Introduction–Loading consideration–Selection of gantry girder–Position of moving load for maximum effects, profile of gantry girder, limitation on vertical deflection–Design of gantry girders.	
<b>4</b>	Design of Light Gauge Structures: Design of light gauge steel structures:  Introduction–Types of cross sections–Materials–Local and post buckling of thin elements–Stiffened and multiple stiffened compression elements–Tension members– Beams and deflection of beams–Combined stresses and connections	<b>9</b>

### Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

#### Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written )	Total
<b>5</b>	<b>15</b>	<b>10</b>	<b>10</b>	<b>40</b>

#### End Semester Examination Marks (ESE)

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

Part A	Part B	Total
<ul style="list-style-type: none"> <li>2 Questions from each module.</li> <li>Total of 8 Questions, each carrying 3 marks</li> </ul> <p><b>(8x3 =24marks)</b></p>	<ul style="list-style-type: none"> <li>Each question carries 9 marks.</li> <li>Two questions will be given from each module, out of which 1 question should be answered.</li> <li>Each question can have a maximum of 3 sub divisions.</li> </ul> <p><b>(4x9 = 36 marks)</b></p>	<b>60</b>

### Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
<b>CO1</b>	Explain the behaviour and properties of structural steel members to resist various structural forces and actions and apply the relevant codes of practice	<b>K2, K4</b>
<b>CO2</b>	Analyse the behaviour of structural steel members and undertake design at both serviceability and ultimate limit states	<b>K3, K4</b>
<b>CO3</b>	Apply a diverse knowledge of design of steel engineering practices applied to real life problems.	<b>K2, K3</b>
<b>CO4</b>	Analyse and design cold formed steel members	<b>K3</b>

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

### CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	-	-	-	-	-	-	-	-	-	-	-
<b>CO2</b>	2	3	2	-	-	-	-	-	-	-	-	-
<b>CO3</b>	2	3	2	-	-	-	-	-	-	-	-	-
<b>CO4</b>	2	3	3	-	-	-	-	-	-	-	-	-
<b>CO5</b>	2	3	3	-	-	-	-	-	-	-	-	-

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation



<b>Text Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
1	Steel structures: Design and Practice	N Subramanian	Oxford Publication	
2	Design of Steel structures	Duggal S.K.	Tata McGraw-Hill	
3	Design of Steel structures	A. S. Arya, J.L. Ajmani and Awadesh Kumar	Nem Chand and Bros	
4	Cold-Formed Steel Structures	Wie-Wen Yu	McGraw Hill Book Company	

<b>Reference Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
1	Steel design	William T Segui	Cenage Learning	
2	Design of Steel Structures- Vol I and Vol II	Ramachandra S. and Virendra Gehlot	Standard Book House	
3	IS 800-2007, Code of practice for structural steel design		BIS	

<b>Sl. No.</b>	<b>Link ID</b>
<b>1</b>	<a href="https://archive.nptel.ac.in/courses/114/106/114106047/">https://archive.nptel.ac.in/courses/114/106/114106047/</a>
<b>2</b>	<a href="https://archive.nptel.ac.in/courses/105/105/105105162/">https://archive.nptel.ac.in/courses/105/105/105105162/</a>

## SEMESTER S8

### URBAN TRANSPORTATION PLANNING

<b>Course Code</b>	<b>PECET866</b>	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3-0-0-0	<b>ESE Marks</b>	60
<b>Credits</b>	3	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	None/ (Course code)	<b>Course Type</b>	Theory

#### Course Objectives:

1. The course aims to introduce to the students the concept of transportation planning and impart in-depth knowledge on the four stage planning process and to highlight the need for sustainable transportation

### SYLLABUS

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	<b>Need for transportation planning-</b> Characteristics of urban travel, Transportation issues and challenges, Detrimental effects of traffic on environment. <b>Urban Structure-</b> types and properties -centripetal, grid, linear, directional, Movement and Accessibility – Hierarchy of transportation facilities. <b>Demand analysis in transportation planning</b> , Modelling based on consumer behavior of travel choices, Basic principles of travel demand analysis and assumptions.	<b>9</b>
<b>2</b>	<b>Transportation planning process</b> -Systems approach, Elements/stages of transportation planning process - Goal, objectives and constraints, Trip-based and Activity-based approaches for transportation planning. <b>Data collection</b> – Definition of study area, zoning- selection of cordon, Sampling techniques and sample size, Sources of data and types of surveys for planning, <b>Trip Generation-</b>	<b>9</b>

	Factors influencing trip generation, methods of forecasting trip generation rates- expansion factor, linear regression, category analysis.	
<b>3</b>	<b>Trip Distribution-</b> Growth factor methods, Synthetic methods- Gravity models, opportunity model. <b>Modal Split-</b> Factors influencing modal split, Types of mode split models – trip end, trip interchange, logit model.  <b>Traffic assignment-</b> Purpose, Elements of transportation networks- Nodes and links, Methods for traffic assignment	<b>9</b>
<b>4</b>	<b>Transportation and land use -</b> Role of urban activity analysis in transportation planning, Transportation impacts on activity system, Land use transportation interaction.  <b>Land use models-</b> Selection of land use model, Lowry model-Structure, features, Model equation system. <b>Sustainable transportation-</b> features, facilities, Transit oriented development, Non transport solutions to transport problems, Transportation demand management, Quick response techniques for demand estimation. <b>Comprehensive Mobility Plan-</b> objectives and activities involved, Application of GIS in transport planning	<b>9</b>

### Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

#### Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written )	Total
<b>5</b>	<b>15</b>	<b>10</b>	<b>10</b>	<b>40</b>

### End Semester Examination Marks (ESE)

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

Part A	Part B	Total
<ul style="list-style-type: none"><li>• 2 Questions from each module.</li><li>• Total of 8 Questions, each carrying 3 marks</li></ul> <p>(8x3 =24marks)</p>	<ul style="list-style-type: none"><li>• Each question carries 9 marks.</li><li>• Two questions will be given from each module, out of which 1 question should be answered.</li><li>• Each question can have a maximum of 3 sub divisions.</li></ul> <p>(4x9 = 36 marks)</p>	<b>60</b>

### Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
<b>CO1</b>	Identify the need for transportation planning, the issues and challenges related totransportation and its interaction with urban structure and land use	<b>K3</b>
<b>CO2</b>	Apply the concept of travel demand and analyse its role in transportation planning and to apply the concept in systems approach to transportation planning process.	<b>K3, K4</b>
<b>CO3</b>	Apply the concept of delineation of study area, sampling of data, and data collection techniques for the four stage planning process and to analyse the techniques for predicting trip generation.	<b>K3, K4</b>
<b>CO4</b>	Apply and analyse the methods for predicting trip distribution, mode split and traffic assignment	<b>K3, K4</b>
<b>CO5</b>	Apply the land use transport models and to analyse the sustainable approaches to transportation planning and preparation of comprehensive mobility plan with application of GIS	<b>K3, K4</b>

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

**CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>		1	2	1		3	3	3				2
<b>CO2</b>		1	2	2		2		1				2
<b>CO3</b>	2	2	2	3	2	2		1				2
<b>CO4</b>	3	3	3	3	3	2		1				2
<b>CO5</b>	2	1	3	3	3	3	3	3		2	2	3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

<b>Text Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
1	Introduction to Transportation Planning	Bruton,M.J	Hutchinson of London	2021
2	Principles of Transportation Engineering	Chakraborty,P and Das,A	PHI Learning	2 <sup>nd</sup> Ed
3	Traffic Engineering and Transport Planning	Kadiyali, L.R	Khanna Publishers	8 <sup>th</sup> Ed
4	Highway Engineering,	Rogers M	Blackwell Science	

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Principles of Urban Transport Planning	chinson, B G	Tata McGrawHill	1974
2	Metropolitan Transportation Planning	Dickey, J. W	Tata McGrawHill	1975
3	Urban Transportation Planning a Decision Oriented Approach	Mayer, M.D and Miller, E. J ,	Tata McGrawHill	2 <sup>nd</sup> Ed
4	Transportation Engineering and Planning	Papacostas, C. S. and Prevedouros, P.D	Prentice Hall of India Pvt. Ltd.	2012, 3 <sup>rd</sup> Ed

Video Links (NPTEL, SWAYAM...)	
SL.No.	Link ID
1	<a href="https://archive.nptel.ac.in/courses/105/105/105105208/">https://archive.nptel.ac.in/courses/105/105/105105208/</a>

**SEMESTER S8**

**RURAL WATER SUPPLY AND ONSITE SANITATION**

**SYSTEMS**

<b>Course Code</b>	<b>PECET867</b>	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3:0:0:0	<b>ESE Marks</b>	60
<b>Credits</b>	3	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	PCCET503	<b>Course Type</b>	Theory

**Course Objectives:**

1. Understand key concepts and the importance of rural water supply and on-site sanitation systems
2. Explore the design, implementation, and sustainability of water supply systems in rural areas
3. Study various on-site sanitation technologies and their applications in rural settings.
4. Develop skills for planning, managing, and evaluating rural water and sanitation projects, considering socio-economic, cultural, and environmental factors.

**SYLLABUS**

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	<p><b>Introduction to Rural Water Supply and Sanitation</b></p> <p>Overview of Global Water and Sanitation Challenges, Global water crisis: statistics and trends, Importance of water and sanitation in rural development, Sustainable Development Goals (SDGs) related to water and sanitation. Principles of Rural Water Supply, Basic water supply concepts: sources, availability, and quality, Water demand estimation in rural communities, Water supply systems: gravity-fed, pumped, and rainwater harvesting</p>	<b>9</b>

<b>2</b>	<b>Design and Implementation of Rural Water Supply Systems</b> Water Source Development, Identifying and protecting water sources: surface water, groundwater, and rainwater, Water source contamination and protection strategies. Water Treatment and Distribution, Water treatment methods: filtration, disinfection, and safe storage, Distribution systems: pipelines, storage tanks, and standpipes, Operation and Maintenance strategies for rural water supply systems, Monitoring and evaluation of water supply services	<b>11</b>
<b>3</b>	<b>Introduction to On-Site Sanitation</b> Concepts of on-site sanitation: Importance of sanitation for public health and environment. Design and construction of basic on-site sanitation systems: pit latrines, septic tanks, and composting toilets. Advanced sanitation technologies: biogas digesters, eco-san toilets. Selecting appropriate sanitation systems based on local conditions. Waste Management and Resource Recovery: Faecal sludge management: collection, treatment, and disposal. Resource recovery from sanitation: composting and biogas generation.	<b>9</b>
<b>4</b>	<b>Planning and Management of Rural Water Supply and Sanitation Projects</b> Planning water supply and sanitation projects: needs for assessment and feasibility studies. Funding and financing options for rural water and sanitation projects. Stakeholder engagement and community participation. National and international policies on water and sanitation. Regulatory frameworks and standards for rural water and sanitation. Role of government, NGOs, and private sector in rural water and sanitation. Sustainability and Innovation in Water and Sanitation technology in rural areas.	<b>9</b>

**Course Assessment Method**

**(CIE: 40 marks, ESE: 60 marks)**

**Continuous Internal Evaluation Marks (CIE):**

<b>Attendance</b>	<b>Assignment/ Microproject</b>	<b>Internal Examination-1 (Written)</b>	<b>Internal Examination- 2 (Written )</b>	<b>Total</b>
<b>5</b>	<b>15</b>	<b>10</b>	<b>10</b>	<b>40</b>



### End Semester Examination Marks (ESE)

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

Part A	Part B	Total
<ul style="list-style-type: none"><li>• 2 Questions from each module.</li><li>• Total of 8 Questions, each carrying 3 marks</li></ul> <p>(8x3 =24marks)</p>	<ul style="list-style-type: none"><li>• Each question carries 9 marks.</li><li>• Two questions will be given from each module, out of which 1 question should be answered.</li><li>• Each question can have a maximum of 3 sub divisions.</li></ul> <p>(4x9 = 36 marks)</p>	<b>60</b>

### Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand global water and sanitation challenges, importance and principles of rural water supply systems	K2
CO2	learn to identify, protect, and treat water sources, manage distribution systems, and oversee the operation and maintenance of rural water supply services.	K3
CO3	design on-site sanitation systems, select appropriate technologies, and manage waste and resource recovery processes.	K3
CO4	plan and assess rural water and sanitation projects, explore funding, engage stakeholders, and apply policies and innovations for sustainable implementation.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

**CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	2	2	2	-		2	2					
<b>CO2</b>	3	3	2			2	2				1	
<b>CO3</b>	3	2	3			2	3				1	
<b>CO4</b>	3	3	2			3	3				3	

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

<b>Text Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
1	Rural water supply and sanitation	Sanjay Gupta	Vayu Education of India	First Edition 2012
2	Rural water supply and sanitation	Sharma J K	Ardent Publications	First Edition 2012

<b>Reference Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
1	Wastewater Engineering, Treatment and Reuse	Metcalf and Eddy	Tata McGrawhill publications	4 th Edition 2017
2	Sewage disposal and air pollution Engineering	S K Garg	Khanna publishers	43 rd edition
3	Manual of water supply and treatment, 3rd edition, CPHEEO, GOI, New delhi			

## SEMESTER S8

### DESIGN OF EARTHQUAKE RESISTANT STRUCTURES

<b>Course Code</b>	<b>PECET865</b>	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3:0:0:0	<b>ESE Marks</b>	60
<b>Credits</b>	5/3	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	PCCET303/ Equivalent	<b>Course Type</b>	Theory

#### Course Objectives:

1. Apply the basic seismic concepts and building code provisions to the seismic design of structures

### SYLLABUS

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	<p><b>Introduction</b> – Classification of dynamic loads – essential characteristics of a dynamic problem – methods of discretization– single degree of freedom systems – basic components of a dynamic system.</p> <p><b>Formulation of equation of motion</b> – Newton’s 2nd law and D’ Alembert’s principle generalized SDOF systems.</p> <p><b>Solution of the equation of motion</b> – undamped free vibration – damped free vibration- critically damped under damped and over damped SDOF systems, Logarithmic decrement. (Numerical examples expected, but not derivations)</p> <p><b>Response to harmonic loading</b> – steady state and transient states steady state amplitude, Dynamic magnification factor. (Numerical examples expected, but not derivations)</p>	<b>9</b>
<b>2</b>	<p><b>Base excited SDOF system</b> - formulation of equation of motion – Response of SDOF base excited systems;</p>	<b>9</b>

	<p><b>Response spectrum:</b> Concept of pseudo acceleration, velocity. Response spectra, Four-way logarithmic plot – DVA spectrum (concept only).</p> <p><b>Multi degree of freedom systems</b> – 2 DOF systems- Equation of motion- Normal modes of vibrations and natural frequencies, MDOF systems: shear building idealization and equation of motion - Natural frequencies and mode shapes, orthogonality of normal modes.</p> <p><b>Forced vibration analysis of MDOF Systems</b> – Modal expansion of response, Mode superposition method. (concept only)</p>	
3	<p><b>Elements of Earthquake Engineering:</b> Plate tectonics – faults, Earthquake magnitude and intensity, Focus and Epicentre, Energy release and seismic waves. Characteristics of Earthquake, Measurement of ground motion- Seismographs, Seismic zone mapping.</p> <p><b>Structural Systems for Seismic Resistance:</b> Lateral load resisting systems in RC and steel structures.</p> <p><b>Building Irregularities:</b> in elevation – plan – influence of structural classification- Concepts of seismic design- Centre of mass, centre of rigidity, torsional eccentricity</p> <p><b>Estimation of Seismic Demand on buildings:</b></p> <p><b>Seismic coefficient method</b> - Estimation of base shear and its distribution along height based on Equivalent static method using IS 1893 for multi storied buildings.</p>	9
4	<p><b>Response spectrum method(RSM):</b> concept, (Numerical problems in RSM not expected in exams)</p> <p><b>Ductility considerations in earthquake resistant design of buildings:</b> Ductility of R.C structures- significance. Factors influencing ductility.</p> <p>Ductile detailing provisions as per IS-13920 (2016)- for beams, columns, beam-column joints and shear walls.</p> <p>Evaluation of Earthquake proneness of building by preliminary inspection - Rapid Visual Screening Technique</p>	9

	NB: Assessment of RSM through submission of course project alone, which involves computer modelling of building, seismic analysis and design and submission of design drawings including ductile detailing provisions.	
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### **Course Assessment Method**

**(CIE: 40 marks, ESE: 60 marks)**

#### **Continuous Internal Evaluation Marks (CIE):**

<b>Attendance</b>	<b>Internal Ex</b>	<b>Evaluate</b>	<b>Analyse</b>	<b>Total</b>
<b>5</b>	<b>15</b>	<b>10</b>	<b>10</b>	<b>40</b>

#### **Criteria for Evaluation (Evaluate and Analyse): 20 marks**

##### **Assignment**

1. Identify any requirement for an earthquake resistant structure and complete its design.

##### **Criteria for evaluation:**

1. *Defining objectives (K4 - 4 points).*
2. *field data collection (K4 - 4 points)*
3. *Analysis of data (K5 - 4 points)*
4. *Verification with standard specification or rating (K5 - 4 points)*
5. *Final design (K4- 2 points, K5 – 2 points)*
  - a. *Summarizes findings and insights. (K4)*
  - b. *Reflects critical thinking and informed decision-making. (K5)*

##### **Scoring:**

1. *Accomplished (4 points): Exceptional analysis, clear implementation, and depth of understanding.*
2. *Competent (3 points): Solid performance with minor areas for improvement.*
3. *Developing (2 points): Adequate effort but lacks depth or clarity.*

4. Minimal (1 point): Incomplete or significantly flawed.

**End Semester Examination Marks (ESE):**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

Part A	Part B	Total
<ul style="list-style-type: none"><li>2 Questions from each module.</li><li>Total of 8 Questions, each carrying 3 marks</li></ul> <b>(8x3 =24marks)</b>	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. Each question carries 9 marks. <b>(4x9 = 36 marks)</b>	<b>60</b>

**Course Outcomes (COs)**

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply structural dynamics principles for seismic analysis of structures.	K3
CO2	Understand the principles of various lateral load resisting systems for building structures and apply the same to seismic design of structures.	K3
CO3	Estimate the seismic demand over structures	K3
CO4	Apply the principles of ductile detailing.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

**CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	3										2
<b>CO2</b>	3	3										2
<b>CO3</b>	3	3										2
<b>CO4</b>	3	3										2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

<b>Text Books</b>				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Dynamics of Structures- Theory and applications to earthquake engineering	Anil K. Chopra	Prentice Hall	2020
2	Earthquake resistant design of structures	Pankaj Agarwal and Manish Shrikhande	PHI New-Delhi	2017
3	Structural Dynamics	Mario Paz	CBS publishers	2004

<b>Reference Books</b>				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Dynamics of Structures	Clough R.W, J.Penzien	MC GrawHill International	
2	Seismic Design of RC and Masonry Buildings	T Paulay and M J N Priestley	Wiley Inter Science, 1	1992
3	IS 1893 (2016): Criteria for Earthquake Resistant Design of Structures - Part 1 : General Provisions and Buildings			
4	IS 13920 (2016) Ductile Design and Detailing of Reinforced Concrete Structures Subjected to Seismic Forces - Code of Practice			

<b>Video Links (NPTEL, SWAYAM...)</b>	
Sl. No.	Link ID
<b>1</b>	<a href="https://archive.nptel.ac.in/courses/105/101/105101004/">https://archive.nptel.ac.in/courses/105/101/105101004/</a>

**SEMESTER S8**  
**WASTE MANAGEMENT**

<b>Course Code</b>	<b>OECET831</b>	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3:0:0:0	<b>ESE Marks</b>	60
<b>Credits</b>	3	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	None	<b>Course Type</b>	Theory

**Course Objectives:**

1. To learn broader understandings on various aspects of solid waste management practiced in industries.
2. To learn recovery of products from solid waste to compost and biogas, incineration and energy recovery, hazardous waste management and treatment, and integrated waste management.

**SYLLABUS**

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	<b>INTRODUCTION TO SOLID WASTE MANAGEMENT:</b> Classification of solid wastes (source and type based), solid waste management (SWM), elements of SWM, ESSWM (environmentally sound solid waste management) and EST (environmentally sound technologies), factors affecting SWM, Indian scenario, progress in MSW (municipal solid waste) management in India. Indian and global scenario of e-waste	<b>9</b>
<b>2</b>	<b>WASTE GENERATION ASPECTS:</b> Waste stream assessment (WSA), waste generation and composition, waste characteristics (physical and chemical), health and environmental effects (public health and environmental) <b>COLLECTION, STORAGE, TRANSPORT AND DISPOSAL OF WASTES:</b> Waste Collection, Storage and Transport: Collection components, storage-containers/collection vehicles, collection operation, transfer station,	<b>9</b>



	waste collection system design, record keeping, control, inventory and monitoring, implementing collection and transfer system.	
<b>3</b>	<b>WASTE DISPOSAL:</b> key issues in waste disposal, disposal options and selection criteria, sanitary landfill, landfill gas emission, leachate formation, environmental effects of landfill, landfill operation issues, a case study. <b>HAZARDOUS WASTE MANAGEMENT AND TREATMENT:</b> Identification and classification of hazardous waste, hazardous waste treatment, pollution prevention and waste minimization, hazardous wastes management in India.	<b>9</b>
<b>4</b>	<b>WASTE PROCESSING TECHNIQUES &amp; SOURCE REDUCTION, PRODUCT RECOVERY &amp; RECYCLING:</b> Purpose of processing, mechanical volume and size reduction, component separation, drying and dewatering. Source Reduction, Product Recovery and Recycling: basics, purpose, implementation monitoring and evaluation of source reduction, significance of recycling, planning of a recycling programme, recycling programme elements, commonly recycled materials and processes, E-waste recycling, a case study.	<b>9</b>

### Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

### Continuous Internal Evaluation Marks (CIE):

<b>Attendance</b>	<b>Assignment/ Microproject</b>	<b>Internal Examination-1 (Written)</b>	<b>Internal Examination- 2 (Written )</b>	<b>Total</b>
<b>5</b>	<b>15</b>	<b>10</b>	<b>10</b>	<b>40</b>

### End Semester Examination Marks (ESE)

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

Part A	Part B	Total
<ul style="list-style-type: none"><li>• 2 Questions from each module.</li><li>• Total of 8 Questions, each carrying 3 marks</li></ul> <p>(8x3 =24marks)</p>	<ul style="list-style-type: none"><li>• Each question carries 9 marks.</li><li>• Two questions will be given from each module, out of which 1 question should be answered.</li><li>• Each question can have a maximum of 3 sub divisions.</li></ul> <p>(4x9 = 36 marks)</p>	<b>60</b>

### Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
<b>CO1</b>	Understand the basics of solid waste management towards sustainable development	<b>K2</b>
<b>CO2</b>	Understand technologies to process waste and dispose the same.	<b>K2</b>
<b>CO3</b>	Design working models to convert waste to energy	<b>K3</b>
<b>CO4</b>	Identify and classify hazardous waste and manage the hazard	<b>K2</b>

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

**CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3					3	3					2
<b>CO2</b>	3					3	3					2
<b>CO3</b>	3					3	3					2
<b>CO4</b>	3					3	3					2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

<b>Text Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
1	Integrated Solid Waste Management, Engineering Principles and Management Issues	Tchobaanoglous, G., Theisen, H., and Samuel A Vigil,	McGraw-Hill Publishers	2014
2	Waste Management	Bilitewski B., Hard He G., Marek K., Weissbach A., and Boeddicker H	Springer	1994
3	Waste Management Practices: Municipal, Hazardous and Industrial,	John Pichtel	CRC Press	2014, 2nd Edition
4	Solid Waste Engineering	Vesilind PA, Worrell W and Reinhart D	Brooks/Cole Thomson Learning Inc	2010, 2nd Edition
5	Thermo-chemical Processing of Biomass: Conversion into Fuels, Chemicals and Power	Robert C. Brown	John Wiley and Sons, USA	2019

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Integrated solid waste management: a life cycle inventory	White, F. R., Franke P. R., & Hindle M.	McDougall,P. John Wiley & Sons.	2001
2	Handbook of solid waste management and waste minimization technologies	Nicholas, P., & Cheremisinoff, P. D.	Imprint of Elsevier Science	2005
3	Environmental Engineering	Peavy, H.S, Rowe, D.R., and G. Tchobanoglous	,McGraw Hill Education	2017, 1st Indian Edition
4	Waste Management Practices,	John Pichtel	CRC Press, Taylor and Francis Group	2005.
5	Hazardous Waste Management	LaGrega, M.D.Buckingham,P.L. and Evans, J.C.	McGraw Hill International Editions, New York	2010
6	Solid Waste Management - Present and Future Challenges,	Jagbir Singh, Ramanathan, AL.	I.K. International publishing House Pvt.Ltd., India.	2019
7	Manual on Municipal Solid Waste Management	CPHEEO	Ministry of Urban Development, India	2016

<b>Video Links (NPTEL, SWAYAM...)</b>	
<b>Sl. No.</b>	<b>Link ID</b>
1	<a href="http://cpheeo.gov.in/cms/manual-on-municipal-solid-waste-management-2016.php">http://cpheeo.gov.in/cms/manual-on-municipal-solid-waste-management-2016.php</a>
2	<a href="https://nptel.ac.in/courses/105/103/105103205/">https://nptel.ac.in/courses/105/103/105103205/</a>
3	<a href="https://nptel.ac.in/courses/120/108/120108005/">https://nptel.ac.in/courses/120/108/120108005/</a>
4	<a href="https://nptel.ac.in/courses/105/106/105106056/">https://nptel.ac.in/courses/105/106/105106056/</a>
5	<a href="https://nptel.ac.in/courses/105/105/105105160">https://nptel.ac.in/courses/105/105/105105160</a>
6	<a href="https://nptel.ac.in/courses/103/107/103107125/">https://nptel.ac.in/courses/103/107/103107125/</a>
7	<a href="https://nptel.ac.in/courses/105103205">https://nptel.ac.in/courses/105103205</a>
8	<a href="https://www.youtube.com/watch?v=k0ktJRoRcOA">https://www.youtube.com/watch?v=k0ktJRoRcOA</a>
9	<a href="https://nptel.ac.in/courses/103/107/103107125/">https://nptel.ac.in/courses/103/107/103107125/</a>
10	<a href="https://onlinecourses.nptel.ac.in/noc22_ce76/preview">https://onlinecourses.nptel.ac.in/noc22_ce76/preview</a>
11	<a href="https://onlinecourses.swayam2.ac.in/cec20_ge13/preview">https://onlinecourses.swayam2.ac.in/cec20_ge13/preview</a>

**SEMESTER S8**

**RAINWATER HARVESTING**

<b>Course Code</b>	<b>OECET832</b>	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3:0:0:0	<b>ESE Marks</b>	60
<b>Credits</b>	3	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	None	<b>Course Type</b>	Theory

**Course Objectives:**

1. To familiarize the students with the important aspects of Rain water harvesting system.
2. To impart the knowledge about the various hydrologic phenomena and their relevance in the field of water conservation.

**SYLLABUS**

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	Introduction: Hydrologic cycle, Advantages of Rainwater, Factors affecting run off from catchment, Important points relating to water storage and recharging, Rainwater harvesting, Components of rain water harvesting, Catchment area, harvesting structures, soil moisture conservation, check dams, artificial recharge, farm ponds, percolation tanks.	<b>9</b>
<b>2</b>	Water harvesting: Principles, importance and issues, Water harvesting techniques – classification based on source, storage and use. Rain water harvesting methods, storing rain water for direct use, Recharging ground water aquifers from roof top runoff, Recharging ground water aquifers with runoff from ground areas, Modular Rain Water Harvesting System- Coarse mesh/leaf screen Gutter - Down spout/Conduit - First flushing device Filter- Sand Filter- Charcoal Water Filter	<b>9</b>
<b>3</b>	Recharging subsurface Aquifers: Methods of recharging subsurface aquifers- through recharge pit - recharge through abandoned hand pump - recharge through abandoned dug well/ open well - through recharge trench - recharge through shafts - recharge trench with bore	<b>9</b>

<b>4</b>	Artificial Recharge - Concept of artificial recharge of groundwater, recharge methods – basin - stream - channel, ditch and furrow, flooding and recharge well methods, recharge mounds and induced recharge.  Concepts of Watershed - need for watershed development in India, Planning of watershed management – Drainage - ,watershed management for rainwater harvesting,	<b>9</b>
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### Course Assessment Method

**(CIE: 40 marks, ESE: 60 marks)**

#### Continuous Internal Evaluation Marks (CIE):

<b>Attendance</b>	<b>Assignment/ Microproject</b>	<b>Internal Examination-1 (Written)</b>	<b>Internal Examination- 2 (Written )</b>	<b>Total</b>
<b>5</b>	<b>15</b>	<b>10</b>	<b>10</b>	<b>40</b>

#### End Semester Examination Marks (ESE)

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

<b>Part A</b>	<b>Part B</b>	<b>Total</b>
<ul style="list-style-type: none"> <li>• 2 Questions from each module.</li> <li>• Total of 8 Questions, each carrying 3 marks</li> </ul> <p><b>(8x3 =24marks)</b></p>	<ul style="list-style-type: none"> <li>• Each question carries 9 marks.</li> <li>• Two questions will be given from each module, out of which 1 question should be answered.</li> <li>• Each question can have a maximum of 3 sub divisions.</li> </ul> <p><b>(4x9 = 36 marks)</b></p>	<b>60</b>

### Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
<b>CO1</b>	Understand the different components of Rain water harvesting system	<b>K1</b>
<b>CO2</b>	Describe the concept of Artificial Recharge and methods for groundwater storage	<b>K3</b>
<b>CO3</b>	To study the watershed development and management with reference to Rain water harvesting system	<b>K3</b>

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

### CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3					1	1			1		
<b>CO2</b>	3					1	2			1		
<b>CO3</b>	3	1	2		1	2	1		1	1		1

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Groundwater Hydrology	Larry W. Mays, David Keith Todd	John Wiley & Sons,	2004
2	Groundwater and Wells	Edward E. Johnson S.I	Johnson Screens	2007



Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Traditional Rainwater Harvesting Structures	Joji V.S., Reshma Susan Jacob	Springer Nature Switzerland,	2023
2	Designing Rainwater Harvesting Systems Integrating Rainwater Into Building Systems	Celeste Allen Novak, Eddie Van Giesen, Kathy M. DeBusk	Wiley	2014
2	Rainwater Harvesting Techniques to augment Groundwater: Ministry of Water Resources			

## SEMESTER S8

### PUBLIC TRANSPORTATION SYSTEMS

<b>Course Code</b>	<b>OECET833</b>	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3-0-0-0	<b>ESE Marks</b>	60
<b>Credits</b>	3	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	None/ (Course code)	<b>Course Type</b>	Theory

#### Course Objectives:

1. To comprehend the Fundamental Concepts of Public Transit Systems
2. To Develop and Evaluate Transit Service and Operational Plans
3. To Plan and Analyze Transit Lines and Networks
4. To analyze performance and economic aspects of Transit Systems

### SYLLABUS

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	Basic Operating Elements of Public Transit, public transport travel characteristics, Transit travel characteristics: factors, spatial distribution, temporal variations, Passenger volume analysis and service capacity determination, Introduction to transit service planning, Operational planning process, Service and evaluation standards, Data requirements and collection, Frequency and Headway distributions, Scheduling of service and timetabling.	<b>9</b>
<b>2</b>	Transit Line Capacity: Elements and Computation, Systems approach to transit line capacity, Capacities of different modes, Level Service measures, Speed of Transit Service, Passenger demand: factors and elasticity. Stops and stopping regimes: Definitions and relationships, Practical and optimal values	<b>9</b>

	of stop spacing, Comparison of all-stop, skip-stop, zonal and express/local operations	
<b>3</b>	Transit Lines and Networks: Planning objectives, principles and considerations, Geometry of transit lines, Types of transit lines and their characteristics, Transfers in transit networks, Analysis of metro network geometric forms, Transit System Statistics, Route choice and assignment	<b>9</b>
<b>4</b>	Introduction to Network design and service design, Performance and Economic Measures: Revenues, costs and operating ratio, Transit Fares: Fare structure and Collection, Costing and cost allocation methods, Modern Approaches in Transit planning: Information System for Passengers, Application of ITS.	<b>9</b>

### Course Assessment Method

**(CIE: 40 marks, ESE: 60 marks)**

#### Continuous Internal Evaluation Marks (CIE):

<b>Attendance</b>	<b>Assignment/ Microproject</b>	<b>Internal Examination-1 (Written)</b>	<b>Internal Examination- 2 (Written )</b>	<b>Total</b>
<b>5</b>	<b>15</b>	<b>10</b>	<b>10</b>	<b>40</b>

#### End Semester Examination Marks (ESE)

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

<b>Part A</b>	<b>Part B</b>	<b>Total</b>
<ul style="list-style-type: none"> <li>• 2 Questions from each module.</li> <li>• Total of 8 Questions, each carrying 3 marks</li> </ul> <p><b>(8x3 =24marks)</b></p>	<ul style="list-style-type: none"> <li>• Each question carries 9 marks.</li> <li>• Two questions will be given from each module, out of which 1 question should be answered.</li> <li>• Each question can have a maximum of 3 sub divisions.</li> </ul> <p><b>(4x9 = 36 marks)</b></p>	<b>60</b>

### Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
<b>CO1</b>	Comprehend the Fundamental Concepts of Public Transit Systems	<b>K2</b>
<b>CO2</b>	Develop and Evaluate Transit Service and Operational Plans	<b>K3</b>
<b>CO3</b>	Plan and Analyze Transit Lines and Networks	<b>K3</b>
<b>CO4</b>	Measure and analyze performance and economic aspects of Transit Systems	<b>K3</b>

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

### CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	1	1				3						3
<b>CO2</b>	1	1				3						3
<b>CO3</b>	1					3						3
<b>CO4</b>	1					3						3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Public Transit Planning and Operation: Theory, Modelling and Practise,	Ceder, Avishai	Elsevier, Oxford, UK	2007
2	Public Transport: Its Planning, Management and Operation	White, Peter	Taylor & Francis, London.	2008
3	Urban Transit: Operations, Planning and Economics	Vuchic, Vukan R.	Wiley, New Jersey.	2005

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Transportation Engineering– An Introduction	Khisty, C J.	Prentice-Hall, New Jersey	2002
2	Transit Capacity and Quality of Service Manual	Transit Cooperative Research Program	Transportation Research Board, Washington,D.C	2013

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	<a href="https://onlinecourses.nptel.ac.in/noc22_ce70">https://onlinecourses.nptel.ac.in/noc22_ce70</a>

## SEMESTER S8

### FUNDAMENTALS OF BUILDING PLANNING

<b>Course Code</b>	<b>OECET834</b>	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3:0:0:0	<b>ESE Marks</b>	60
<b>Credits</b>	3	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	None/	<b>Course Type</b>	Theory

#### Course Objectives:

1. To enable students to develop creative and sustainable building design

### SYLLABUS

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	Definition of architecture –Historical development of architecture.  Principles of architectural composition – Unity/ harmony – character– balance – proportion – scale –rhythm — Accentuation and contrast.  Organising principles in architecture – Symmetry – hierarchy – axis – linear – concentric, radial – and asymmetric grouping – primary and secondary masses.  Form and Space in architecture – Positive and negative space – Defining space with horizontal and vertical elements -qualities of architectural space  Architecture Design Process: The 7 phases : The pre-design phase: The schematic design phase: The design development phase: The construction documents phase: The building permit phase: The bidding and negotiation phase: The construction administration phase.	
<b>2</b>	Acoustics, fundamentals: Intensity of sound- Watts/m2- Bel- Decibel scales- dBA-Phon. Addition of sound levels.  Acoustical Defects- Echoes, Reverberation, Foci and Dead Spots, Loudness, Noise	

	<p>Sound absorption-materials and fixings.</p> <p>Natural lighting: Visual task requirements, Units of Light, Light, Vision and Buildings, Standards of Lighting and Visual comfort-The sky as a source of light, Daylight factor, Recommended daylight factors for interiors.</p>	
<b>3</b>	<p>Thermal comfort: Factors affecting thermal comfort- effective Temperature</p> <p>Thermal comfort indices-ET-CET Charts- Bioclimatic chart- Psychrometry and Psychrometric chart.</p> <p>Earth-Sun relationship: Sun's apparent movement with respect to the earth. Solar angles</p> <p>Thermal design of buildings: Thermo physical properties of building materials and thermal control-.</p> <p>Functional protection: Causes of fire, Mechanism of fire spread in buildings, classification of fire-High temperature effects and combustibility of building materials and structure</p>	
<b>4</b>	<p>Architecture Design aspect: basic anthropometrics- human functions and their implications for space requirements- movement and circulation diagrams-special interpretations- various activities and their relationship with spaces</p> <p>Energy efficiency in buildings – Energy assessment in buildings – Green building rating guidelines</p>	

### **Course Assessment Method**

**(CIE: 40 marks, ESE: 60 marks)**

#### **Continuous Internal Evaluation Marks (CIE):**

<b>Attendance</b>	<b>Assignment/ Microproject</b>	<b>Internal Examination-1 (Written)</b>	<b>Internal Examination- 2 (Written )</b>	<b>Total</b>
<b>5</b>	<b>15</b>	<b>10</b>	<b>10</b>	<b>40</b>

### End Semester Examination Marks (ESE)

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

Part A	Part B	Total
<ul style="list-style-type: none"><li>• 2 Questions from each module.</li><li>• Total of 8 Questions, each carrying 3 marks</li></ul> <p>(8x3 =24marks)</p>	<ul style="list-style-type: none"><li>• Each question carries 9 marks.</li><li>• Two questions will be given from each module, out of which 1 question should be answered.</li><li>• Each question can have a maximum of 3 sub divisions.</li></ul> <p>(4x9 = 36 marks)</p>	<b>60</b>

### Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Use principles of architectural composition and organization for development of building form and planning of functional spaces in buildings.	K3
CO2	Show good understanding of the comprehensive architectural design process, from the pre-design stage to construction management.	K3
CO3	Adopt principles of acoustics and lighting for efficient functional design of buildings.	K3
CO4	Show good understanding of fire protection methods for efficient and safe function of buildings.	K3
CO5	Apply climate conscious architectural principles for creating energy efficient buildings.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create



**CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	2	1										2
<b>CO2</b>	2	1										2
<b>CO3</b>	2	1					2					2
<b>CO4</b>	2	1										2
<b>CO5</b>	3	2					2					2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

<b>Text Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
1	A global history of architecture	Francis D. K. Ching , Mark M. Jarzombek , Vikramaditya Prakash	Wiley	3 <sup>rd</sup> edition 2017
2	Architecture: Form, Space, and Order	Francis D. K. Ching	Wiley	5 <sup>th</sup> edition 2023
3	Architecture And Town Planning	Satish Chandra Agarwala	Dhanpath Rai &Co	2018
4	Architectural Engineering Design: Mechanical Systems	Robert Butler Brown	Mc Graw Hill	1 <sup>st</sup> edition
5	Building Services Engineering	David Chadderton	T&F India	6 <sup>th</sup> Edition 2017
6	Architectural Acoustics	Marshall Long	Academic Press	2014
7	Lighting	Pritchard, D.C	Longman Scientific & Technical, Harlow	1995
8	Daylight in Architecture	Benjamin Evans	McGraw - Hill Book Company	1981
9	Building Environment	AjithaSimha.D	Tata McGraw Hill Publishing Co	1985

10	Design and Installation of Services in Building complexes & High Rise Buildings	Jain. V.K.,	Khanna Tech. Publishers	1986
11	A text book of Vastuvidya	A. Achyuthan, Balagopal. T.S. Prabhu	Vastuvidyaparatishtanam	1996
12	Manual of tropical Housing and Building Part I – Climatic design	Koenigseberger	Orient Longman	2011

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Architecture: From Prehistory to Climate Emergency	Barnabas Calder	Pelican	2021
2	Building construction illustrated	Francis D. K. Ching	Wiley	6 <sup>th</sup> edition 2017
3	Architectural Engineering Design: Mechanical Systems	Robert Butler Brown	Mc Graw Hill	1 <sup>st</sup> edition
4	Acoustical Design in Architecture	Knudsen V.O. and Harris C.M	John Wiley	1980
5	Energy Efficient Buildings: Architecture, Engineering, and Environment	Wayne Forster and Dean Hawkes	W.W. Norton Company Inc	2002
6	Bureau of Indian standards, Handbook on Functional Requirement of Buildings – SP:41(S and T)-1987			
7	National Building Code of India ( latest revisions to be referred)			
8	Bureau of Energy Efficiency, India. Design Guidelines for Energy Efficient Multi-Storey Buildings, 2014.			

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	<a href="https://archive.nptel.ac.in/courses/124/107/124107005/">https://archive.nptel.ac.in/courses/124/107/124107005/</a> <a href="https://nptel.ac.in/courses/124107012">https://nptel.ac.in/courses/124107012</a>
2	<a href="https://archive.nptel.ac.in/courses/105/102/105102175/">https://archive.nptel.ac.in/courses/105/102/105102175/</a>
3	<a href="https://archive.nptel.ac.in/courses/105/107/105107156/">https://archive.nptel.ac.in/courses/105/107/105107156/</a>
4	<a href="https://nptel.ac.in/courses/101104065">https://nptel.ac.in/courses/101104065</a> <a href="https://archive.nptel.ac.in/noc/courses/noc22/SEM1/noc22-ar03/">https://archive.nptel.ac.in/noc/courses/noc22/SEM1/noc22-ar03/</a>

## SEMESTER S8

### HYDROGEOLOGY

<b>Course Code</b>	<b>OECET835</b>	<b>CIE Marks</b>	40
<b>Teaching Hours/Week (L: T:P: R)</b>	3:0:0:0	<b>ESE Marks</b>	60
<b>Credits</b>	3	<b>Exam Hours</b>	2 Hrs. 30 Min.
<b>Prerequisites (if any)</b>	PECET416	<b>Course Type</b>	Theory

#### Course Objectives:

1. Understand Groundwater Origin and Occurrence: Gain foundational knowledge necessary for advanced hydrogeological studies.
2. Identify Geologic Structures Favourable to Groundwater Movement: Learn to describe and assess structures that influence groundwater availability and flow.
3. Apply Groundwater Exploration Principles: Develop practical skills for locating water resources and evaluating groundwater quality.
4. Analyse Groundwater Conditions Across Different Terrains: Formulate strategies for managing and protecting groundwater resources.
5. Overview of Groundwater Impacts on Civil Engineering Structures: Understand how groundwater affects civil engineering projects and structures.

### SYLLABUS

<b>Module No.</b>	<b>Syllabus Description</b>	<b>Contact Hours</b>
<b>1</b>	Groundwater- origin and occurrence. Hydrological cycle. Geologic structures favouring groundwater occurrence and movement. Vertical distribution of groundwater. Water table. Groundwater reservoirs – aquifer, aquiclude, aquifuge and aquitard. Types of aquifers– unconfined, confined, leaky and bounded aquifers – artesian aquifers; springs and their types. Hydrological	<b>9</b>

	characteristics of aquifers and aquifer properties: Porosity, Permeability, Void Ratio, Specific Yield and Specific Retention – Aquifer parameters– Hydraulic conductivity, Transmissivity and Storativity. Hydraulic Conductivity determination – Lab tests – Permeameter methods and Field tests – Auger Hole test, Tracer test and Pump test	
<b>2</b>	Groundwater exploration- Remote sensing and GIS applications. Geophysical methods of groundwater exploration: Principles of electrical resistivity method- Wenner and Schlumberger methods. Subsurface investigations- test drilling, resistivity logging, SP logging, radiation logging- brief description. Groundwater movement – Water table and Piezometric level (surface) – Theory of groundwater flow – Darcy's law and its experimental verification – differential equation governing groundwater flow. Groundwater level fluctuations	<b>9</b>
<b>3</b>	Well design criteria. Water wells– types of wells. Methods for drilling deep wells. Quality of groundwater-domestic, irrigation and industrial & construction purpose. Chemical characteristics of groundwater – Graphical representation of water quality data: Interpretation of hydrochemical analysis data: Hill-Piper Trilinear diagram, Durov's diagram and U. S. Salinity diagram – Sodium Adsorption Ratio (SAR). WHO, BIS and ISI water quality standards. Biological health of groundwater	<b>9</b>
<b>4</b>	Saline water intrusion in coastal and other aquifers and its prevention. Ghyben-Herzberg relationship– methods and need for artificial recharge to aquifers. Groundwater management. Groundwater development– safe yield and optimal mining policy. Relation between geomorphology of a terrain and its hydrogeological condition. Problems created by groundwater in the construction phase of mega civil engineering projects. Groundwater provinces of India. Groundwater conditions in Kerala	<b>9</b>

### Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

#### Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written )	Total
5	15	10	10	40

#### End Semester Examination Marks (ESE)

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

Part A	Part B	Total
<ul style="list-style-type: none"><li>• 2 Questions from each module.</li><li>• Total of 8 Questions, each carrying 3 marks</li></ul> <p>(8x3 =24marks)</p>	<ul style="list-style-type: none"><li>• Each question carries 9 marks.</li><li>• Two questions will be given from each module, out of which 1 question should be answered.</li><li>• Each question can have a maximum of 3 sub divisions.</li></ul> <p>(4x9 = 36 marks)</p>	60

#### Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	A comprehensive understanding of the origin, occurrence and storage of groundwater	K2
CO2	Identify and describe geologic structures that favour groundwater occurrence and movement, including the vertical distribution of groundwater and water table dynamics	K2
CO3	Apply the principles of geospatial and geophysical methods for ground water exploration	K3
CO4	Evaluate the quality of groundwater for human consumption, irrigation and industrial & construction purpose.	K3
CO5	Evaluate the groundwater conditions across various terrains and assess the level of groundwater contamination for formulating approaches for groundwater conservation	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

**CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	<b>3</b>											
<b>CO2</b>	<b>3</b>	<b>2</b>										<b>2</b>
<b>CO3</b>	<b>3</b>	<b>2</b>	<b>2</b>									<b>1</b>
<b>CO4</b>	<b>3</b>					<b>2</b>	<b>2</b>					<b>1</b>
<b>CO5</b>	<b>3</b>	<b>2</b>				<b>2</b>	<b>3</b>					<b>1</b>

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

<b>Text Books</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
1	Groundwater Hydrology	Bouwer,	McGraw-Hill	1978.
2	Hydrogeology	Davis, S.N. and Dewiest, R.J.N.	John Wiley and Sons Inc. New York,	1966.
3	Hydrogeology, Principle and Practice	Kevin M. Hiscock, Victor F. Bense	Wiley	2021
4	Groundwater geophysics,	Krisch R	Springer - Verlag	2008
5	Groundwater	Reghunath,	Wiley Eastern Limited.	3 <sup>rd</sup> Edn. 2007

<b>Reference Texts</b>				
<b>Sl. No</b>	<b>Title of the Book</b>	<b>Name of the Author/s</b>	<b>Name of the Publisher</b>	<b>Edition and Year</b>
1	Hydrogeology: Groundwater Science and Engineering	Alain Dassargues	CRC Press	2018
2	Introduction to Hydrogeology Unesco-IHE Delft Lecture Note Series	J.C. Nonner, Johannes Nonner	CRC Press	2010