

Programme Name/s : **Civil Engineering/ Civil & Rural Engineering/ Construction Technology/ Civil & Environmental Engineering/**

Programme Code : **CE/ CR/ CS/ LE**

Semester : **Fourth**

Course Title : **WATER AND WASTEWATER ENGINEERING**

Course Code : **314314**

I. RATIONALE

Urbanization is rapidly increasing, straining resources and infrastructure, and jeopardizing environmental quality. Therefore, it is necessary to ensure safe drinking water, effective waste disposal methods, and a pollution-free environment for maintaining good sustainable public health. A civil engineer is required to develop a basic understanding of the sources, characteristics, purification methods and conveyance system of water supply including the knowledge of domestic sewage disposal and its treatment. This course is intended to develop the basic competencies among the learners about water and wastewater treatments.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Maintain the processes related to water treatment and wastewater treatment.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Interpret the water demand and quality of water.
- CO2 - Apply the water purification processes.
- CO3 - Select the distribution system and pipe network for water supply.
- CO4 - Interpret the plumbing system and sewer appurtenances.
- CO5 - Apply the wastewater treatment processes.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme						Credits	Paper Duration	Assessment Scheme								Total Marks	
				Actual Contact Hrs./Week			SLH	NLH	Theory			Based on LL & TL				Based on SL					
				CL	TL	LL			Practical			SLA									
									FA-TH			SA-TH	Total	FA-PR	SA-PR	Max	Min				
314314	WATER AND WASTEWATER ENGINEERING	WWE	DSC	4	-	2	-	6	3	3	30	70	100	40	25	10	-	-	-	-	125

Total IKS Hrs for Sem. : 2 Hrs

Abbreviations: CL- Classroom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative

Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, ** On Line Examination , @\$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	<p>TLO 1.1 Classify the sources with intake structures of water on the basis of given criteria.</p> <p>TLO 1.2 Determine future population by using relevant forecasting method.</p> <p>TLO 1.3 Undertake the testing of given water sample using relevant method as per IS code.</p>	<p>Unit - I Sources, Characteristics and Demand of Water</p> <p>1.1 Sources of water: Surface and Subsurface sources of water. Intake Structures: Definition, types and factors governing the location.</p> <p>1.2 Demand of water: Need to protect water supplies, Demand of water: Definition, Types, Factors affecting, rate and variations in water demands. Forecasting of population: Introduction and Methods, (Numerical based on Arithmetical Increase, geometrical decrease & Incremental increase only). Design period, estimating of demand of water supply required for city or town.</p> <p>1.3 Characteristics and testing of water: Need for analysis of water, Physical, Chemical and Biological properties of water. Testing of water for Total solids, hardness, chlorides, Dissolved Oxygen, pH, Fluoride, Nitrogen and its compounds, Bacteriological tests, E. coli, B. coli index, MPN.</p> <p>Sampling of Water: Single & Grab. Water quality standards as per (I.S. 10500:2012).</p>	<p>Demonstration Video</p> <p>Demonstrations Lecture Using</p> <p>Chalk-Board</p>
2	<p>TLO 2.1 Draw the labeled flow diagram of water treatment plant with enough description.</p> <p>TLO 2.2 Justify the process of filtration of water.</p> <p>TLO 2.3 Justify the process of disinfection of water.</p> <p>TLO 2.4 Apply the relevant technique of water softening and de-fluoridation for the given sample of water.</p> <p>TLO 2.5 Apply electrolysis and reverse osmosis technique on the given sample of water for the intended purpose.</p>	<p>Unit - II Purification of Water</p> <p>2.1 Purification of Water: Flow diagram of water supply scheme, function of units of water supply scheme. Screening - Types, functions and suitability. Aeration - objects and methods of aeration. Plain sedimentation, Sedimentation with coagulation, principles of coagulation, types of coagulants, (IKS*: Alum is placed in clay water pot) Jar Test, process of coagulation, types of sedimentation tanks. Clariflocculator - Principle and working with diagram.</p> <p>2.2 Filtration: Theory of filtration, classification of filters - slow sand filter, rapid sand filter, pressure filter, construction and working of slow sand filter and rapid sand filter.</p> <p>2.3 Disinfection: Objects, methods of disinfection, Chlorination- Application of chlorine, forms of chlorination, types of chlorination practices, residual chlorine and its importance, orthotolidine test.</p> <p>2.4 Water Softening Methods: Need and necessity of Water softening, lime soda process and zeolite process. De-fluoridation techniques.</p> <p>2.5 Advanced Water Treatments: Electrolysis, Reverse Osmosis.</p>	<p>Demonstration Lecture Using</p> <p>Chalk-Board Collaborative learning Video</p> <p>Demonstrations</p> <p>Site/Industry Visit</p> <p>Case Study</p>

Sr.No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	<p>TLO 3.1 Select the relevant mode of conveyance system in the given situation.</p> <p>TLO 3.2 Suggest the water distribution method for the given situation.</p> <p>TLO 3.3 Use the relevant pipe network system for water distribution in the given situation.</p>	<p>Unit - III Water Distribution System</p> <p>3.1 Conveyance: Pipes - Types, Choice of materials, Joints and valves - Types, location and functions.</p> <p>3.2 Distribution methods: Methods - Gravity, pumping, and combined system, suitability, advantages and disadvantages. (IKS* Harappa and Mohenjo-daro, Katraj lake-Shaniwar wada, Nahr-e-Ambari water course) Service reservoirs - types and functions.</p> <p>3.3 Pipe Network System: Dead end system, grid iron system, circular system, radial system - their suitability, advantages and disadvantages.</p>	<p>Demonstration Video</p> <p>Demonstrations Lecture Using</p> <p>Chalk-Board Collaborative learning</p> <p>Case Study</p>
4	<p>TLO 4.1 Propose the relevant sanitary fittings to be used at the given location of sanitation system.</p> <p>TLO 4.2 Illustrate relevant type of plumbing system for the given situation.</p> <p>TLO 4.3 Justify the relevant type of sewerage system for the given situation.</p> <p>TLO 4.4 Illustrate sewer appurtenances in the given situation.</p>	<p>Unit - IV Building Sanitation System</p> <p>4.1 Building Sanitation: Necessity of sanitation, Necessity to treat domestic sewage, Definitions: Sewage, sullage, types of sewage, Water pipe, Rain water pipe, Soil pipe, Sullage pipe, Vent pipe, Building sanitary fittings - Water closet (Indian and European type), flushing cistern, wash basin, sinks, Urinals. Traps: Types, quality and function.</p> <p>4.2 Systems of plumbing: One pipe, two pipe, single stack, choice of system, Principles regarding design of building drainage, layout plan for building sanitary fittings (drainage plan), Inspection and junction chambers- necessity, location, size and shape, Maintenance of sanitary units such as wash basin, sink, traps and chambers.</p> <p>4.3 Systems of Sewerage: Introduction, Systems of sewerage: Separate, Partially Separated and Combined.</p> <p>4.4 Sewer Appurtenances: Definition, Types of Sewers, Design of sewers, Self cleansing velocity and non scouring velocity, Laying, Testing and maintenance of sewers, Cleaning of municipal sewers before and after monsoon, Manholes and Drop Manhole - component parts, location, spacing, construction details. Sewer Inlets, Street Inlets.</p>	<p>Lecture Using</p> <p>Chalk-Board Lecture Using</p> <p>Chalk-Board</p> <p>Demonstration Video</p> <p>Demonstrations</p> <p>Site/Industry Visit</p>
5	<p>TLO 5.1 Evaluate the given characteristics of the sewage sample in relation with MPCB norms.</p> <p>TLO 5.2 Describe the function of various units of sewage treatment plant.</p> <p>TLO 5.3 Describe the construction of septic tank with its working principle.</p> <p>TLO 5.4 Describe the construction of septic tank with its working principle.</p>	<p>Unit - V Sewage Treatment System</p> <p>5.1 Analysis of sewage: Characteristics of sewage, D.O., B.O.D., C.O.D. and its significance, Aerobic and anaerobic process, Maharashtra Pollution Control Board Norms for the discharge of treated sewage, Purposes of sewage treatment.</p> <p>5.2 Treatment of Sewage: Flow diagram, Screening, Grit removal, Skimming, Sedimentation of sewage, Sludge digestion, Trickling filters, Activated sludge process. Disposal of sewage, Oxidation pond, Oxidation ditch.</p> <p>5.3 Septic tank & soak pit: Principle, Construction, Working and Maintenance.</p> <p>5.4 Recycling and Reuse of domestic wastewater: Necessity, Advantages, Disadvantages, methods and uses.</p>	<p>Lecture Using</p> <p>Chalk-Board Video</p> <p>Demonstrations</p> <p>Demonstration</p> <p>Site/Industry Visit Collaborative learning</p> <p>Case Study</p>

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Determine the pH value of the given sample of water.	1	*Determination of pH value of water sample.	2	CO1
LLO 2.1 Determine the turbidity of the given sample of water.	2	*Determination of the turbidity of the sample of water.	2	CO1
LLO 3.1 Use the Whatman filter paper to determine the suspended solids, dissolved solids and total solids of given sample of water.	3	*Determination of suspended solids, dissolved solids and total solids of a water sample.	2	CO1
LLO 4.1 Use digital TDS meter to determine the TDS (Total Dissolved Solids).	4	Determination of the TDS by using a portable digital TDS meter.	2	CO1
LLO 5.1 Use mechanical/digital DO meter to find the dissolved oxygen content present in a given sample of water.	5	Determination of the dissolved oxygen in a given sample of water.	2	CO1
LLO 6.1 Undertake the test to detect the presence of residual chlorine in a given sample of water using orthotolidine testing kit.	6	*Determination of residual chlorine in the sample of water.	2	CO2
LLO 7.1 Undertake a field visits to water treatment plant.	7	*Preparation of report on field visit to the nearby water treatment plant.	2	CO2
LLO 8.1 Deploy the jar test method to find the optimum dose of coagulant in the given raw water sample.	8	*Determination of the optimum dose of coagulant in the given raw water sample by jar test.	2	CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 9.1 Write a report on working of water purifier, (RO purifier).	9	Demonstration of water purifier based on its components and working, (RO purifier).	2	CO2
LLO 10.1 Draw sketches of various joints used in the water supply pipeline.	10	*Illustration of various joints used in water supply pipeline through sketches.	2	CO3
LLO 11.1 Draw a labeled sketch of the one pipe, two pipe system and layout plan for drainage for a residential building.	11	Preparation of a sketch of one pipe, two pipe system and layout plan for drainage for a residential building.	2	CO4
LLO 12.1 Calculate BOD of given sample of wastewater.	12	Determination of BOD of a given sample of wastewater.	2	CO5
LLO 13.1 Calculate the dissolved oxygen content in the given sample of wastewater.	13	*Determination of the dissolved oxygen in the given sample of wastewater.	2	CO5
LLO 14.1 Calculate COD of a given sample of wastewater.	14	Determination of COD of a given sample of wastewater.	2	CO5
LLO 15.1 Write a report on wastewater treatment plant.	15	Preparation of a report on a field visit to the wastewater treatment plant.	2	CO5

Note : Out of above suggestive LLOs -

- ** Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Present the test results of minimum three water samples obtained from a locally available area to ascertain its characteristics. (pH, Turbidity, D. O., Residual chlorine, Temperature, etc.)
Conduct an internet surfing survey/visit to local statutory water bodies for the quality of water, prepare a report on it and write your comment.
Present the test results of minimum three wastewater samples obtained from a locally available area to ascertain its characteristics. Suggest minimum ten remedial measures for the control of pollution of local water sources by conducting relevant studies and tests. Visit the site where recycling and utilization of treated wastewater is being implemented and prepare a detailed report on it. Suggest minimum three social and eco-friendly methods to treat sullage water. Suggest minimum five relevant methods/strategies to save water. Suggest a treatment given to bore water to make it fit for drinking. List a minimum of six building sanitary appurtenances used in current practice. Prepare a presentation with minimum ten slides on the treatment of wastewater.

Assignment

- Collect information regarding minimum ten norms for water and wastewater treatment of statutory water bodies.
Prepare a presentation with minimum ten slides on conventional or advanced wastewater treatment processes.
Draw minimum four sketches of valves used in the water supply pipeline.
Study the related free open software for the design of the water supply distribution network.
Prepare a report of minimum five pages on the plumbing system for an existing building (G+1 or above) in the nearby area.
Prepare a report of minimum five pages on the drainage system for an existing building (G+1 or above) in the nearby area.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicious mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Digital pH meter (4 Digit Display (LED), 0 to 1000 mV, Resolution: 0.01 pH, Manual Temperature, Compensation: 0 to 80 degree C.)	1,12
2	BOD incubator with BOD bottles (Rated Voltage: AC 220V \pm 10% 50Hz, Power: 2800W, Temperature Controlling Mode: Digital Display, Temperature Controlling Point: 24 degree C, 93.5 degree C, Temperature Controlling Precision: \pm 0.1 degree C)	11
3	Digital COD digester (Glassware: 15 Reaction Vessels & Air Condensers, Temperature: 150 \pm 1% degree C, Capacity: 15 Samples at a time, Sample Size: 20 ml, Range: 0 to 500 ppm without dilution, Timer: 2 hours timer with Buzzer, Power Requirement: 230V 1000W)	14

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
4	Digital Turbidity Meter. (Range 0 to 200 NTU, Resolution 1NTU, Accuracy: $\hat{A} \pm 3\%$ FS, $\hat{A} \pm 1$ Digit, Display 3 \hat{A} $\frac{1}{2}$ Digit 7-Segment LED Light Source 6V, 0.3 Amp Tungsten Lamp, Detector: Photodiode, Sample System: 30 mm Clear Glass Test Tubes, Power 230 V $\hat{A} \pm 10\%$ AC, 50 Hz, Accessories Test tube Set of 5, Operation Manual, Dust Cover.	2
5	Electric Oven with digital control (Temperature: 300 degree C, 25 kg capacity)	3
6	Digital DO meter (Range: 0 to 20 ppm, Resolution: 0.1 ppm, Temperature compensation: 0 to 50 degree C)	5,11,13,14
7	Orthotolidine test kit (free and total chlorine testing for EPA reporting over the range of 0-4 mg/L.)	6
8	Jar Test Apparatus (Digital timer: 1 to 99 minutes, material: Stainless steel, Power: Electric supply, Range: 25 to 250 rpm, with 6 glass jars of 1000 mL)	8

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Sources, Characteristics and Demand of Water	CO1	10	4	8	0	12
2	II	Purification of Water	CO2	16	6	6	6	18
3	III	Water Distribution System	CO3	8	2	4	4	10
4	IV	Building Sanitation System	CO4	14	2	4	10	16
5	V	Sewage Treatment System	CO5	12	0	8	6	14
Grand Total				60	14	30	26	70

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two-unit tests of 30 marks each will be conducted and average of two-unit tests considered. For formative assessment of laboratory learning 25 marks. Each practical will be assessed considering appropriate % weightage to process and product and other instructions of assessment.

Summative Assessment (Assessment of Learning)

- Assignment and Term Work, Written end semester examination.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO- 1	PSO- 2	PSO- 3

CO1	3	3	2	1	-	2	3			
CO2	3	2	1	3	3	2	2			
CO3	3	2	2	3	2	2	1			
CO4	3	2	2	2	1	2	2			
CO5	3	3	1	1	3	2	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -

*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	N. N. Basak	Environmental Engineering	McGraw Hill Education India ISBN: 9780070494633, 0070494630.
2	Birdie, G. S. Birdie, J. S.	Water Supply and Sanitary Engineering	Dhanpat Rai and Sons, 2011 ISBN: 81874337954.
3	Garg, S.K.	Environmental Engineering Vol. I and Vol. II	Khanna Publishers, New Delhi, 2017, ISBN-10: 8174091203; ISBN-13: 978-8174091208.
4	B. C. Punmia Ashok Jain Arun Jain	Environmental Engineering Vol. I & Vol. II Water Supply Engineering & Wastewater Engineering (Including Air Pollution)	Laxmi Publications (P) Ltd., New Delhi ISBN: 81-7008-092-4, ISBN-13: 9788131805961.
5	Nelson DI	Environmental Engineering	CBS Publisher and Distributor ISBN: 9788123928715.

XIII. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://ee1-nitk.vlabs.ac.in/List%20of%20experiments.html	Experiments for drinking Water.
2	https://ee1-nitk.vlabs.ac.in/	Experiments for drinking water and wastewater.
3	https://www.vlab.co.in/participating-institute-nitk-surathkal	Experiments for drinking water and wastewater.
4	https://www.vlab.co.in/ba-nptel-labs-civil-engineering	Experiments for drinking water and wastewater.
5	https://iitb.vlabs.co.in/discipline.html?discipline=Civil_Engineering	Experiments for drinking water and wastewater.
6	https://nitsri.ac.in/Department/Library/List_VLabs	Experiments for drinking water and wastewater.
7	https://www.youtube.com/watch?v=V_bd-ljo7Ic	Determination of pH.
8	https://www.youtube.com/watch?v=4AWR_xfwf4	Turbidity Determination
9	https://www.youtube.com/watch?v=fHRxhuMQQnE&list=PLbRMhDVUMngdeOSgQOe399aBKqdxkxNCp	Working of wastewater treatment Plant.
10	https://www.youtube.com/watch?v=4-SRMmqH2s4&list=PLLy_2iUCC87AZvtaiuD3r4HATrBKhb90P	Working of wastewater treatment Plant.
11	https://www.mpcb.gov.in./water-quality/standards-	Standard Norms as per MPCB
12	https://cpcb.nic.in/who-guidelines-for-drinking-water-quality/	Standard Norms as per CPCB
13	chrome-extension://efaidnbmninnibpcapjcgclclefindmkaj/https://cpcb.nic.in/wqm/BIS_Drinking_Water_Specification.pdf	BIS: Drinking Water specifications (IS 10500:2012)

Sr.No	Link / Portal	Description
14	https://archive.nptel.ac.in/content/storage2/courses/105104102/Lecture%2014.htm	Water distribution systems

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students