

Maharashtra State Board Of Technical Education, Mumbai

Learning and Assessment Scheme for Post S.S.C Diploma Courses

Programme Name : Diploma In Civil Engineering / Civil & Rural Engineering / Construction Technology / Civil & Environmental Engineering

Programme Code : CE / CR / CS / LE **With Effect From Academic Year** : 2023-24

Duration Of Programme : 6 Semester **Duration** : 16 WEEKS

Semester : Fourth **NCrF Entry Level** : 3.5 **Scheme** : K

Sr No	Course Title	Abbreviation	Course Type	Course Code	Total IKS Hrs for Sem.	Learning Scheme						Credits	Assessment Scheme													
						Actual Contact Hrs./Week			Self Learning (Activity/ Assignment /Micro Project)	Notional Learning Hrs /Week	Paper Duration (hrs.)		Theory				Based on LL & TL				Based on Self Learning		Total Marks			
																	Practical									
						CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA					
																									Max	Max
(All Compulsory)																										
1	ENVIRONMENTAL EDUCATION AND SUSTAINABILITY	EES	VEC	314301	2	3	-	-	1	4	2	1.5	30	70*#	100	40	-	-	-	-	25	10	125			
2	RAILWAY, BRIDGE AND TUNNEL ENGINEERING	RBT	DSC	314312	3	4	-	-	2	6	3	3	30	70	100	40	-	-	-	-	25	10	125			
3	HYDRAULICS	HYD	DSC	314303	-	4	-	2	2	8	4	3	30	70	100	40	25	10	25@	10	25	10	175			
4	ESTIMATING, COSTING AND VALUATION	ECV	DSC	314313	-	4	-	4	-	8	4	4	30	70	100	40	50	20	25#	10	-	-	175			
5	WATER AND WASTEWATER ENGINEERING	WWE	DSC	314314	2	4	-	2	-	6	3	3	30	70	100	40	25	10	-	-	-	-	125			
6	GEOTECHNICAL ENGINEERING	GTE	DSC	314315	1	3	-	2	3	8	4	3	30	70	100	40	25	10	25#	10	25	10	175			
Total					8	22		10	8		20		180	420	600		125		75		100		900			

Abbreviations : CL- Classroom Learning , TL- Tutorial Learning, LL-Laboratory Learning, 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.

Course Category : Discipline Specific Course Core (DSC) , Discipline Specific Elective (DSE) , Value Education Course (VEC) , Intern./Apprenti./Project./Community (INP) , Ability Enhancement Course (AEC) , Skill Enhancement Course (SEC) , Generic Elective (GE)

Programme Name/s	: Architecture Assistantship/ Automobile Engineering./ Artificial Intelligence/ Agricultural Engineering/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Architecture/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Fashion & Clothing Technology/ Dress Designing & Garment Manufacturing/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Food Technology/ Computer Hardware & Maintenance/ Instrumentation & Control/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Instrumentation/ Interior Design & Decoration/ Interior Design/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Medical Laboratory Technology/ Medical Electronics/ Production Engineering/ Printing Technology/ Polymer Technology/ Surface Coating Technology/ Computer Science/ Textile Technology/ Electronics & Computer Engg./ Travel and Tourism/ Textile Manufactures/
Programme Code	: AA/ AE/ AI/ AL/ AN/ AO/ AT/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CW/ DC/ DD/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ FC/ HA/ IC/ IE/ IF/ IH/ IS/ IX/ IZ/ LE/ ME/ MK/ ML/ MU/ PG/ PN/ PO/ SC/ SE/ TC/ TE/ TR/ TX
Semester	: Fourth
Course Title	: ENVIRONMENTAL EDUCATION AND SUSTAINABILITY
Course Code	: 314301

I. RATIONALE

The survival of human beings is solely depending upon the nature. Thus, threats to the environment directly impact on existence and health of humans as well as other species. Depletion of natural resources and degradation of ecosystems is accelerated due to the growth in industrial development, population growth, and overall growth in production demand. To address these environmental issues, awareness and participation of individuals as well as society is necessary. Environmental education and sustainability provide an integrated, and interdisciplinary approach to study the environmental systems and sustainability approach to the diploma engineers.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Resolve the relevant environmental issue through sustainable solutions

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Identify the relevant Environmental issues in specified locality.
- CO2 - Provide the green solution to the relevant environmental problems.
- CO3 - Conduct SWOT analysis of biodiversity hotspot
- CO4 - Apply the relevant measures to mitigate the environmental pollution.
- CO5 - Implement the environmental policies under the relevant legal framework.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

ENVIRONMENTAL EDUCATION AND SUSTAINABILITY**Course Code : 314301**

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										
											FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
													Max	Max	Max	Min	Max	Min	Max	Min	
314301	ENVIRONMENTAL EDUCATION AND SUSTAINABILITY	EES	VEC	3	-	-	1	4	2	1.5	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	TLO 1.1 Explain the need of studying environment and its components. TLO 1.2 Investigate the impact of population growth and industrialization on the relevant environmental issues and suggest remedial solutions TLO 1.3 Explain the Concept of 5 R w.r.t. the given situation TLO 1.4 Elaborate the relevance of Sustainable Development Goals in managing the climate change TLO 1.5 Explain the concept of zero carbon-footprint with carbon credit	Unit - I Environment and climate change 1.1 Environment and its components, Types of Environments, Need of environmental studies 1.2 Environmental Issues- Climate change, Global warming, Acid rain, Ozone layer depletion, nuclear accidents. Effect of population growth and industrialization 1.3 Concept of 5R, Individuals' participation in i) 5R policy, ii) segregation of waste, and iii) creating manure from domestic waste 1.4 Impact of Climate change, Factors contributing to climate change, Concept of Sustainable development, Sustainable development Goals (SDGs), Action Plan on Climate Change in Indian perspectives 1.5 Zero Carbon footprint for sustainable development, (IKS-Environment conservation in vedic and pre-vedic India)	Lecture Using Chalk-Board Presentations

ENVIRONMENTAL EDUCATION AND SUSTAINABILITY

Course Code : 314301

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.
2	TLO 2.1 Justify the importance of natural resources in sustainable development TLO 2.2 Explain the need of optimum use of natural resources to maintain the sustainability TLO 2.3 Differentiate between renewable and non-renewable sources of energy TLO 2.4 Suggest the relevant type of energy source as a green solution to environmental issues	Unit - II Sustainability and Renewable Resources 2.1 Natural Resources: Types, importance, Causes and effects of depletion. (Forest Resources, Water Resources, Energy Resources, Land resources, Mineral resources), (IKS- Concepts of Panchmahabhuta) 2.2 Impact of overexploitation of natural resources on the environment, optimum use of natural resources 2.3 Energy forms (Renewable and non-renewable) such as Thermal energy, nuclear energy, Solar energy, Wind energy, Geothermal energy, Biomass energy, Hydropower energy, biofuel 2.4 Green Solutions in the form of New Energy Sources such as Hydrogen energy, Ocean energy & Tidal energy	Lecture Using Chalk-Board Presentations
3	TLO 3.1 Explain the characteristics and functions of ecosystem TLO 3.2 Relate the importance of biodiversity and its loss in the environmental sustainability TLO 3.3 Describe biodiversity assessment initiatives in India TLO 3.4 Conduct the SWOT analysis of the biodiversity hot spot in India TLO 3.5 Explain the need of conservation of biodiversity in the given situation	Unit - III Ecosystem and Biodiversity 3.1 Ecosystem - Definition, Aspects of ecosystem, Division of ecosystem, General characteristics of ecosystem, Functions of ecosystem 3.2 Biodiversity - Definitions, Levels, Value, and loss of biodiversity 3.3 Biodiversity Assessment Initiatives in India 3.4 SWOT analysis of biodiversity hot spot in India 3.5 Conservations of biodiversity - objects, and laws for conservation of biodiversity	Lecture Using Chalk-Board Presentations Video Demonstrations
4	TLO 4.1 Classify the pollution based on the given criteria TLO 4.2 Justify the need of preserving soil as a resource along with the preservation techniques TLO 4.3 Maintain the quality of water in the given location using relevant preventive measures TLO 4.4 State the significance of controlling the air pollution to maintain its ambient quality norms TLO 4.5 Compare the noise level from different zones of city with justification TLO 4.6 Describe the roles and responsibilities of central and state pollution control board	Unit - IV Environmental Pollution 4.1 Definition of pollution, types- Natural & Artificial (Man- made) 4.2 Soil / Land Pollution – Need of preservation of soil resource, Causes and effects on environment and lives, preventive measures, Soil conservation 4.3 Water Pollution - sources of water pollution, effects on environment and lives, preventive measures, BIS water quality standards for domestic potable water, water conservation 4.4 Air pollution - Causes, effects, prevention, CPCB norms of ambient air quality in residential area 4.5 Noise pollution - Sources, effects, prevention, noise levels at various zones of the city 4.6 Pollution Control Boards at Central and State Government level: Norms, Roles and Responsibilities	Lecture Using Chalk-Board Presentations

ENVIRONMENTAL EDUCATION AND SUSTAINABILITY**Course Code : 314301**

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.
5	TLO 5.1 Explain Constitutional provisions related to environmental protection TLO 5.2 Explain importance of public participation (PPP) in enacting the relevant laws TLO 5.3 Use the relevant green technologies to provide sustainable solutions of an environmental problem TLO 5.4 Explain the role of information technology in environment protection	Unit - V Environmental legislation and sustainable practices 5.1 Article (48-A) and (51-A (g)) of Indian Constitution regarding environment, Environmental protection and prevention acts 5.2 Public awareness about environment. Need of public awareness and individuals' participation. Role of NGOs 5.3 Green technologies like solar desalination, green architecture, vertical farming and hydroponics, electric vehicles, plant-based packaging 5.4 Role of information technology in environment protection and human health	Lecture Using Chalk-Board Presentations Video Demonstrations

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES : NOT APPLICABLE.**VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)****Assignment**

- Suggest the steps to implement (or improve the implementation) of the 5R policy in your home/institute stating your contribution
- Draft an article on India's Strategies to progress across the Sustainable Development Goals
- Make a chart of Renewable and non-renewable energy sources mentioning the advantages and disadvantages of each source
- Conduct the SWOT analysis of biodiversity hotspot in India
- Prepare a mind-mapping for the zero carbon footprint process of your field
- Prepare a chart showing sources of pollution (air/water/ soil), its effect on human beings, and remedial actions
- Any other assignment on relevant topic related to the course suggested by the facilitator

UNICEF Certification(s)

- Students may complete the self-paced course launched by Youth Leadership for climate Exchange under UNICEF program on portal www.mahayouthnet.in . The course encompasses five Modules in the form of Units as given below:

- Unit 1: Living with climate change
- Unit 2 : Water Management and Climate Action
- Unit 3: Energy Management and Climate Action
- Unit 4 : Waste Management and Climate Action
- Unit 5 : Bio-cultural Diversity and Climate Action

If students complete all the five Units they are not required to undertake any other assignment /Microproject/activities specified in the course. These units will suffice to their evaluations under SLA component

Micro project

- Technical analysis of nearby commercial RO plant.
- Comparative study of different filters used in Household water filtration unit
- Evaluate any nearby biogas plant / vermicomposting plant or any such composting unit on the basis of sustainability and cost-benefit
- IKS-Study and prepare a note on Vedic and Pre-Vedic techniques of environmental conservation

ENVIRONMENTAL EDUCATION AND SUSTAINABILITY**Course Code : 314301**

Visit a local polluted water source and make a report mentioning causes of pollution

Any other activity / relevant topic related to the course suggested by the facilitator

Activities

- Prepare a report on the working and functions of the PUC Center machines and its relevance in pollution control.
- Prepare and analyse a case study on any polluted city of India
- Prepare a note based on the field visit to the solid waste management department of the municipal corporation / local authority
- Record the biodiversity of your institute/garden in your city mentioning types of vegetation and their numbers
- Visit any functional hall/cultural hall /community hall to study the disposal techniques of kitchen waste and prepare a report suggesting sustainable waste management tool
- Watch a video related to air pollution in India and present the summary
- Any other assignment on relevant topic related to the course suggested by the facilitator

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	Nil	All

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	Environment and climate change	CO1	8	4	4	4	12
2	II	Sustainability and Renewable Resources	CO2	10	4	4	8	16
3	III	Ecosystem and Biodiversity	CO3	8	4	4	4	12
4	IV	Environmental Pollution	CO4	12	4	8	6	18
5	V	Environmental legislation and sustainable practices	CO5	7	4	4	4	12
Grand Total				45	20	24	26	70

X. ASSESSMENT METHODOLOGIES/TOOLS**Formative assessment (Assessment for Learning)**

- Two-unit tests (MCQs) of 30 marks will be conducted and average of two-unit tests considered. Formative assessment of self learning of 25 marks should be assessed based on self learning activity such as UNICEF Certification(s)/Microproject/assignment/activities. (60 % weightage to process and 40 % to product)

Summative Assessment (Assessment of Learning)

- Online MCQ type Exam

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

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	Y. K. Singh	Environmental Science	New Age International Publishers, 2006, ISBN: 81-224-2330-2
2	Erach Bharucha	Environmental Studies	University Grants Commission, New Delhi
3	Rajagopalan R.	Environmental Studies: From Crisis to Cure.	Oxford University Press, USA, ISBN: 9780199459759, 0199459754
4	Shashi Chawla	A text book of Environmental Science	Tata Mc Graw-Hill New Delhi
5	Arvind Kumar	A Text Book of Environmental science	APH Publishing New Delhi (ISBN 978-8176485906)

XIII. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://sdgs.un.org/goals	United Nation's website mentioning Sustainability goals
2	http://www.greenbeltmovement.org/news-and-events/blog	Green Belt Movement Blogs on various climatic changes and other issues
3	http://www.greenbeltmovement.org/what-we-do/tree-planting-for-watersheds	Green Belt Movement's work on tree plantation, soil conservation and watershed management techniques
4	https://www.youtube.com/@ierekcompany/videos	International Experts For Research Enrichment and Knowledge Exchange – IEREK's platform to exchange the knowledge in fields such as architecture, urban planning, sustainability
5	www.mahayouthnet.in	UNICEF Initiative for youth leadership for climate action

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Sr.No	Link / Portal	Description
6	https://eepmoefcc.nic.in/index1.aspx?lsid=297&lev=2&lid=1180&langid=1	GOI Website for public awareness on environmental issues
7	https://egyankosh.ac.in/handle/123456789/61136	IGNOU's Initiative for online study material on Environmental studies
8	https://egyankosh.ac.in/handle/123456789/50898	IGNOU's Initiative for online study material on sustainability
9	https://sustainabledevelopment.un.org/content/documents/11803Official-List-of-Proposed-SDG-Indicators.pdf	Final list of proposed Sustainable Development Goal indicators
10	https://sustainabledevelopment.un.org/memberstates/india	India's Strategies to progress across the SDGs.
11	https://www.un.org/en/development/desa/financial-crisis/sustainable-development.html	Challenges to Sustainable Development
12	https://nptel.ac.in/courses/109105190	NPTEL course on sustainable development
13	https://onlinecourses.swayam2.ac.in/cec19_bt03/preview	Swayam Course on Environmental studies (Natural Resources, Biodiversity and other topics)
14	https://onlinecourses.nptel.ac.in/noc23_hs155/preview	NPTEL course on environmental studies which encompasses SDGs, Pollution, Climate issues, Energy, Policies and legal framework
15	https://www.cbd.int/development/meetings/egmbped/SWOT-analysis-en.pdf	SWOT analysis of Biodiversity
16	https://www.sanskrit.nic.in/SVimarsha/V2/c17.pdf	Central Sanskrit University publication on Vedic and pre Vedic environmental conservation
Note : Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students		

MSBTE Approval Dt. 21/11/2024**Semester - 4, K Scheme**

RAILWAY, BRIDGE AND TUNNEL ENGINEERING**Course Code : 314312**

Programme Name/s : Civil Engineering/ Civil & Rural Engineering/ Construction Technology/ Civil & Environmental Engineering/
Programme Code : CE/ CR/ CS/ LE
Semester : Fourth
Course Title : RAILWAY, BRIDGE AND TUNNEL ENGINEERING
Course Code : 314312

I. RATIONALE

Railway, Bridge and Tunnel Engineering is an important aspect of Civil Engineering as they are very crucial in shortening the distance of travel. Efficient and Effective network of different modes of transportation plays an important role in the Nation's economic progress and its integration. The basic requirements of efficient transportation are speed, safety and comfort. This course is intended to develop the basic skills related to investigation, surveys, alignment, construction and maintenance of Railway, Bridge, and Tunnels.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Execute the construction and maintenance of railways, bridges and tunnels.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Identify the relevant components of Railway Tracks.
- CO2 - Maintain the given Railway Track.
- CO3 - Maintain the given type of bridge through due inspection.
- CO4 - Suggest the relevant method of constructing a tunnel in the given strata.
- CO5 - Supervise the construction of tunnels including maintenance activities.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme						Credits	Assessment Scheme												Total Marks
				Actual Contact Hrs./Week			SL	H	NL		Paper Duration	Theory				Based on LL & TL				Based on SL			
				CL	TL	LL						Practical				Based on SL							
												FA-TH	SA-TH	Total	FA-PR		SA-PR		SLA				
															Max	Min	Max	Min		Max	Min		
314312	RAILWAY, BRIDGE AND TUNNEL ENGINEERING	RBT	DSC	4	-	-	2	6	3	3	30	70	100	40	-	-	-	-	25	10	125		

Total IKS Hrs for Sem. : 3 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

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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	TLO 1.1 Describe the development of Indian railways till date. TLO 1.2 Show the components of railway track in the given cross section of track. TLO 1.3 Suggest the types of sleepers provided for the specified railway track with justification. TLO 1.4 Propose the relevant type of ballast to be provided in specified railway track with justification. TLO 1.5 Identify the fixtures with fastening provided in the given rail section.	Unit - I Introduction to Railway Engineering 1.1 History of development of railways in India (IKS), Railway: Zones of Indian railways, Merits and demerits of roadway and railway, Introduction to Metro and Mono rail, Bullet Train. 1.2 Components of railway track: Rails, ideal requirements of railway track, types of Rails, Rail Gauge- types, factors affecting selection of a gauge. tilting of rails and coning of wheels. Rail Joints : Necessity, types, requirements of welded joints. Creep of rail: Definition, causes and prevention of creep. 1.3 Sleepers : Requirement, functions and types, sleeper density 1.4 Ballast : requirement, function, types, suitability. 1.5 Rail fixtures and fastenings: fish plate, spikes, bolts, keys, bearing plates, chairs, types of anchors and anti-creepers.	Model Demonstration Video Demonstrations Lecture Using Chalk-Board Site/Industry Visit Case Study

RAILWAY, BRIDGE AND TUNNEL ENGINEERING

Course Code : 314312

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.
2	TLO 2.1 Fix the alignment of given railway track laid on typical terrain. TLO 2.2 Draw the cross section of the track showing its geometric elements with neat labels. TLO 2.3 Explain the track geometric components with its importance in its design. TLO 2.4 Explain with sketches the concept of turn outs, points, and crossings w.r.t railway track. TLO 2.5 Propose the relevant type of station with its salient parameters considered in its site selection. TLO 2.6 Justify the necessity of station yard in railway engineering. TLO 2.7 Maintain the track in the capacity of the permanent way inspector.	Unit - II Track Geometrics 2.1 Alignment: Factors governing rail alignment. 2.2 Cross sections of Track : Important technical terms- permanent land width/right of way, formation width, side slopes, side drains. Standard cross section of single and double line in cutting and in embankment. 2.3 Railway Track Geometrics: types and factors affecting Gradient , curves , grade compensation , super elevation- limits of Super elevation on curves , cant deficiency (No numerical in question-paper). 2.4 Branching of Tracks: Points and crossings: Turn out- left and right-hand turnout, components, and their functions ,important technical terms ,track junctions- crossovers, scissor cross over, diamond crossing, track triangle. 2.5 Railway Station : Purpose , requirement of railway station , factors affecting site selection for railway station, important technical terms , types of railway station. 2.6 Station yard: Function , Classification- Passenger, goods, locomotive and marshalling yards, drawbacks of marshalling yards. 2.7 Track Maintenance: Necessity , Classification , Tools required for track maintenance with their function , Organization of track maintenance , Duties of permanent way inspector, gang mate and key man.	Model Demonstration Video Demonstrations Case Study Presentations Lecture Using Chalk-Board Site/Industry Visit
3	TLO 3.1 Elaborate the typical features of major important bridges in India. TLO 3.2 Suggest the relevant type of bridge based on available data. TLO 3.3 Explain Factors affecting Site selection of given type of bridge. TLO 3.4 Explain with sketch Important technical terms related to a bridge. TLO 3.5 Explain with neat sketches the given component of bridge. TLO 3.6 Suggest the relevant type of bridge to be used in the given situation. TLO 3.7 Undertake the inspection of bridge during Pre and post monsoon period. TLO 3.8 Maintain the given type of bridge.	Unit - III Bridge Engineering 3.1 History of development of bridges in India (IKS) 3.2 Classification of bridges: according to span, purpose, material, life, alignment, H.F.L, Loading, level of bridge floor. 3.3 Site selection and investigation Factors affecting and controlling: Site For Bridge, Bridge Alignment. 3.4 Important technical terms: Waterway, Economic Span , Afflux , Scouring , Erosion, Freeboard , Cut Water ,Ease Water, Apron 3.5 Component parts of bridge: Function, requirement, and types- Pier , Abutment , Wing Wall , Foundation , Bearing 3.6 Types of Bridges: Causeway: Flush, low level, and high-level causeway. RCC Bridges , Pre-stressed bridge: Advantage & dis-advantages, Culvert: Types- Arch, Open or slab, Pipe and box 3.7 Inspection of bridges: General points to be observed, Pre and post monsoon inspection. 3.8 Maintenance of bridges: types - routine and special Maintenance.	Model Demonstration Video Demonstrations Case Study Presentations Lecture Using Chalk-Board Site/Industry Visit

RAILWAY, BRIDGE AND TUNNEL ENGINEERING**Course Code : 314312**

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.
4	TLO 4.1 Summarize the typical features of major important tunnels in India. TLO 4.2 Identify the type of the tunnel from the given sketch. TLO 4.3 Explain the criteria for selection of the tunnel for given situation with justification. TLO 4.4 Describe the process of shifting the alignment inside the tunnel through shaft. TLO 4.5 Suggest the relevant method of constructing the tunnel in the given terrain.	Unit - IV Tunnel Engineering 4.1 History of development of tunnels in India (IKS). 4.2 Classification of tunnels: according to purpose, conveyance, strata through which tunnel passing, alignment, shape, and size of tunnels. 4.3 Tunnels: Tunnel investigations and surveying, Cross sections for highways and railways. 4.4 Tunnel Shaft : its purpose and construction. 4.5 Methods of tunnelling in soft rock: Needle Beam method, Fore-Poling method, Line Plate method, Shield method.	Model Demonstration Video Demonstrations Case Study Presentations Lecture Using Chalk-Board Site/Industry Visit
5	TLO 5.1 Suggest the relevant method of constructing the tunnel in the available ground strata. TLO 5.2 Select the relevant type of drilling machine for the given strata. TLO 5.3 Describe the process of lining in the given tunnel in the given situation with justification. TLO 5.4 Justify the need to provide the provision for ventilation and drainage in the tunnel. TLO 5.5 Describe the procedure of maintenance of the given tunnel.	Unit - V Construction and Maintenance of Tunnels 5.1 Methods of Tunnelling in Hard Rock: Full-face method, Heading and bench method, drift method, New Austrian Tunnelling Method (NATM). 5.2 Drilling Equipment: TBM Tunnel Boring Machine, drills and drills carrying equipment's, Types of explosives used in tunnelling. 5.3 Tunnel Lining: Purpose, factors affecting type of lining, and methods. 5.4 Tunnel Ventilation and Drainage: Purpose and methods. 5.5 Tunnel Maintenance: Purpose and Methods.	Model Demonstration Video Demonstrations Case Study Presentations Lecture Using Chalk-Board Site/Industry Visit

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES : NOT APPLICABLE.**VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)****Micro project**

- Prepare report on Railway Zones in India .
- Prepare model of a bridge/Tunnel to demonstrate the relevant concepts.
- Prepare models of different gauges used in railways.
- Collect the details of new technologies of tunnel excavation and prepare the report.
- Collect the information relevant to transportation engineering about ongoing and completed Railway/Bridge/Tunnel projects. (Minimum 3)
- Role of Indian Railway (IR), MSRDC, NHAI and IRC in development and construction of Railways, Tunnels and Bridges.
- Prepare a report on Bullet Train, Mono rail, Metro Rail project.

RAILWAY, BRIDGE AND TUNNEL ENGINEERING**Course Code : 314312**

- Summarize the salient features of relevant IS codes used in this course in the form of a report.

Assignment

- Inspect nearby Railway Track /Bridge/Tunnel (any one) to enumerate the defects if any and prepare the report suggesting remedial measures for ensuring its stability.
- Draw the standard cross section of single line and double line railway on embankment and in cutting.
- List the advanced equipment's/machineries and materials required for preparation of subgrade of railway.
- Compile the relevant information on project Atal tunnel/Patalpani Rail tunnel with your own comments.
- Compile the relevant information on project Bandra Worli sea link bridge/Pamban Bridge with your own comments.
- Visit a nearby Bridge site/Tunnel and prepare a detailed photographic report.
- Compile the relevant information on project Mumbai to Ahmadabad Bullet Train with your own comments.
- Prepare a site visit report to the nearby railway station mentioning the details of the type of station, requirements fulfilling the station and any other important findings with required figures and facts.

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	Computer with internet facility	All

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	Introduction to Railway Engineering	CO1	10	4	4	4	12
2	II	Track Geometrics	CO2	18	4	12	6	22
3	III	Bridge Engineering	CO3	14	2	6	6	14
4	IV	Tunnel Engineering	CO4	10	4	4	4	12
5	V	Construction and Maintenance of Tunnels	CO5	8	0	4	6	10
Grand Total				60	14	30	26	70

X. ASSESSMENT METHODOLOGIES/TOOLS**Formative assessment (Assessment for Learning)**

- Under SLA : Assignment, Microproject (60% Weightage to process and 40% weightage to product), Question and Answer

Summative Assessment (Assessment of Learning)

RAILWAY, BRIDGE AND TUNNEL ENGINEERING**Course Code : 314312**

- Pen and Paper Test (Written Test)

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

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	S. C. Saxena , S. P. Arora	A Text Book of Railway Engineering	Dhanpat Rai Publications (p) Ltd.-New Delhi ISBN-13:978-8189928834
2	Bindra S. P.	Elements of Bridge ,Tunnel & Railway Engineering	Dhanpat Rai Publications (p) Ltd.-New Delhi ISBN: 9789383182220, 9383182229
3	Ahuja & Birdi	Roads, Railways, Bridges and Tunnels Engineering	Standard Book House ISBN: 978-81-89401-33-7
4	Raji A K, K K Babu	Transportation Engineering (Theory and Practice)	AICTE New Delhi ISBN 978-81-960576-1-9
5	N L Arora	Transportation Engineering	New India Publishing House, New Delhi
6	R. Srinivasan	Harbour, Dock and Tunnel Engineering	Charotar Publishing House Pvt. Ltd.ISBN-13 978-9385039195

XIII. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://indianrailways.gov.in/	Indian Railway Zones (IKS)
2	https://iricen.gov.in/iricen/BooksList.jsp	IRICEN Books on Railway and Bridge Engineering
3	https://nhsrcl.in/en/home	National High Speed Rail Corporation Limited (Bullet Train)
4	https://msrdc.in/Site/Common/ProjectListDetails.aspx?ID=56&MainId=18	Versova-Bandra Sea Link Project by MSRDC
5	https://marvels.bro.gov.in/AtalTunnel	Atal Tunnel, Rohtang
6	https://archive.nptel.ac.in/courses/105/105/105105216/	Bridge Engineering video lectures by NPTEL
7	https://nptel.ac.in/courses/105107123	Railway Engineering video lectures by NPTEL
8	https://mmrda.maharashtra.gov.in/projects/transport/metro-line-1/overview	Mumbai Metropolitan Region Development Authority

RAILWAY, BRIDGE AND TUNNEL ENGINEERING**Course Code : 314312**

Sr.No	Link / Portal	Description
Note : Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students		

MSBTE Approval Dt. 21/11/2024**Semester - 4, K Scheme**

HYDRAULICS**Course Code : 314303**

Programme Name/s	: Agricultural Engineering/ Civil Engineering/ Civil & Rural Engineering/ Construction Technology/ Civil & Environmental Engineering
Programme Code	: AL/ CE/ CR/ CS/ LE
Semester	: Fourth
Course Title	: HYDRAULICS
Course Code	: 314303

I. RATIONALE

Hydraulics is a course of civil engineering which consists of study of fluid behavior and design of hydraulic structures. The study of hydraulics plays a important role in various civil engineering applications such as water supply, wastewater management, drainage systems and hydraulic structures. Understanding hydraulics for civil engineers will help them to make decisions during design of hydraulic structures and ensuring the efficient management of water supply and wastewater sources. In this course, student will learn behavior of fluid at rest, fluid in motion, flow through open channel and flow through pipe.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

- Apply the principles of hydraulics in given situation to solve the civil engineering problem.

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 pressure parameters obtained from pressure measuring devices in liquids.
- CO2 - Determine total hydrostatic pressure and center of pressure for different conditions.
- CO3 - Calculate relevant parameters for given fluid flow.
- CO4 - Determine loss of head for flow through pipe in given situation.
- CO5 - Find the relevant fluid flow parameters in open channels.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												Total Marks		
				Actual Contact Hrs./Week			SL	H		NLH	Paper Duration	Theory				Based on LL & TL				Based on SL				
				CL	TL	LL						Practical												
												FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA				
														Max	Max	Max	Min	Max	Min	Max	Min		Max	Min
314303	HYDRAULICS	HYD	DSC	4	-	2	2	8	4	3	30	70	100	40	25	10	25@	10	25	10	175			

HYDRAULICS**Course Code : 314303****Total IKS Hrs for Sem. : 0 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	TLO 1.1 Describe the role of hydraulics in the given civil engineering application. TLO 1.2 Compute different properties of liquid from given data. TLO 1.3 Convert gauge pressure into absolute pressure for the given data and vice-versa. TLO 1.4 Compute pressure at a point and pressure difference between two points for the given data using appropriate device.	Unit - I Pressure Measurement 1.1 Technical terms used: Fluid, Fluid Mechanics, Hydraulics, Hydrostatics, and hydrodynamics-Ideal and Real Fluid, Application of hydraulics in Civil Engineering field. 1.2 Physical properties of fluid : Mass Density, Weight Density, Specific Volume, Specific Gravity, Surface Tension of Water, Capillarity of Water, Viscosity, Units of Viscosity, Kinematic Viscosity, Newton's law of Viscosity. 1.3 Various types of pressure: Fluid Pressure, Pressure Head, Pascal's Law and its applications, Absolute Pressure, Gauge Pressure, Atmospheric Pressure, Vacuum Pressure. 1.4 Pressure Measuring Devices: Piezometer, Simple U tube Manometer, U Tube Differential Manometer and Inverted U Tube Differential Manometer, Bourdon Tube Pressure Gauge.	Model Demonstration Video Demonstrations Demonstration Presentations Lecture Using Chalk-Board Hands-on Site/Industry Visit Case Study
2	TLO 2.1 Determine the variation of pressure with depth for the given fluid. TLO 2.2 Find Total Pressure and Centre of Pressure for given immersed surface. TLO 2.3 Calculate the resultant pressure and its position using pressure diagram.	Unit - II Hydrostatics 2.1 Definition of Hydrostatics, Total Pressure and Centre of Pressure :Concept and Applications. 2.2 Total Hydrostatic Pressure and Center of Pressure :on:Horizontally, Vertically Immersed Surfaces: for rectangular, Triangular and Circular lamina. 2.3 Total Pressure and Center of Pressure using Pressure diagram on sides, bottom and partition wall of a tank.	Model Demonstration Video Demonstrations Demonstration Presentations Lecture Using Chalk-Board Hands-on

HYDRAULICS**Course Code : 314303**

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	TLO 3.1 Identify the type of flow using the concept of Reynold Number. TLO 3.2 Calculate discharge and velocity in the given situation using Continuity Equation. TLO 3.3 Calculate Total Energy of the given fluid flow. TLO 3.4 Apply Bernoulli's Theorem in the given situation to calculate losses and direction of flow.	Unit - III Hydro kinematics and Hydro dynamics 3.1 Types of Fluid Flow: Steady, unsteady, uniform, non uniform, laminar, turbulent, compressible and incompressible flow, Reynold's number. 3.2 Discharge: Definition, Unit, Continuity Equation. 3.3 Energies associated with fluid flow: Potential, Kinetic, Pressure Energy and total energy. 3.4 Bernoulli's Equation: Statement, Assumptions, Equation, Practical applications, Modified Bernoulli's Theorem.	Model Demonstration Video Demonstrations Demonstration Presentations Lecture Using Chalk-Board Hands-on
4	TLO 4.1 Apply the Darcy Weisbach equation to calculate the relevant losses in a pipe flow. TLO 4.2 Calculate minor losses from the given data. TLO 4.3 Calculate Discharge of pipe system (in Parallel and in series) and Design equivalent pipe. TLO 4.4 Draw HGL and TEL from the given data. TLO 4.5 Calculate discharge in a pipe for the given data using venturimeter. TLO 4.6 Calculate coefficients of Orifice Cd, Cc, Cv for given data. TLO 4.7 Suggest the type of pump for given situation. TLO 4.8 Describe the working of the centrifugal pump with sketch. TLO 4.9 Describe the different types of heads associated with Centrifugal pump. TLO 4.10 Compute the power required for Centrifugal pump from the given data.	Unit - IV Flow through Pipes And Pumps 4.1 Major head loss in pipe: Frictional loss and its computation by Darcy Weisbach equation. (Simple Numericals on Darcy Weisbach equation) 4.2 Minor Energy (Head) losses in pipe: Sudden Enlargement, Sudden Contraction, loss of head at entrance of pipe, loss of head at exit of pipe, loss of head due to bend in pipes and fittings. 4.3 Flow through pipes in series, pipes in parallel and Dupit's equation for equivalent pipe. 4.4 Hydraulic Gradient Line and Total Energy Line (No Numerical, only representative Diagram). 4.5 Discharge measuring device for pipe flow: Venturimeter, Construction and working. 4.6 Discharge measuring for a tank: using Orifice, Hydraulic Coefficients of Orifice. 4.7 Pump: Types of pump :Centrifugal, Reciprocating pumps and Submersible pumps. 4.8 Centrifugal pump: Component parts and working. 4.9 Types of heads :Suction head, delivery head, static head and Manometric head. 4.10 Compute power requirement of Centrifugal Pump.	Model Demonstration Video Demonstrations Demonstration Presentations Lecture Using Chalk-Board Hands-on Site/Industry Visit

HYDRAULICS**Course Code : 314303**

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.
5	TLO 5.1 Describe the geometrical properties of the given Channel. TLO 5.2 Determine discharge in the given channel using relevant formulae for the given data. TLO 5.3 Design the most economical channel section for the given conditions. TLO 5.4 Describe the procedure of finding velocity and discharge using the given flow measuring device. TLO 5.5 Measure the velocity of flow through open channel for the given condition.	Unit - V Flow through Open Channel 5.1 Geometrical properties of Channel section: Wetted area, Wetted perimeter, Hydraulic Radius for Rectangular and Trapezoidal Channel section. 5.2 Determination of discharge by Chezy's equation and Manning's equation. 5.3 Conditions for most economical rectangular and trapezoidal channel section. 5.4 Discharge Measuring Devices: 'V' Notches and Rectangular Notches. 5.5 Velocity measurement devices: Floats, Pitot tube.	Model Demonstration Video Demonstrations Demonstration Presentations Lecture Using Chalk-Board Hands-on Site/Industry Visit

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 physical parameters of given sample of tap water and muddy water.	1	*Computation of physical properties of given fluid (tap water and muddy water).	2	CO1
LLO 2.1 Determine the physical properties of given sample of oil and Mercury.	2	Computation of physical properties of given liquid (oil and Mercury).	2	CO1
LLO 3.1 Measure the pressure at a given point using Bourdon Gauge.	3	Use of Bourdon Gauge to measure the pressure at a given point.	2	CO1
LLO 4.1 Measure the pressure difference between two given points using U tube differential manometer.	4	*Use of U tube differential manometer to measure the pressure difference between two given points.	2	CO1
LLO 5.1 Calculate the resultant pressure and its position for given situation of liquid in a tank.	5	*Find the resultant pressure and its position for given situation of liquid in a tank.	2	CO2
LLO 6.1 Interpret type of flow based on computed value of Reynold's number.	6	Use of Reynold's apparatus to determine type of flow.	2	CO3
LLO 7.1 Apply Bernoulli's theorem the given situation to obtain Total Energy Line.	7	*Use of Bernoulli's apparatus to obtain Total Energy Line for flow in closed conduit of varying cross sections.	2	CO3
LLO 8.1 Determine friction factor for the given pipe using Friction factor Apparatus.	8	*Use of Friction factor Apparatus to determine the friction factor for the given pipe.	2	CO4
LLO 9.1 Determine minor losses in pipe fittings (sudden contraction and Sudden enlargement).	9	*Determination of minor losses in pipe for sudden contraction and sudden enlargement.	2	CO4
LLO 10.1 Calculate minor losses in pipe fitting (Bend and Elbow).	10	Determination of minor losses in pipe fitting such as Bend and Elbow.	2	CO4
LLO 11.1 Determine the Coefficient of discharge for the given venturimeter fitted in pipe section.	11	*Calibration of Venturimeter to find out the discharge in a pipe.	2	CO4
LLO 12.1 Calculate Cd, Cc and Cv for given type of Orifice.	12	Calibration of Orifice to find out the discharge through a tank.	2	CO4

HYDRAULICS**Course Code : 314303**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 13.1 Calculate the efficiency of given Centrifugal Pump.	13	*Determination of efficiency of given Centrifugal Pump.	2	CO4
LLO 14.1 Determine the Coefficient of discharge for given 'V' notch fitted to open channel.	14	*Use of 'V' notch to measure the discharge through open channel.	2	CO5
LLO 15.1 Determine the Coefficient of discharge for flow through open channel using rectangular notch.	15	Use of rectangular notch to measure the discharge through open channel.	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**

- Collect the technical brochure of available brands of pump in the market and prepare report with your comments. Determination of type and capacity of pump for residential bungalow (06 Occupants) of G+1 Storey having 200 Sq m built up area.
- Prepare a model of rectangular and trapezoidal channel.

Assignment

- State and explain causes and remedial measures of water hammer.
- Explain the necessity of hydraulic jump.
Explain with neat sketch working of single acting and double acting reciprocating pump.
Explain critical, sub critical and supercritical flow with reference to Froude's number.

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 judicial 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	Measuring cylinder, Weighing balance	1,2
2	Pipe setup, bend, elbow fittings, stop watch	10
3	Pipe set up fitted with Venturimeter, U tube differential manometer, Stop watch	11
4	Centrifugal pump set up	13
5	Channel set up with different notches, Stop watch	14,15
6	U tube differential manometer, Mercury	2,4
7	Bourdon tube pressure gauge	3

HYDRAULICS**Course Code : 314303**

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
8	Reynold's apparatus, colour dye, Stop watch	6
9	Bernoulli's apparatus, Stop watch	7
10	Friction factor Apparatus, Stop watch	8
11	Apparatus for finding minor losses in the pipe, Stop watch	9

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	Pressure Measurement	CO1	12	2	8	4	14
2	II	Hydrostatics	CO2	12	2	8	4	14
3	III	Hydro kinematics and Hydro dynamics	CO3	10	2	4	6	12
4	IV	Flow through Pipes And Pumps	CO4	16	4	10	6	20
5	V	Flow through Open Channel	CO5	10	4	0	6	10
Grand Total				60	14	30	26	70

X. ASSESSMENT METHODOLOGIES/TOOLS**Formative assessment (Assessment for Learning)**

- Term work ,Assignment, Microproject (60% Weightage to process and 40% weightage to product), Question and Answer

Summative Assessment (Assessment of Learning)

- Pen and Paper Test (Written Test), Practical Exam , Oral Exam

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	2	3	3	2	3	2	2			
CO2	2	2	3	2	2	2	2			
CO3	2	2	3	3	2	2	2			
CO4	2	2	2	2	2	2	2			
CO5	2	3	2	1	2	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	Modi, P. N. and Seth, S.M.	Hydraulics and Fluid Mechanics	Standard book house, Delhi ISBN:13: 978-8189401269;

HYDRAULICS**Course Code : 314303**

Sr.No	Author	Title	Publisher with ISBN Number
2	Ramamrutham S, and Narayan, R.	Hydraulics, Fluid Mechanics and Fluid Machines	Dhanpat Rai Publishing Company, New Delhi, ISBN:8187433841
3	Khurmi, R S	Hydraulics, Fluid Mechanics, Hydraulic machines	S Chand Publishers, New Delhi ISBN: 9788121901628
4	Rajput, R K	Fluid Mechanics	S Chand, New Delhi ISBN: 9788121916677
5	Dr. R.K. Bansal	Fluid mechanics and hydraulic machines	Laxmi Publication; New Delhi, ISBN: 978-8131808153

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://eerc03-iiith.vlabs.ac.in/	An MoE, Govt of India virtual laboratory of Hydraulics and Fluid Mechanics.
2	https://nptel.ac.in/courses/105105203	Basics of Fluid Mechanics
3	https://archive.nptel.ac.in/courses/105/106/105106114/	Classification of flow
4	https://nptel.ac.in/courses/105103021	Open Channel flow
5	http://www.nitttrc.edu.in/nptel/courses/video/105101082/L01.html	Fluid Properties
6	https://onlinecourses.nptel.ac.in/noc24_ce20/preview	Hydraulic Jump
7	http://www.nitttrc.edu.in/nptel/courses/video/105103021/L01.html	Advanced Hydraulics
8	https://www.youtube.com/watch?v=mIF7nQBbaj0&list=UU__JX7j7HYXROO6jCAUmHIw&index=231	Fluid Pressure
9	https://www.youtube.com/watch?v=-jb5A9GIuNQ	Energy Gradient of pipe flow
10	https://www.youtube.com/watch?v=qie6UCJqM_Q	Bernoulli's Equation
11	https://www.youtube.com/watch?v=PH75Y1wIubQ	Hydraulic Pumps

Note :

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

MSBTE Approval Dt. 21/11/2024

Semester - 4, K Scheme

ESTIMATING, COSTING AND VALUATION**Course Code : 314313**

Programme Name/s : Civil Engineering/ Civil & Rural Engineering/ Construction Technology/ Civil & Environmental Engineering/
Programme Code : CE/ CR/ CS/ LE
Semester : Fourth
Course Title : ESTIMATING, COSTING AND VALUATION
Course Code : 314313

I. RATIONALE

In the construction of any civil engineering structure, estimating, costing, and valuation are the fundamental processes that provide valuable insights and support to project planning, budgeting, resource allocation, decision-making, contract negotiation, compliance, performance evaluation, and investment analysis. Today being the era of technology, a provision is also required to be made to implement the above mentioned processes through the use of the various software for achieving the speedy determination of quantities with inbuilt accuracy and precision. This course is specifically designed to develop the basic competencies among the learners to discharge their duties in the field with high efficiency and effectiveness to mitigate risks in projects and thereby to achieve the strategic objective.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Estimate for the given construction materials, labor, and resources required for construction projects accurately.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Use the relevant modes of measurements for the given item of work.
- CO2 - Prepare approximate estimate of a civil engineering works.
- CO3 - Prepare detailed estimate of a civil engineering works.
- CO4 - Fix the rate for the given item of work using relevant rate analysis technique.
- CO5 - Conduct the process of the valuation for the specified purpose.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												Total Marks	
				Actual Contact Hrs./Week	SLH NLH			Paper Duration		Theory				Based on LL & TL				Based on SL					
														Practical									
										CL	TL	LL	FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
																	Max	Min	Max	Min	Max		Min
314313	ESTIMATING, COSTING AND VALUATION	ECV	DSC	4	-	4	-	8	4	4	30	70	100	40	50	20	25#	10	-	-	175		

Total IKS Hrs for Sem. : 0 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	TLO 1.1 Justify the importance of an Administrative Approval and Technical Sanction in civil engineering projects. TLO 1.2 Perform the role of an estimator in civil engineering projects TLO 1.3 Write the detailed specifications for the given construction project. TLO 1.4 Undertake the relevant modes of measurement as per IS 1200 TLO 1.5 Apply the rule of deduction for the given construction work as per IS: 1200 TLO 1.6 Use the various formats of measurements and bill of quantities for the given work.	Unit - I Basics of Estimating and costing 1.1 Introduction: Estimating, Types and purpose, costing, Administrative Approval, Technical Sanction and Budget provision. 1.2 Roles and responsibility of Estimator. 1.3 SSR: Meaning, Purpose, Checklist and Detailed Specification of items of work in load bearing and framed structure as per the Execution. 1.4 Modes of measurement and desired accuracy in measurements of different items of work as per IS: 1200. 1.5 Rules for deduction in Masonry work, Plastering and Pointing and Painting work as per IS: 1200. 1.6 Standard formats of Measurement sheet, Abstract sheet, Face sheet.	Lecture Using Chalk-Board Presentations Video Demonstrations
2	TLO 2.1 Specify the purpose of an approximate estimate in the given civil engineering project. TLO 2.2 Use relevant type of method to prepare an approximate estimate TLO 2.3 Prepare an approximate estimate for the given civil engineering structure.	Unit - II Approximate Estimate 2.1 Approximate estimate: Definition, Purpose, types. 2.2 Methods of approximate estimate: Service unit method, Plinth area rate method, Cubical content method, Typical bay method, Approximate quantity method. (Numerical on any one method out of Service unit method, Plinth area rate method, Typical bay method). 2.3 Approximate estimate for roads, Railways, bridges/culvert, irrigation projects and water supply projects.	Lecture Using Chalk-Board Presentations Flipped Classroom

ESTIMATING, COSTING AND VALUATION**Course Code : 314313**

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	TLO 3.1 Explain the procedure of the detailed estimate for the given project. TLO 3.2 Classify the detailed estimate based on the purpose of civil work. TLO 3.3 Propose the relevant method of detailed estimate for the given project. TLO 3.4 Determine the quantities for given Load bearing structure. TLO 3.5 Calculate the quantities of given component of RCC framed structure. TLO 3.6 Prepare the bar bending schedule for the given component of RCC project. TLO 3.7 Estimate the steel requirement of given building component. TLO 3.8 Prepare the bill of quantity for the given civil work. TLO 3.9 Calculate the earthwork quantity for the given civil Engineering work.	Unit - III Preparation of Detailed Estimate 3.1 Detailed Estimate: Definition and Purpose, Data required for detailed estimate, Procedure of preparation of detailed estimate, taking out quantities and Abstracting in prescribed format. 3.2 Types and Uses of detailed Estimates: Revised estimate, supplementary estimate, revised and supplementary estimate, repair and maintenance estimate. 3.3 Methods of Detailed Estimate- a) Unit quantity method and total quantity method. b) Long wall and Short wall method (out to out and in to in method or PWD method), Centre line method. 3.4 Calculate the quantities of the given items for the given load bearing structure. 3.5 Calculate the quantities of the given items for the given RCC framed structure. 3.6 Bar bending schedule, Rebar: Meaning, Purposes. 3.7 Steel requirement for footing, column, beam, Lintel, chajja and slab, Determination of rebar quantities as per IS 2502:1963. 3.8 Provisions in detailed estimate: contingencies, work charged establishment, centage charges, water supply and sanitary Charges and electrification charges. 3.9 Earthwork : Quantities for roads, Bunds and canal by Mid sectional area method, Mean sectional area method, Prismoidal formula method and trapezoidal formula method.	Lecture Using Chalk-Board Presentations Video Demonstrations Site/Industry Visit Case Study
4	TLO 4.1 Explain the importance of rate analysis in civil engineering. TLO 4.2 Justify the importance of sundry charges in the estimate of the civil work TLO 4.3 Fix the market rate of a given item of work using relevant rate analysis method TLO 4.4 Assign different skilled labor for different items TLO 4.5 Deploy the relevant type of manpower for the specified work. TLO 4.6 Prepare rate analysis for the given items of work.	Unit - IV Rate Analysis 4.1 Rate Analysis: Definition, purpose, importance and factors affecting. 4.2 Sundry Expenses: Lead (Standard and Extra), lift, overhead charges, water charges and contractors profit. 4.3 Procedure of rate analysis market rate determination etc. 4.4 Task work- Definition, factors Affecting, types, Task work of different skilled labor for different items. 4.5 Categories of labors, their daily wages, types and number of labors for different items of work. 4.6 Preparing rate analysis of different items of work: PCC, RCC work in (column, beam, lintel, slab), brick masonry, stone masonry, Vitrified tile flooring, plastering.	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom

ESTIMATING, COSTING AND VALUATION**Course Code : 314313**

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.
5	TLO 5.1 Explain the purpose of valuation of the given civil structure. TLO 5.2 Differentiate between the terms, “cost, value and price” with their significance in civil engineering. TLO 5.3 Classify the value of the given structure. TLO 5.4 Calculate the depreciation of the cost of the given structure using relevant method of depreciation. TLO 5.5 Compute the capitalized value of the structure based on given data. TLO 5.6 Calculate monthly rent of the given building as per PWD norms. TLO 5.7 Signify the importance of the terms, “Lease and Mortgage”.	Unit - V Valuation 5.1 Definition and purpose of Valuation, role of valuer. 5.2 Define: Cost, Price and Value, Characteristics of Value, Factors Affecting Value. 5.3 Types of Value: Book Value, Scrap Value, Salvage Value, Speculative Value, Distress Value, Market Value, monopoly Value, Sentimental Value. 5.4 Depreciation, Obsolescence, Sinking Fund. Methods of Calculation of Depreciation : Straight Line Method, Sinking Fund Method, Constant Percentage Method. 5.5 Computation of capitalized value, Gross income, Outgoings, Net Income, Year Purchase, Types of outgoings. 5.6 Fixation of rent as per PWD Norms and Practice. 5.7 Lease : types of lease, lease hold property and free hold property, Mortgage : Mortgage deed, precautions to be taken while making mortgage.	Presentations Case Study Site/Industry Visit

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 Prepare the check list of items to be executed with market rates and units for detailed estimate of the given structure from the given drawing.	1	Prepare the checklist of items from given drawing.	2	CO1
LLO 2.1 Analyze the SSR of into relevant categories and subcategories of construction activities.	2	*Analysis of SSR for any five item of construction.	2	CO1
LLO 3.1 Prepare the approximate estimate for the given civil engineering works. (service unit method)	3	*Prepare approximate estimate by using service unit method.	2	CO2
LLO 4.1 Prepare the approximate estimate for the given civil engineering works. (Typical bay method)	4	*Prepare approximate estimate by using Typical bay method.	2	CO2
LLO 5.1 Use long wall short wall method to determine the quantity of items of work (Excavation,PCC ,UCR,DPC) using standard measurement sheet for 1BHK load bearing residential Building (Part-I).	5	*Determine the quantities for Excavation, PCC ,UCR, DPC of 1BHK load bearing residential building using long wall short wall method. (Part I)	2	CO3
LLO 6.1 Use long wall short wall method to determine the quantity of items of work (Brick Work,Plastering, flooring, slab)using standard measurement sheet for 1BHK load bearing residential Building (Part-II	6	*Determine the quantities for Brick Work, Plastering, flooring, slab of 1BHK load bearing residential building using long wall short wall method. (Part II)	2	CO3

ESTIMATING, COSTING AND VALUATION**Course Code : 314313**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 7.1 Use Center line method to determine the quantity of items of work (Excavation,PCC ,UCR,DPC) using standard measurement sheet for 1BHK load bearing residential Building. (Part-I)	7	Determine the quantities for Excavation, PCC ,UCR,DPC of 1BHK load bearing residential building using Center line method (Part I).	2	CO3
LLO 8.1 Use Center line method to determine the quantity of items of work (Brick Work,Plastering, flooring, slab)using standard measurement sheet for 1BHK load bearing residential Building (Part-II)	8	Determine the quantities for Brick Work, Plastering, flooring, slab of 1BHK load bearing residential building using Center line method (Part II).	2	CO3
LLO 9.1 Prepare detailed estimate for RCC (G+1) residential framed structure from the given drawing. (Part-I)	9	*Prepare detailed estimate with abstract for RCC (G+1) residential framed structure. (Part I) (Manual)	2	CO3
LLO 10.1 Prepare detailed estimate for RCC (G+1) residential framed structure from the given drawing. (Part-II)	10	*Prepare detailed estimate with abstract for RCC (G+1) residential framed structure. (Part II) (Manual)	2	CO3
LLO 11.1 Use the relevant open source software to prepare detailed estimate for RCC (G+1) residential framed structure from the given drawing. (Part-I)	11	*Prepare detailed estimate with abstract for RCC (G+1) residential framed structure using relevant available open source Software.(Part-I)	2	CO3
LLO 12.1 Use the relevant open source software to prepare detailed estimate for RCC (G+1) residential framed structure from the given drawing. (Part-II)	12	Prepare detailed estimate with abstract for RCC (G+1) residential framed structure using relevant available open source software.(Part-II)	2	CO3
LLO 13.1 Calculate the reinforcement quantities for footing of a room size for 4 m X 5 m from the given set of drawings.	13	Prepare the bar bending schedule with reinforcement estimate for the footing of given structure.	2	CO3
LLO 14.1 Calculate the reinforcement quantities for column of a room size for 4 m X 5 m from the given set of drawing.	14	*Prepare the bar bending schedule with reinforcement estimate for the column of given structure.	2	CO3
LLO 15.1 Calculate the reinforcement quantities for beam of a room size for 4 m X 5 m from the given set of drawing.	15	Prepare the bar bending schedule with reinforcement estimate for the beam of given structure.	2	CO3
LLO 16.1 Calculate the reinforcement quantities for slab of a room size for 4 m X 5 m from the given set of drawing.	16	*Prepare the bar bending schedule with reinforcement estimate for the slab of given structure.	2	CO3
LLO 17.1 Estimate the steel quantity from the given drawing using IS code 2502-1963 for rebaring of beam structural members.	17	Prepare the bar bending schedule with reinforcement estimate for rebaring of beam to be extended.	2	CO3
LLO 18.1 Estimate the steel quantity from the given drawing using IS code 2502-1963 for rebaring of column structural members.	18	Prepare the bar bending schedule with reinforcement estimate for rebaring of column to be extended.	2	CO3
LLO 19.1 Use the Trapezoidal method to determine the earth work quantity in embankment and cutting.	19	*Determine the earth work quantity in embankment and cutting using Trapezoidal method.	2	CO3
LLO 20.1 Use the Prismoidal method to determine the earth work quantity in embankment and cutting.	20	Determine the earth quantity in embankment and in cutting using Prismoidal method.	2	CO3
LLO 21.1 Use the mid sectional area method to determine the earth work quantity in embankment and cutting	21	*Determine the earth work quantity in embankment and in cutting using mid sectional area method.	2	CO3

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 22.1 Use the mean area method to determine the earth work quantity in embankment and cutting.	22	Determine the earth work quantity in embankment and cutting using mean area method.	2	CO3
LLO 23.1 Use the relevant open source software to prepare detailed estimate of the WBM Road. (Part I)	23	Prepare the detailed estimate of W.B.M. Road using relevant open source software (Part I)	2	CO3
LLO 24.1 Use the relevant open source software to prepare detailed estimate of the WBM Road. (Part II)	24	Prepare the detailed estimate of W.B.M. Road using relevant open source software (Part II)	2	CO3
LLO 25.1 Prepare the detailed estimate for small septic tank from given set of drawing. (Part I)	25	Prepare the detailed estimate for small septic tank (Part I)	2	CO3
LLO 26.1 Prepare the rate analysis for the given five item of work.	26	*Prepare the rate analysis for the given five item of work.	2	CO3
LLO 27.1 Carry out survey of different categories of labor it's types, and no of labor for different item of work on site and prepare its report..	27	*Carry out survey and prepare a report on different Categories and types of labor required for completion of various items of work on site. (visit and compare any three sites).	2	CO4
LLO 28.1 Prepare the chart reflecting all values pertaining to valuation of residential building with their significance.	28	Create a chart reflecting all values pertaining to valuation of residential building with their significance.	2	CO5
LLO 29.1 Determine the valuation of a given structure and submits the valuation report in prescribed formats.	29	*Prepare the valuation report for the given building.	2	CO5
LLO 30.1 Determine the monthly rent of the given area of the building from the given data.	30	*Determine the monthly rent of the given area of building from the given data.	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

- Enlist the minimum ten salient provisions made in IS:1200 with special reference to load bearing structure.
- Enlist the minimum ten salient provisions made in IS:1200 with special reference to Framed structure.
- Prepare detailed estimate of minimum one load bearing structure using available open source software.
- Rate analysis by analyzing no of labor required for different items of civil works such as 10 cu. m excavation, cement concrete in foundation, Bricks work, rubble stone masonry works. Etc. and 100 m² 12mm thick plastering, 20 mm thick Damp proof course, cement pointing, white washing etc.
- Collect the rebar reinforcement drawings of minimum one building and interpret the drawings with report.
- Prepare rate analysis of Painting work for OBD, Plastic emulsion, Oil paint, luster paint having minimum 150 m² area.
- Prepare approximate estimate of minimum one residential building.
- Prepare valuation report of minimum one residential building.
- Workout quantities of cement, sand and bricks for 30 m³, 40 m³, 50 m³, 60 m³ in cement mortar 1:6

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	Computer systems with internet connection	3
2	Available Software of estimating and Costing.	3

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	Basics of Estimating and costing	CO1	6	2	4	0	6
2	II	Approximate Estimate	CO2	8	0	4	4	8
3	III	Preparation of Detailed Estimate	CO3	24	6	14	10	30
4	IV	Rate Analysis	CO4	12	4	4	6	14
5	V	Valuation	CO5	10	2	4	6	12
Grand Total				60	14	30	26	70

X. ASSESSMENT METHODOLOGIES/TOOLS**Formative assessment (Assessment for Learning)**

- Two-unit tests of 30 marks will be conducted and average of two-unit test considered for formative assessment of exercises writing 50 marks. Each exercise will be assessed considering appropriate % weightage to process and product and other instructions of assessments.

Summative Assessment (Assessment of Learning)

- Term Work, Practical Exam, Oral and Written End semester Exam

XI. SUGGESTED COS - POS MATRIX FORM

ESTIMATING, COSTING AND VALUATION**Course Code : 314313**

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

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	Datta, B.N.	Estimating and Costing in Civil engineering	UBS Publishers Distributors Pvt. Ltd. New Delhi. ISBN:9788174767295
2	Chakraborti,M.	Estimating and costing, specification and valuation in civil engineering	Monojit Chakraborti, Kolkata (2006) ISBN-10: 818530436X ISBN-13: 978-8185304366
3	Patil, B.S.	Civil Engineering Contracts and Estimates	Orient Longman, Mumbai, Ed.2010 ISBN: 9788173715594, 8173715599
4	Rangwala,S.C.	Valuation of Real Properties	Charotar Publishing House Pvt. Limited (2008) ISBN:9788185594774, 8185594775
5	Birdie,G.S.	Estimating and Costing	Dhanpat Rai Publishing Company(P) Ltd.NewDelhi110002 ISBN : 978-93-84378-13-4

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://mjp.maharashtra.gov.in/schedule-rate-dsr/	Schedule Rate (DSR) Maharashtra Jeevan Pradhikaran
2	https://mjp.maharashtra.gov.in/schedule-rate-dsr/	CPWD in house codes, manuals, schedules, technical specifications, design manuals and technical publications.
3	https://www.microsoft.com/en-in/microsoft-365/excel	Microsoft Excel 365 open source software
4	https://www.youtube.com/watch?v=IoBd5UhGifs	Full Building Estimation in Excel sheet
5	https://youtube.com/playlist?list=PLMCEXauCXvoOGL3nP49ee_-Ua tf1PAJ8q&si=N4gNlyNL3PzLvRTx	Estimating, Costing and Valuation
6	https://www.youtube.com/watch?v=iry2zEoPvsU	Sinking Fund / Book Value / Scrap Value / Market Value / Salvage Value / Valuation
7	https://www.youtube.com/watch?v=C6O09yOa45c	Rate Analysis Of Civil Work How to Prepare Rate Analysis Rate Analysis for 1000 sqft house plan
8	https://www.youtube.com/watch?v=H5qIwRCOFn4&list=PLv20kpHlal H1zD-oueYjooR-KdO6q_NLa&index=4	Administrative approval, Technical sanction and Budget provision

ESTIMATING, COSTING AND VALUATION**Course Code : 314313**

Sr.No	Link / Portal	Description
9	https://www.youtube.com/watch?v=ZAnIaZIMGtw&list=PLv20kpHlalH1zD-oueYjooR-KdO6q_NLa&index=5	Types of estimates - Approximate estimate and Detailed estimate
10	https://www.youtube.com/watch?v=-BRwUs27ByY	Valuation of a Property / What is the purpose of Valuation / What factors affecting Valuation
11	http://acl.digimat.in/nptel/courses/video/124105015/lec40.pdf	Rebar Detailing
Note : Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students		

MSBTE Approval Dt. 21/11/2024

Semester - 4, K Scheme

WATER AND WASTEWATER ENGINEERING**Course Code : 314314**

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	Assessment Scheme												Total Marks	
				Actual Contact Hrs./Week CLTLLLSLHNLH							Paper Duration	Theory				Based on LL & TL				Based on SL				
																Practical								
												FA-TH		SA-TH		Total		FA-PR		SA-PR		SLA		
				Max	Max	Max	Min	Max	Min		Max	Min	Max	Min	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	TLO 1.1 Classify the sources with intake structures of water on the basis of given criteria. TLO 1.2 Determine future population by using relevant forecasting method. TLO 1.3 Undertake the testing of given water sample using relevant method as per IS code.	Unit - I Sources, Characteristics and Demand of Water 1.1 Sources of water: Surface and Subsurface sources of water. Intake Structures: Definition, types and factors governing the location. 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. 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. Sampling of Water: Single & Grab. Water quality standards as per (I.S. 10500:2012).	Demonstration Video Demonstrations Lecture Using Chalk-Board

WATER AND WASTEWATER ENGINEERING

Course Code : 314314

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.
2	TLO 2.1 Draw the labeled flow diagram of water treatment plant with enough description. TLO 2.2 Justify the process of filtration of water. TLO 2.3 Justify the process of disinfection of water. TLO 2.4 Apply the relevant technique of water softening and de-fluoridation for the given sample of water. TLO 2.5 Apply electrolysis and reverse osmosis technique on the given sample of water for the intended purpose.	Unit - II Purification of Water 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. 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. 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. 2.4 Water Softening Methods: Need and necessity of Water softening, lime soda process and zeolite process. De-fluoridation techniques. 2.5 Advanced Water Treatments: Electrolysis, Reverse Osmosis.	Demonstration Lecture Using Chalk-Board Collaborative learning Video Demonstrations Site/Industry Visit Case Study
3	TLO 3.1 Select the relevant mode of conveyance system in the given situation. TLO 3.2 Suggest the water distribution method for the given situation. TLO 3.3 Use the relevant pipe network system for water distribution in the given situation.	Unit - III Water Distribution System 3.1 Conveyance: Pipes - Types, Choice of materials, Joints and valves - Types, location and functions. 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. 3.3 Pipe Network System: Dead end system, grid iron system, circular system, radial system - their suitability, advantages and disadvantages.	Demonstration Video Demonstrations Lecture Using Chalk-Board Collaborative learning Case Study

WATER AND WASTEWATER ENGINEERING**Course Code : 314314**

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.
4	TLO 4.1 Propose the relevant sanitary fittings to be used at the given location of sanitation system. TLO 4.2 Illustrate relevant type of plumbing system for the given situation. TLO 4.3 Justify the relevant type of sewerage system for the given situation. TLO 4.4 Illustrate sewer appurtenances in the given situation.	Unit - IV Building Sanitation System 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. 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. 4.3 Systems of Sewerage: Introduction, Systems of sewerage: Separate, Partially Separated and Combined. 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.	Lecture Using Chalk-Board Lecture Using Chalk-Board Demonstration Video Demonstrations Site/Industry Visit
5	TLO 5.1 Evaluate the given characteristics of the sewage sample in relation with MPCB norms. TLO 5.2 Describe the function of various units of sewage treatment plant. TLO 5.3 Describe the construction of septic tank with its working principle. TLO 5.4 Describe the construction of septic tank with its working principle.	Unit - V Sewage Treatment System 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. 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. 5.3 Septic tank & soak pit: Principle, Construction, Working and Maintenance. 5.4 Recycling and Reuse of domestic wastewater: Necessity, Advantages, Disadvantages, methods and uses.	Lecture Using Chalk-Board Video Demonstrations Demonstration Site/Industry Visit Collaborative learning Case Study

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

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
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
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.

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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±10% 50Hz, Power: 2800W, Temperature Controlling Mode: Digital Display, Temperature Controlling Point: 24 degree C, 93.5 degree C, Temperature Controlling Precision: ±0.1 degree C)	11
3	Digital COD digester (Glassware: 15 Reaction Vessels & Air Condensers, Temperature: 150 ± 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
4	Digital Turbidity Meter. (Range 0 to 200 NTU, Resolution 1NTU, Accuracy: ± 3% FS, ± 1 Digit, Display 3½ 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 ± 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
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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	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.

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Sr.No	Author	Title	Publisher with ISBN Number
3	Birdie, G. S. Birdie, J. S.	Water Supply and Sanitary Engineering	Dhanpat Rai and Sons, 2011 ISBN: 81874337954.
4	Garg, S.K.	Environmental Engineering Vol. I and Vol. II	Khanna Publishers, New Delhi, 2017, ISBN-10: 8174091203; ISBN-13: 978- 8174091208.
5	Nelson DI	Environmental Engineering	CBS Publisher and Distributer 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-Ijo7Ic	Determination of pH.
8	https://www.youtube.com/watch?v=4AWR_xfwfi4	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_2iUCG87AZvtaiuD3r4HATrBKhb90P	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://efaidnbmnnnibpcajpcglclefindmkaj/https://cpcb.nic.in/wqm/BIS_Drinking_Water_Specification.pdf	BIS: Drinking Water specifications (IS 10500:2012)
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

MSBTE Approval Dt. 21/11/2024**Semester - 4, K Scheme**

GEOTECHNICAL ENGINEERING**Course Code : 314315**

Programme Name/s : Civil Engineering/ Civil & Rural Engineering/ Construction Technology/ Civil & Environmental Engineering/
Programme Code : CE/ CR/ CS/ LE
Semester : Fourth
Course Title : GEOTECHNICAL ENGINEERING
Course Code : 314315

I. RATIONALE

The stability of any structure depends upon behavior of soil and bearing capacity of soil to carry loads under different loading conditions. Thus, the geotechnical engineering enables the decision maker to predict the behavior of soil under different loading conditions and also to determine the probable settlement arising from the construction activities. This course therefore will develop the basic understanding among the students to ensure the safety, stability, and long-term quality in the wide range of civil engineering projects such as buildings, dams, towers, embankments, roads, railways, retaining walls, bridges, underground tank and underwater structures.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Evaluate various soil properties required for design of foundation.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Apply the basic knowledge of Geology and Geotechnical Engineering in given situation
- CO2 - Measure the physical properties of given soil sample
- CO3 - Determine the shear strength of given soil sample
- CO4 - Use the relevant method of compaction to determine parameters of given soil sample
- CO5 - Undertake the relevant soil investigation techniques to determine the bearing capacity of the given soil strata

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												Total Marks		
				Actual Contact Hrs./Week			SL	LH		NLH	Paper Duration	Theory				Based on LL & TL				Based on SL				
				CL	TL	LL						Practical												
												FA-TH	SA-TH	Total						FA-PR			SA-PR	
												Max	Max	Max	Min	Max	Min	Max	Min	Max	Min		Max	Min
314315	GEOTECHNICAL ENGINEERING	GTE	DSC	3	-	2	3	8	4	3	30	70	100	40	25	10	25#	10	25	10	175			

Total IKS Hrs for Sem. : 1 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	TLO 1.1 Elaborate the importance of geology in civil engineering field. TLO 1.2 Classify the given type of rocks based on their genesis. TLO 1.3 Signify the importance of soil as a construction material. TLO 1.4 Justify the importance of Geo-technical Engineering in civil Engineering.	Unit - I Overview of geology and geotechnical engineering 1.1 Introduction to Geology: Branches, importance of geology, composition of earth. 1.2 Petrology: Definition of a rock, classification based on their genesis (mode of origin), formation, classification and engineering uses of igneous, sedimentary and metamorphic rocks. (IKS*: Sun temple of Konark made up of Chlorite, Laterite, Khondalite stones) 1.3 IS definition of soil, Importance of soil in Civil Engineering as construction material for foundation bed of structures. 1.4 Field applications of geotechnical engineering for foundation design, pavement design, design of earth retaining structures, design of earthen dam.	Lecture Using Chalk-Board Presentations Demonstration Site/Industry Visit Case Study

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.
2	TLO 2.1 Elaborate the physical properties of soil. TLO 2.2 Determine the Index properties of given soil sample using the relevant method. TLO 2.3 Draw the particle size distribution curve for the given sample with its interpretation. TLO 2.4 Interpret the computed values of Atterberg's limits of Consistency for the given soil specimen data.	Unit - II Physical and Index Properties of Soil 2.1 Physical Properties: Soil as a three phase system, water content, void ratio, porosity and degree of saturation, density index, unit weight of soil mass; bulk unit weight, dry unit weight, unit weight of solids, saturated unit weight, submerged unit weight, specific gravity 2.2 Determination of Index Properties of Soil: determination of water content by oven drying method as per IS code, determination of bulk unit weight and dry unit weight by core cutter method and sand replacement method as per IS code, determination of specific gravity by pycnometer. 2.3 Particle size distribution, mechanical sieve analysis as per IS code, particle size distribution curve, effective diameter of soil, Uniformity coefficient and coefficient of curvature, well graded and uniformly graded soils, particle size. classification of soils, I.S. classification of soil. 2.4 Consistency of soil: Stages of consistency, Atterberg's limits of consistency viz. Liquid limit, plastic limit and shrinkage limit, plasticity index, determination of liquid limit, plastic limit	Lecture Using Chalk-Board Presentations Demonstration Hands-on Site/Industry Visit
3	TLO 3.1 Apply the Darcy's law of permeability in given situation to determine the coefficient of permeability for a given soil sample. TLO 3.2 Apply the concept of flow net in the given situation. TLO 3.3 Draw the Mohr-coulomb failure envelope for the given type of soil sample. TLO 3.4 Use the relevant method to determine shear strength of given soil sample.	Unit - III Permeability and Shear Strength of Soil 3.1 Definition of permeability, Darcy's law of permeability, coefficient of permeability, factors affecting permeability, determination of coefficient of permeability by constant head and falling head permeability tests, simple problems to determine coefficient of permeability. 3.2 Seepage through earthen structures, seepage velocity, seepage pressure, phreatic line, flow lines, application of flow net, (No numerical problems.) 3.3 Shear failure of soil, field situation of shear failure, concept of shear strength of soil, components of shearing resistance of soil – cohesion, internal friction. Mohr-coulomb failure theory, Strength envelope, strength Equation for purely cohesive and cohesion less soils. 3.4 Laboratory methods: Direct shear test, vane shear test (Numerical on direct shear test only)	Lecture Using Chalk-Board Presentations Demonstration Hands-on Site/Industry Visit

GEOTECHNICAL ENGINEERING**Course Code : 314315**

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.
4	TLO 4.1 Undertake the compaction of given sample using relevant method of compaction. TLO 4.2 Use the relevant method of soil stabilization for the given situation as per IS code. TLO 4.3 Determine the CBR value of given soil sample as per IS code. TLO 4.4 Explain the lateral earth pressure theory with labelled sketch for given situation.	Unit - IV Compaction and Stabilization of soil 4.1 Concept of compaction, purpose of compaction, field situations where compaction is required, Standard proctor test – test procedure as per IS code, Compaction curve, optimum moisture content, maximum dry density, Zero air voids line, Modified proctor test, factors affecting compaction, field methods of compaction : rolling, ramming and vibration, concept of consolidation, difference between compaction and consolidation. 4.2 Concept of soil stabilization, necessity of soil stabilization 4.3 California bearing ratio, C.B.R. test, interpretation of C.B.R. values. 4.4 Definition of earth pressure, lateral earth pressure at rest, active earth pressure and passive earth pressure with no surcharge condition, coefficient of earth pressure, Rankine's theory and its assumptions.	Lecture Using Chalk-Board Presentations Video Demonstrations Hands-on Site/Industry Visit
5	TLO 5.1 Undertake relevant Exploration Technique for evaluating soil strata. TLO 5.2 Determine the bearing capacity of soil using the relevant data for the given soil sample. TLO 5.3 Justify the need of field test in determining the bearing capacity of the soil for the given strata	Unit - V Site Investigation and Bearing Capacity of Soil 5.1 Site Investigation: Necessity of site investigation and sub-soil exploration, types of exploration, criteria for deciding the location and number of test pits and bores. Field identification of soil: dry strength test, dilatancy test and toughness test, Determination of free swell index. 5.2 Bearing capacity: Definition of bearing capacity, ultimate bearing capacity, safe bearing capacity and allowable bearing pressure, Introduction to Terzaghi's analysis and its assumptions (No Numerical). Types of failures in soil: general, local and punching shear failure, effect of water table on bearing capacity. 5.3 Field methods for determination of bearing capacity – Plate load test and standard penetration test. Test procedures as Per IS: 1888 & IS:2131	Lecture Using Chalk-Board Presentations Video Demonstrations Collaborative learning Site/Industry Visit

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 Identify the type of given rock specimen.	1	*Identification of rocks from the given specimen	2	CO1
LLO 2.1 Use oven drying method to determine the percentage of moisture content in given soil specimen.	2	*Determination of moisture content of given soil sample by oven drying method as per I.S. 2720 part- II	2	CO2
LLO 3.1 Use pycnometer method for determining specific gravity of given soil sample to classify its type.	3	*Determination of specific gravity of soil by pycnometer method as per I.S. 2720 part- III.	2	CO2
LLO 4.1 Undertake the core cutter method to find bulk and dry unit weight of given soil sample in field.	4	*Determination of Bulk and dry unit weight of soil in field by core cutter method as per I.S. 2720 (Part- XXIX).	2	CO2
LLO 5.1 Undertake the sand replacement method to find bulk and dry unit weight of coarse-grained soils.	5	Determination of bulk and dry unit weight of soil in field by sand replacement method as per I.S. 2720 (Part- XXVIII).	2	CO2

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 6.1 Classify type of soil based on grain size distribution.	6	*Determination of grain size distribution of given soil sample by mechanical sieve analysis as per I.S. 2720 (Part- IV).	2	CO2
LLO 7.1 Identify given soil based on plasticity chart.	7	*Determination of Plastic Limit & Liquid Limit along with Plasticity Index of given soil sample as per I.S. 2720 (Part- V).	2	CO2
LLO 8.1 Find co efficient of permeability of soil through coarse grained soils and fine grained soil.	8	*Determination of co efficient of permeability by constant head test as per I.S. 2720 (Part- XVII) or Determination of co efficient of permeability by falling head test as per I.S. I.S. 2720 (Part- XVII)	2	CO3
LLO 9.1 Determine the shear strength of soil sample using direct shear test.	9	Determination of shear strength of soil by direct shear test as per I.S. 2720 (Part-XIII)	2	CO3
LLO 10.1 Determine shear strength of soil in undisturbed as well as remoulded cohesive soil sample.	10	Determination of shear strength of soil by vane shear test as per I.S. 2720 (Part-XXX)	2	CO3
LLO 11.1 Perform standard proctor test to determine parameters such as OMC, MDD and amount of compaction	11	*Determination of OMC and MDD by standard proctor test of given soil sample as per I.S. 2720 (Part- VII).	2	CO4
LLO 12.1 Perform modified proctor test to determine parameters such as OMC, MDD and amount of compaction	12	Determination of OMC and MDD by Modified proctor test of given soil sample as per I.S. 2720 (Part- VIII).	2	CO4
LLO 13.1 Perform the CBR test on a given soil sample to evaluate thickness of pavement	13	Determination of CBR value as per IS 2720 (Part-16).	2	CO4
LLO 14.1 Classify given soil sample by conducting field tests Through Visual inspection, Dry strength test, Dilatancy test and Toughness test.	14	Use of field tests to identify type of given soil sample.	2	CO5
LLO 15.1 Find degree of Expansiveness of given soil based on free swell index.	15	Determination of free Swell index of soil as per IS 2720 (Part 40)	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)**SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)/ASSIGNMENTS**

- a. Collect the data of various rock specimen such as igneous, sedimentary, metamorphic and compare their properties with respect to geotechnical Engineering.
- b. Collect minimum three pictures rock mass showing Folds, Faults, Joints along with description.
- c. Observe open source videos for determination of Shrinkage limit of soil sample as per I.S. 2720 (Part- V) and write a procedure.
- d. Determine bearing capacity of soil using assumed value of liquid limit and plastic limit and show calculations (Workout bearing capacity of soil using established co relation.)
- e. Enlist minimum five compaction equipments along with their description
- f. Enlist various soil stabilization techniques and write information of any three (including sketches).

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- g. Comment in the form of report on the effect of unconsolidated undrained, consolidated undrained and consolidated drained in shear test
- h. Summarize the importance of Geosynthetic materials including their applications in civil Engineering
- i. Summarize in the form report on the importance of piles including sketches and case studies
- j. Write a report on role of Geophysical Exploration in civil Engineering.

Micro project

- a. Collect minimum five types of rock specimen in your area and compare their properties with respect to geotechnical Engineering aspect
- b. Visit nearby site having excavation pits and write short note about it strata by visual inspection.
- c. Collect minimum three samples of soil in your area and compare them for any three properties of soil
- d. Visit nearby reclamation land and study the stabilization method.
- e. Identify two different locations and suggest the appropriate stabilization methods (soil-cement, soil-lime, soil-flyash etc.) to improve its engineering properties.
- f. Study different free open sources software available for Geotechnical Engineering.
- g. Collect the photograph and information of anchors (stabilization of slopes) used to avoid over turning of structure.
- h. Collect the photographs and information on Causes, Effects and Types of Landslides.
- i. Collect information on foundations of ancient structures with Geotechnical Engineering aspect.
- j. Visit nearby two sites to classify soil based on field tests.

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	Vane shear test apparatus- as per 2720 (Part -30)	10
2	Proctor compactometer for light compaction and heavy compaction as per IS specification	11,12
3	CBR apparatus as per IS specification IS 2720 (Part-16).	13
4	425 micron IS Sieve and 100ml capacity graduated glass cylinder	15
5	Oven-thermostatically controlled to maintain temperature of 110 degree Celsius to 115 degree Celsius	2,3,4,7,11,12
6	Pycnometer – consisting of 1 kg. honey /fruit jar with plastic cone, locking ring and rubber seal.	3
7	Core cutter apparatus- cylindrical core cutter of steel 100 mm dia x 127.3mm high with 3mm wall thickness beveled at 1mm.	4
8	Sand replacement apparatus- as per IS: 2720(Part-28)	5
9	Mechanical sieve shaker- carries up to 7 sieves of 15 cm to 20 cm dia (as per IS 2720-(Part 4)1985)	6
10	Casagrande liquid limit apparatus- as per IS: 9259-1979	7
11	Constant head permeameter- as per IS:2720(Part-4)1986	8
12	Falling head permeameter -as per IS:2720(Part-4)1986	8

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Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
13	Direct shear test apparatus- as per IS: 2720(Part 13) 1986	9

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	Overview of geology and geotechnical engineering	CO1	5	4	4	0	8
2	II	Physical and Index Properties of Soil	CO2	12	4	4	12	20
3	III	Permeability and Shear Strength of Soil	CO3	10	2	8	6	16
4	IV	Compaction and Stabilization of soil	CO4	10	4	4	6	14
5	V	Site Investigation and Bearing Capacity of Soil	CO5	8	0	8	4	12
Grand Total				45	14	28	28	70

X. ASSESSMENT METHODOLOGIES/TOOLS**Formative assessment (Assessment for Learning)**

- Two unit test of 30 marks will be conducted and average of two unit test is considered, Assessment of laboratory learning, Assignment, Microproject, Self learning (60% Weightage to process and 40% weightage to product), Question and Answer.

Summative Assessment (Assessment of Learning)

- Pen and Paper Test (Written Test), Practical Exam/ Oral Exam

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	-	-	2	1	-	2			
CO2	3	3	1	3	2	1	3			
CO3	2	2	1	2	1	2	2			
CO4	2	2	2	2	2	1	2			
CO5	2	2	2	2	2	1	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
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Sr.No	Author	Title	Publisher with ISBN Number
1	Punmia, B.C.	Soil Mechanics and Foundation Engineering	Laxmi Publication (P) Ltd., New Delhi, ISBN 9788170087915
2	Murthy, V.N.S.	A text book of soil mechanics and foundation Engineering	CBS Publishers & Distributors Pvt. Ltd., New Delhi 2016 ISBN: 9788123913629
3	Ramamurthy, T.N. & Sitharam, T.G.	Geotechnical Engineering (Soil Mechanics)	S Chand and Company LTD., New Delhi, ISBN: 9788121924573
4	Braja M. Das	Principles of Geotechnical Engineering	Cengage Learning ISBN: 9789355738103
5	Parbin Singh	Engineering And General Geology	S K Kataria and Sons ISBN-13 978-8188458516

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://youtu.be/N2J-tvEeI4c?si=SgQP0ICSbFAuOVLd	Determination of Water Content of Soil by Oven Drying Method
2	https://youtu.be/l6vk0EM4yPg?si=-M6WwrxOlZYHy94	Determination of Specific Gravity of soil
3	https://youtu.be/5rDHJz_RJq0?si=V714qzw1vE8f5pSP	Determination of Dry Density of Soil by Core Cutter Method
4	https://youtu.be/YejCi5SEOAU?si=n8w1uAauI7ZgaG9P	Determination of Dry Density of Soil by Sand Replacement Method
5	https://youtu.be/pM-w_cvk1nA?si=3evWNLpjtwFxtsP0	Determination of Liquid Limit and Plastic Limit of Soil
6	https://youtu.be/bmpn5oNDvOs?si=LxcoQUSe_lmL3QQ1	Direct Shear Test
7	https://youtu.be/CAezS3mPzOc?si=9-bIMPqTKy1MuPDG	Grain Size Analysis of Soil
8	https://youtu.be/c4i_y6u-tsE?si=BjcItf55LqNn2Ihn	Water Content Dry Density Relation Using Light Compaction OMC and MDD
9	https://youtu.be/fCmMW73rP64?si=mdAiqlWPkpc9n1DI	California Bearing Ratio (CBR) value test
10	https://youtu.be/Lrml0egYtM4?si=ag1mezmK74UAuyCf	Determination of swelling properties (Free Swell Index of Soil)
11	https://smfe-iiith.vlabs.ac.in/List%20of%20experiments.html	Virtual laboratory practical for Soil Mechanics.
12	https://youtu.be/8Q8CZW9-jXE?si=8Yrf2NvS9b5v9kcF	A Soil Investigation Work (Borehole Drilling: SPT & Rock Coring)
13	https://www.ijsrp.org/research-paper-0121/ijsrp-p10935.pdf	The Architectural Study of Sun Temples in India: Based on Location, Construction Material and Spatial Analysis Study
14	https://youtu.be/QuE4tEK-5iY?si=t61uZOWhS_nd5z8H	Shallow Foundation: Plate Load Test
15	https://youtu.be/DjWDOqQjysQ?si=k43rXl2I19YK9msV	How to conduct SPT / Standard Penetration Test/ Soil Exploration Technique/ Site Investigation

Note :

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