Maharashtra State Board of Technical Education, Mumbai

Teaching and Examination Scheme for Post S.S.C. Diploma Courses

Program Name : Civil Engineering Groups

Program Code : CE/CR/ CS — **With Effect From Academic Year: 2017 - 18**

Duration of Program : 6 Semesters — **Duration : 16 Weeks**

Semester : Fourth — **Scheme - I**

S. N.	Course Title	Course Abbreviation	Course Code	Teaching Scheme			Credit (L+T+P)	Examination Scheme												Grand Total
								Theory						Practical						
								Exam Duration in Hrs.	ESE		PA		Total		ESE		PA		Total	
				L	T	P			Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
1	Hydraulics	HRY	22401	3	2	2	7	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
2	Theory of Structures	TOS	22402	4	2	-	6	4	70	28	30*	00	100	40	--	--	--	--	--	--	100
3	Railway and Bridge Enginering	RBE	22403	4	-	-	4	3	70	28	30*	00	100	40	--	--	--	--	--	--	100
4	Geo-Technical Engineering	GTE	22404	3	-	2	5	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
5	Building Planning and Drawing	BPD	22405	3	-	4	7	4	70	28	30*	00	100	40	50#	20	50	20	100	40	200
6	Environmental Studies	EST	22447	3	-	-	3	90 Min	70*#	28	30*	00	100	40	--	--	--	--	--	--	100
			Total	**20**	**4**	**08**	**32**	--	**420**	--	**180**	--	**600**	--	**100**	--	**100**	--	**200**	--	**800**

Student Contact Hours Per Week: **32 Hrs.** Medium of Instruction: **English**

Theory and practical periods of 60 minutes each. Total Marks : **800**

Abbreviations: ESE- End Semester Exam, PA- Progressive Assessment, L - Lectures, T - Tutorial, P - Practical

@ Internal Assessment, # External Assessment, *# On Line Examination , @^ Computer Based Assessment

* Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain LOs required for the attainment of the COs.

~ For the courses having ONLY Practical Examination, the PA marks Practical Part - with 60% weightage and Micro-Project Part with 40% weightage

- **If Candidate not securing minimum marks for passing in the "PA" part of practical of any course of any semester then the candidate shall be declared as "Detained" for that semester.**
- **In-Plant Training during Summer vacation for minimum Six Weeks at the end of Fourth Semester (Second Year).**

Program Name : **Civil Engineering Program Group**

Program Code : **CE/CR/CS**

Semester : **Fourth**

Course Title : **Hydraulics**

Course Code : **22401**

1. RATIONALE

It is necessary for Civil Engineering technologist to understand the behaviour of fluid flow in different water carriages. Basics of hydraulics and its application oriented content will help them to solve practical problems in the field of Water Resources, Irrigation, Environmental Engineering and Public health Engineering.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Apply hydraulics principles in water carriage systems and water retaining structures.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above-mentioned competency:

a. Interpret the pressure parameters from pressure measuring devices in flowing liquids.
b. Determine total hydrostatic pressure and centre of pressure for different conditions.
c. Use relevant fluid flow parameters in different situations.
d. Determine the loss of head of fluid flow through pipes.
e. Find the fluid flow parameters in open channels.
f. Select relevant hydraulic pumps for different applications.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory							Practical				
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
L	T	P			Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	2	2	7	3	70	28	30*	00	100	40	25#	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment.*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the

course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

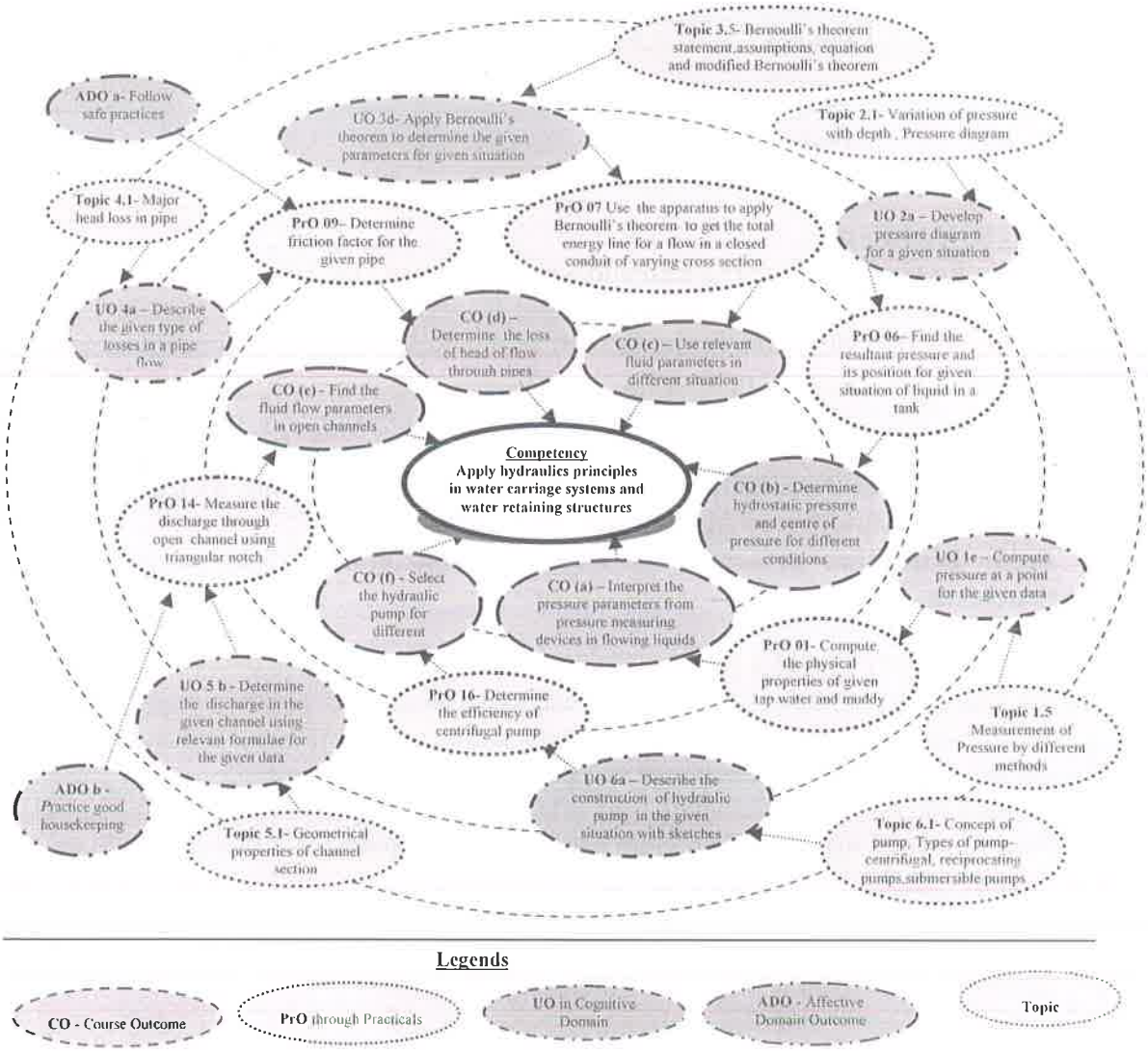

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Compute the physical properties of given tap water and muddy water	I	02*
2	Compute the physical properties of given oil and Mercury	I	02
3	Use the piezometerto measure the pressure at a given point.	I	02
4	Use the Bourdon Gauge to measure the pressure at a given point.	I	02
5	Use the U tube differential manometer to measure the pressure difference between two given points.	I	02*
6	Find the resultant pressure and its position for given situation of liquid in a tank.	II	02*
7	Use the Reynold's apparatus to interpret type of flow	III	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
8	Use the Bernoulli's apparatus to apply Bernoulli's theorem to get the total energy line for a flow in a closed conduit of varying cross sections.	III	02*
9	Use the Friction factor Apparatus to determine friction factor for the given pipe.	IV	02*
10	Determine the minor losses in pipe fittings due to sudden contraction and sudden enlargement.	IV	02*
11	Determine the minor losses in pipe fitting due to Bend and Elbow	IV	02
12	Calibrate the Venturimeter to find out the discharge in a pipe.	IV	02*
13	Calibrate the Orifice to find out the discharge through a tank	IV	02*
14	Use the current meter to measure the velocity of flow of water in open channel.	IV	02
15	Use the Pitot tube to measure the velocity of flow of water in open channel.	IV	02
16	Use the Triangular notch to measure the discharge through open channel.	V	02*
17	Use the Rectangular Notch to measure the discharge through open channel	V	02
18	Determine the efficiency of centrifugal pump.	VI	02*
	Total		**36**

Note

*i. A suggestive list of **PrOs** is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical LOs/tutorials need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. Hence, the 'Process' and 'Product' related skills associated with each PrO of the laboratory/workshop/field work are to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	10
2	Setting and operation	20
3	Safety measures	10
4	Observations and recording	20
5	Interpretation of result and conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
	Total	**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safe practices
b. Practice good housekeeping
c. Practice energy conservation

d. Demonstrate working as a leader/a team member
e. Maintain tools and equipment
f. Follow ethical practices

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Measuring cylinder, Weighing balance	01, 02
2	Piezometer	03
3	Bourdon tube pressure gauge	04
4	U tube differential manometer, Mercury	05
5	Reynold's apparatus, colour dye, Stop watch	06
6	Bernoulli's apparatus, Stop watch	07
7	Friction factor Apparatus, Stop watch	08
8	Apparatus for finding minor losses in the pipe, Stop watch	09
9	Pipe setup, bend, elbow fittings, stop watch	10
10	Pipe set up fitted with Venturimeter, U tube differential manometer, Stop watch	11
11	Current meter, stop watch	12
12	Pitot tube, stop watch	13
13	Channel set up with different notches, Stop watch	14
14	Centrifugal pump set up	15

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Pressure measurement	1a. Describe the role of hydraulics in the given civil engineering application. 1b. Compute different properties of liquid from given data. 1c. Convert gauge pressure into absolute pressure for the given data and viceversa.	1.1 Technical terms used in Hydraulics – fluid, fluid mechanics, hydraulics, hydrostatics, and hydrodynamics-ideal and real fluid, application of hydraulics in Civil Engineering field. 1.2 Physical properties of fluid – density-specific volume, specific gravity-surface tension-capillarity, viscosity-

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	1d. Convert pressure head of one liquid to that of another liquid for the given data. 1e. Compute pressure at a point for the given data. 1f. Compute pressure difference between two points for the given data.	Newton's law of viscosity 1.3 Various types of pressure – Atmospheric Pressure- Gauge Pressure-Absolute Pressure-Vaccume Pressure, Concept of Pressure Head and its unit, Pascal's law of fluid pressure and its uses. 1.4 Conversion of pressure head of one liquid in terms of other liquid. 1.5 Measurement of Pressure by different methods(By Piezometer, simple manometers and Bordon pressure Gauge) 1.6 Measurement of difference of pressure by differential U tube manometers and inverted U tube manometers
Unit-II Hydrostatics	2a. Develop pressure diagram for a given situation. 2b. Determine total pressure and centre of pressure for given immersed surface with sketches. 2c. Find the resultant pressure and its position for given situation of liquid in a tank. 2d. Find the resultant pressure and its position for the given liquid on either side of the partition wall.	2.1 Variation of pressure with depth , Pressure diagram –concept and use 2.2 Total hydrostatic pressure and center of pressure on immersed surfaces and on tank walls 2.3 Determination of total pressure and center of pressure on vertical, inclined and horizontal immersed surfaces. 2.4 Determination of total pressure and center of pressure on sides and bottom of water tanks, sides and bottom of tanks containing two liquids, vertical surface in contact with liquid on either side
Unit– III Fluid Flow Parameters	3a. Differentiate the given types of flow. 3b. Interpret the type of flow using Reynold's number 3c. Calculate velocity and discharge in the given situation using continuity equation. 3d. Apply Bernoulli's theorem to determine the given parameters for given situation. 3e. Apply Modified Bernoulli's theorem to determine the given parameters for given situation	3.1 Types of flow – Gravity and pressure flow, Laminar -Turbulent -Uniform - Non-uniform –Steady-Unsteady flow 3.2 Reynold's number 3.3 Discharge and its unit, continuity equation of flow. 3.4 Energy of flowing liquid: potential, kinetic and pressure energy. 3.5 Bernoulli's theorem : statement, assumptions, equation and modified Bernoulli's theorem
Unit– IV Flow through	4a. Describe the given type of losses in a pipe flow. 4b. Use Darcy Weisbach equation to	4.1 Major head loss in pipe: Frictional loss and its computation by Darcy

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
pipes	find out the head loss due to friction for the given data. 4c. Compute the discharge in the given network (Parallel or series) of pipes. 4d. Apply Dupit's equation to determine the equivalent pipe for given data. 4e. Use Moody's diagram to find diameter of pipe from given data. 4f. Use nomogram to find diameter of pipe from given data. 4g. Calculate discharge in a pipe for the given data using Venturimeter.	Weisbach equation $h_f = \frac{flv^2}{2gD}$ 4.2 Minor losses in pipe: loss at entrance, exit, sudden contraction, sudden enlargement 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 4.5 Water hammer in pipes : causes and Remedial measures 4.6 Use of Moody's Diagram and Nomograms. 4.7 Discharge measuring device for pipe flow: Venturimeter-construction and working 4.8 Discharge measuring for a tank: using Orifice, Hydraulic Coefficients of Orifice.
Unit –V Flow through Open Channel	5a. Describe the geometrical properties of the given channel. 5b. Determine discharge in the given channel using relevant formulae for the given data 5c. Design the most economical channel section for the given conditions. 5d. Describe the procedure of finding velocity and discharge using the given flow-measuring device. 5e. Measure the velocity of flow through open channel for the given condition.	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: Triangular and rectangular Notches 5.5 Velocity measurement devices: current meter, floats and Pitot tube 5.6 Specific energy diagram, Froude's Number, and Hydraulic.
Unit –VI Hydraulic Pumps	6a. Describe the construction of the hydraulic pump in the given situation with sketches. 6b. Describe the working of the pump used for the given data with sketches. 6c. Describe the different heads of pump in the given situation. 6d. Compute the power of	6.1 Concept of pump, Types of pump-centrifugal, reciprocating pumps, submersible pumps 6.2 Centrifugal pump: Component parts and working 6.3 Reciprocating pump: single acting and double acting, component parts and working. 6.4 Suction head, delivery head, static

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	Centrifugal pump from the given data. 6e. Select relevant type of pump for the given situation.	head Manometric head 6.5 Compute power of centrifugal pump. 6.6 Selection and choice of pump

***Note**: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Pressure and pressure measurement	08	4	4	4	12
II	Hydrostatics	08	2	4	4	10
III	Fundamentals of fluid flow	08	2	4	6	12
IV	Flow through pipes	10	2	6	6	14
V	Flow through open channel	10	4	4	6	14
VI	Pumps	04	-	4	4	08
Total		**48**	**14**	**26**	**30**	**70**

***Legends:** R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
***Note**: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Prepare journals based on practical performed in laboratory.
b. Follow the safety precautions.
c. Library / Internet survey of hydraulic structures.
d. Prepare power point presentation or animation for understanding different principles of hydraulics.
e. Visit nearby natural channel/canal and Submit report consisting flow data, cross sections, hydraulic data for the same.
f. Interpretation and relevance of Moody's chart.
g. Collect the data from YouTube/videos showing various concepts and technologies related to the subject under consideration
h. Interpretation and relevance of Nomogram.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics***, which is relatively simpler or descriptive in nature, is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. Use Flash/Animations to explain various theorems in circuit analysis
g. Demonstrate various concepts used in hydraulics.
h. Encourage the students to refer different websites to have deeper understanding of new concepts and new technologies related to hydraulics.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a. Collect the information of different types of pumps for selection of type of pump.
b. Suggest the relevant type of Pump for typical bungalow/single storey building for the given data.
c. Construct a channel for a given specific discharge.
d. Determine the total head loss for a multistoried building.
e. Measure the discharge of the channel by using triangular notches of different angle.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Hydraulics and Fluid Mechanics	Modi,P. N.and Seth, S.M.	Standard book house, Delhi **ISBN:**13: 978-8189401269;
2	Hydraulics, Fluid Mechanics and Fluid Machines	Ramamrutham, and Narayan, R.	Dhanpat Rai Publishing Company, New Delhi, **ISBN:**8187433841
3	Hydraulics, Fluid Mechanics,	Khurmi,R S	S Chand Publishers, New Delhi

S. No.	Title of Book	Author	Publication
	Hydraulic machines		ISBN: 9788121901628
4	Fluid Mechanics	Rajput, R K	S Chand, New Delhi ISBN: 9788121916677
5	Fluid Mechanics and Machinery	Ojha, C S P, and Berndtsson, R	Oxford University Press, New Delhi, ISBN: 9780195699630

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. https://www.youtube.com/watch?v=5RCeLYbiZCk
b. https://www.youtube.com/watch?v=qGQ4fojjwvQ
c. https://www.youtube.com/watch?v=YrFM51hBQXk
d. https://www.youtube.com/watch?v=JXQxdQt3Zac&list=PL1YauKdEeDpX5ycmkxY7WTLWfBLUV_CLp
e. https://www.youtube.com/watch?v=9DYyGYSUhIc
f. https://www.youtube.com/watch?v=UJ3-Zm1wbIQ
g. https://www.youtube.com/watch?v=H3TcLoapJBo
h. https://www.youtube.com/watch?v=upHHx42r4E0
i. https://www.youtube.com/watch?v=DnHZOFmlQqI
j. https://www.youtube.com/watch?v=7dHmGYGt6Dg
k. https://www.youtube.com/watch?v=4Pyu_YBxYpE
l. https://www.youtube.com/watch?v=BaEHVpKc-1Q
m. https://www.youtube.com/watch?v=s6RIx0SL3C8
n. https://www.youtube.com/watch?v=aGIemvowbPs
o. https://www.youtube.com/watch?v=f_NChxpnc20

Program Name : **Civil Engineering Program Group**

Program Code : **CE/CR/CS**

Semester : **Fourth**

Course Title : **Theory of Structures**

Course Code : **22402**

1. RATIONALE

Civil engineering structures are mainly made-up of column, Beam and Slabs and these structures are subjected to axial as well as eccentric loading along with different end conditions. The content on calculations of shear forces, bending moments, bendingstresses, slope and deflections which are developed in various types of beams will be useful in design of these members. Analysis of members for axial forces, slope, deflection, combined direct and bending stresses will be useful in safe design of various structural members.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Analyze structural components using different methods.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a. Analyze stresses induced in vertical membersubjected to direct and bending loads.
b. Analyze slope and Deflection in beams under different loading conditions.
c. Analyze end moments of fixed beams.
d. Analyse continuous beam under different loading conditions using the principles of Three Moments.
e. Analyze continuous beam using Moment Distribution Method under different loading conditions.
f. Evaluate axial forces in the members of simple truss.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
				Theory							Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
4	2	-	6	4	70	28	30*	00	100	40	--	--	--	--	--	--

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

***Legends:** **L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **ESE** -End Semester Examination; **PA** - Progressive Assessment.*

5. COURSE MAP(with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

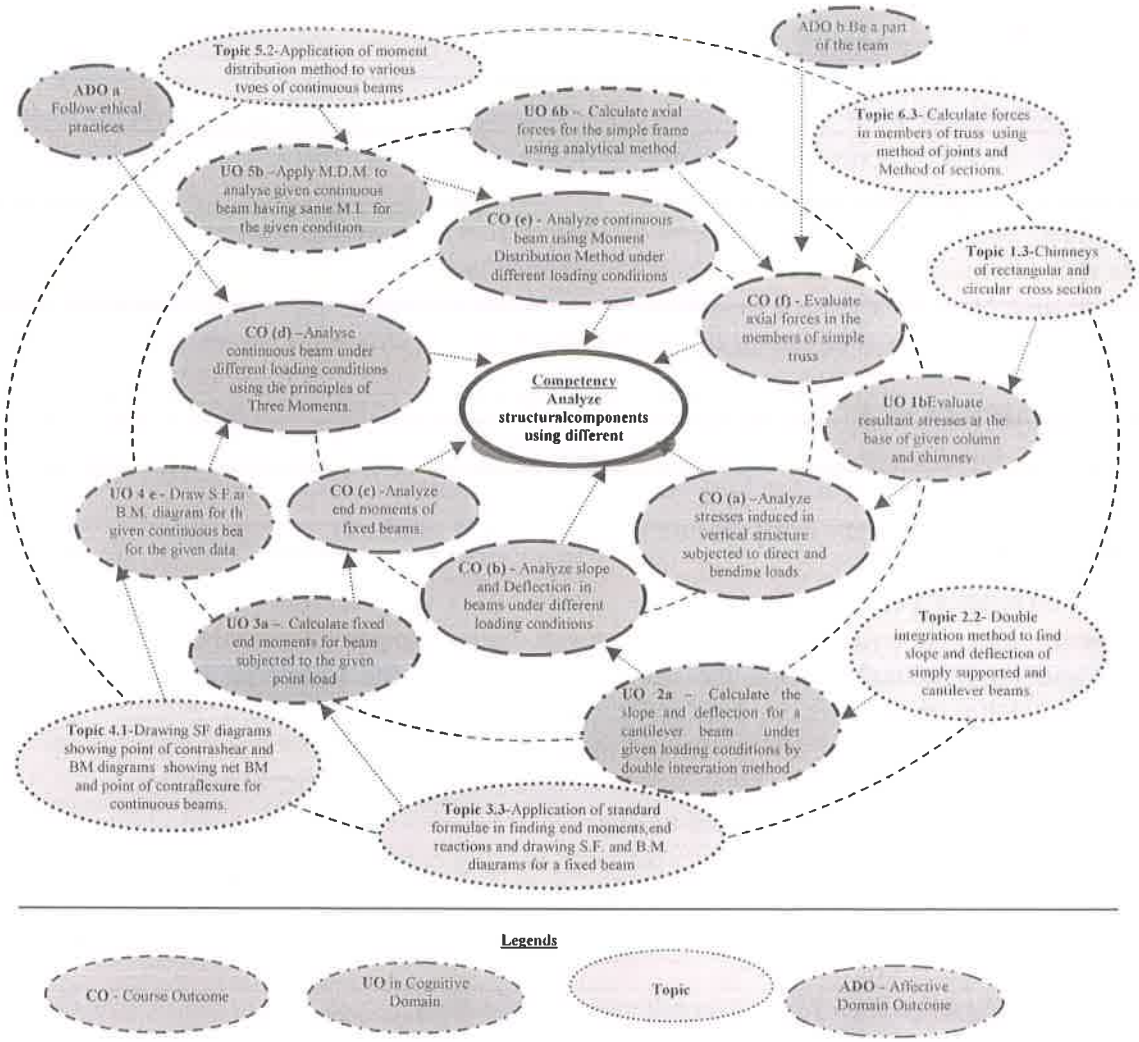

Figure 1 - Course Map

6. UNDERPINNING THEORY COMPONENTS

The following topicsare to betaught and assessed in order to develop the sample UOs given below for achicving thc COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Direct and Bending Stresses in vertical members.	1a. Compare stresses developed due to the axial load and eccentric load in the given situation. 1b. Evaluate resultant stresses at the base of given column and chimney under given loading conditions. 1c. Draw stress distribution diagram	1.1 Introduction toaxial and eccentric loads, Eccentricity about one principal axis only, nature of stresses. Maximum and minimum stresses, resultant stresses and stress distribution diagram. 1.2 Condition for no tension or zero stress at extreme fiber, Limit of eccentricity.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	for the given column and chimney under given loading conditions. 1d. Calculate the limit of eccentricity and core of a given section. 1e. Analyze stresses in a given dam section for given loading conditions. 1f. Draw stress distribution diagram for the given dam section.	core of section for rectangular and circular cross sections, Middle third rule. 1.3 Chimneys of rectangular and circular cross section subjected to wind pressure, coefficient of wind pressure, Maximum and minimum stresses, resultant stresses and stress distribution diagram at base. 1.4 Analysis of dams subjected to horizontal water pressure, conditions of stability, Maximum and minimum stresses, resultant stresses and stress distribution diagram at base.
Unit-II Slope and Deflection	2a. Calculate the slope and deflection for a cantilever beam under given loading conditions by double integration method. 2b. Determine the slope and deflection for a simply supported beam under given loading conditions by double integration method. 2c. Find the slope and deflection for a cantilever beam under given loading conditions by Macaulay's method. 2d. Calculate the slope and deflection for a simply supported beam under given loading conditions by Macaulay's method.	2.1 Concept of slope and deflection, stiffness of beams, Relation among bending moment, slope, deflection and radius of curvature, (no derivation). 2.2 Double integration method to find slope and deflection of cantilever and simply supported beams subjected to concentrated load and uniformly distributed load on entire span. 2.3 Macaulay's method for slope and deflection, application to cantilever and simply supported beam subjected to concentrated and uniformly distributed load on entire span.
Unit– III Fixed Beam	3a. Explain the effect of fixity in the given beam section. 3b. Calculate fixed end moments for beam subjected to the given point load. 3c. Determine fixed end moments for the given beam subjected to UDL over entire span by first principle. 3d. Find end moments and reactions for fixed beam under given loading condition. 3e. Draw S.F. and B.M. diagrms for the given fixed beam using	3.1 Concept of fixity, effect of fixity, advantages and disadvantages of fixed beam over simply supported beam. 3.2 Principle of superposition, Fixed end moments from first principle for beam subjected to central point load, UDL over entire span, Point load other than mid span. 3.3 Application of standard formulae in finding end moments,end reactions and drawing S.F. diagrams showing point of contrashear and B.M. diagrams showing net BM and point

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	given data.	of contraflexurefor a fixed beam.
Unit– IV Continuous Beam	4a. Explain the effect of continuity in the given situation. 4b. Draw deflected shape of continuos beam subjected to given load and end conditions. 4c. Explain Calpeyron's theorem of three moments used for the analysis of given continuous beam. 4d. Analyse continuous beam under given loading conditions, using Clapeyrons theorem of three moment. 4e. Draw S.F.and B.M. diagram for the given continuous beam using given data.	4.1 Definition, effect of continuity, nature of moments induced due to continuity, concept of deflected shape,practical example. 4.2 Clapeyron's theorem of three moment (no derivation) Application of Clapeyron's theorem maximum up to three spans and two unknown support moment only. Supports at same level, spans having same and different moment of inertia subjected to concentrated loads and uniformly distributed loads over entire span. 4.3 Drawing SF diagrams showing point of contrashear and BM diagrams showing net BM and point of contraflexure for continuous beams.
Unit –V Moment Distribution Method	5a. Explain Moment Distribution Method(M.D.M.) used for analyzing the given indeterrminate beam. 5b. Apply M.D.M. to analyse given continuous beam having same M.I.for the given condition. 5c. Apply M.D.M. to analyse given continuous beam having different M.I.for the given condition. 5d. Plot S.F. and B.M. Diagrams for continuous beam using given data. 5e. Identify the type of given portal frame with justification. 5f. Plot S.F. and B.M. Diagrams for the portal frame using given data.	5.1 Introduction to moment distribution method, sign convention, Carry over factor, stiffness factor, distribution factor. 5.2 Application of moment distribution method to various types of continuous beams subjected to concentrated loads and uniformly distributed load over entire span having same or different moment of inertia, supports at same level, up to three spans and two unknown support moments only. 5.3 Drawing SF diagrams showing point of contrashear and BM diagrams showing net BM and point of contraflexure for continuous beams. 5.4 Introduction to portal frames – Symmetrical and unsymmetrical portal frames with the concept of Bays and stories.(Numericals on Symmetrical portal frames only) 5.5 Drawing SF diagrams and BM diagrams for Symmetrical portal frames only.
Unit–VI Simple Trusses	6a. Select the type of truss for given situation with justification. 6b. Calculate the support rections for the given simple truss using	6.1 Types of trusses (Simple, Fink, compound fink, French truss, pratt truss, Howe truss, North light truss, King post and Queen post truss)

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	analytical method. 6c. Calculate axial forces for the given simple truss using method of joint and method of section. 6d. Calculate axial forces for the given simple truss using graphical method.	6.2 Calculate support reactions for trusses subjected to point loads at nodal points only. 6.3 Calculate forces in members of truss using method of joints and Method of sections. 6.4 Graphical method of analysis of truss. (No numerical on graphical method of analysis of truss)

***Note**:To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'.*

7. SUGGESTED SPECIFICATION TABLE FORQUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Direct And Bending Stresses	12	02	04	08	14
II	Slope And Deflection	10	02	04	06	12
III	Fixed Beam	10	00	04	04	08
IV	Continuous Beam	12	02	04	06	12
V	Moment Distribution Method	10	02	04	06	12
VI	Simple Trusss	10	02	04	06	12
Total		**64**	**10**	**24**	**36**	**70**

***Legends:** R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
***Note**: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

8. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Collect the data of existing structures where direct and bending stresses have a predominant role(for example: Leaning Tower Of Pisa)
b. Study the deflected shape and measure maximum deflection in a simply supported beam in laboratory.Check the results using analytical method.
c. Compare Fixed Beam with Simply Supported Beam of same span and loading.
d. Analyse given continuous beam using different methods and compare the results.
e. Collect the data from YouTube/videos showing change in deflected shape due to change in number of supports in a beam.
f. Prepare truss using given number of members and joints to carry given load(use webtools/ video games available on internet such as Xconstruction)

9. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects
f. Use Flash/Animations to explain various theorems in circuit analysis
g. Assign unit wise tutorials to group of 4 to 5 students for solving problems unit wise.
h. Assign micro projects to group of 4 to 5 students and let them prepare and present the project through PPT. Group shall submit a report which is limited to 5 pages.
i. Use of video animation films to explain concept, Facts and applications related to Theory of Structures.
j. In respect of item 10 below teacher needs to ensure to create opportunity and provisions for such co curricular activities.

10. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a. Prepare a model to demonstrate effect of eccentricity.
b. Prepare a chart showing values of maximum slope and deflection in a fixed beam and simply supported beam, under various loading conditions.
c. Collect photographs of fixed beams from actual site.
d. Collect information of continuous beams on actual sites and study the reinforcement provided.
e. Collect information and photographs of simple truss, its span and type. Prepare a chart based on the information.
f. Prepare models of different trusses.
g. Compare member forces in different type of trusses of same span,rise and loading.

11. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Theory of Structures	Ramanrutham, S.	Dhanpatrai& Sons, Delhi ISBN : 978-93-84378-10-3
2	Theory of Structures	Khurmi, R. S.	S. Chand and Co., New Delhi, 2006 ISBN:978-81-21905-20-6
3	Structural Analysis Vol-1	Bhavikatti, S S	Vikas Publishing House PvtLtd.New Delhi; ISBN: 978-81-25927-90-7
4	Mechanics of structures, Volume-I and II	Junnarkar, S. B.	Charotar Publishing House,Anand ISBN:978-93-80358-99-4
5	Theory of Structures	Pandit, G.S. and Gupta, S.P.	Tata McGraw Hill, New Delhi, 2006 ISBN :978-00-74634-93-6

12. SUGGESTEDSOFTWARE/LEARNING WEBSITES

a. nptel.ac.in/courses/112107146/lects%20&%20picts/.../lecture30%20and%2031.htm
b. www.nptel.ac.in/courses/105101085/downloads/lec-32.pdf
c. www.facweb.iitkgp.ernet.in/~baidurya/CE21004/online_lecture_notes/m2l12.pdf
d. https://en.wikipedia.org/wiki/Theorem_of_three_moments
e. https://en.wikipedia.org/wiki/Moment_distribution_method
f. www.facweb.iitkgp.ernet.in/~baidurya/CE21004/online_lecture_notes/m3l19.pdf
g. www.bgstructuralengineering.com/BGSMA/ContBeams/BGSMA_CB_0201.htm
h. www.facweb.iitkgp.ernet.in/~baidurya/CE21004/online_lecture_notes/m3l19.pdf
i. www.civilprojectsonline.com › Building Construction
j. www.mathalino.com/reviewer/engineering.../method-sections-analysis-simple-trusses

13. COURSE CURRICULUM DEVELOPMENT COMMITTEE

MSBTE Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
1	Mr. R.T. Aghao Lecturer in App. Mechanics	Govt. Polytechnic Aurangabad (0019)	9326146501	rajesh_aghao@rediffmail.com
2	Mrs. A.A. Dixit HOD ,Civil Engineering	MIT Polytechnic Pune(0148)	9822172544	ashwiniadixit@gmail.com
3	Mrs. S.M. Kulkarni Lecturer in App. Mechanics	Govt. Polytechnic Pune (0006)	9422035228	smkpune@yahoo.com

Program Name : **Civil Engineering Program Group**

Program Code : **CE/CR/CS**

Semester : **Fourth**

Course Title : **Railway and Bridge Engineering**

Course Code : **22403**

1. RATIONALE

Railway and Bridge Engineering is an important aspect in Civil Engineering; as the progress and integration of any country can be well judged by good network of railways and bridges. This course is expected to develop the competency to execute the construction and maintain the permanent way i.e. railways, associated bridges and tunnels. Bridge plays a vital role in better connectivity for our country during perennial seasons. Bridge engineering involves components of construction and maintenance of different types of bridges across the country. The tunnel engineering work is also quite crucial as it shortens the distances of travel. The civil engineering diploma holders (also called technologists) have to do the related construction and maintenance activities effectively, as safety is also the prime objective.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Execute the construction and maintenance of railways,, bridges and tunnels**

3. COURSE OUTCOMES (COs)

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

a. Identify the components of railway tracks.
b. Maintain the railway tracks.
c. Diagnose the condition of bridges.
d. Maintain different types of railway bridges and their components.
e. Maintain different types of tunnels.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory							Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
4	-	-	4	3	70	28	30*	00	100	40	--	--	--	--	--	--

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit,*
***ESE** - End Semester Examination; **PA** - Progressive Assessment*

5. COURSE MAP (with sample COs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

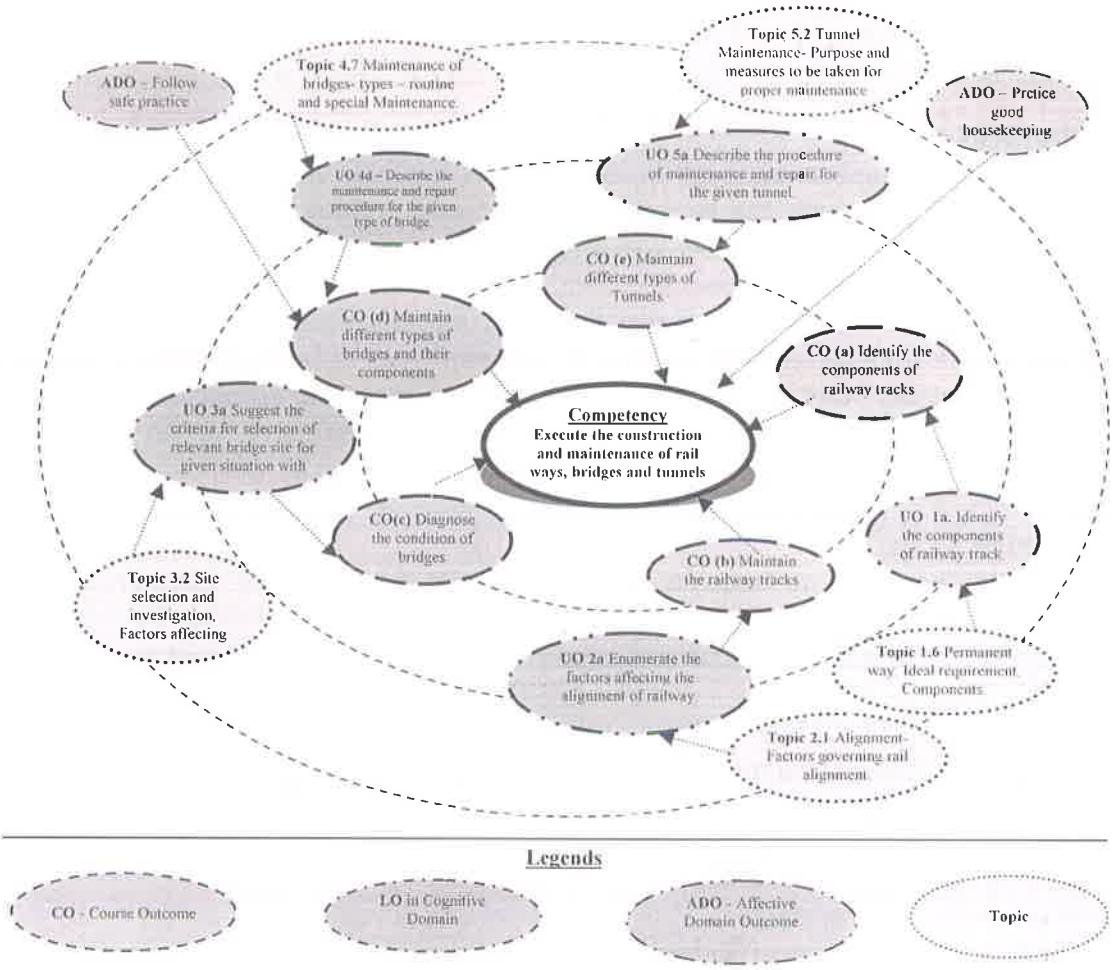

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

- Not applicable –

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

-Not applicable-

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit—I Basics of Railway Engineering	1a. Describe with sketches the given components of railway track in the diagram. 1b. Suggest the remedy for	1.1 Role of transportation in the development of nation; Modes of transportation system – land way, waterway, airway. Merits and demerits of roadway and railway; Classification of Indian Railways, zones of Indian Railway

	the specified fault railway track with justification. 1c. Suggest the type of rail track joint for the given situation with justification. 1d. Suggest the type of fixtures and fastening for the given rail section with justification.	1.2 Permanent way: Ideal requirement, Components; Rail Gauge, types, factors affecting selection of a gauge. 1.3 Rail material, Rail Joints - requirements, types. 1.4 Creep of rail: causes and prevention of creep. 1.5 Sleepers - functions and Requirement, types - concrete sleepers and their density 1.6 Ballast - function and types, suitability. 1.7 Rail fixtures and fastenings – fish plate, spikes, bolts, keys, bearing plates, chairs-types of anchors and anti creepers.
Unit—II Track geometrics, Construction and Maintenance	2a. Explain the factors affecting the alignment of railway for the given terrain. 2b. Explain with sketches the turn outs, points and crossings with for the given situation. 2c. Describe with sketches the track geometrics elements for the given terrain. 2d. Describe the process of rail track maintenance for the given season. 2e. Describe the functions of the given tools and equipment required for maintaining the track in the specified terrain.	2.1 Alignment- Factors governing rail alignment. 2.2 Track Cross sections – standard cross section of single and double line in cutting and embankment. Important terms-permanent land, formation width, side drains, 2.3 Railway Track Geometrics : Gradient, curves-types and factors affecting, grade compensation, super elevation, limits of Super elevation on curves, cant deficiency negative cant, grade compensation on curves, Coning of wheel, tilting of rail. 2.4 Branching of Tracks-Points and crossings-Turn out-left and right hand turnout, components and their functions, important technical terms, components, types and inspection, track junctions: crossovers, scissor cross over, diamond crossing, track triangle. 2.5 Station and Yards-Purpose, requirement of railway station, important technical terms, types of railway station, factors affecting site selection for railway station. 2.6 Station yard-Classification-Passenger, goods, locomotive and marshalling yards-function & drawbacks of marshalling yards. 2.7 Steps involved in construction of rail track 2.8 Track Maintenance- Necessity, Classification, Tools required for track maintenance with their function, Organisation of track maintenance, duties of permanent way inspector, gang mate and key man.
Unit—III Overview of Bridge Engineering	3a. Propose the relevant type of bridge for the given situation on the basis of relevant criteria with justification. 3b. Identify the components	3.1 Classification of bridges according to span, purpose, material, life, alignment, H.F.L., Loading, level of bridge floor. 3.2 Site selection and investigation, Factors affecting selection of site for bridge. Bridge alignment-Factors controlling.

	of a given type of bridge with their functions. 3c. Explain with sketches the bridge section for the given site conditions. 3d. Propose the relevant type of foundation for the given type of bridge for the given situation with justification.	3.3 Important technical terms- waterway, economic span, afflux, scouring, freeboard, cut water, ease water. 3.4 Component parts of bridge: pier, abutment, wing wall, foundation, bearing 3.5 Piers-function, requirements, types. 3.6 Abutment – function, types. 3.7 Wing walls – functions and types. 3.8 Foundation – function, types of bridge foundations 3.9 Bearing – functions, types of bearing
Unit—IV Construction and Maintenance of bridge	4a. Compare the structure of the permanent and temporary bridge with reference to the given criteria. 4b. Suggest the type of bridge for the given site condition with justification. 4c. Describe the construction procedure for given type of bridge. 4d. Describe the maintenance and repair procedure for the given type of bridge.	4.1 Temporary Bridge- Necessity, Causeway-Flush, low level and high level causeway 4.2 Permanent Bridges- Types of RCC Bridges-Slab, Girder, RCC girder, 4.3 Pre-stressed bridge-Advantage & dis-advantages 4.4 Culvert-Types-Arch, Open or slab, Pipe and box 4.5 Choice of type of bridge, Types of bridge foundations 4.6 Steps involved in bridges construction 4.7 Inspection of bridges-General points to be observed, Pre and post monsoon inspection 4.8 Maintenance of bridges- types – routine and special Maintenance.
Unit—V Construction and Maintenance of tunnels	5a. Describe the criteria for selection of the tunnel for given situation with justification. 5b. Choose the relevant method of constructing the tunnel in the given situation with justification. 5c. Explain the process of lining of the tunnel in the given situation justification. 5d. Describe the type of ventilation provided for the given type of tunnel. 5e. Describe the procedure of maintenance and repair for the given type of tunnel.	5.1 Tunnel - Classification of tunnels according to purpose, conveyance, material, position or alignment, shape and size of tunnels. 5.2 Tunnels: Cross sections for highways and railways, Tunnel investigations and surveying, Tunnel Shaft - its purpose and construction. 5.3 Methods of tunnelling in Soft rock-needle beam method, fore-poling method. Line plate method, shield method. 5.4 Methods of tunnelling in Hard rock-Full-face heading method, Heading and bench method, drift method. 5.5 Drilling equipment-drills and drills carrying equipments, Types of explosives used in tunnelling. 5.6 Tunnel lining –Purpose, factors affecting type of lining, and methods 5.7 Tunnel ventilation and drainage- Purpose and methods 5.8 Tunnel Maintenance- Purpose and measures to be taken for proper maintenance

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basics of Railway Engineering	12	04	04	04	12
II	Track geometrics, Construction and Maintenance	14	04	06	06	16
III	Overview of Bridge Engineering	14	04	08	04	16
IV	Construction and Maintenance of Bridge	10	02	04	04	10
V	Construction and Maintenance of Tunnels	14	04	06	06	16
Total		**64**	**18**	**28**	**24**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Collect the statistical data of Indian Railways and prepare chart showing the development of railways.
b. Prepare the scaled bridge model of any one type using ice-cream sticks.
c. Collect the details of new technologies of tunnel excavation and prepare the report.
d. Collect the data from YouTube/videos showing various concepts and technologies related to the subject under consideration.
e. Visit the railway station nearby to understand the cross-section of rail components, arrangement of station yard and layout of railway station and prepare the detailed report with site photographs.
f. Visit to any one type of bridge to summarize its components and its present condition and prepare the detailed report with site photographs.
g. Visit to roadway tunnel or railway tunnel to verify the structural components and ty lining work and prepare the detailed report with site photographs.
h. Library/ Internet survey of hydraulic structures.
i. Prepare power point presentation or animation for understanding different principles of the course under consideration.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. Teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects
f. Use Flash/Animations to explain various theorems, concepts and procedures related to the subjects under consideration.
g. Demonstrate various concepts of components of railway, bridge using corresponding models.
h. Encourage students to refer different websites to have deeper understanding of new concepts of railway, bridge and tunnel construction works.
i. Recommend the students to collect statistical and physiological data of present railway, bridge and tunnel conditions across the country.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a. Draw the cross-section of rail components and layout of a railway station and yard. Prepare the detailed report with site photographs.
b. Inspect the nearby railway track, bridge or tunnel **(any one)** to enumerate the defects (if any) and prepare the report suggesting the remedial measures for ensuring its stability.
c. Prepare a model of a bridge/tunnel to demonstrate the relevant associated concept.
d. Prepare a chart showing Classification of tunnels according to purpose, conveyance, material, position or alignment, shape and size of tunnels under different conditions
e. Collect photographs of different types of bridge and tunnels from actual site and compare their relevance at that particular site.
f. Prepare models of different gauges used in railways.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication
1	Road,Railways, Bridge and Tunnel Engg	Birdi, Ahuja	Standard Book House, New Delhi, March 2010, ISBN: 978-8189401337
2	Traffic Engineering and Transport Planning	Kadiyali, L.R.	Khanna Publishers, New Delhi, 2008, ISBN: 978-8174092205
3	Bridge Engineering	Ponnuswamy, S.	McGraw-Hill Education, New Delhi, 2008, ISBN: 9780-070656956
4	Railway Engineering	Chandra, Satish and Agarwal, M.M.	Oxford University Press, New Delhi, 2013, ISBN: 978-0198083535
5	Railway Engineering	Rangwala, S.C.	Charotar Publishing House , Anand 2002, ISBN: 978-9380358772
6	Highway, Railway, Airport and Harbour Engineering	Subramanian, K.P.	Scitech Publications, Hyderabad, 2016, ISBN: 978-8183712712

14. SOFTWARE/LEARNING WEBSITES

a. https://www.youtube.com/watch?v=w_4V8kwkdNU
b. http://www.nptel.ac.in/courses/105107123/14
c. http://nptel.ac.in/courses/105107123/9
d. https://www.youtube.com/watch?v=37WMS483T7Y
e. http://onlinepubs.trb.org/onlinepubs/millennium/00014.pdf
f. http://nptel.ac.in/courses/105103093/24
g. https://www.youtube.com/watch?v=qx_EjMlLgqY
h. http://nptel.ac.in/courses/105103093/23

Program Name : **Civil Engineering Program Group**

Program Code : **CE/CR/CS**

Semester : **Fourth**

Course Title : **Geo-Technical Engineering**

Course Code : **22404**

1.RATIONALE

Geotechnical engineering is the important for every structure, since all structures rest on soil. The stability of these structures depends upon behavior of soil and bearing capacity of soil to carry loads under different loading conditions. Formation of soil and rocks, defects in rocks, soil behavior, and soil as an engineering material are essential parameter to an engineer. The design of foundation of buildings, dams, towers, embankments, roads, railways, retaining walls, bridges is mainly governed by these above stated parameters. The content of this subject are also useful in designing basement, underground tank and underwater structures. Knowledge of geology, soil characteristics, and stress distribution under loading on soil, bearing capacity of soil is also useful to every engineer in the design, execution and stability analysis of structures.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Evaluate soil properties for determining stability of foundation**.

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a. Identify types of rocks and sub soil strata of earth.
b. Interprete the physical properties of soil related to given construction activities.
c. Use the results of permeability and shear strength test for foundation analysis.
d. Interpret the soil bearing capacity results.
e. Compute optimum values for moisture content for maximum dry density of soil through various tests.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme													
				Theory							Practical						
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total		
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	
3	-	2	5	3	70	28	30*	00	100	40	25#	10	25	10	50	20	

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

Legends: ***L****-Lecture;* ***T*** *– Tutorial/Teacher Guided Theory Practice;* ***P*** *- Practical;* ***C*** *– Credit,* ***ESE*** *- End Semester Examination;* ***PA*** *- Progressive Assessment.*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

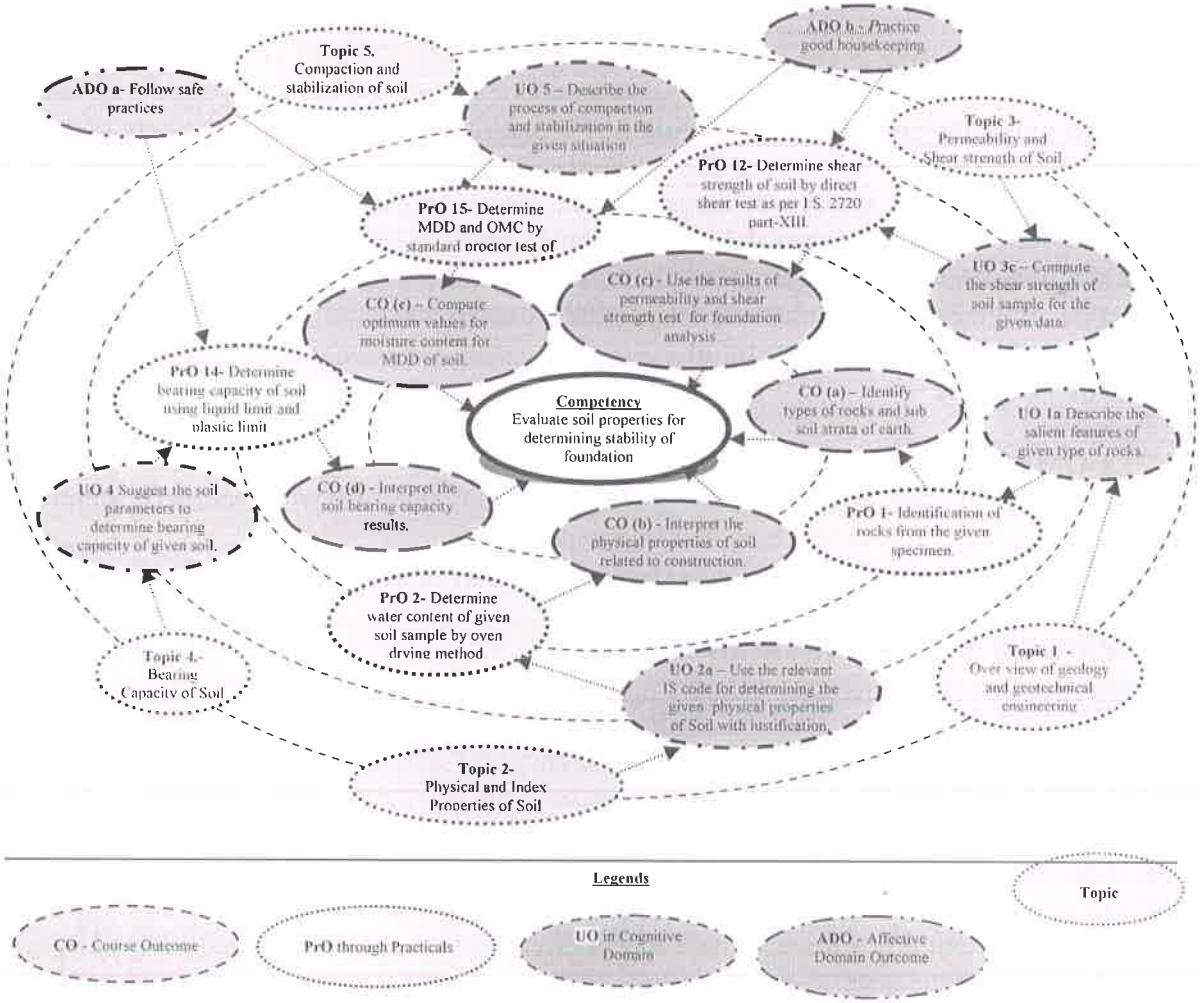

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Identification of rocks from the given specimen	I	02
2	Determine water content of given soil sample by oven drying method as per I.S. 2720 part- II	II	02*
3	Determine specific gravity of soil by pycnometer method as per I.S.	II	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	2720 part- III.		
4	Determine dry unit weight of soil in field by core cutter method as per I.S. 2720 (Part- XXIX).	II	02*
5	Determine dry unit weight of soil in field by sand replacement method as per I.S. 2720 (Part- XXVIII).	II	02
6	Determine Plastic Limit & Liquid Limit along with Plasticity Index of given soil sample as per I.S. 2720 I(Part- V).	II	02*
7	Determine Shrinkage limit of given soil sample as per I.S. 2720 (Part- V).	II	02
8	Determine grain size distribution of given soil sample by mechanical sieve analysis as per I.S. 2720 (Part- IV).	II	02*
9	Use different types of soil Identify and classify soil by conducting field tests-Through Visual inspection, Dry strength test, Dilatancy test and Toughness test .	II	02
10	Determine co efficient of permeability by constant head test as per I.S. 2720 (Part- XVII)	III	02
11	Determine co efficient of permeability by falling head test as per I.S. I.S. 2720 (Part- XVII)	III	02*
12	Determine shear strength of soil by direct shear test as per I.S. 2720 (Part-XIII)	III	02*
13	Determine shear strength of soil by vane shear test as per I.S. 2720 (Part-XXX)	III	02
14	Determine bearing capacity of soil using liquid limit and plastic limit	IV	02
15	Determine MDD and OMC by standard proctor test of given soil sample as per I.S. 2720 (Part- VII).	V	02*
16	Determination of CBR value on the field as IS.	IV	02
	Total		**32**

Note

i. *A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. *The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:*

S.No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and Recording	10
5	Interpretation of result and Conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
	Total	**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/a team member.
d. Maintain tools and equipment.
e. Follow ethical Practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year.
- 'Organising Level' in 2nd year.
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Oven-thermostatically controlled to maintain temperature of 110° Cto 115° C	2
2	Pycnometer – consisting of 1 kg.honey /fruit jar with plastic cone, locking ring and rubber seal.	3
3	Core cutter apparatus- cylindrical core cutter of steel 100 mm dia x 127.3mm high with 3mm wall thickness beveled at 1mm.	4
4	Sand replacement apparatus- as per IS: 2720(Part-28)	5
5	Casagrande liquid limit apparatus- as per IS: 9259-1979	6
6	Shrinkage limit apperatus as per IS: 2720(Part- V)	7
7	Mechanical sieve shaker- carries up to 7 sieves of 15 cm to 20 cm dia (as per IS 2720-(Part 4)1985)	8
8	Constant head permeameter- as per IS:2720(Part-4)1986	10
9	Falling head permeameter -as per IS:2720(Part-4)1986	11
10	Direct shear test apparatus- as per IS: 2720(Part 13) 1986	12
11	Vane shear test apparatus- as per 2720 (Part -30)	13
12	Proctor compactometer for light compaction as per IS specification	15
13	Field CBR apperatus as per IS specification	16

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Over view of	1a. Describe the salient features of given type of	1.1 Introduction of geology, different branches of geology, importance of geology for civil

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
geology and geotechnical engineering	rocks. 1b. Identify the given type of rocks. 1c. Suggest the type of soil for the given situation. 1d. Describe the applications of Geo-technical Engineering for the construction of the given civil structure.	engineering structure and composition of earth. 1.2 Introduction of petrology, definition of a rock, classification based on their genesis (mode of origin), formation, classification and engineering uses of igneous, sedimentary and metamorphic rocks. 1.3 IS definition of soil, Importance of soil in Civil Engineering as construction material in Civil Engineering Structures, as foundation bed for structures 1.4 Field application of geotechnical engineering for foundation design,pavement design, design of earth retaining structures, design of earthen dam.
Unit –II Physical and Index Properties of Soil	2a. Use the relevant IS code for determining the given physical properties of Soil with justification . 2b. Calculate Atterberg's limits of Consistency for the given data. 2c. Interprete Atterberg's limits of Consistency for the given data.. 2d. Classify the given soil sample as per IS provision. 2e. Interpret the particle size distribution curve for the given data.	2.1 Soil as a three phase system, water content, determination of water content by oven drying method as per IS code, 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, determination of bulk unit weight and dry unit weight by core cutter method and sand replacement method as per IS code, specific gravity, determination of specific gravity by pycnometer. 2.2 Consistency of soil, stages of consistency, Atterberg's limits ofconsistency viz. Liquid limit, plastic limit and shrinkage limit,plasticity index, determination of liquid limit, plastic limit andshrinkage limit as per IS code. 2.3 Particle size distribution, mechanical sieve analysis as per IS codeparticle size distribution curve, effective diameter of soil, Uniformitycoefficient and coefficient of curvature, well graded and uniformlygraded soils, particle size. classification of soils, I.S. classification ofsoil.
Unit III Permeability and Shear Strength of Soil.	3a. Identify the factors affecting the permeability of given type of soil sample. 3b. Compute the coefficient of permeability for a given soil sample data.	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.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	3c. Compute the shear strengh of soil sample for the given data. 3d. Interpret the shear failure of soil sample for the given data. 3e. Use the application of flow net in the given situation.	Seepage through earthen structures, seepage velocity, seepage pressure, phreatic line, flow lines, application of flow net,(No numerical problems.) 3.2 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. Direct shear test and vane shear test –laboratory methods.
Unit IV Bearing Capacity of Soil	4a. Suggest the soil parameters to determine bearing capacity of given soil sample with justification. 4b. Suggest the method to determine bearing capacity of the soil for the given strata with justification. 4c. Choose the relevant type of foundation using Rankine formula for the given situation. 4d. Corelate the effect of water table on bearing capacity of soil for the given data.	4.1 Bearing capacity and theory of earth pressure: Concept of bearing capacity, ultimate bearing capacity, safe bearing capacity and allowable bearing pressure, Introduction to Terzaghi's analysis and assumptions made, effect of water table on bearing capacity. 4.2 Field methods for determination of bearing capacity – Plate load test and standard penetration test. Test procedures as Per IS: 1888 & IS:2131 4.3 Definition of earth pressure, active earth pressure and passive earth pressure for no surcharge condition, coefficient of earth pressure, Rankine's theory and assumptions made for non-cohesive Soils.
Unit V Compaction and stabilization of soil	5a. Describe the process of compaction and stabilization in the given situation. 5b. Suggest the relevant compacting equipment for the given type soil sample with justification. 5c. Choose the relevant method of soil stabilization for the given situation with justification. 5d. Compute the CBR value for given data of soil sample.	5.1 Concept of compaction, purpose of compaction, field situations where compaction is required, Standard proctor test test procedure as per IScode, 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 and Suitability of various compaction equipments-smooth wheel roller, sheep foot roller, pneumatic tyred roller, rammer and vibrator, difference between compaction and consolidation. 5.2 Concept of soil stabilization, necessity of soil stabilization, different methods of soil

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	5e. Interpret the value of CBR with reference to IS Provisions.	stabilization – echanical soil stabilization, lime stabilization, cement stabilization, bitumen stabilization, fly-ash stabilization. California bearing ratio, C.B.R. test, meaning of C.B.R. value. 5.3 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.

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	General Geology and Over view of Geotechical Engineering	06	04	06	--	10
II	Physical properties of soil	12	04	04	08	16
III	Permeability and Shear strength of soil	12	04	04	08	16
IV	Bearing capacity of soil	06	04	04	04	12
V	Compaction and Stabilization of soil	12	04	04	08	16
Total		**48**	**20**	**22**	**28**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Visit to different site and identify the type of strata encounter and judge the bearing capacity of strata and correlate with actual value adopted as per IS provision.
b. Collection of soil sample of various types of soil.
c. Collection of photographs of machines used for stabilization and compaction.
d. Contribution of various scientists in geotechnical engineering.
e. Preparation of chart showing engineering properties of soil along with IS specification
f. Collection of data about soil deposites available in various region of India and showing it in the map of India.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects
f. Use Flash/Animations to explain various theorems in Geotechnical Engineering.
g. Demonstrate various concepts related to Geotechnical Engineering .
h. Encourage students to refer different websites to have deeper understanding of new concepts of Geotechnical Engineering.
i. Assign unit wise tutorials to group of 4 to 5 students for solving problems unit wise.
j. Assign micro projects to group of 4 to 5 students and let them prepare and present the project through PPT. Group shall submit a report which is limited to 5 pages.
k. Use of video animation films to explain concept, Facts and applications related to Geotechnical Engineering .
l. In respect of item 10 above teacher needs to ensure to create opportunity and provisions for such co curricular activities.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a. Write a report on role of a geotechnical engineer in civil engineering practice.
b. Taking the samples in field and test it in laboratory for different properties of soil.
c. Calculate the bearing capacity of soil from the Atterberg limit values.
d. Compute the plasticity index and toughness index for the given soil sample from given data.
e. Select a soil sample from given one which contains more clay particle, has greater saturated unit weight, has a greater dry unit weight, has a greater void reatio.

f. Derive the relation between discharge velocity and seepage velocity.
g. Compute the permeability of a given soil sample of stratified soil deposites.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Soil Mechanics and Foundation Engineering	Punmia, B.C.	Laxmi Publication (P) ltd., New Delhi, ISBN 9788170087915
2	A text book of soil mechanics and foundation Engineering	Murthy, V.N.S.	CBS Publishers & Distributors Pvt. Ltd., New Delhi 2016 ISBN: 9788123913629
3	Geotechnical Engineering(Soil Mechanics)	Ramamurthy, T.N. & Sitharam,T.G.	S Chand and Company LTD., New Delhi, ISBN: 9788121924573
4	Soil Mechanics and Foundation Engineering	Raj, P. Purushothama	Pearson India, New Delhi, 2014 ISBN: 9789332515123
5	Geltechnical Engineering	Kasamalkar, B. J.	Pune Vidyarthi Griha Prakashan, Pune

14. SOFTWARE/LEARNING WEBSITES

a. www.nptelvideos.in
b. www.youtube.com /geotechnical engineering
c. www.learnerstv.com (video lecture course – Engg Lectures-soil mechanics)
d. www.whatisgeotech.org

Program Name : **Civil Engineering Program Group**

Program Code : **CE/CR/CS**

Semester : **Fourth**

Course Title : **Building Planning and Drawing**

Course Code : **22405**

1. RATIONALE

This subject is core technology subject, enabling the principles of planning for drafting the content into graphical form and thereafter its execution. Civil Engineer has to convert design parameters and process details into actual practice. The principles of planning for buildings includes the entire facilities to be provided as per individual's requirements, economical status and suitable to the users. Therefore, students are required to understand, interpret and prepare working drawing. This will further lead into reading and understanding of drawing that will make the execution and implementation easy in the field. In long run construction industry should have orientation towards the skillful design,software skill and energy efficient technique. This will create confidence and share a grain of salt in building nation in a beautiful way of approach.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Prepare engineering drawings as per principles of planning using CAD Software.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a. Interpret the symbols,signs and conventions from the given drawing.
b. Prepare line plans of residential and public buildings using principles of planning.
c. Prepare submission and working drawing from the given requirement for Load Bearing Structure.
d. Prepare submission and working drawing from the given requirement for Framed Structure.
e. Draw Two point perspective drawing for given small objects.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	4	7	4	70	28	30*	00	100	40	50#	20	50	20	100	40

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

Legends: ***L***-*Lecture;* ***T*** - *Tutorial/Teacher Guided Theory Practice;* ***P*** - *Practical;* ***C*** - *Credit,* ***ESE*** - *End Semester Examination;* ***PA*** - *Progressive Assessment.*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

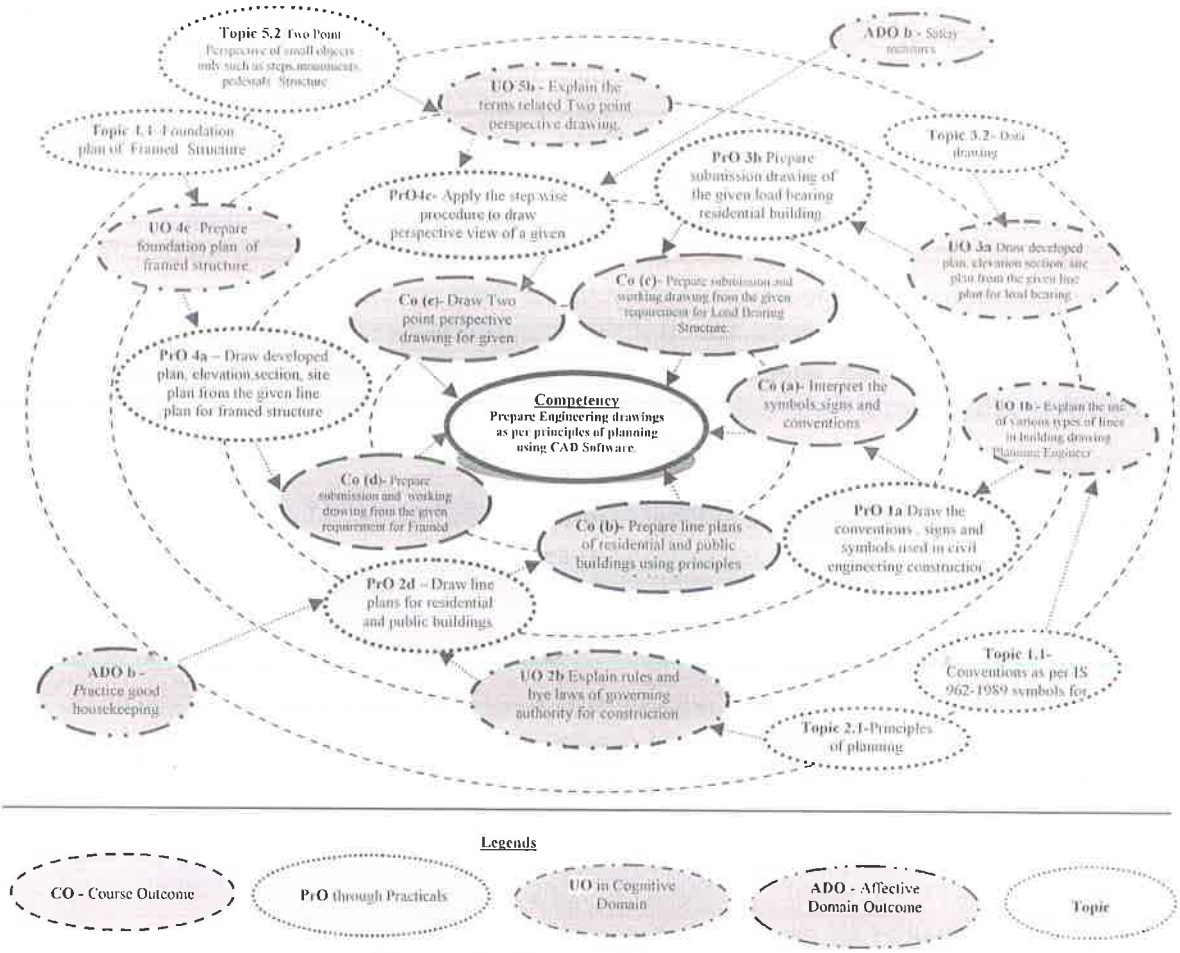

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
A. Sketch Book			
1	Draw various types of lines, graphical symbols for materials, doors and windows, symbols for sanitary,water supply and electrical installations and write abbreviations as per IS 962:1989.	I	02*
2	Write summary of observations of all technical details from the given drawing (One/Two BHK) obtained from the professional architect or civil engineer. (Group activity in 4 students)	I	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
3	a)Measure the units of existing building (Load Bearing / Frame structure) .	II	02*
	b)Draw line plan of measured existing building at **serial no 3a** to the suitable scale.	II	02
4	Draw line plan to suitable scale (Minimum 1BHK,staircase, WC and Bathroom)		
	a) Residential Bunglows (Minimum three plans)	II	02
	b) Apartment (Minimum two plans)	II	02
5	Draw line plans to suitable scale for any **Five** Public Buildings from the following (School Building, Primary Health Centre, Bank, Post Office, Hostel, Restaurant , Community Hall and Library).	II	02
6	Draw the following plans for a Framed Structure (One/Two BHK) from given line plan.		
	a. Developed plan, Elevation,	II,IV	02*
	b. Section for above developed plan.	IV	02
	c. Site plan for above drawings including area statement, schedule of opening and construction notes .	IV	02
B. Full Imperial Size Sheet (A1)			
1	Draw submission drawing to the scale 1:100 of a single storey load bearing residential building (2BHK) with flat Roof and staircase showing … a)Developed plan and elevation	II,III	02*
	b) Section passing through Stair **or** W.C. and Bath	III	02
	c) Foundation plan and schedule of openings.	III	02
	d) Site plan (1:200), area statement, construction notes.	III	02
2	Draw submission drawing, to the scale 1:100, of (G+1) Framed Structure Residential Building (2BHK) with Flat Roof and staircase showing: a) Developed plan .	II,IV	02
	b) Elevation.	IV	02
	c) Section passing through Stair ,W.C. and Bath	IV	02
	d) Section passing through Stair ,W.C. and Bath	IV	02
	e) Site plan (1:200) and area statement	IV	02
	f) Schedule of openings and construction notes.	IV	02
3	Draw the above mentioned drawing at serial number (B-2) using CAD software and enclose the print out. a) Developed plan	II, IV	02*
	b) Elevation.	IV	02
	c) Section passing through Stair,W.C. and Bath	IV	02
	d) Section passing through Stair,W.C. and Bath	IV	02
	e) Foundation plan .	IV	02
	f) Site plan (1:200), area statement, Schedule of openings and construction notes.	IV	02
4	Draw working drawing for above mentioned drawing at serial number (B-2) showing: a)Foundation plan to the scale 1:50	IV	02
	b) Detailed enlarge section of of RCC column and footing with	IV	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	plinth filling		
	c) Detailed enlarge section of of RCC Beam, Lintel and Chajjas.	IV	02
	d) Detailed enlarge section of of RCC staircase and slab.	IV	02
5	Draw two point perspective drawing of small objects - steps, monuments, pedestals (any one) scale 1:50		
	a)Draw plan,elevation,eye level,picture plane and vanishing points	V	02*
	b) Draw perspective view.	V	02
	Total		**64**

Note

i. *A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. *The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:*

S. No.	Performance Indicators	Weightage in %
1	Preparation of Sketch book	15
2	Prepare drawing sheets	30
3	Safety measures	05
4	Neatness and drawing skills	10
5	Attendance and punctuality	20
6	Answer to sample questions	10
7	Submission of report in time	10
	Total	**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/ a team member.
d. Maintain tools and equipment.
e. Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	Pro. No.
1	Computer with specification as 2GB Ram,HDD 500GB,LCD Monitor with relevant CAD software.	B 3
2	Laser Printer preferably for the output of A3 size.	B 3

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Conventions and Symbols	1a. Draw the conventions , signs and symbols used in given civil engineering drawings. 1b. Explain the use of various types of lines in the given building drawing. 1c. Select relevant scale in given situation. 1d. Interpret the given drawings for the given civil structures.	1.1 Conventions as per IS 962-1989, symbols for different materials such as earthwork, brickwork, stonework, concrete ,woodwork and glass used in civil engineering. 1.2 construction, Graphical symbols for door and window, Abbreviations, symbols for sanitary and electrical installations 1.3 Types of lines- visible lines, centre line, hidden line, section line,dimension line, extension line, pointers, arrow head or dots. Appropriate size of lettering and numerals for Titles,sub titles , notes and dimensions . 1.4 Types of scale- Monumental, Intimate, criteria for Proper Selection of scale for various types of drawing. 1.5 Sizes of various standard papers/sheets. 1.6 Reading and interpreting readymade Architectural building drawing (To be procured from Architect, Planning Consultants, Planning Engineer)

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit-II Planning of Building	2a. Apply the norms for minimum dimensions to various units in a given residential building. 2b. Desribe rules and bye laws of governing authority in a given area for construction. 2c. Compute built up, carpet and plinth ,super built up area for the given building. 2d. Draw line plans for the given residential and public buildings.	2.1. Principles of planning of Residential and Public building- Aspect,Prospect ,Orientation,Grouping, Privacy, Elegance, Flexibility, Roominess, Circulation, Furniture requirements, Sanitation,Economy. 2.2. Space requirement and norms for minimum dimension of different. 2.3. units in the residential and public buildings as per IS 962-1989. 2.4. Rules and bye-laws of sanctioning authorities for construction work. 2.5. Plot area, built up area, super built up area, plinth area, carpet area, floor area and FAR (Floor Area Ratio) / FSI. 2.6. Line plans for residential building of minimum three rooms including w/c, bath and staircase as per principles of planning. 2.7. Line plans for public building-school building, primary health centre, restaurant, bank, post office, hostel, Function Hall and Liabrary.
Unit– III Drawing of Load Bearing Structure	3a. Draw developed plan, elevation,section, site plan from the given line plan for load bearing residential building. 3b. Prepare submission drawing of the given load bearing residential building. 3c. Prepare working drawing of the given load bearing residential building. 3d. Prepare foundation plan of the given load bearing residential building.	3.1. Drawing of Single storey Load Bearing residential building (2 BHK) with staircase. 3.2. Data drawing – developed plan, elevation, section, site plan, schedule of openings, construction notes with specifications, area statement. Planning and design of staircase-Rise and Tread for residential and public building. 3.3. Working drawing – developed plan, elevation, section passing through staircase or w.c. and bath. 3.4. Foundation plan of Load bearing structure.
Unit– IV Drawing of Framed Structure	4a Draw developed plan, elevation,section, site plan from the given line plan for framed structure residential building. 4b Prepare submission drawing of the given	4.1 Drawing of Two storey Framed Structure (G+1) residential building (2 BHK) with staircase. 4.2 Data drawing – developed plan, elevation, section, site plan, schedule of openings, construction notes with specifications, area statement. Planning and design of staircase-

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	framed structure residential building. 4c Prepare foundation plan of framed structure. 4d Draw component parts of the given framed structure. 4e Explain the functions of Draw and modify commands in the given CAD software. 4f Prepare the given drawing in minimum three layers using CAD software.	Rise and Tread for residential and public building. 4.3 Working drawing of Framed Structure – developed plan, elevation, section passing through staircase or w.c. and bath. 4.4 Foundation plan of Framed Structure. 4.5 Details of RCCfooting , column, Beam, Chajjas Lintel ,Staircase and slab. 4.6 Drawing with CAD- Draw commands, modify commands, layer commands.
Unit–V Perspective Drawing	5a. Explain the principles of perspective drawings in the given situation. 5b. Apply the step wise procedure to draw perspective view of the given object. 5c. Draw perspective drawing of the given object.	5.1 Definition, Types of perspective , terms used in perspective drawing , principles used in perspective drawing 5.2 Two Point Perspective of small objects only such as steps,monuments, pedestals.

***Note**: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Conventions And Symbols	04	02	04	-	06
II	Planning of Building	16	02	06	10	18
III	Drawing of Load Bearing Structure	08	-	04	12	16
IV	Drawing of Framed Structure	14	-	06	12	18
V	Perspective Drawing	06	-	-	12	12
Total		**48**	**04**	**20**	**46**	**70**

***Legends:** R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
***Note**: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question papers may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Prepare two line plans of bunglows using CAD.
b. Prepare two line plans of Flat system using CAD.
c. Prepare two line plan of public building using CAD.
d. Collect detailed set of drawings of flat scheme .

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Use Flash/Animations to explain various theorems in circuit analysis
f. Guide student(s) in undertaking micro-projects

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a. Prepare report on Provisions given in National Building Code 2005.
b. Collect and study building Bye laws , rules and regulation for planning as per local competent authority.
c. Prepare list of the documents required for obtaining permission for construction of residential building/apartment from competent authority and write report.
d. Draw developed plan, Elevation, section, site plan, area statement, schedule of opening and construction notes for public building.

e. Prepare list of the documents required for obtaining permission for construction of commercial building from competent authority and write report.
f. Prepare a model of a simple building using card board showing different components with suitable colour.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Building Drawing	Shah. M.G. Kale, CM, Patki, S.Y.	Mcgraw Hill Publishing company Ltd. New Delhi 2002 ISBN: 9780074638767
2	Civil Engineering Drawing	Malik and Mayo	Computech Publication Ltd New Asian Publishers, 2009, New Delhi ISBN:978-8173180026
3	Principles of Perspective Drawing	M. G. Shah and C. M. Kale	Mcgraw Hill Publishing company Ltd. New Delhi, Edition 2002
4	Building Planning and Drawing	Swamy, Kumara; Rao, N, Kameshwara, A .	Charotar Publication, ANAND ISBN : 978-93-85039-12-6 (Ed.2015)
5	MRTP Act	Governmnet of Maharashtra	Governmnet of Maharashtra
6	Building Construction	Bhavikatti, S. S.	Vikas Publication House Pvt. Ltd., New Delhi, ISBN: 978-93259-6079-4
7	A to Z Building Construction	Mantri, Sandip	Satya Prakashan; 2nd edition (2015), New Delhi, ISBN: 978-8176849692
8	Working with Auto CAD 2000	Singh, Ajit	Mcgraw Hill Publishing company Ltd. New Delhi, Edition 2002
9	Planning and design of Building	Sane, Y.S.	Allied Publishers, New Delhi ASIN : B0007JVH92

14. SOFTWARE/LEARNING WEBSITES

a. https://www.youtube.com/watch?v=bCn0X9RRjN0andlist=PL060E3166E87E1FD5
b. https://www.youtube.com/watch?v=VYiVjVulnm4
c. https://www.youtube.com/watch?v=HTrZurVyHmw
d. https://www.youtube.com/watch?v=rX6XfCMRYU0
e. https://www.youtube.com/watch?v=RpLJT_SHqpU
f. https://www.youtube.com/watch?v=2l8ToJIFQwo
g. https://www.youtube.com/watch?v=NZ0IgP25sV8
h. https://www.youtube.com/watch?v=Ib213mnC8hA
i. https://www.youtube.com/watch?v=bCn0X9RRjN0
j. https://www.youtube.com/watch?v=mind4POSagcandlist=PLUjXrjdMJ1cxUKgVHhqbMnDMBo_ybJ-fb
k. www.drawingnow.com
l. www.learn-to-draw-.com

Program Name : **Diploma in Production Engineering/Production Technology/ Mechanical Engineering/Civil Engineering/Electrical Engineering**

Program Code : **PG/PT/ME/CE/CR/CS/EE/EP/EU**

Semester : **Fourth**

Course Title : **Environmental Studies**

Course Code : **22447**

1. RATIONALE

The world today is facing the biggest challenge of survival. Degradation of ecosystem, depletion of natural resources, increasing levels of pollution pose major threat to the survival of mankind. The need of the hour, therefore, is to concentrate on the area of environmental aspects, which shall provide an insight into various environment related issues. Environmental studies are an interdisciplinary academic field that integrates physical, chemical and biological sciences, with the study of the environment. It provides an integrated, quantitative, and interdisciplinary approach to the study of environmental system & gives an insight into solutions of environmental problems.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Diagnose and manage environment related issues**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a. Develop Public awareness about environment
b. Select alternative energy resources for Engineering Practice
c. Conserve Ecosystem and Biodiversity
d. Apply techniques to reduce Environmental Pollution
e. Manage social issues and Environmental Ethics as lifelong learning

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme													
				Theory						Practical							
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total		
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	
3	-	-	3	90 Min	70*#	28	30*	00	100	40	--	--	--	--	--	--	

(#) Online Theory Examination.

(*): *Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.*

Legends: L*-Lecture;* ***T*** *– Tutorial/Teacher Guided Theory Practice;* ***P*** *- Practical;* ***C*** *– Credit,* ***ESE*** *- End Semester Examination;* ***PA*** *- Progressive Assessment*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

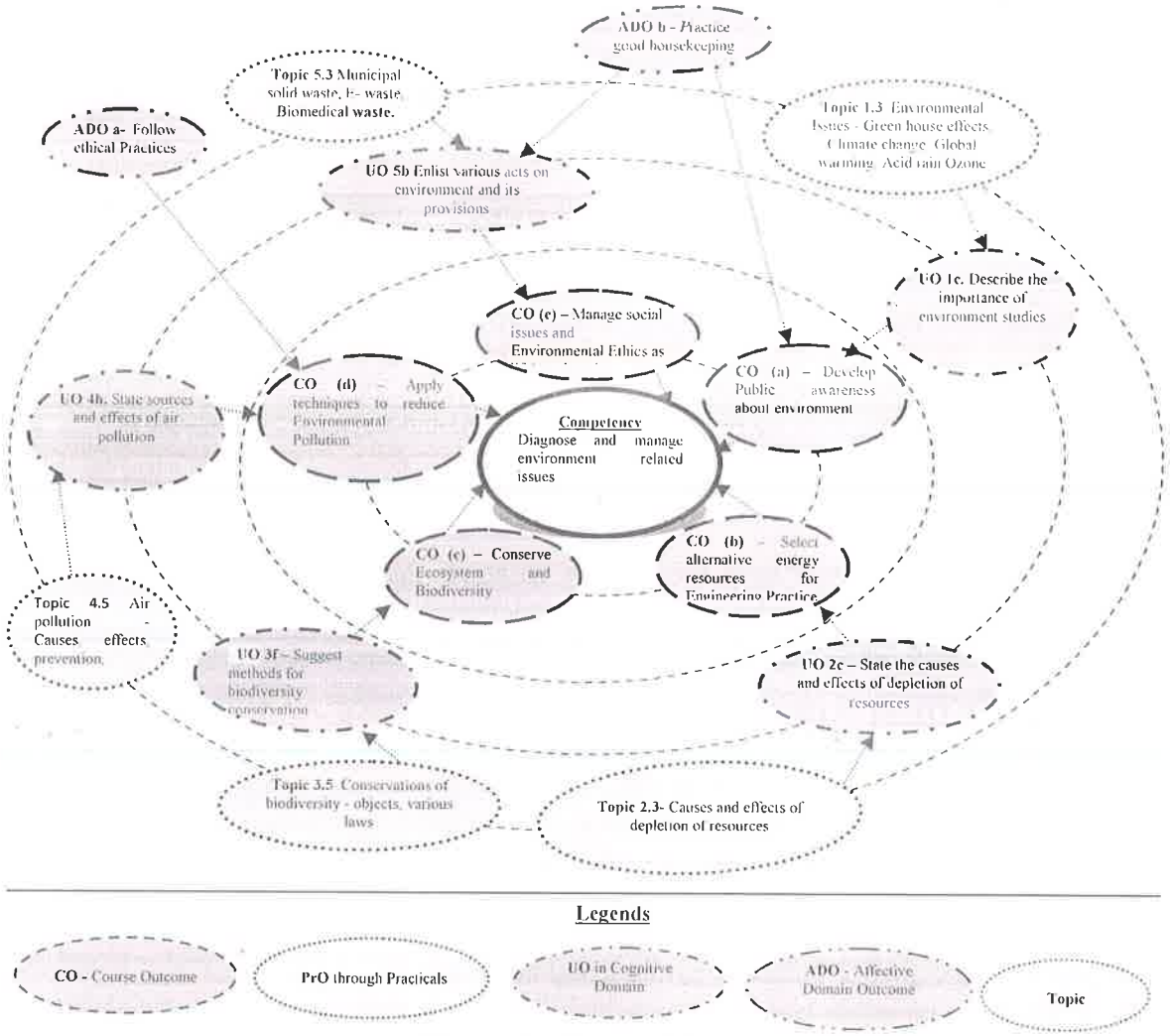

Figure 1 - Course Map

6. SUGGESTED EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	NIL		
	Total		

Note

i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '' are compulsory, so that the student*

reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.

ii. *The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:*

S. No.	Performance Indicators	Weightage in %
1	NIL	
	Total	

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safety practices.
b. Practice good housekeeping.
c. Practice energy conservation.
d. Demonstrate working as a leader/a team member.
e. Maintain tools and equipment.
f. Follow ethical Practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	NIL	-

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Environment	1a. Discuss the scope of Environment. 1b. Describe various types of environment 1c. Describe the importance of environment studies. 1d. Discuss about the need of public awareness about environment. 1e. Describe various	1.1 Definitions, need of environmental studies. 1.2 Segments of environment- Atmosphere, Hydrosphere Lithosphere, Biosphere. 1.3 Environmental Issues - Green house effects, Climate change, Global warming, Acid rain Ozone layer depletion, Nuclear accidents. 1.4 Concept of 4R (Reduce, Reuse,

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	environmental issues.	Recycle and Recover). 1.5 Public awareness about environment.
Unit– II Energy Resources	2a. List various natural resources. 2b. Describe Renewable, Nonrenewable and Cyclic resources. 2c. State the causes and effects of depletion of resources. 2d. State advantages and disadvantages of forms of energy. 2e. Select appropriate solutions of efficient use of energy. 2f. State the impacts of overuse of natural resources.	2.1 Natural Resources - Forest Resources, Water Resources, Energy Resources, Land resources, Mineral resources. 2.2 Renewable, Non-renewable and Cyclic Resources. 2.3 Causes and effects of depletion of resources. 2.4 Energy forms (Conventional and non-conventional). 2.5 Present global energy use and future demands. 2.6 Energy conservation. 2.7 Over use of natural resources and its impacts on environment.
Unit- III Ecosystem and Biodiversity	3a. State the aspects and division of ecosystem. 3b. State the general characteristics and function of ecosystem. 3c. List levels of biodiversity. 3d. Enlist the endangered species. 3e. Describe value of biodiversity. 3f. Suggest methods for biodiversity conservation.	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 Threats and Hotspots of biodiversity. 3.5 Conservations of biodiversity - objects, various laws.
Unit– IV Environmental Pollution	4a. Define pollution. 4b. State the sources of pollution. 4c. State the effects of land pollution on environment and lives. 4d. State various units and their functions of water treatment plant. 4e. State the needs of water conservation. 4f. State the impacts of sewage. 4g. State various units and their functions of sewage treatment plant. 4h. State sources and effects of air pollution. 4i. Describe various methods to prevent air pollution. 4j. State sources and effects of noise pollution.	4.1 Definition of pollution, types- Natural & Artificial (Man- made). 4.2 Soil / Land Pollution – Causes and effects on environment and lives , preventive measures. 4.3 Water Pollution - Sources of water (surface and sub surface), sources of water pollution, effects on environment and lives, preventive measures, BIS water quality standards, flow diagram of water treatment plant, Water conservation. 4.4 Wastewater - Generation(domestic and industrial), Impacts, flow diagram of sewage treatment plant, CPCB norms of sewage discharge. 4.5 Air pollution - Causes, effects, prevention, Ambient air quality standards. 4.6 Noise pollution - Sources, effects,

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	4k. Describe preventive measures for noise pollution. 4l. State characteristics of solid waste. 4m. State the impacts of solid waste. 4n. Describe incineration, RDF and sanitary landfilling. 4o. State the standards limiting/controlling values of various types of pollution.	prevention, noise levels at various zones of the city. 4.7 Municipal Solid Waste, Bio-medical waste and E-waste - Sources, generation, characteristics, effects, and methods to manage.
Unit-V Social Issues and Environmental Education	5a. Elaborate article (48-A) and (51-A (g)) 5b. Enlist various acts on environment and its provisions. 5c. State the roles and responsibilities of CPCB. 5d. Define sustainable development, and EIA. 5e. Describe rain water harvesting and groundwater recharge. 5f. Differentiate between formal and non formal education.	5.1 Article (48-A) and (51-A (g)) of Indian Constitution regarding environment, Environmental protection and prevention acts, CPCB and MPCB norms and responsibilities. The role of NGOs. 5.2 Concept of sustainable development, EIA and environmental morality. 5.3 Management Measures - Rain Water harvesting, Ground water recharge, Green Belt Development, Use of Renewable energy, water shed management, interlinking of rivers. 5.4 Role of information technology in environment and human health.

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Environment	06	4	6	-	10
II	Energy Resources	10	4	8	4	16
III	Ecosystem and Biodiversity	08	4	4	4	12
IV	Environmental Pollution	16	8	8	4	20
V	Social Issues and Environmental Education	08	4	4	4	12
	Total	**48**	**24**	**30**	**16**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual*

distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Plant and adopt a tree in your nearby locality/Polytechnic campus and prepare report about its growth and survival after six months with photos.
b. Organize seminar on air pollutants of relevant MIDC area/vehicle
c. Organize poster exhibition about global warming and ozone depletion.
d. Visit a nearest water purification/effluent treatment plant.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. Use proper equivalent analogy to explain different concepts.
g. Use Flash/Animations to explain various topics.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a. Prepare a report on visit to PUC Center.
b. Visit a near by RO plant and prepare detail technical report
c. Prepare report on Household water filtration unit

d. Prepare a list of polluted natural resources which are responsible for pollution and collect information on how to manage them .
e. **Collection of Data from Hospital: Collect** everyday information on percentage of solid hazardous and toxic waste for two month
f. **Visit of Municipal Effluent Treatment Plant:** Visit effluent treatment plant and prepare report on waste management.
g. **Visit of Water Treatment Plant:** Visit water treatment plant and prepare report on various units of water treatment and its management.
h. **Preparation of report**: Prepare the chart of solid waste management showing effects on environment.
i. **And any other relevant topic related to course**

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Basic Environmental Sciences	Michael Allaby	Routledge Publication, 2nd Edition, 2000, ISBN: 0-415-21176-X
2	Environmental Science	Y. K. Singh	New Age International Publishers, 2006, ISBN: 81-224-2330-2
3	Environmental Studies	Erach Bharucha	University Grants Commission, New Delhi
4	Environmental Studies	Rajagopalan	Third Edition, Oxford University Press, USA, ISBN: 9780199459759, 0199459754
5	A text book of Environmental Science	Arvind Kumar	APH Publishing New Delhi
6	A text book of Environmental Studies	Shashi Chawla	Tata Mc Graw-Hill New Delhi

14. SOFTWARE/LEARNING WEBSITES

a. www.eco-prayer.org
b. www.teriin.org
c. www.cpcb.nic.in
d. www.indiaenvironmentportal.org.in
e. www.whatis.techtarget.com
f. www.sustainabledevelopment.un.org
g. www.conserve-energy-future.com