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 : Third — **Scheme - I**

S. N.	Course Title	Course Abbreviation	Course Code	Teaching Scheme			Credit (L+T+P)	Examination Scheme														Grand Total
									Theory								Practical					
									ESE		PA		Total		ESE		PA		Total			
				L	T	P		Exam Duration in Hrs.	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	Advanced Surveying	ASU	22301	3	-	4	7	3	70	28	30*	00	100	40	50#	20	50	20	100	40	200
2	Highway Engineering	HEN	22302	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
3	Mechanics of Structures	MOS	22303	3	2	2	7	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
4	Building Construction	BCO	22304	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
5	Concrete Technology	CTE	22305	3	-	2	5	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
6	Computer Aided Drawing	CAD	22022	-	-	4	4	--	--	--	--	--	--	--	50@	20	50~	20	100	40	100
			Total	**15**	**2**	**16**	**33**	--	**350**	--	**150**	--	**500**	--	**200**	--	**200**	--	**400**	--	**900**

Student Contact Hours Per Week: **33 Hrs.** Medium of Instruction: **English**

Theory and practical periods of 60 minutes each. Total Marks : **900**

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.**

Program Name : **Civil Engineering Program Group**

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

Semester : **Third**

Course Title : **Advanced Surveying**

Course Code : **22301**

1. RATIONALE

In the era of globalization today, the technology has brought the significant advancements in surveying instruments and technology. Available precise digital surveying instruments are used currently due to their accuracy, speed and easy operation of the same. These equipments and the applications are extensively used in the fields of civil engineering, mining engineering, environmental engineering, transportation engineering and marine engineering. Since, Remote sensing and Geographic Information System (GIS) is a vital discipline and being widely used for plotting and storing spatial information, it is expected the students should know the basics of the same to apply it in field. Through this course students will develop the desired skills and competencies which are expected from them for survey related works.

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 plans, contour maps using Advanced Surveying equipment and techniques.**

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. Prepare plans using Plane Table Surveys.
b. Prepare plans using Theodolite surveys.
c. Find distances and elevations using Tacheometer.
d. Set out simple circular curves.
e. Prepare plans using Total Station instrument.
f. Locate coordinates of stations using GPS.

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	-	4	7	3	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 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.*

1. 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.

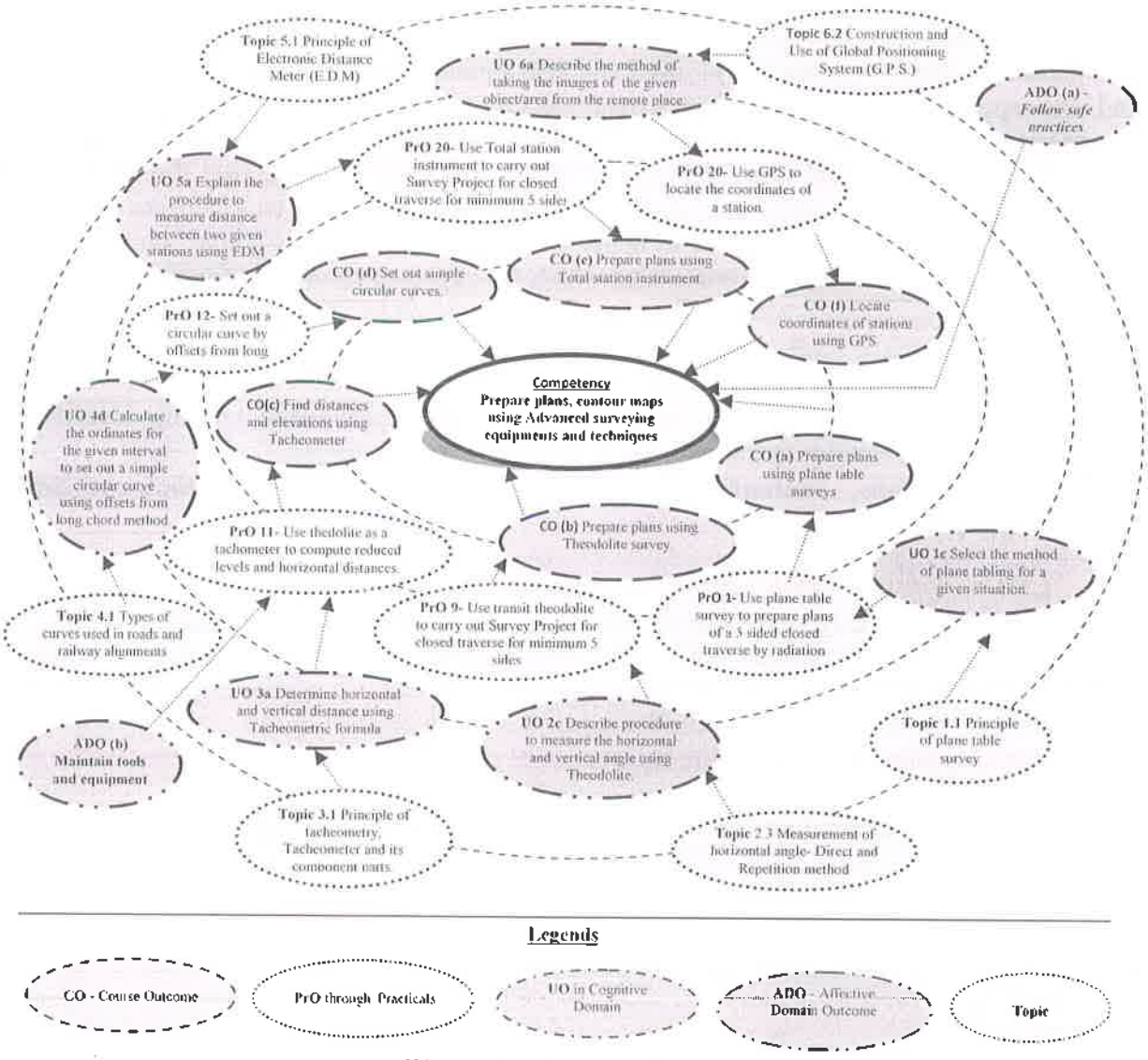

Figure 1 - Course Map

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	Use Plane Table Survey to prepare plans of a 5 sided closed traverse by Radiation Method.	I	02*
2	Use plane table survey to prepare plans of a plot of 7 sided closed traverse by Radiation Method.	I	02
3	Use plane table survey to prepare plans locate details by Intersection Method	I	02*
4	Use plane table survey to prepare plans locate details by Traversing Method	I	02*
5	Use plane table survey to carry out Survey Project for closed traverse for minimum 5 sides around a building.**(Compulsory)**	I	Full day*
6	Set up the transit Theodolite	II	02
7	Use transit theodolite to measure Horizontal angle correctly by Direct Method.	II	02*
8	Use transit theodolite to measure Vertical angle correctly by Direct Method.	II	02*
9	Use transit theodolite to measure Horizontal angle correctly by method of Repetition.	II	02*
10	Use transit theodolite to measure Vertical angle correctly by method of Repetition	II	02
11	Use transit theodolite to carry out Survey Project for closed traverse for minimum 5 sides(Compulsory).	II	Full day*
12	Plot the traverse on A1 size imperial drawing sheet for the collected data from preceding Theodolite Survey Project.	II	02*
13	Plot the traverse on A1 size imperial drawing sheet for the collected data from preceding Theodolite Survey Project.	II	02*
14	Use thedolite as a Tacheometer to compute reduced levels and horizontal distances.	III	02*
15	Set out a circular curve by offsets from Long Chord Method.	IV	02*
16	Set out a circular curve by Rankine's Method of Deflection Angles.	IV	02
17	Use One Second Micro Optic Theodolite to Measure Horizontal angle by Direct Method	V	02
18	Use One Second Micro Digital Theodolite to Measure Horizontal angle by Direct Method	V	02
19	Use EDM to measure horizontal distance.(PartI)	V	02*
20	Use EDM to measure horizontal distance(Part II)	V	02
21	Set up the Total Station instrument. (PartI)	V	02*
22	Set up the Total Station instrument. (Part II)	V	02
23	Use Total station instrument to measure horizontal distances.	V	02*
24	Use Total station instrument to measure horizontal distances.	V	02
25	Use Total station instrument to measure horizontal distances.	V	02
26	Use Total station instrument to measure horizontal distances.	V	02
27	Use Total station instrument to measure horizontal angle.	V	02*
28	Use Total station instrument to measure horizontal angle.	V	02
29	Use Total station instrument to measure horizontal angle.	V	02
30	Use Total station instrument to measure vertical angle.	V	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
31	Use Total station instrument to measure vertical angle.	V	02
32	Use Total station instrument to carry out Survey Project for closed traverse for minimum 5 sides.**(Compulsory)**	V	Full day*
33	Plot the traverse on A1 size imperial drawing sheet for the collected data from preceding Total Station Survey Project.	V	02*
34	Plot the traverse on A1 size imperial drawing sheet for the collected data from preceding Total Station Survey Project.		02*
35	Use GPS to locate the coordinates of a station.	VI	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 24 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 plotting.	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/ 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. S. No.
1	Plane table with accessories- Plane and telescopic Alidade,Trough compass, U-fork ,Spirit level.	1-5
2	Twenty Second Transit theodolite with accessories.	6-11
3	One second Micro optic Theodolite with accessories.	14,16,17
4	Electronic Digital Theodolite with accessories.	18
5	Electronic Distance meter (+or- 2mm accuracy) with accessories.	19,20
6	Total Station (+ or - 2mm accuracy) instrument with accessories	21-32
7	GPS instrument	35

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 Plane Table Surveying	1a. Explain the functions and use of the given accessories of plane table. 1b. Describe the method of orienting the plane table in a given situation. 1c. Select the method of plane tabling for a given situation. 1d. Compare the given two methods of doing plane table survey.	1.1 Principle of plane table survey. 1.2 Accessories of plane table and their use, Telescopic alidade. 1.3 Setting of plane table; Orientation of plane table - Back sighting and Magnetic meridian method, True Meridian Method 1.4 Methods of plane table surveys- Radiation, Intersection and Traversing. 1.5 Merits and demerits of plane table survey.
Unit– II Theodolite Surveying	2a. Explain the given components of a transit Theodolite 2b. Describe the salient features and the relationship between the given fundamental axes. 2c. Describe the procedure to measure the horizontal and vertical angles using Theodolite for the given situation. 2d. Apply checks for determining the type of traverse using the given data. 2e. Compute Latitude, Departure, Consecutive co ordinates. Independent coordinates from the	2.1 Types and uses of Theodolite; Component parts of transit Theodolite and their functions, Reading the Vernier of transit Theodolite, 2.2 Technical terms- Swinging, Transiting, Face left, Face right, 2.3 Fundamental axes of transit Theodolite and their relationship 2.4 Temporary adjustment of transit Theodolite, 2.5 Measurement of horizontal angle- Direct and Repetition method, Errors eliminated by method of repetition,

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	data given. 2f. Select relevant method of Theodolite traversing for given condition. 2g. Apply Bowditch's rule and Transit rule to balance the traverse for a given data. 2h. Tabulate Gale's Traverse table for the given data.	2.6 Measurement of magnetic bearing of a line, Prolonging and ranging a line, deflection angle. 2.7 Measurement of vertical Angle. 2.8 Theodolite traversing by included angle method and deflection angle method. 2.9 Checks for open and closed traverse, Calculations of bearing from angles. 2.10 Traverse computation-Latitude. Departure, Consecutive co ordinates, Independent coordinates, Balancing the traverse by Bowditch's rule and Transit rule. Gale's Traverse table computation.
Unit- III Tacheometric surveying	3a. Explain the functions of the given component(s) of a Tacheometer. 3b. Determine horizontal and vertical distances using Tacheometric formula in the given situation. 3c. Calculate constants of tacheometer from the given data. 3d. Determine RLs of stations and the distance between the stations using tachometric survey for the given data.	3.1 Principle of tacheometry, Tacheometer and its component parts, Anallatic lens. 3.2 Tacheometric formula for horizontal distance with telescope horizontal and staff vertical. 3.3 Field method for determining constants of tacheometer, 3.4 Determining horizontal and vertical distances with tacheometer by fixed hair method and staff held vertical, 3.5 Limitations of tacheometry.
Unit– IV Curve setting	4a. Propose the curves used in alignment of roads for given condition with justification. 4b. Propose the types of curves used in alignment of railways for given condition with justification. 4c. Label the figure of given simple circular curve. 4d. Calculate the ordinates for the given interval to set out a simple circular curve using offsets from long chord method. 4e. Tabulate the given data required for setting out a circular curve using Rankine's method of deflection angle.	4.1 Types of curves used in roads and railway alignments. 4.2 Notations of simple circular curve Designation of the curve. 4.3 Setting simple circular curve by offsets from long chord and Rankine's method of deflection angles.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit –V Advanced surveying equipments	5a. Explain the procedure to measure the distance between two given stations using EDM. 5b. Describe procedure to measure the horizontal angle using givenTheodolite. 5c. Describe the procedure to measure the vertical angle using the given Theodolite. 5d. Explain the procedure to measure Horizontal and vertical angles between the given lines using Total Station instrument. 5e. Describe the procedure to measure distances and coordinates of the given points to prepare plans using Total Station instrument.	5.1 Principle of Electronic Distance Meter (EDM), its component parts and their Functions, use of EDM. 5.2 Construction and use of One Second Micro Optic Theodolite, Electronic Digital Theodolite. Features of Electronic Theodolite. 5.3 Construction and Use of Total Station, Temporary adjustments. 5.4 Use of function keys. 5.5 Measurements of Horizontal angles, vertical angles, distances and coordinates using Total Station. Traversing, Profile Survey and Contouring with Total Station.
Unit-VI Remote sensing, GPS and GIS	6a. Describe the method of taking the images of the given object/area from the remote place. 6b. Propose the relevant system of remote sensing to be used for given situation. 6c. Describe the procedure to find the coordinates of the given station using GPS. 6d. Explain the utility of GIS applications in given civil engineering problem.	6.1 Remote Sensing – Over view, Electro-Magnetic Energy, Remote sensing system-, Active and Passive system, Applications of remote sensing in Mining, land use / Land cover, mapping, disaster management and Environment. 6.2 Construction and use of Global Positioning System (G.P.S.) 6.3 Geographic Information System(GIS): Over view, Components, Applications, Soft wares for GIS, Sources of errors in GIS.

***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	Plane Table Surveying	04	02	02	04	08
II	Theodolite Surveying	16	04	06	14	24
III	Tacheometric surveying	06	02	02	04	08
IV	Curve setting	06	02	02	04	08
V	Advanced surveying equipments	10	02	06	06	14
VI	Remote sensing and GIS	06	02	02	04	08
Total		**48**	**14**	**20**	**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.*

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. Measure area of small open ground by plane tabling.
b. Prepare a flex chart to explain one method of plane tabling.
c. Measure the height of the flag post using Theodolite.
d. Set the alignment of proposed road using Theodolite.
e. Measure the height of the flag post using Theodolite as tacheometer.
f. Plot the contours using Total station by direct method.
g. Mark building layout using Total station.
h. Measure distance between two distant(>500m) points using EDM
i. Locate the coordinates of the campus using GPS
j. Search and download the demo versions of various software and prepare a report stating the applications.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning 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. Arrange visit to nearby newly started site for understanding various surveying techniques.
g. Show video/animation films to explain various instruments like EDM,Total Station, GPS
h. Prepare maintenance charts for various instruments in survey laboratory.

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 relevant technical and commercial information of advanced survey instruments available in the market with specifications.
b. Carry out comparative study of following survey instruments of different make and brands: Total station/ EDM/GPS/Micro optic theodolite.
c. Set the profiles of curves at the changes in alignment of road in the premises of the institute.
d. Determine the RLs of the existing structures like lintels, chajja, slab, and beam using Tacheometer and Total station in a multi-storeyed building and compare the results.
e. Download specifications for Total station/ EDM/GPS/Micro optic theodolite and make a chart.
f. Coordinate System –UTM (Universal Transverse Mercator Coordinate system
g. Mobile devices used for distance measurement
h. 360 degree lazer
i. Information about Drone survey

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Surveying and Levelling Part I and II	Kanetkar, T. P. and Kulkarni, S. V.	Pune Vidyarthi Gruh Prakashan, Pune; ISBN: 13: 9788185825007
2	Surveying and Levelling	Basak, N. N.	McGraw Hill Education (India) Pvt. Ltd.,Noida ISBN: 93-3290-153-8
3	Survey I and Survey II	Duggal, S. K.	Tata McGraw Hill Education Pvt. Ltd., Noida. ISBN:13: 978-1259029837
4	Surveying	Saikia, M D; Das B.M. and Das, M.M.	PHI Learning Pvt. Ltd., New Delhi ISBN: 978-81-203-3985-9
5	Surveying and Levelling	Subramanian, R.	Oxford University Press. New Delhi ISBN 13:978-0-19-808542-3
6	Surveying Vol. I and Surveying Vol. II	Punmia, B.C.; Jain, Ashok Kumar and Jain, Arun Kumar	Laxmi Publications Pvt. Ltd., New Delhi. ISBN: 13: 9788170088837
7	Textbook of Surveying	Rao, P. Venugopala and Akella, Vijayalakshmi	PHI Learning Pvt. Ltd., New Delhi ISBN: 978-81-203-4991-9
8	Textbook of Surveying	Venkatramaiah, C	Universities Press, Hyderabad ISBN: 978-81-737-1021-6
9	Surveying theory and	Anderson, James M	Mc Graw Hill Education, Noida

S. No.	Title of Book	Author	Publication
	practice	and Mikhail, Edward M.	ISBN:13-978-1-25-902564-8
10	Plane Surveying	De, Alak	S.Chand Publications, New Delhi ISBN:9788121917803

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. http://nptel.ac.in/courses/105107121/
b. https://www.youtube.com/watch?v=QtEkZPEeeZk
c. https://www.youtube.com/watch?v=KQgq5xqSTUw
d. https://www.youtube.com/watch?v=zcRs3KTQzN0
e. https://www.youtube.com/watch?v=6d4mERJFPpI
f. https://www.youtube.com/watch?v=Dj06aUJ9Wjc
g. https://www.youtube.com/watch?v=Ob8LLRfo0tA
h. https://www.youtube.com/watch?v=n_EMrTbDZak
i. https://www.youtube.com/watch?v=H2AQq2jshgg
j. https://www.youtube.com/watch?v=C8UKJtZIAWE
k. https://www.youtube.com/watch?v=J6j_sJyyudI
l. http://www.asnu.com.au
m. www.oupinheonline.com

Program Name : **Civil Engineering Program Group**

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

Semester : **Third**

Course Title : **Highway Engineering**

Course Code : **22302**

1. RATIONALE

Road Transportation is the most effective and economical means of transportation in our country. The need for travel to various places at faster speed has also increased. In order to professionally contribute to the field of highway engineering, the associated engineers and supervisors must have adequate knowledge and skills relating to technical aspects of continuously increasing volume of traffic flow, design of highway intersections/interchanges, geometric alignment and design, materials, structural design of pavement, new developments in road construction and use of modern and waste materials, techniques, design and maintenance of pavements. Agencies like NHAI and State Government and private organisation are intensely involved in improving and building road networks in India. Diploma Engineering students have good scope in jobs related to road construction as well as such infrastructural associated different projects works. This course provides scope of learning about various aspects of roads, carrying out survey, investigation, planning, design, construction and maintenance works related to road constructions.

2. COMPETENCY

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

- **Undertake construction and maintenance of pavements (Roads).**

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 the types of roads as per IRC recommendations.
b. Implement the geometrical design features of different highways.
c. Perform different tests on road materials.
d. Evaluate traffic flow characteristics.
e. Implement hill road construction using relevant materials, techniques and methods.
f. Undertake maintenance of roads and drainage.

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	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 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.

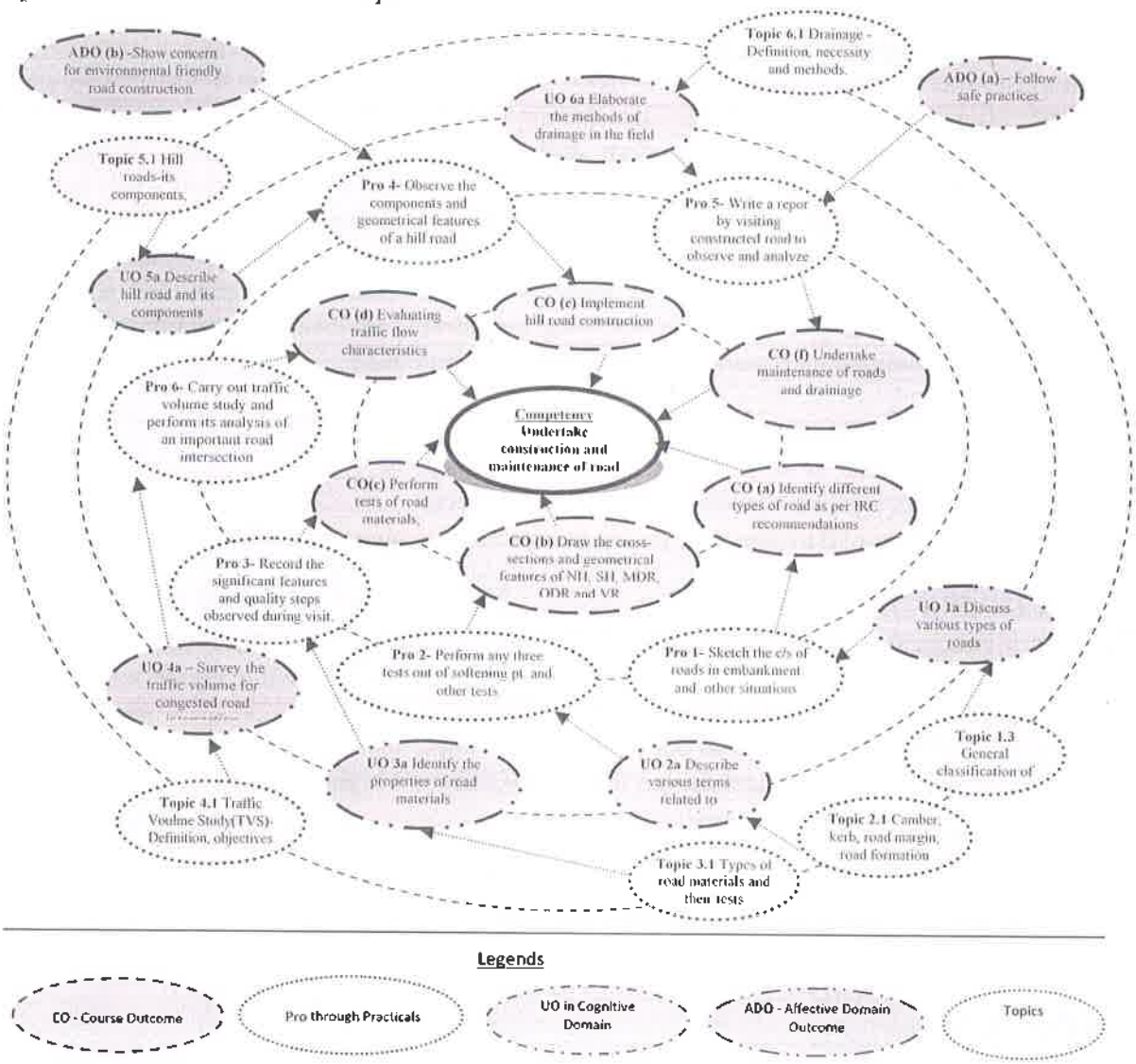

Figure 1 - Course Map

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	Draw the sketches showing standard cross sections of NH/SH, MDR/ODR in embankment and cutting on A3 size sheets.	II	02*
2	Conduct Flakiness Index Test on the aggregates.	II	02*
3	Conduct Elongation Index Test on the aggregates.	II	02*
4	Conduct Angularity Number Test on the aggregates.	II	02
5	Conduct Softening point test on bitumen.	III	02*
6	Conduct Penetration test on bitumen.	III	02*
7	Conduct Flash and Fire Point test on bitumen.	III	02
8	Conduct Ductility test on Bitumen.	III	02
9	Visit the constructed road to suggest the possible remedial measures against the observed defects	III	02*
10	Prepare the photographic report containing details for experiment no. 9	III	02*
11	Carry out Traffic Volume Study (minimum two hours of peak period) for an important road intersection or roadway in your city/ town/ village.	IV	02*
12	Perform analysis of traffic volume data of experiment no. 11.	IV	02*
13	Draw the sketch of collision diagram for any one case.	IV	02*
14	Visit the hill road constructed site to understand its components and prepare the photographic report containing details.	V	02
15	Prepare the photographic report containing details for experiment no. 14.	V	02
16	Visit the road of any one type (flexible or rigid) to know the drainage condition.	VI	02
17	Prepare the photographic report suggesting possible repairs and maintenance for experiment no. 16.	VI	02
	Total		**34**

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	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**

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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	Thickness gauge containing openings for aggregate sizes 63, 50, 40,31.5, 25,20,16,12.5,10 & 6.3mm as per IS:2386(Part I)-1963	2
2	Length gauge containing openings for aggregate sizes 63, 50, 40,31.5, 25,20,16,12.5,10 & 6.3mm as per IS:2386(Part I)-1963	3
3	Ring and Ball test apparatus (Hot plate 160mm dia. with magnetic stirrer, brass ring, steel ball and glass vessel 600ml and glass thermometer +80^{0}c.	5
4	Standard Penetrometer with penetration needle 100gm weight, container 55mm dia. and 53mm ht. as per IS:1203.	6
5	Pensky Marten's Flash and Fire Point test apparatus 100x200x240mm with measurement range 0-95 as per IS:1209-1953	7
6	Ductility Testing Machine with ductility mould and base plate	8

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 Overview to Highway Engineering	1a. Describe key features of the given type of road. 1b. Explain significant aspects of the given road development plans as per IRC. 1c. Explain ideal road alignment	1.1 Scope and Importance of roads in India and its' Characteristics. 1.2 Different modes of transportation. 1.3 General classification of roads. 1.4 Road classifications in India (Nagpur plan) Third road development

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	and its requirements. 1d. Prepare the list of factors affecting given type of road alignment. 1e. Suggest the ideal requirements of road alignment for the given road condition.	(Lucknow) plan. 1.5 Development of Urban roads. 1.6 Requirements of an ideal road alignment and the factors affecting road alignment.
Unit—II Geometric Design of Highway	2a. Explain various functional terms related to geometrics of of the given type of highway with sketches. 2b. Describe the given type of road curves and their necessity. 2c. Calculate SSD, Super-elevation, and widening of roads required for the given road construction problem. 2d. Sketch the cross sections of roads in embankment and cutting for the given site condition.	2.1 Various terms used in Highway: Camber: Definition, purpose, types as per IRC – recommendations. 2.2 Kerbs: Road margin, road formation, right of way. 2.3 Design speed and various factors affecting design speed as per IRC – recommendations. 2.4 Gradient: Definition, types as per IRC – Recommendations. 2.5 Sight distance (SSD): Definition, types IRC – recommendations, simple numerical. 2.6 Curves: Necessity, types: Horizontal, vertical curves. 2.7 Widening of roads: types and problems 2.8 Super elevation: Definition, formula for calculating minimum and maximum Super elevation and method of providing super-elevation 2.9 Standards cross-sections of national highway in embankment and cutting.
Unit—III Construction of Road Pavements	3a. Describe the properties of given type of road materials 3b. Explain function/s of components of given type pavements with sketches/s. 3c. Describe with sketches the construction method for the given type of road pavement. 3d. Explain procedure for testing the given parameter of road construction. 3e. Describe with sketches the road construction method for the given situation.	3.1 Types of road materials and their Tests – Test on aggregates-Flakiness and Elongation Index test, Angularity Number test, test on Bitumen-penetration, Ductility, Flash and Fire point test and Softening point test. 3.2 Pavement – Definition, Types, Structural Components of pavement and their functions 3.3 Construction of WBM road. Merits and demerits of WBM road. 3.4 Construction of Flexible pavement / Bituminous Road, Types of Bitumen and its properties, Emulsion, Cutback, Tar, Terms used in BR-prime coat, tack coat, seal coat, Merits and Demerits of

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		BR. 3.5 Construction of cement concrete-methods of construction-Alternate and Continuous Bay Method, Construction joints, filler and sealers, merits and demerits of concrete roads.
Unit—IV Traffic Engineering.	4a. Prepare survey plan for the traffic volume for congested road intersection. 4b. Interpret the observations recorded in traffic volume study to suggest the suitable solutions for traffic problems. 4c. Explain the given collision diagram to express various causes of accidents. 4d. Explain with sketches the working of various traffic control devices with their functions. 4e. Suggest suitability of traffic control device for the given situation with justification.	4.1 Traffic Volume Study(TVS)-Definition of Traffic Volume and Traffic Density. Objectives of TVS 4.2 Passenger Car Unit (PCU) and factors affecting it. 4.3 Traffic control devices – road signs, marking, Signals, Traffic island, Signals-Types, 4.4 Road signs-Types-Regulatory, Prohibitory and Informatory, Sketches of road signs. Types of road markings. 4.5 Traffic island-Types-Divisional, Channelizing, Pedestrian, Rotary. 4.6 Road intersections- Grade and grade separated intersections. 4.7 Accident studies with causes, Collision Diagram.
Unit—V Hill Roads	5a. Describe with sketches the given components of the hill road 5b. Suggest the drainage protective works on hill roads for the given situation with justification. 5c. Explain with sketches the causes of landslides in the given type of hill road. 5d. Suggest preventive measures to check landslide for the given condition with justification.	5.1 Hill roads, its components, functions 5.2 Types of hill road curves. 5.3 Drainage of hill roads: Side drains, catch water drains, cross drains, 5.4 Construction procedure of hill roads. 5.5 Landslides- Types and Causes 5.6 Prevention of landslides.
Unit—VI Drainage, Maintenance and Road Repair.	6a. Describe with sketches the relevant method of providing drainage in the given type of field. 6b. Interpret the information of the causes of failure of given type of pavement. 6c. Suggest suitable preventive	6.1 Drainage-Definition, necessity and methods . 6.2 Surface drainage: side gutter, catch 6.3 Water drain. Subsurface drainage-Longitudinal and Cross drains. 6.4 Classification and necessity highway of maintenance. Causes of failure of flexible pavement-WBM road,

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	measures to avoid failures in the given type of pavement with justification. 6d. Suggest the maintenance and repair works of given type of defective road	Bituminous road. 6.5 Causes of failure of rigid pavement-Cement concrete road 6.6 Need for highway maintenance. Classification of maintenance. 6.7 Special repair of flexible and Rigid pavements.

***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	Introduction to Highway Engineering	04	02	02	--	04
II	Geometric Design of Highway.	14	04	06	06	16
III	Construction of Road Pavements	10	04	06	06	16
IV	Traffic Engineering	08	04	04	06	14
V	Hill Roads	06	02	04	04	10
VI	Drainage, Maintenance and Road Repair.	06	02	04	04	10
Total		**48**	**18**	**26**	**26**	**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. Undertake micro-projects related to road construction.
b. Observe the components of roadway and record the details of the same with necessary sketches.
c. Collect the information of NH and SH constructed and under construction across the country.
d. Visit the crowded area i.e. city/town/village and note down the traffic control devices to suggest the possible action for smooth traffic flow.
e. Collect the typical samples of drawings and legal documents required for road project form PWD office.
f. Search the software/freeware on the course content and prepare the detailed report stating their applications.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning 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. Demonstrate various concepts using videos of construction work of flexible and rigid pavement.
g. Encourage students to refer different websites to have deeper understanding of new concepts of road works.
h. Recommend the students to collect statistical and physiological data of present road 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. Collect all the details of all types of existing NH, SH across the country.
b. Evaluate the camber and gradient of any one road of each type of pavement in the vicinity of area of college.
c. Develop the photographic model of typical pavement structure for actual visited site.
d. Advance Techniques of repairs like CBTR , White topping, Preventive maintenance, overlays, MSA (Million Standard Axle Load), utility system, encroachment , forest land under roads
e. Any other micro-projects suggested by subject faculty on similar line.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Highway Engineering	Khanna S.K. , Justo, C E G and Veeraragavan, A.	Nem Chand and Brothers, Roorkee, 2010, ISBN 978-8185240800
2	Road, Railways, Bridge and Tunnel Engg	Birdi, Ahuja,	Standard Book House, New Delhi, March 2010, ISBN: 978-8189401337
3	Traffic Engineering and Transport Planning	Kadiyali, L.R.	Khanna Publishers, New Delhi, 2008, ISBN: 978-8174092205
4	Principles, Practice and Design of Highway Engineering,	Sharma, S.K.	S. Chand Publication, New Delhi, 2012, ISBN:9788121901314
5	Laboratory Manual in Highway Engineering	Duggal, Ajay K. and Puri, V. P.	New Age International (P) Limited, Publishers, New Delhi, 2010, ISBN: 9788122403107

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. https://www.youtube.com/watch?v=1fc4NVP9wXk
b. https://www.youtube.com/watch?v=m8U76Bm8kDY
c. https://www.youtube.com/watch?v=lORIZ1shRIM
d. https://www.youtube.com/watch?v=Xf89KDiblFE

Program Name : **Civil Engineering Program Group**

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

Semester : **Third**

Course Title : **Mechanics of Structures**

Course Code : **22303**

1. RATIONALE

Design and analysis of structure and its components, needs the basic understanding and application of mechanical properties of material and their behavior under different loading and stress conditions. Concepts and principles of structural analysis shall be well understood by students, which is important for design of reinforced cement concrete and steel structures and the same has been covered in this course. Analysis of determinate structure under action of transverse loading along with analysis of members under direct loading will also be studied in this course. The approach of teaching the course shall focus on development of students' analytical and critical thinking while solving structural problems.The experiments expected to be conducted in laboratory will integrate knowledge and required skills as regards to the structural behavior of components and materials.

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. Articulate practical applications of moment of inertia of symmetrical and unsymmetrical structural sections.
b. Interpret structural behaviour of materials under various loading conditions.
c. Select material considering engineering properties for various structural applications.
d. Interpret shear force and bending moment diagrams for various types of beams and loading conditions.
e. Determine the bending and shear stresses in beams under different loading conditions.
f. Check the column safety for various loading and end conditions.

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 are 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.

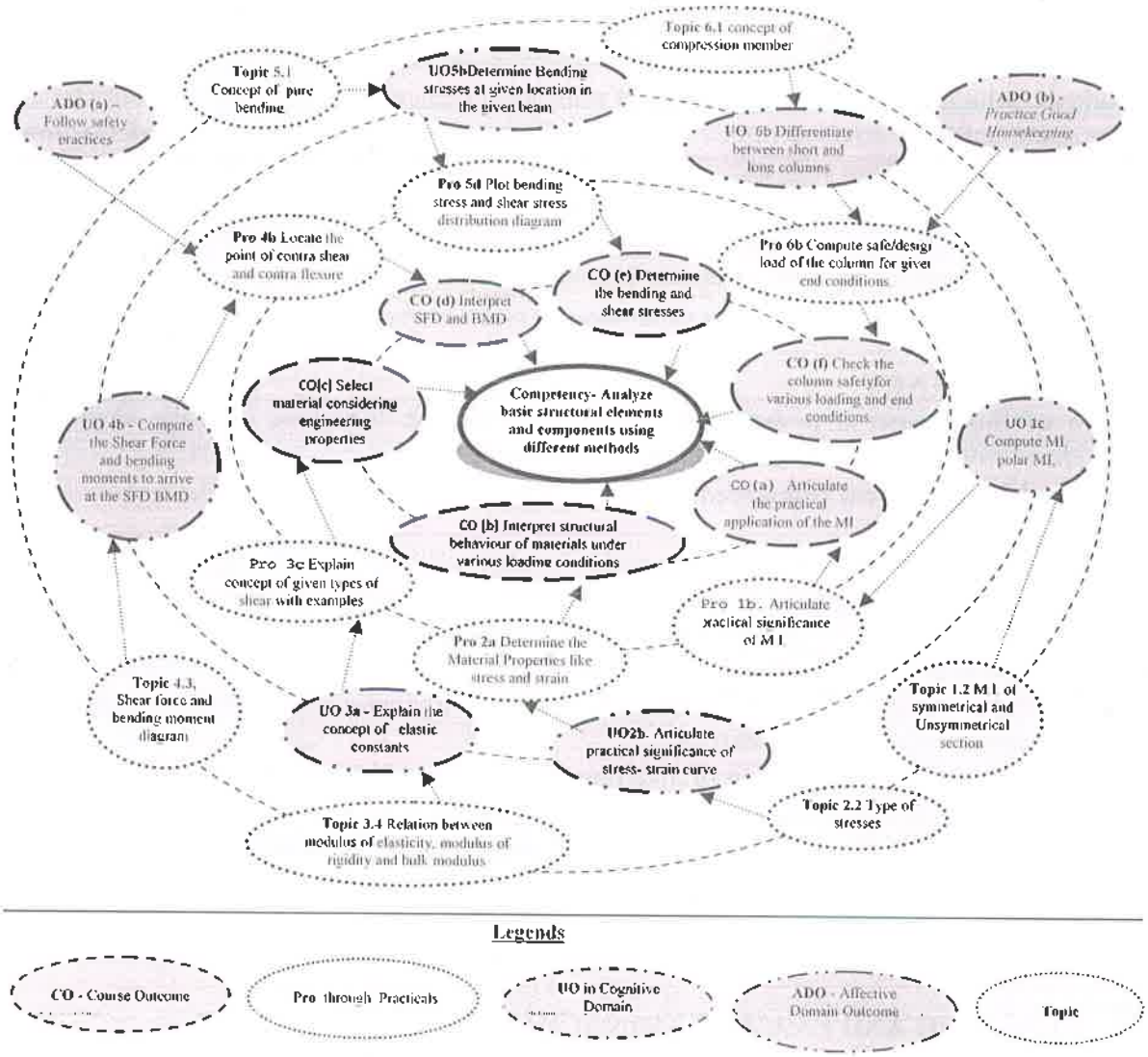

Figure 1 - Course Map

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.	Conduct compressive and tensile tests on sample test pieces using Universal Testing Machine along with introduction to other tests to be conducted on UTM.	II	02
2.	Conduct compression test on sample test piece using Compression Testing Machine.	II	02
3.	Perform Tension test on mild steel as per IS:432(1)	II	02*
4.	Perform tension test on Tor steel as per IS:1608,IS:1139	II	02
5.	Conduct Izod Impact test on three metals. E.g. mild steel/ brass/aluminum/ copper /cast iron etc as per IS:1598	II	02
6.	Conduct Charpy Impact test on three metals. E.g. mild steel/ brass/aluminum/ copper /cast iron etc as per IS:1757	II	02*
7.	Determine Water Absorption on bricks per IS:3495 (part II), IS:1077 or tile IS:1237	II	02*
8.	Determine Compressive strength of dry and wet bricks as per IS:3495(part I), IS:1077	II	04*
9.	Conduct Abrasion Test on flooring tiles (any one) e.g. Mosaic tiles, Ceramic Tiles as per IS: 13630(part7), Cement Tile as per IS: 1237	II	02
10.	Perform Single Shear and double shear test on any two metals e.g. Mild steel/ brass/aluminum/copper / cast iron etc as per IS:5242	III	02*
11.	Conduct Compression test on timber section along the grain and across the grain as per IS:2408	II,VI	02
12.	Plot Shear force and Bending Moment diagrams of cantilever, simply supported and overhanging beams for different types of loads two problems on each type of beam	IV	06
13.	Conduct Flexural test on timber beam on rectangular section in both orientation as per IS:1708, IS:2408	I,V	02*
14.	Conduct Flexure test on floor tiles IS:1237,IS:13630 or roofing tiles as per IS:654,IS:2690	V	02
15.	Field test on TMT bars.	II	02
	Total		**34**

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 %
a.	Preparation of experimental set up	20
b.	Setting and operation	20

S.No	Performance Indicators	Weightage in %
c.	Safety measures	10
d.	Observations and recording	10
e.	Interpretation of results and conclusion	20
f.	Answer to sample question	10
g.	Submission of report in time	10
		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
- 'Organizing Level' in 2nd year
- 'Characterizing 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. S.No
1	Universal Testing machine of capacity 1000kN, 600 kN/400kN, analog type/digital type with all attachments and accessories.	1,3,4, 10,13
2	Extensometer with least count 0.01mm, maximum extension 25 mm with dial gauge/ digital display suitable for various gauge length.	3,4
3	Compression testing machine of capacity 2000kN/1000kN, analog /digital type with all attachments and accessories.	2,8,11
4	Tile abrasion testing machine confirming to IS:1237 and IS :1706 for determining resistance to wear and abrasion of flooring tiles complete with dial gauges , revolution counter, thickness measurement holder and abrasion powder.	9
5	Izod/Charpy impact testing machine confirming to IS: 1757.	5,6
6	Tile flexural testing machine confirming to IS:654,capacity 200Kg with uniform loading rate of 45 to 55 Kg/minute provided with lead shots	13
7	Hot Air Oven with thermostatic control having temp. range 100 to 105° C	7
8	Accessories: venire caliper, meter scale, weighing balance, weights, punch, file, hammer, screw driver, pliers ,etc.	All

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 Moment of Inertia	1a. Compute Moment of Inertia, polar moment of inertia section modulus of given section. 1b. Articulate practical significance of M.I. for given section and loading condition(s). 1c. Compute Moment of Inertia, polar moment of inertia, section modulus of given standard section. 1d. Compute Moment of Inertia of given unsymmetrical section.	1.1 Moment of inertia (M.I.): definition, M.I. of plane lamina, radius of gyration, section modulus, parallel and perpendicular axes theorems (without derivation), M.I. of rectangle, square, circle, semi circle, quarter circle and triangle section(without derivation). 1.2 M.I. of symmetrical and unsymmetrical I-section, channel section, T-section, angle section, and hollow sections and built up section about centroidal axes and any other reference axis. 1.3 Polar Moment of Inertia of solid circular sections.
Unit –II Simple Stresses and Strains	2a. Articulate practical significance of stress- strain curve for given materials under given loading conditions for their relevant use. 2b. Compute stresses and load shared by given Composite section subjected to direct load. 2c. Calculate modulus of elasticity, modulus of rigidity and axial deformation under given conditions for given material. 2d. Compute stresses induced in given homogeneous sections under temperature variations for given conditions.	2.1 Concept of rigid, elastic and plastic bodies, deformation of elastic body under various forces, definition of stress, strain, elasticity, Hook's law, elastic limit, modulus of elasticity, SI units. 2.2 Type of stresses-normal, direct, bending and shear and nature of stresses i.e. tensile and compressive stresses. 2.3 Standard stress strain curve for mild steel bar and tor steel bar under tension test, Yield stress, proof stress, ultimate stress, breaking stress, and working stress, strain at various critical points, percentage elongation and Factor of safety. 2.4 Deformation of body due to axial force, forces applied at intermediate sections, deformation of body of stepped cross section due to axial load, maximum stress and minimum stress induced. 2.5 Concept of composite section, conditions to have a section composite, stresses induced and load shared by materials under axial loading. 2.6 Concept of temperature stresses and strain, stress and strain developed due to temperature variation in homogeneous simple bar.(no composite section) Introduction to strain energy and types of loadings such as gradually applied load,

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		suddenly applied load and impact load only.
Unit–III Elastic Constants	3a. Explain the concept of elastic constants for given situation and their significance. 3b. Calculate change in volume of members for given stress condition. 3c. Explain concept of given types of shear with examples. 3d. Compute shear stress, shear strain and modulus of rigidity for given section.	3.1 Longitudinal and lateral strain, Poisson's ratio, biaxial and triaxial stresses, volumetric strain, change in volume, Bulk modulus. 3.2 Shear stress and strain, modulus of rigidity, simple and complementary shear stress. 3.3 Concept of single shear, double shear and punching shear. 3.4 Relation between modulus of elasticity, modulus of rigidity and bulk modulus.
Unit-IV Shear Force and Bending Moment	4a. Interpret the given types of support(s) and load(s). 4b. Interpret with simple sketch(s) of the given type(s) of beam, load and end conditions, relevant to the actual field situations. 4c. Compute the Shear Force and bending moments to arrive at the Shear force diagram, Bending Moment Diagram for given beam and load conditions. 4d. Locate the point of contra shear and point of contra flexure for the given SFD and BMD.	4.1 Types of supports, beams and loads. 4.2 Concept and definition of shear force and bending moment , relation between load, shear force and bending moment 4.3 Shear force and bending moment diagram for cantilever and simply supported beams subjected to point loads, uniformly distributed loads and couple, point of contra shear and point of contra flexure. 4.4 Shear force and bending moment diagram for overhanging beams subjected to, point loads, uniformly distributed loads only. Point of contra shear and point of contra flexure.
Unit-V Bending and Shear Stresses in beams	5a. Identify with justification nature of bending stresses for given situation. 5b. Determine Bending stresses and shear stresses at given location in the given beam. 5c. Design the beam section for the given data. 5d. Plot bending and shear stress distribution diagram for given beam section and given type of loading.	5.1 Concept and theory of pure bending, assumptions, flexural, meaning of term used in equation, bending stresses and their nature, bending stress distribution diagram. 5.2 Concept of moment of resistance and using flexure equation. 5.3 Shear stress equation, meaning of term used in equation, relation between maximum and average shear stress for rectangular and circular section, shear stress distribution diagram. 5.4 Shear stress distribution for square, rectangular, circle, hollow square, rectangular, circle, angle sections, channel

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		section, I-section, T sections.
Unit-VI Columns	6a. Differentiate between short and long columns based on given criteria. 6b. Compute safe/design load of the column for given different end conditions. 6c. Calculate the limitations of Euler's theory for the given data. 6d. Compute safe/design load of long column using Rankin's formula for given conditions.	6.1 Concept of compression member, short column, long column, effective length, radius of gyration, slenderness ratio, type of end conditions for columns, buckling of axially loaded columns. 6.2 Euler's theory, assumptions made in Euler's theory and its limitations. application of Euler's equation to calculate buckling load. 6.3 Rankin' s formula and its application to calculate crippling load. 6.4 Concept of working load/safe load, design load and factor of safety.

***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	Moment of Inertia	08	02	04	04	10
II	Simple stress and strain	10	04	04	06	14
III	Elastic constants	06	02	02	04	08
IV	Shear force and bending moment	12	02	04	12	18
V	Bending and shear stresses in beams	08	02	06	06	14
VI	Columns	04	02	02	02	06
Total		**48**	**14**	**22**	**34**	**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. Compare stability of different geometric shapes.
b. Correlate the actual field situations about various members subjected to different types of loading.

c. Select appropriate shape, type and material of member from day to day situations for various types of stress and strain.
d. Correlate the actual field situations with various types of beams (such as cantilever means canopy of a building, overhanging beam means slab with balcony provision). Shapes of various structural components resembling with shear force and bending moment diagrams of simple structures subjected to different types of loading. Identify the type of failure with respect to the shape.
e. Study the mode of failures due to flexure and shear from field situations and prepare a report.
f. Visit site/ design office and collect the data from day to day situation about stability and strength of column for buckling load.
g. Search the software / freeware on the course content and prepare the detailed report stating their applications.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning 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. Assign unit wise tutorials to group of 4 to 5 students for solving problems unit wise.
g. 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.
h. Use of video animation films to explain concept, Facts and applications related to Mechanics of Structures.
i. 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. Collect the IS related to methods of testing and specifications for five materials used in actual practice.
b. Select ten materials from day to day life and compare their mechanical properties and present it in a format of report.
c. Prepare prototype model of various types of support, beams and loading.
d. Prepare a report about beam sections subjected to bending and shear stresses from actual field/design office along with photographs and its justification.
e. Collect photographs along with justification about failure of short and long columns from actual field situations.

13. SUGGESTED LEARNING RESOURCES

S.No.	Title of Book	Author	Publication
1	Strength of Materials, Vol. I	Timoshenko, S.	CBS; 3 New Delhi; 2015, ISBN 978-8123910307
2	Strength of Materials	Khurmi, R.S.	S Chand and Co. Ltd. New Delhi, 2015, ISBN 978-8121928229
3	Strength of Materials	Ramamurtham, S	Dhanpat Rai and sons, New Delhi, 2015, ISBN 9788187433545
4	Strength of Materials	Punmia B C	Laxmi Publications (p) Ltd. New Delhi, 2015, ISBN-13: 978-8131809259
5	Strength of Materials	Rattan S.S.	McGraw Hill Education; New Delhi 2016, ISBN-13: 978-9385965517

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. https://www.youtube.com/watch?v=-JG9IEqRzQ4
b. https://www.youtube.com/watch?v=4VIhh6sGkrI
c. https://www.youtube.com/watch?v=EcPGKLUE04I
d. https://www.youtube.com/watch?v=-ndT35aqDfAQ
e. https://www.youtube.com/watch?v=ZJn_Mj2HeNM
f. https://www.youtube.com/watch?v=KU1gHy8Adrc
g. www.slideshare.net/nell0511/columns-and-struts
h. nptel.ac.in/courses/IIT-MADRAS/Strength_of_Materials/Pdfs/4_1.pdf
i. https://www.youtube.com/watch?v=nNcfzNjIifU
extofvideo.nptel.iitm.ac.in/105105108/lec28.pdf
j. http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/engg_mechanics/ui/Course_home_9.htm

Program Name: Civil Engineering Program Group

Program Code : CE/CR/CS

Semester : Third

Course Title : Building Construction

Course Code : 22304

1. RATIONALE

Building Construction is a core subject in Civil Engineering, which deals with the construction processes of sub structure, super structure, Building Finishes and maintenance of buildings. This course essentially imparts the knowledge of construction technology along with the processes involved in it and various construction equipments used for effective execution of various construction activities. This knowledge shall be used for effective and efficient up keeping of building after construction. This will enable the students to undertake the activities in comparatively shorter period of time.

2. COMPETENCY

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

- **Implement safe building construction practices.**

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 components of building structures.
b. Propose suitable type of foundation for building structures.
c. Select suitable type of masonry for building structures.
d. Propose relevant means of communications for different types of buildings.
e. Select the relevant material for finishing works.
f. Execute safe practices in building construction activities.

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	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. AlOs 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.

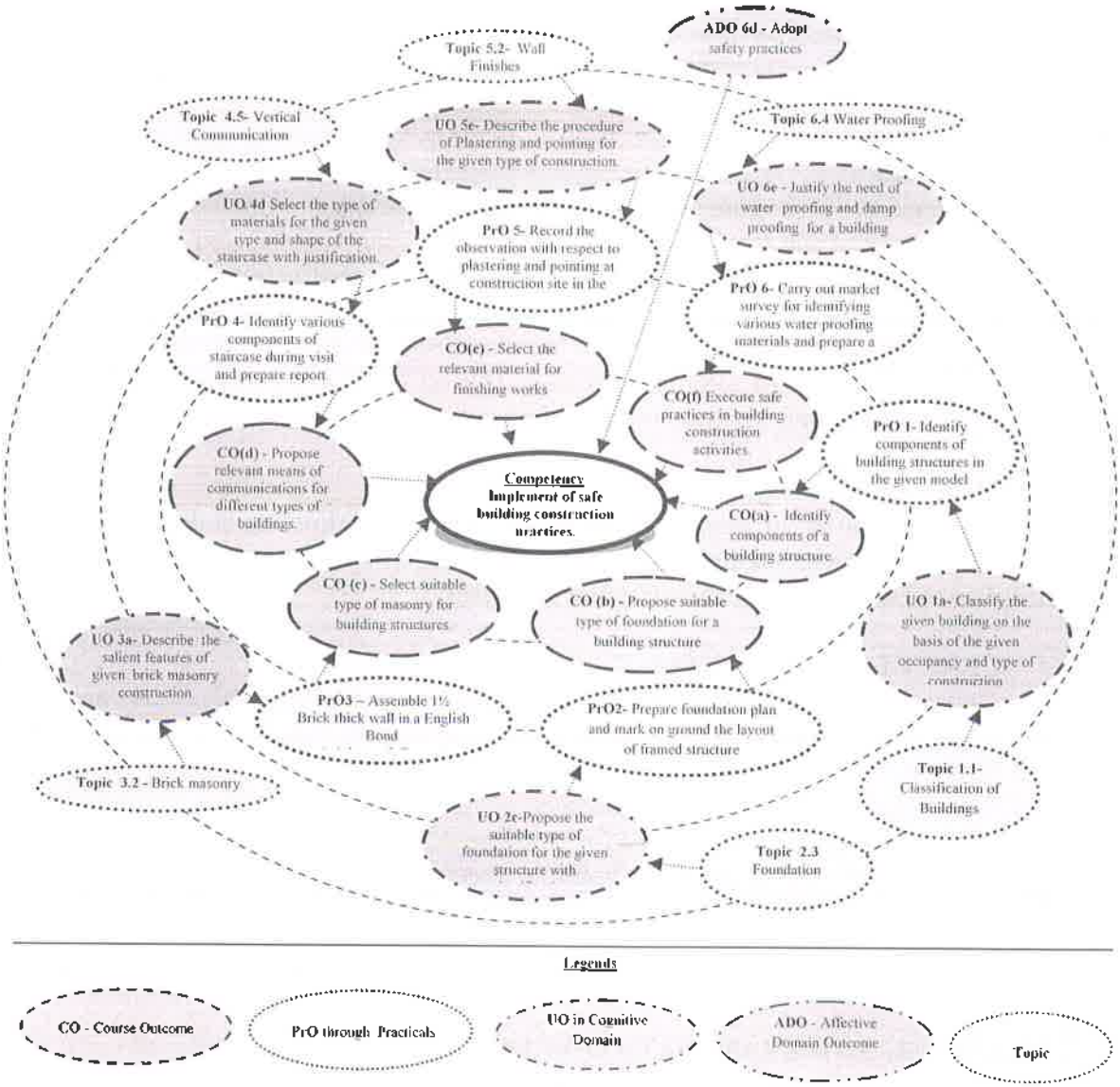

Figure 1 - Course Map

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	Identify components of building structures in the given model.	I	02*
2	Prepare foundation plan to mark layout on the ground of the load bearing structure from the given building plan.(Part I)	II	02*
3	Prepare foundation plan to mark layout on the ground of the load bearing structure from the given building plan.(Part II)	II	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
4	Prepare foundation plan to mark layout **on the ground** of the framed structure from the given building plan.(Part I)	II	02*
5	Prepare foundation plan to mark layout **on the ground** of the framed structure from the given building plan.(Part II)	II	02*
6	Assemble $1\frac{1}{2}$ Brick thick wall in a English Bond, (minimum 3 Course)	III	02*
7	Assemble $1\frac{1}{2}$ brick thick wall in a Flemish Bond. (minimum 3 Course)	III	02
8	Prepare a simple stone masonry construction work.	III	02
9	Prepare a report on visit to construction site with respect to scaffolding, formwork and centering work.(Part I)	III	02*
10	Prepare a report on visit to construction site with respect to scaffolding, formwork and centering work.(Part II)	III	02*
11	Identify various components of staircase in the given model.	IV	02*
12	Identify various components of doors and windows in the lab in the model to prepare the report with sketches.	IV	02
13	Identify various types of flooring and roofing materials in the lab to prepare report.(Part I)	V	02*
14	Identify various types of flooring and roofing materials in the lab to prepare report.(Part II)	V	02*
15	Record the observation of plastering and pointing work at construction site to prepare a report.	V	02*
16	Record the observation of painting in residential / public building work to prepare a report.	V	02
17	Carry out market survey for identifying various water proofing materials and prepare a report	VI	02
18	Prepare a sketch book consisting of all the sketches from experiment Number 1, 2, 4, 6, 7,11,12	I to IV	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 %
a.	Preparation of experimental set up	20
b.	Setting and operation	20
c.	Safety measures	10

S. No.	Performance Indicators	Weightage in %
d.	Observations and Recording	10
e.	Interpretation of result and Conclusion	20
f.	Answer to sample questions	10
g.	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. S. No.
1	Optical Square, Ranging rod, Pegs. Arrows. Line dori, Lime powder, Measuring Tape, Hammer of standard size and specification as per civil engineering application.	2-5
2	Bricks, Plumbs. Mason Square. Level tube. Line dori.	6,7
3	Models: a.Model of a civil engineering structure depicting various components. b.Cut section of building showing different components c.Types of Bonds in Brick masonry d.Types of Door and Windows e.Types of Stairs f.Types of Roofs g.Formwork for different RCC elements	9-12

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 Overview of Building components	1a.Classify the given building on the basis of the given occupancy and type of construction. 1b.Categorize the component parts of the given type of building. 1c.Explain the salient characteristics for the given building structure. 1d.Compare the given parameters of given load bearing and framed structure.	**1.1Classification of Buildings** As per National Building Code-Part III (2005) Group A to I Latest code may be referred As per Types of Constructions-Load Bearing Structure, Framed Structure, Composite Structure. **1.2Building Components** a.Building Components and their function. b.Substructure – Foundation, Plinth and Plinth Filling. c.Superstructure – Walls, Partition wall, cavity wall, Sill, Lintel, Doors and Windows, Floor, Mezzanine floor, Roof, Columns, Beams, Parapet.
Unit – II Construction of Substructure	2a.Describe the procedure of line out of the given building for the given method 2b.Explain the precautions required in excavation for the given type of foundation. 2c.Propose the suitable type of foundation for the given structure with justification 2d.Suggest the relevant pumping method of dewatering from given excavation pit with justification.	**2.1 Job Layout :** Site Clearance, Preparing Job Layout, Layout For Load Bearing Structure and Framed Structure by Center Line And Face Line Method, Precautions **2.2 Earthwork:** Excavation For Foundation, Timbering and Strutting, Earthwork for Embankment, Material For Plinth Filling. Tools and Plants Used for Earthwork **2.3 Foundation:** Functions of Foundation, Types of Foundation –Shallow Foundation, Stepped Footing, Wall Footing, Column Footing, Isolated And Combined Column Footing, Raft Foundation, Grillage Foundation. Deep Foundation-Pile Foundation, classification based on materials and functions, Well foundation and Caissons. Pumping Methods of Dewatering. Deep wells, Well points, Cofferdams.
Unit- III Construction of Superstructure	3a.Describe the salient features of given type of brick masonry construction 3b.Describe the major features of the given type of stone masonry construction 3c.Describe the given type(s) of brick masonry bonds	**3.1Stone Masonry:** Terms used in stone masonry- facing, backing, hearting, through stone, corner stone, cornice. Type of stone masonry: Rubble masonry. Ashlar Masonry and their types. Joints in stone masonry and their purpose and procedure. Selection of Stone Masonry, Precautions to be observed in Stone Masonry Construction

	with sketches. 3d.Describe the given type(s) of joints in stone masonry with sketches. 3e.Compare stone masonry with brick masonry on the basis of given criteria.	**3.2 Brick masonry:** Terms used in brick masonry- header, stretcher, closer, quoins, course, face, back, hearting, bat bond, joints, lap, frog line, level and plumb. Bonds in brick masonry- header bond, stretcher bond, English bond and Flemish bond. Requirements of good brick masonry, Junctions in brick masonry and their purpose and procedure. Precautions to be observed in Brick Masonry Construction. Comparison between stone masonry and Brick Masonry. Tools and plants required for construction of stone masonry and brick masonry. Hollow concrete block masonry and composite masonry. **3.3Scaffolding:** Necessity, component parts and types of Scaffolding, platforms used for multi storeyed building. **3.4Scaffolding and Shoring:** Purpose, Types of Scaffolding, Process of Erection and Dismantling. Purpose and Types of Shoring, Underpinning. Formwork: Definition of Formwork, Requirements of Formwork, Materials used in Formwork, Types of Formwork, Removal of formwork.
Unit– IV Building Communication and Ventilation	4a.Describe the type of opening for the given situation with sketches. 4b.Select the relevant types of doors and windows for the given situation with justification. 4c.Select the type of fixture and fastener for given type of door or window with justification. 4d.Select the type of materials for the given type and shape of the staircase with justification. 4e.Suggest the type of staircase for the given situation with justification.	**4.1Horizontal Communication: Doors** – Components of Doors, Fully Panelled Doors, Partly Paneled and Glazed Doors, Flush Doors, Collapsible Doors, Rolling Shutters, Revolving Doors, Glazed Doors. Sizes of Door recommended by BIS. **4.2 Windows:** Component of windows, Types of Windows-Fully Panelled, Partly Panelled and Glazed, wooden, Steel, Aluminum windows, Sliding Windows, Louvered Window, Bay window, Corner window, clear-storey window, Gable and Dormer window, Skylight. Sizes of Windows recommended by BIS. Ventilators, Cement Grills. 4.3Fixtures and fastenings for doors and windows. 4.4Material used and Functions of Window Sill and Lintels, Weather, Shed/Chajja. **4.5Vertical Communication:** Means of Vertical Communication- Stair Case, Ramps, Lift, Elevators and Escalators.

		Terms used in staircase-steps, tread, riser, nosing, soffit, waist slab, baluster, balustrade, going, scotia, hand rails, newel post, landing, headroom, winder. Types of staircase-on the basis of shape: Straight, dog-legged, open well, Spiral, Quarter turn, Bifurcated, Three quarter turn, and Half turn, On the basis of Material: Stone, Brick, R.C.C., wooden and Metal.
Unit–V Building Finishes	5a.Choose the flooring material for the given type of building with justification. 5b.Explain the procedure for laying and construction of given type of floor. 5c.Describe the procedure of Plastering and pointing for the given type of construction. 5d.Select the relevant type of paint material(s) to be used for the given type of building surface.	**5.1 Floors and Roofs**: Types of Floor Finishes and its suitability- Shahabad , Kota, Marble, Granite, Kadappa, Ceramic Tiles, Vitrified, Chequerred Tiles, Pavement Blocks, Concrete Floors, wooden Flooring, Skirting And Dado. Process of Laying- Process of laying And Construction, Finishing and Polishing of Floors, Roofing Materials- RCC, Mangalore Tiles, AC Sheets, G.I. and Painted Corrugated G.I. Sheets, Plastic and Fibre Sheets. Types of Roof: Flat roof, Pitched Roof-King Post truss, Queen Post Truss and Lean to Roof, terms used in roofs. **5.2 Wall Finishes:** Plastering – Necessity of Plastering, Procedure of Plastering, Single Coat Plaster, Double Coat Plaster, rough finish, Neeru Finishing and POP. Special Plasters- Stucco Plaster, sponge finish, pebble finish. Plaster Board And Wall Claddings. Precaution to be Taken While Plastering. Defects in Plaster. Pointing – Necessity, Types of pointing and Procedure of Pointing, Painting –Necessity, Surface Preparation for painting, Methods of Application, Selecting Suitable Painting Material.
Unit– VI Building Maintenance	6a.Suggest the techniques for repair of given type of cracks with justification. 6b.Describe the causes and remedial measure for settlement of foundation of the given type of building structure. 6c. Describe the safe procedure for demolition of the given structure. 6d.Justify the need of water	**6.1Cracks** : Causes and Types of Cracks, Identification and Repair of Cracks. Grouting and Guniting. **6.2Settlement of Foundation:** Types, Causes and Remedial measures. **6.3Demolition:** Necessity, Method of Demolition- Hand Demolition, Machine Demolition, Controlled Blasting. Demolition Implosion, Precautions During Demolition. **6.4Water Proofing:** Necessity and importance. Material used for Water Proofing, Non

	proofing and damp proofing for the given type of building construction. 6e. Describe safe practices to be used during the construction of the given type of building.	conventional method of waterproofing-Introduction of crystalline waterproofing, cement base polymer coatings. conventional waterproofing methods-brick bat coba waterproofing, Box type water proofing, Injection/grouting. Plinth Protection necessity and material used, Damp Proof Course.

***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	Overview of building components	6	2	2	4	08
II	Construction of Substructure	10	4	4	6	14
III	Construction of Superstructure	12	4	6	10	20
IV	Building Communication and Ventilation	8	2	4	6	12
V	Building Finishes	6	2	2	4	08
VI	Building Maintenance	6	2	2	4	08
Total		48	**18**	**20**	**34**	**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. Classify minimum three buildings near by your institute with reference to National Building Code- Part III (2005) and prepare a report.
b. Identify the components of a building by inspecting the available model and prepare a report.
c. Visit to construction site to observe brickwork, Sill, Lintel, Chajja, Slab, Parapet wall and prepare a report.
d. Identify types of foundation by inspecting available models and prepare a report.
e. Search software/freeware for the course content and write the report stating their applications.

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. Procure various materials required for practical exercises.
g. Arrange visit to nearby industries and workshops for understanding various construction materials.
h. Use video/animation films to explain various processes like Manufacturing of construction materials, concrete mixing, and base preparation for painting, mortar laying, carpentry work, false ceiling.
i. Use different instructional strategies in classroom teaching.
j. Demonstrate different samples of various construction materials like Stone. aggregate of different sizes, timber, lime, bitumen, Bricks, tiles, precast concrete products, Water proofing material, Termite proofing material, Thermal insulating material, plaster of Paris, paints, distemper, and varnishes.
k. Display various technical brochures of recent building materials.

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 a sketchbook consisting of components of building (for Sketches which are not included in Practical sketch book).
b. Collect the relevant information of recent technologies in building construction and prepare a report on it.
c. Identify the different types of cracks and remedial measures and submit a report on case study.
d. Collect the relevant information of different techniques of demolition of existing structure and submit a report on it.
e. Prepare a summary report with reference to content in any one part of National Building Code.

f. Carryout market survey for identifying various water proofing materials and prepare a report.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1.	Building Construction	S. P. Arora and Bindra	Dhanpat Rai Publication, Delhi Edition 2013,ISBN: 9788189928803
2.	Building construction illustrated	Francis D.K. Ching	Wiley India,USA, 2014,ISBN: 978-1-118-45834-1
3.	Building Construction	S. C. Rangawala	Charotar Publication,Dist-Anand ISBN-13: 978-8185594859
4.	Building Construction	B. C. Punmia and A.K.Jain	Firewall Media, 2005 ISBN 9788170080534
5.	Building Construction	S.K. Sharma	S. Chand and Co. Pvt. Ltd., New Delhi (ISBN:978-81-219-0479-7)
6.	Building Construction	Dr.Janardan Zha	Khanna Publication, New Delhi 2007, ISBN –8174091106
7.	Building Construction	S. S. Bhavikatti	Vikas Publication House Pvt. Ltd., New Delhi (ISBN: 978-93259-6079-4)
8.	A to Z Building Construction	Sandip Mantri	Satya Prakashan; New Delhi (2015) ISBN-13: 978-8176849692

HandBooks

S. No.	Title of Book	Author	Publication
1.	PWD Handbooks for Materials, Masonry, Building, Plastering and Pointing - Foundation	All India Council for Technical Education	All India Council for Technical Education (AICTE)
2.	Practical Civil Engineering Handbook	Khanna	Khanna Publication

BIS/ International Codes of Practice

S. No.	Title of Book	Author	Publication
1	National Building Code	BIS	Bureau of Indian Standard, New Delhi
2	BIS 962-1989 Code of Architectural and Building Drawing	BIS	
3	BIS 1038- 1983 Steel Doors, Windows and Ventilators	BIS	

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. http://www.learningconstruction.com/
b. http://www.understandconstruction.com/
c. http://www.constructionknowledge.net/

STATE BOARD OF TECHNICAL EDUCATION MUMBAI

Program Name : **Civil Engineering Program Group**

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

Semester : **Third**

Course Title : **Concrete Technology**

Course Code : **22305**

1. RATIONALE

Concrete is the most widely used construction material today for different kinds of infrastructural development works. The versatility and mouldability of the concrete and its high compressive strength have contributed largely to its wide spread use in development and construction works. The contents of course will focus on learning about quality of concrete with regards to mix design, preparation, transporting and placing in position for various structures. It will also provide guidelines for effective supervision and quality control of concreting work. With good knowledge of concrete materials namely cement, aggregates, water and admixtures and concreting operation namely selection of materials, mixed design, mixing, placing, compacting and finishing, curing, one can obtain concrete of desired workability and required strength. The content of this course will also enable students to acquire knowledge and skills for carrying out various tests on different materials of concrete for quality construction works. Effective learning on above aspects will assist students to become a useful professional civil engineer contributing to the profession of construction and development works.

2. COMPETENCY

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

- **Use relevant types of concrete in different site conditions.**

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. Use relevant types of cement in different site conditions.
b. Use relevant aggregates for required concrete works.
c. Prepare concrete of desired compressive strengths.
d. Prepare concrete of required specifications.
e. Maintain the quality of concrete.
f. Use relevant admixtures for concreting for different weather conditions.

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	7	3	70	28	30*	00	100	40	25#	10	25	10	50	20

(*): Under the theory PA; Out of 30 marks, 10 marks of theory PA is for micro-project assessment to facilitate attainment of UOs and the remaining 20 marks is for tests and assignments given by the teacher.
***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.

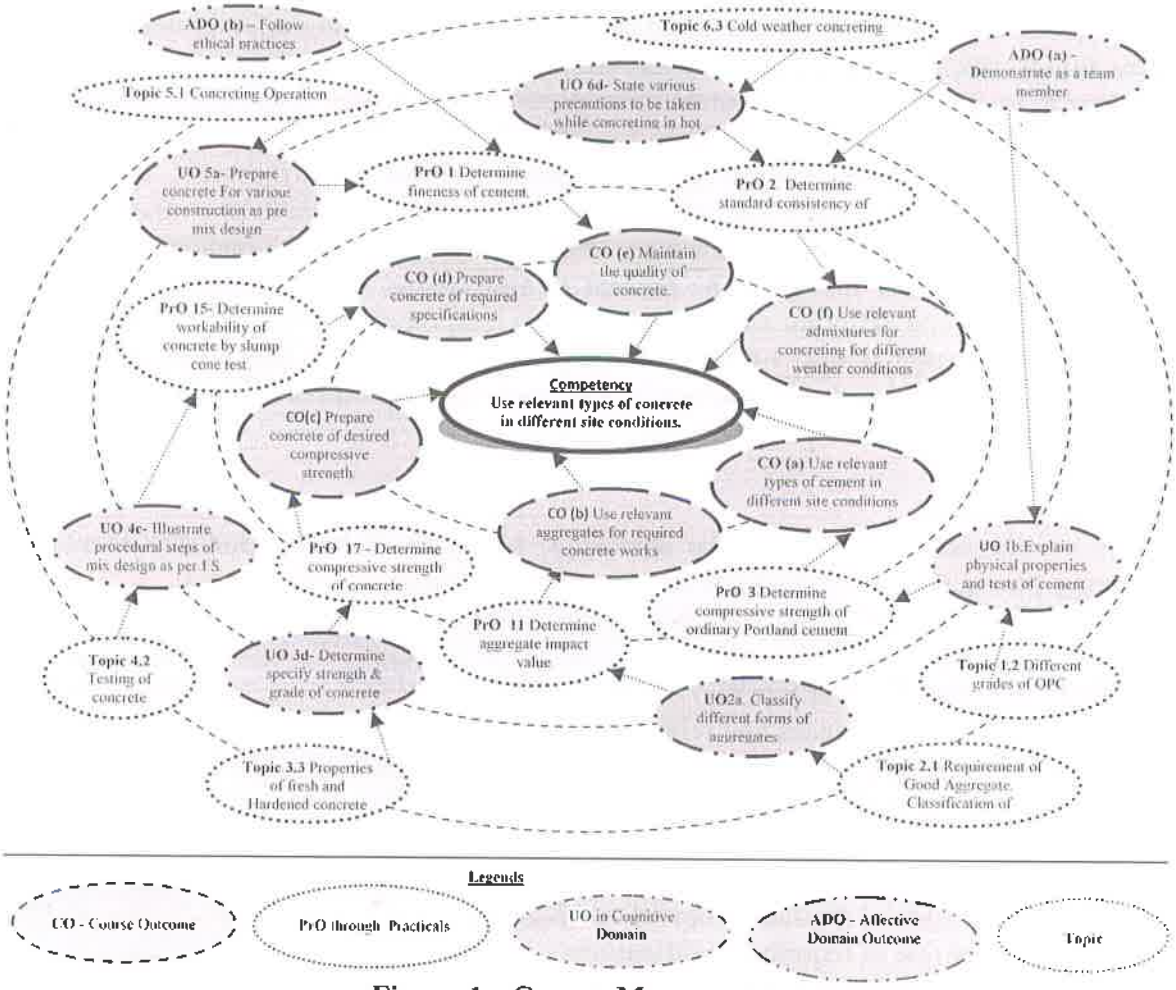

Figure 1 - Course Map

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	Determine fineness of cement by Blaine's air permeability apparatus Or by sieving.	I	02*
2	Determine standard consistency, initial and final setting times of	I	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	OPC.		
3	Determine compressive strength of ordinary Portland cement.	I	02
4	Determine specific gravity of ordinary Portland cement.	I	02
5	Determine silt content in sand by volume.	II	02
6	Determine bulking of sand.	II	02
7	Determine bulk density of fine and coarse aggregates.	II	02*
8	Determine water absorption of fine and coarse aggregates.	II	02
9	Determine Fineness modulus of fine aggregate by sieve analysis.	II	02*
10	Determine Fineness modulus of coarse aggregate by sieve analysis.	II	02
11	Determine aggregate impact value.	II	02*
12	Determine aggregate crushing value.	II	02
13	Determine abrasion value of aggregate.	II	02
14	Determine aggregate elongation index and flakiness index.	I	02
15	Determine workability of concrete by slump cone test.	IV	02*
16	Determine workability of concrete by compaction factor test.	IV	02
17	Determine compressive strength of concrete for 7 days	IV	02*
18	Determine compressive strength of concrete by any one method of NDT .	IV	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 %
a.	Preparation of experimental setup	20
b.	Setting and operation	20
c.	Observation and recording	10
d.	Safety measures	10
e.	Interpretation of results and conclusion	20
f.	Answer to sample questions	10
g.	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. S. No.
1	Blaine's air permeability apparatus as per IS: 4031 (part 1)-1999, and sieve no. IS 90 micron - IS Brass Sieve (200 mm dia), 90 Micron size.	1
2	Vicats apparatus- VICAT mould of dia. 80 mm & 40 mm high glass base plate, initial needle, final needle. Consistency plunger M.S. base plate (non porous) of weight 300 gm. Vicat mould split type with camping ring.	2
3	Compression testing machine-2000 kN capacity, Cement mortar cube vibrator-, moulds size 50 cm^2 (7.07 cm x 7.07 cm)	3,17
4	Lee Chartlier flask and Kerosine	4
5	Measuring Cylinder of 100 ml capacity	2,3,5,6,
6	Measuring Cylinder 1000 ml capacity	2,3,5,6,
7	Density basket as per IS specification	7
8	I S sieve set (sizes- 80 mm, 40 mm, 20 mm, 10 mm, 4.75 mm, 2.36 mm, 1.18 mm, 600 μ, 300 μ. 150 μ and pan) , sieve shaker with adaptors	1,9,10
9	Aggregate impact testing m/c with mould,	11
10	Aggregate crushing mould	12
11	Los Angeles abrasion testing m/c	13
12	Elongation gauge and thickness gauge.	14
13	Slump cone(top dia.100mm, bottom dia.200mm, Height 300mm)	15
14	Compaction factor test apparatus	16
15	Table vibrator, moulds(150mm x150mmx 150mm)	17
16	NDT apparatus – rebound concrete hammer, ultrasonic pulse velocity meter	18
17	Hot Air Oven	8
18	Weighing Balance	For All

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 Cement	1a. Describe the given types of cement and their	1.1 Chemical Constituents of OPC and their effects on properties of OPC. Bogue's

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	relevant use with justification. 1b. Justify the need for the given chemical constituents for given type OPC. 1c. Describe the practical significance of the given types of cements for the given conditions. 1d. Suggest the method to judge the quality of the given type of cement with justification.	compounds and their properties, hydration of cement. Physical properties of OPC: fineness, standard consistency, setting time, soundness, compressive strength. 1.2 Different grades of OPC. 33, 43, and 53 with specifications of physical properties as per relevant IS codes. 1.3 Testing of OPC: Field tests and laboratory tests-fineness test, standard consistency test, setting time test, soundness test, compressive strength test, Storage of cement and effect of storage on properties of cement. 1.4 Physical properties, I.S. Specifications and field applications of different types of cements: Rapid hardening cement, Low heat cement, Portland pozzolana cement, sulphate resisting cement, blast furnace slag cement, White cement.
Unit– II Aggregates	2a. Identify the type of given aggregate samples based on and source shape and size. 2b. Explain the methodology to suggest suitability of given fine aggregate. 2c. Explain the methodology to suggest suitability of given coarse aggregate. 2d. Describe the permissible limits of solids for using sea water in mixing concrete.	2.1 Aggregates: Requirement of good aggregates, Classification according to source, size and shape. 2.2 Fine aggregates: Properties, size, specific gravity, bulk density, water absorption and bulking, fineness modulus and grading zone of sand by sieve analysis, silt content in sand and their specification as per IS 383, bulking of sand. Concept of crushed Sand. 2.3 Coarse aggregates: Properties, size, shape. surface texture, water absorption, soundness. specific gravity and bulk density, fineness modulus of coarse aggregate by sieve analysis, grading of coarse aggregates, crushing value, impact value and abrasion value of coarse aggregates with specification. 2.4 Water: Quality of water, impurities in mixing water, and permissible limits for solids as per IS: 456, use of sea water for mixing concrete.
Unit– III Concrete	3a. Justify use of different grades of concrete and their properties for given applications, with justification. 3b. Select w/c for a given grade of concrete, with justification 3c. Interpret the given data obtained from test on given type of concrete samples	3.1 Concrete: Necessity of supervision for concreting operation, different grades of concrete (ordinary Concrete, standard concrete and high strength concrete as per provisions of IS 456. 3.2 Water cement ratio Duff Abraham w/c law, significance of w/c ratio, selection of w/c ratio for different grades of concrete prepared from different grades of OPC as per graphs specified in IS 10262, maximum w/c ratio for different grades of concrete for different

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	3d. Describe the factors affecting overall durability of given type of concrete.	exposure conditions. 3.3 Properties of fresh concrete: Workability, Factors affecting workability of Concrete. Determination of workability of concrete by slump cone test, compaction factor test. Range values of workability requirement for different types of concrete works. Segregation, bleeding and preventive measures. 3.4 Properties of Hardened concrete: compressive strength, durability, impermeability and dimensional changes of concrete.
Unit-IV Concrete Mix Design and Testing of Concrete	4a. Explain the given method of concrete mix design for the given situation. 4b. Interpret the given data obtained from test on given type of concrete. 4c. Describe the need of NDT for the given field situation. 4d. Interpret the given data obtained from NDT on given structure.	4.1 Concrete mix design, objectives, methods of mix design, study of mix design procedure by I.S. method as per I.S. 10262-(Only procedural steps) 4.2 Testing of concrete: Significance of testing, determination of compressive strength of concrete cubes at different ages, interpretation and co-relation of test results. 4.3 Non- destructive testing of concrete: Importance of NDT, methods of NDT, 4.4 Rebound hammer test, working principle of rebound hammer and factor affecting the rebound index, Ultrasonic pulse velocity test, specification for deciding the quality of concrete by Ultrasonic pulse velocity as per I.S.13311 (part 1 and 2).
Unit –V Quality Control of Concrete	5a. Explain the sequential operations of concreting in given situation. 5b. Explain the given type of form works and stripping time. 5c. Select given method of waterproofing for given situation with justification 5d. Identify the type of construction joint to be used in given situations of concreting works, with justification.	5.1 Concreting Operations: Batching, Mixing, Transportation, Placing, Compaction, Curing and Finishing of concrete. 5.2 Forms for concreting: Different types of form works for beams, slabs, columns, materials used for form work, requirement of good form work. Stripping time for removal of form works per IS 456-2000 provision for different structural members. 5.3 Waterproofing: Importance and need of waterproofing, methods of waterproofing and materials used for waterproofing. 5.4 Joints in concrete construction: Types of joints, joining old and new concrete, methods of joining, materials used for filling joints.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit-VI Chemical Admixture in concrete, Special Concrete and, Extreme weather concreting	6a. Justify the need of given admixtures in concrete mix. 6b. Describe the characteristics and uses of given type of concrete. 6c. Explain effects and preventive measures in the given type of weather concreting. 6d. Select the type of weather concreting in the given situation with justification. 6e. Select the type of industrial flooring in the given situation with justification.	6.1 Admixture in concrete: Purpose, properties and application for different types of admixture such as accelerating admixtures, retarding admixtures, water reducing admixture, air entraining admixture and super plasticizers. 6.2 Special Concrete: Properties, advantages and limitation of the following types of Special concrete: Ready mix Concrete, Fiber Reinforced Concrete, High performance Concrete and self compacting concrete, light weight concrete. 6.3 Cold and Hot weather concreting: Effect of cold and Hot weather on concrete, precautions to be taken while concreting in cold and hot weather condition. 6.4 Concrete as industrial flooring material and various techniques: Vacuum dewatering flooring, Free Movement flooring. Techniques of groove cutting and various materials used for groove filling in concrete flooring.

***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	Cement	04	02	02	02	06
II	Aggregates	06	02	02	06	10
III	Concrete	10	02	02	10	14
IV	Concrete Mix Design and testing of Concrete	12	02	04	10	16
V	Quality Control of Concrete	10	02	06	06	14
VI	Chemical Admixture in concrete, Special Concrete and Extreme weather concreting	06	02	04	04	10
Total		**48**	**12**	**20**	**38**	**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:

i. Market survey to select type of cement for various types of construction works.
ii. Visit to site under construction to collect detail information about the ingredients of concrete mix.
iii. Visit to nearby RMC plant and draw flow chart.
iv. Visit to site under construction to observe concreting operations.
v. Visit to site under construction to observe the quality of fresh concrete.
vi. Visit to site under construction to observe form work, scaffolding used and joints in concrete.
vii. Visit to site under construction and make a check list of effect of each property of Cement and aggregate on quality of concrete.
viii. Search the software/freeware for the course content and prepare report stating their applications.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning 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. Assign unit wise tutorials to group of 4 to 5 students for solving problems unit wise.
g. 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.
h. Use of video animation films to explain concept, Facts and applications related to Concrete Technology.
i. 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. Undertake any one micro-projects (Group of 4 to 6 students)

i. Prepare cast in situ concrete of given grade. It includes visit to site, observations, records,field tests of cement, sand and coarse aggregate. Follow the concrete chain operations.

ii. Using IS code method of mix design obtain ingredients of concrete and prepare concrete.

Note: Any other relevant micro project suggested by subject teacher.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Concrete Technology	Gambhir, M.L.	Tata McGraw Hill Publishing Co. Ltd., New Delhi, ISBN-13: 978-1-259-06255-1
2	Concrete Technology	Shetty, M.S.	S. Chand and Co. Pvt. Ltd., Ram Nagar, New Delhi-110055 ISBN, : 978-8-121-90003-4
3	Concrete Technology	Santhakumar ,A. R.	Oxford University Press, New Delhi ISBN-13: 978-0-195-67153-7
4	Concrete Technology	Neville, A. M. and Brooks, J.J.	Pearson Education Pvt. Ltd., New Delhi ISBN 978-0-273-73219–8
5	Properties of Concrete	Neville A. M.	Pearson Education Pvt. Ltd., New Delhi ISBN 978-0-273-75580-7

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. http://nptel.ac.in
b. www.w3schools.com
c. www.engineeringcivil.com/various-lab-test-on-cement.html
d. www.engineeringcivil.com/various-lab-test-on-aggregates.html
e. www.aboutcivil.org/tests-on-concrete.html
f. https://theconstructor.org/practical-guide/non-destructive-testing-of-concrete/5553/
g. nptel.ac.in/courses/105104030/34
h. nptel.ac.in/courses/105104030/
i. nptel.ac.in/courses/105102012/38
j. https://www.youtube.com/watch?v=cbL5q0HBlnE
k. www.nbmcw.com/concrete/3834-steel-fibre-concrete-composites-for-special applicati.

Program Name : **Civil Engineering Program Group**

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

Semester : **Third**

Course Title : **Computer Aided Drawing**

Course Code : **22022**

1. RATIONALE

An essential skill of a civil engineering diploma holder is to use Computer aided drawing as a drafting tool to draw, read and interpret the civil engineering drawings. This will facilitate the more speed, accuracy and repetitive use of drawings as and when needed. Through this technique student will be able to edit the existing drawing and create new 2 and 3-dimensional drawings and isometrics as per requirements.

2. COMPETENCY

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

- **Draw civil engineering drawings using Computer aided drawing 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 given 2-dimensional drawing.
b. Use CAD software for drafting and editing 2-dimensional drawings.
c. Locate the dimensions of the drafted drawing.
d. Draw the isometric and 3- dimensional drawings.

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
-	-	4	4	--	--	--	--	--	--	--	50@	20	50~	20	100	40

*(~[2]): For the **practical only courses,** the PA has two components under practical marks i.e. the assessment of practicals (seen in section 6) has a weightage of 60% (i.e.30 marks) and micro-project assessment (seen in section 12) has a weightage of 40% (i.e.20 marks). This is designed to facilitate attainment of COs holistically, as there is no theory ESE.*
***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.

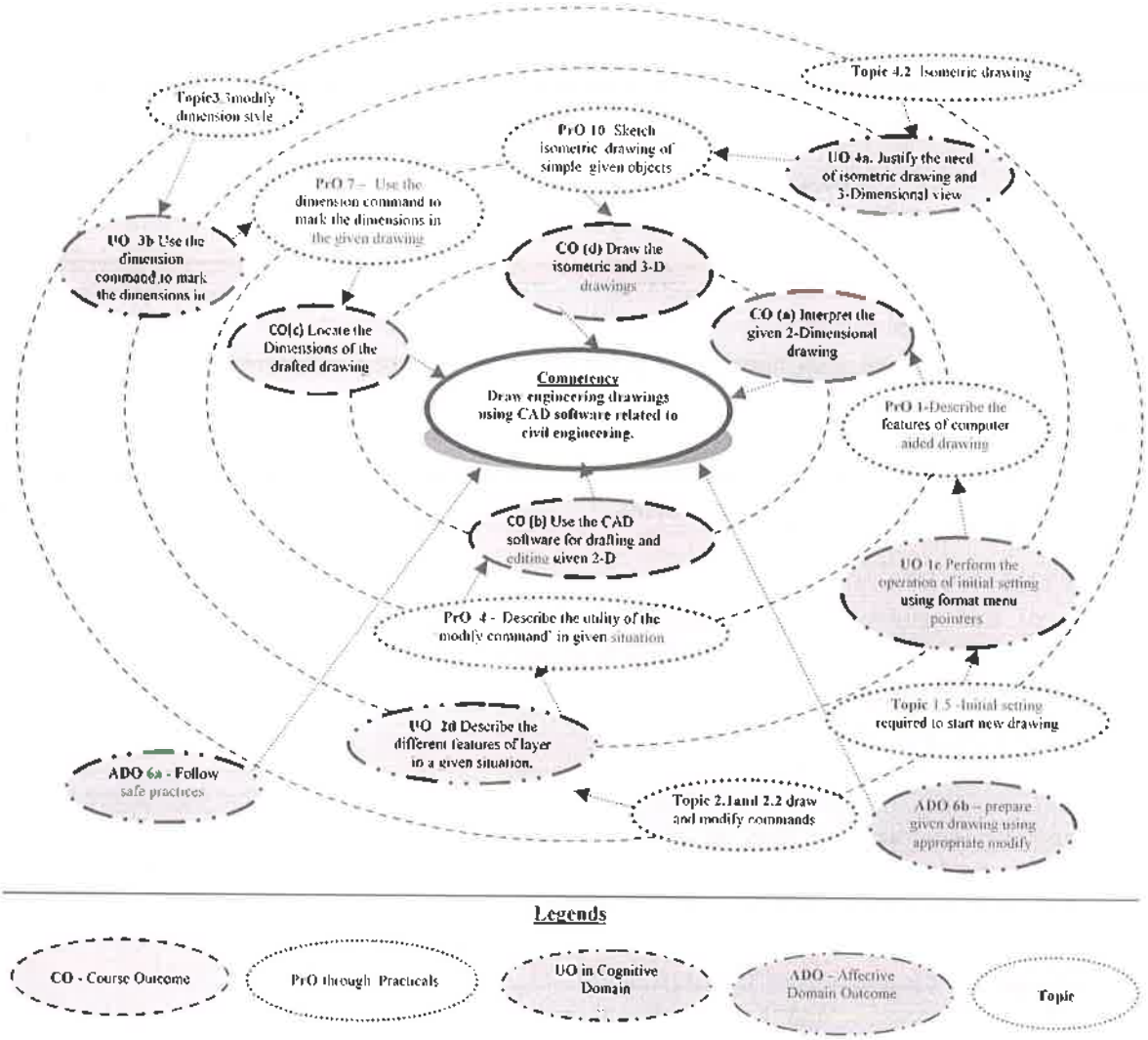

Figure 1 - Course Map

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	Identify the components of CAD screen and apply the processes of Initial setting using format menu. Part I	I	02*
2	Identify the components of CAD screen and apply the processes of Initial setting using format menu. Part II	I	02*
3	Calculate -Cartesian coordinates (relative and absolute) Polar coordinates of given shapes.(any Two)	I	02*
4	Calculate -Cartesian coordinates (relative and absolute) Polar coordinates of given shapes.(any Two)	I	02*
5	Draw the given figures according to Cartesian coordinate system. (any Two)	I	02*
6	Draw the given figures according to Polar coordinate system. (any Two)	I	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
7	Use " Draw and modify command" to draw the given shapes - (minimum 2 shapes)	II	02*
8	Use " Draw and modify command" to draw the given shapes - (minimum 2 shapes)	II	02*
9	Use " Draw and modify command" to draw the given shapes - (minimum 2 shapes)	II	02*
10	Use " Draw and modify command" to draw the given shapes - (minimum 2 shapes)	II	02
11	Use " Draw and modify command" to draw given shapes - (minimum 2 shapes)	II	02
12	Use " Draw and modify command" to draw given shapes - (minimum 2shapes)	II	02
13	Use " Draw and modify command" to draw given shapes - (minimum 2shapes)	II	02
14	Use " Draw and modify command" to draw given shapes - (minimum 2shapes)	II	02
15	Use " Draw and modify command" to draw given shapes - (minimum 2shapes)	II	02
16	Use "Draw and modify command" to draw cross section of walls showing different building components symbols.	II	02
17	Use "Draw and modify command" to draw cross section of walls showing different building material symbols.	II	02*
18	Draw plan of any one stair case from the given drawing.(Dog legged stair case / spiral stair case)	II	02*
19	Draw sectional elevation of stair case drawn in exercise no 18.	II	02*
20	Mark the dimensions in the figures drawn in exercise number 5 to 15.and 18,19.	III	02 *
21	Use area command to compute the area of the given, figure, line plan (of residential and public building).	III	02*
22	Use "Draw and modify command" to prepare line plan of given residential building.	III	02*
22	Use "Draw and modify command" to prepare line plan of given public building.	II	02*
23	Use "Draw and modify command" to prepare typical floor developed plan of a given framed residential building in minimum four layers.	II	02*
24	Use "Draw and modify command" to prepare above typical floor developed plan of a given framed residential building in minimum four layers .Give labels , doors and window openings , schedule of openings . scale . north direction.	II	02*
25	Use "Draw and modify command" to prepare elevation of given framed residential building in exercise 22.	II	02*
26	Use "Draw and modify command" to prepare section of a given framed residential building in exercise 22.	II	02*
27	Use "Draw and modify command" to prepare section of a given framed residential building in exercise 22.	II	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
28	Use "dimension command" to locate dimensions of typical floor plan, elevation and section dimensions of a given framed residential building in layer in exercise 22 to 26.	II	02*
29	Draw isometric drawing of simple objects.(minimum 02 objects)	IV	02*
30	Draw isometric drawing of simple objects.(minimum 02 objects)	IV	02
31	Draw 3-D view of simple object.(any one)	IV	02*
32	Draw 3-D view of simple object.(any one)	IV	02
Note: 1. The term work consists of a journal with the relevant write up and output of 2-11 experiment in the form of print out as an output and soft copy as well. **2.** The figures used for practical numbers from 7 to 15 are different for each practical.			
	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 24 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.	Prepare Initial setting necessary for given drawing.	10
2.	Prepare given drawing using draw commands.	30
3.	Follow Safety measures	05
4.	Prepare given drawing using appropriate modify commands.	20
5.	Answer the questions related to drafted drawing.	10
6.	Submit journal report on time	15
7.	follow Housekeeping	05
8.	Attendance and punctuality	05
	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.

Sr. No.	Equipment Name with Broad Specifications	PrO. S.No.
1.	Computer with specification as 2GB RAM ,HDD 500GB,LCD Monitor with relevant CAD software.(with latest configuration)	1 to 32
2.	Printer preferably for the output of A-3 size ,paper	5to 32
3.	LCD projector.	1 to 32

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 Fundamentals of computer aided drawing	1a. Explain the importance of computer aided drawing in civil engineering applications. 1b. Describe the features of computer aided drawing screen. 1c. Describe the operation of initial setting using Format menu. 1d. Calculate coordinates in given situation.	1.1 CAD software –meaning, various drafting software for civil engineering applications. 1.2 System requirement for drawing software 1.3 Advantages of computer aided drawing over traditional method of drawing. 1.4 Features of CAD screen. 1.5 Initial setting required to start new drawing from scratch 1.6 Coordinate systems used in CAD. 1.7 Save and plot/print command.
Unit-II CAD commands	2a. Draw the given figures using ."draw commands" 2b. Describe the utility of the 'modify command' in given situation. 2c. Describe the utility of enquiry command to find the parameters like distance, area, perimeter of a given figure. 2d. Describe the different features of layer in a given situation.	2.1 Draw commands-line, poly line, construction line, rectangle, polygon, circle, ellipse, hatch, boundary, text, arc, point, make block 2.2 Modify commands- erase, copy, mirror, offset, trim, move, extend, rotate, array, lengthen, scale, chamfer, fillet, explode, stretch, join, brake, divide. 2.3 Enquiry –list, area ,distance, mass property 2.4 Changing properties of entity-line type, color, scale, font- size, color,

		style. 2.5 Layer command.
Unit– III Introduction to Dimension command	3a. Explain the necessity of the dimensioning the given figure. 3b. Use the dimension command to mark the dimensions in the given drawing. 3c. Modify the existing dimension style.	3.1 Enter form of dimension style. 3.2 Type of dimensions-quick dimension, linear dimension, and continuous dimension; align dimension, angle dimension and radius, diameter. 3.3 Modify dimension style.
Unit– IV Introduction to 3-Dimensional view	4a. Justify the need of isometric drawing and 3-Dimensional view. 4b. Sketch isometric drawing of simple given objects. 4c. Sketch 3- dimensional drawing of simple given object.	4.1 Necessity of 3 dimensional view 4.2 Isometric drawing- meaning and necessity, use of isometric snap, isometric axes, isocircle, isotext 4.3 3-Dimensional drawing –use of extrude ,pressfull command.

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

- Not applicable -

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 working drawings from builders, architect and engineers.
b. Collect the 3-Dimensional drawings from various resources.
c. Collect information of similar software other than Computer Aided drawing available in construction industry.
d. Search for the websites related to course contents.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning outcomes in this course. 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. Demonstrate students thoroughly before they start doing the practice.
g. Encourage students to refer different websites to have deeper understanding of the subject.
h. Observe continuously and monitor the performance of students in Lab.

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 plan, elevation, and section of a given framed structure as it is from the available drawings using software available in laboratory.
b. Prepare construction notes, site plan, and schedule of openings from the drawings of a framed structure made available from builder/engineer/civil engineering service provider.
c. Draw plan, elevation, and section and site plan of a given load bearing structure as it is from the available drawings using software available in laboratory.
d. Prepare construction notes, site plan, and schedule of openings from the drawings of a load bearing structure made available from builder/engineer/civil engineering service provider.
e. Learn latest software's of Civil Engg Drawing

13. SUGGESTED LEARNING RESOURCES

S.N.	Title of Book	Author	Publication
1	AUTOCAD-2000	Frey, David	BPB Publication, New Delhi, ISBN13: 9788176560801
2	Introduction to Auto CAD 2012 for Civil Engineering Applications	Yasmin, Nighat	SDC Publication, 2011 ISBN 978-1-58503-642-4
3	AutoCAD 2016: A Problem-Solving Approach, Basic and Intermediate	Tickoo, Shyam	CADCIM Technologies, 22nd Edition , August 2015 ISBN 13: 9781942689003
4	Auto CAD 2010 Instructor	Leach, James	Tata Mc Graw Hill, New Delhi 2007; ISBN:9780073375410
5	Auto CAD and its Applications-Basics	Shumaker, Terence M.; Madsen, David	Good heart- Willcox Publishers, 2010; ISBN:13: 9781590707608

S.N.	Title of Book	Author	Publication
	2010	A.; Madsen, David P.;	
6	Engineering drawing	Bhatt, N.D.	Charotar Publications, Anand, 2016 ISBN:978-93-80358-96-
7	Working with Auto CAD 2000	Singh, Ajit	Mc Graw Hill Publishing New Delhi, 2002; ISBN: 9780070435964

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. http://www.autodesk.com/education/freesoftware/autocad
b. http://www.youtube.com/playlist?list=PLIpyIybv 1CupI-9xve13CxzzwK0PLL
c. www.zwsoft.com/cad accessed on 15th October 2016,
d. https://www.scribd.com/doc/260678036/ accessed on 12th October 2016,
e. medobute.pixnet.net/blog/post/123908069 accessed on 10th October2016
f. www.ndl.iitkgp.ac.in