Curriculum of Diploma Programme

in

Civil Engineering

J.P. Institute Of Technology

State Board of Technical Education (SBTE) Bihar

Semester - IV

Semester – IV
Teaching & Learning Scheme

Board of Study	Course Codes	CourseTitles	Teaching & Learning Scheme (Hours/Week)					
			Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
			L	T				
	2415401	Advance Surveying	3	-	4	2	9	6
	2415402	Theory of Structure	3	-	4	2	9	6
	2415403	Building Planning and Drawing with Auto CAD	3	-	4	2	9	6
	2415404	Soil Mechanics & Foundation	3	-	4	2	9	6
	2415405	Transportation Engg.	3	-	4	2	9	6
Total			**15**	**-**	**20**	**10**	**45**	**30**

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

Semester - IV

Assessment Scheme

Board of Study	Course Codes	Course Titles	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
	2415401	**Advance Surveying**	30	70	20	30	20	30	200
	2415402	**Theory of Structure**	30	70	20	30	20	30	200
	2415403	**Building Planning and Drawing with Auto CAD**	30	70	20	30	20	30	200
	2415404	**Soil Mechanics & Foundation**	30	70	20	30	20	30	200
	2415405	**Transportation Engg.**	30	70	20	30	20	30	200
Total			**150**	**350**	**100**	**150**	**100**	**150**	**1000**

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

A) Course Code : **2415401(T2415401/P2415401/S2415401)**

B) Course Title : Advance Surveying

C) Pre-requisite Course(s) : Basic Surveying

D) Rationale :

Land surveying is very important art and science of mapping and measuring land and has a wide scope in civil engineering applications. In civil engineering, this branch has the significant importance because it facilitates the goal of erecting the big infrastructural projects, railroads, skyscrapers etc. It is always necessary to carry out first the field survey of the area on which the civil engineering projects are planned. This helps in preparing various type of survey maps which are used by the decision makers in taking the decisions regarding planning, designing, estimation, execution and construction process etc.

Today's technological era 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. The diploma engineers are therefore required to know the various methods and instruments required for surveying. They are also expected to have the skill and information to handle and operate these Survey instruments. It is also important for them to be well- aware about the use of advance surveying instrument such as total station, GPS and related software to enhance the knowledge and abilities required for surveying in field.

It is expected the students should have the sound knowledge of this science to apply it in the practice. Through this course students will develop these skills and competency which are required in their professional career.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/laboratory/workshop/ field/industry.

After completion of the course, the students will be able to-

CO-1 Draw the plan of the given building using Plane table survey.

CO-2 Measure the angle between two given stations using Theodolite.

CO-3 Determine the reduced level of the given point using Tachometer.

CO-4 Use Total Station instrument for the given purpose in the given situation.

CO-5 Locate coordinates of stations on ground using GPS.

F) Suggested Course Articulation Matrix (CAM):

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

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Board of Study	Course Code	Course Title	Scheme of Study (Hours/Week)					
			Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
			L	T				
Civil Engineering	**2415401**	Advance Surveying	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

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Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Board of Study	Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Assessment (TA)		Term Work& Self Learning Assessment (TWA)		Lab Assessment (LA)		
			Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
Civil Engineering	**2415401**	Advance Surveying	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs)and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS)and other must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2415401

Major Theory Session Outcomes (TSOs)	Units	Relevant Cos Number(s)
TSO 1a Conduct the plane table survey for the given situation. TSO 1b Explain different types of equipment & Accessories to perform Plane table survey. TSO 1c Explain the different method of Orientation of plane table survey. TSO 1d Select relevant method of plane table survey to be used in a given situation. TSO 1e Write advantages and disadvantages of plane table survey.	**Unit-1.0 Plane Table Surveying**: 1.1 Principle of plane table survey. 1.2 Equipment & Accessories used in plane table Survey. 1.3 Setting of plane table; Orientation of plane table by Back sighting and Magnetic meridian method. 1.4 Methods of plane table surveys-Radiation, Intersection, Traversing and Resection. 1.5 Advantages and disadvantages of plane table survey.	**CO1**
TSO 2.a Explain functions of different components of transit theodolite with a neat sketch. *TSO 2.b* Describe the temporary adjustment of transit theodolite. *TSO 2.c* Measure the horizontal angle between selected points by using the relevant method. TSO 2.d Determine the vertical angle between two given points by using Transit Theodolite. TSO 2.e Apply the Bowditch's & Transit rule for balancing the traverse.	**Unit-2.0 Theodolite Surveying.** 2.1 Types and uses of Theodolite, Components of transit Theodolite and their functions, Reading the Vernier of transit Theodolite. Technical terms used in Theodolite Survey-Swinging, Transiting, Face left & Face right position, Face change, telescope normal, Telescope inverted etc. 2.2 Temporary adjustment of transit Theodolite. 2.3 Measurement of horizontal angle-Direct and Repetition method, Reiteration method, Errors eliminated by method of repetition. 2.4 Measurement of vertical Angle 2.5 Traverse computation-Latitude, Departure, Consecutive coordinates, independent coordinates, balancing the traverse by Bowditch's rule and Transit rule, Gale's Traverse table computation.	**CO2**
TSO 3a Explain the basic principle of tacheometric survey. *TSO 3b* Derive tacheometric formula for determining horizontal distance with telescope horizontal and staff vertical. *TSO 3c* Determine tacheometric constant for a given field data. TSO 3d Set a curve for a given road/railway alignment. TSO 3e Design a simple circular curve by using the method of offsets from long chord and Rankine's method of deflection angle.	**Unit-3.0 Tacheometric Surveying and Curve Setting:** 3.1 Principles 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, determining horizontal and vertical Distances with tacheometer by fixed Hair method and staff held vertical, Limitations of tacheometry.	**CO2, CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant Cos Number(s)
	3.4 Types of curves used in roads and railway alignments. Designation of curves. 3.5 Setting simple circular curve by offsets from long chord and Rankine's method of deflection angles.	
TSO 4a Explain the principle of EDM Survey. TSO 4b Measure the given type of angle between two points using EDM. TSO 4c Explain the function of different parts of Total Station with a neat sketch. TSO 4d Determine coordinates of a given point using Total station. TSO 4e Prepare a contour map of given terrain using Total station instrument.	**Unit-4.0 Advance Surveying Equipment's**: 4.1 Principle of Electronic Distance Measuring instrument (EDM). Components & use of EDM. 4.2 Use of Electronic Digital Theodolite. 4.3 Total Station Equipment: Use, Construction, function keys, Measurements of Horizontal angles, vertical angles, distances and coordinates using Total Station. 4.4 Traversing, Profile Survey and Contouring with Total Station.	**CO4**
TSO 5a Describe the system of remote sensing to select a suitable site of construction TSO 5b Determine the location of specific object on earth using G.P.S. Instrument TSO 5c Explain the term, "GIS" with its components and application. TSO 4f Discuss the use and importance of drone surveying in the given situation.	**Unit-5.0 Remote Sensing, GPS and GIS**: 5.1 Remote Sensing – Overview, Remote sensing system, Applications of remote sensing in Civil engineering. 5.2 Use of Global Positioning System (G.P.S.) instruments. 5.3 Geographic Information System (GIS): Over view, Components, Applications, Software for GIS. 5.4 Introduction to Drone Surveying.	**CO4, CO5**

Note: One major TSO may require more than one theory session/period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2415401

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant Cos Numbers
LSO1.1. Prepare plan of given area by Radiation Method of Plane table.	1.	Use Plane Table Survey to prepare plans of a five sided closed traverse by Radiation Method.	CO1
LSO2.1. Locate the inaccessible point by Intersection method.	2.	Use plane table survey to prepare plans, locate details by Intersection Method.	CO1
LSO3.1. Find details on the ground through Traversing method.	3.	Use plane table survey to prepare plans, locate details by Traversing Method.	CO1
LSO4.1. Prepare a project report for closed Traverse around a building	4.	Use plane table survey to carry out Survey Project for closed traverse for minimum five sides around a building.	CO1
LSO5.1. Measure Horizontal angle between two given points using Transit Theodolite.	5.	Use transit theodolite to measure Horizontal angle by Direct Method.	CO2
LSO6.1. Determine Vertical angle between two given points using Transit Theodolite by direct method	6.	Use transit theodolite to measure vertical angle by Direct Method.	CO2

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant Cos Numbers
LSO7.1. Calculate the value of Additive Constant and Multiplying Constant for Stadia measurements.	7.	Use transit theodolite to calculate the additive and multiplying constant for stadia measurements.	CO2
LSO8.1. Determine Horizontal Distance between Instrument Station and Staff using Tacheometer Instrument.	8.	Use Tacheometer for measuring horizontal distance between instrument station and staff station.	CO3, CO2
LSO9.1. Draw a simple circular curve between two points by Rankine's Method.	9.	Set out a simple circular curve between two straight points by Rankine's method.	CO3, CO2
LSO10.1. Measure Horizontal distance using Electronics Distance Measurement Instrument.	10.	Use EDM to measure horizontal distance.	CO4
LSO11.1. Compute Horizontal/ Vertical angle between given points using total station.	11.	Use Total station instrument to measure horizontal and vertical angle between two given points.	CO4
LSO12.1. Prepare a map for a closed traverse taking measurement using Total Station.	12.	Use Total station instrument to carry out Survey Project for closed traverse for minimum five sides.	CO4
LSO13.1. Locate the coordinates of given point by the application of GPS.	13.	Use GPS to locate the coordinates of a station	CO5

L) **Suggested Term Work and Self Learning: S2415401** Some sample suggested assignments, microproject and other activities are mentioned here for reference.

a. Assignments:

1. Draw a labeled diagram of accessories used in Plane Table Survey.
2. Explain Intersection method of Plane Table Surveying with neat sketches.
3. Draw a labeled diagram of Transit Theodolite.
4. Determine Tacheometric constant.
5. Design a simple circular curve for the given situation by Rankine's method of deflection angle.
6. Find coordinates of a given point using GIS.

b. Micro Projects:

1. 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.
2. Collect the relevant technical and commercial information of advanced survey instruments available in the market with specifications
3. Carry out comparative study of following survey instruments of different make and brands: Total station/ EDM/GPS/Micro optic theodolite.

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. There response/performance of each student in each of these designed activities is to be used to calculate CO attainment.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	20%	17%	20%	20%	-	25%	20%
CO-2	25%	27%	30%	20%	-	25%	20%
CO-3	25%	28%	30%	25%	33%	25%	20%
CO-4	15%	14%	10%	15%	33%	15%	20%
CO-5	15%	14%	10%	20%	34%	10%	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (Cl) Hours	Relevant COs Number (s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above(A)
Unit-1.0 Plane table survey	10	CO1	14	4	4	6
Unit-2.0 Theodolite survey	12	CO2	18	5	5	8
Unit-3.0 Tacheometric survey & Curve setting	12	CO3	18	5	5	8
Unit-4.0 Advance Surveying Equipment's	7	CO4	10	3	3	4
Unit-5.0 Remote Sensing, GPS and GIS	7	CO5	10	3	3	4
Total	**48**	**-**	**70**	**20**	**20**	**30**

Note: Similar table can also be used to design class/mid-term/internal question paper for progressive assessment.

O) Suggested Assessment table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number (s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1	Use Plane Table Survey to prepare plans of a five sided closed traverse by Radiation Method.	CO1	30	60	10
2	Use plane table survey to prepare plans, locate details by Intersection Method.	CO1	40	50	10
3	Use plane table survey to prepare plans, locate details by Traversing Method.	CO1	30	60	10
4	Use plane table survey to carry out Survey Project for closed traverse for minimum five sides around a building.	CO1	30	60	10
5	Use transit theodolite to measure Horizontal angle by Direct Method.	CO2	30	60	10
6	Use transit theodolite to measure vertical angle by Direct Method.	CO2	30	60	10
7	Use transit theodolite to calculate the additive and multiplying constant for stadia measurements.	CO2	30	60	10
8	Use Tacheometer for measuring horizontal distance between instrument station and staff station.	CO3	40	50	10
9	Set out a simple circular curve between two straight points by Rankine's method.	CO3	40	50	10
10	Use EDM to measure horizontal distance	CO4	40	50	10
11	Use Total station instrument to measure horizontal and vertical angle between two given points.	C04	30	60	10
12	Use Total station instrument to carry out Survey Project for closed traverse for minimum five sides.	CO4	30	60	10
13	Use GPS to locate the coordinates of a station	CO5	40	50	10

Legend:
PRA*: Process Assessment
PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student's performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Portfolio Based Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field, Information and Communications Technology (ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Plane table with accessories-	Plane and telescopic Alidade, Trough compass, U-fork, Sprit level.	1,2,3,4
2.	Twenty Second Transit.	theodolite with accessories	5,6
3.	One second Micro optic	Theodolite with accessories.	7,8
4.	Electronic digital	theodolite with accessories.	9,10
5.	Electronic distance meter	Electronic distance meter (+ or – 2mm accuracy) with accessories.	11
6.	Total station	Total station (+ or – 2mm accuracy) instruments with accessories.	12
7.	GPS instruments	GPS instruments	13

R) Suggested Learning Resources:

(a) Books

S. No	Titles	Author (s)	Publisher and Edition with ISBN
1	Surveying and Levelling Part I and II	Kanitkar, 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 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	Punamia, B.C.; Jain, Ashok kumar and Jain, Arun kumar	Laxmi Publications Pvt. Ltd, New Delhi. ISBN: 13: 9788170088837
7	Text book of Surveying	Rao, P. Venugopala and Akella, Vijayalakshmi	PHI Learning Pvt. Ltd., New Delhi ISBN:978-81-203-4991-9
8	Text book of Surveying	Venkatramaiah, C	Universities Pres, Hyderabad ISBN: 978-81-737-1021-6
9	Surveying theory and practice	James M Anderson, James McMurry Anderson, Edward M Mikhail	Mc Graw Hill Education, Noida ISBN: 13-978-1-25-902564-8
10	Plane Surveying	De, Alak	S. Chand Publications, New Delhi ISBN: 9788121917803

(b) Online Educational Resources:

1. https://www.youtube.com/watch?v=DZKhf5yB4GU
2. https://www.youtube.com/watch?v=HPUbNF_v2cw&list=PLLzxVHCUielDpHUviscEnDADEek4VgiT-
3. https://www.youtube.com/watch?v=ZSuOeUGZE-4&list=PLLzxVHCUielDpHUviscEnDADEek4VgiT-&index=2
4. https:/ https://www.youtube.com/watch?v=CvCzQjfACRw

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students

(c) Others

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A) Course Code : 2415402(T2415402/P2415402/S2415402)

B) Course Title : Theory of structures

C) Pre- requisite Course(s) : Strength of Material

D) Rationale :

Civil engineering structures are mainly made-up of column, Beam and slabs and these structures are subjected to axial as well as eccentric loading along with different loading and end conditions. The analysis of shear forces, bending moments, bending stresses, slope and deflections which are developed in various structural parts of a building will be useful in the design of these structural members.

Theory of structure gives an understanding of the analysis of structures to a Civil Engineer. It deals with the determination of forces and stresses at any point or section of the member of a given structure so as to provide data for the selection and design of suitable sections to resist these forces within the safe limits for designing a safe structure.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1 Analyze stresses induced in vertical member subjected to direct and bending loads.

CO-2 Calculate slope and deflection at the given point of the beam subjected to given loading conditions.

CO-3 Calculate end moments of fixed beam under given loading.

CO-4 Analyze continuous beam under given loading conditions using Clapeyron's theorem of three moments.

CO-5 Analyze continuous beam under given loading conditions using Moment Distribution method.

CO-6 Check the safety of column for the given loading and end conditions.

F) Suggested Course Articulation Matrix (CAM):

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

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

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			L	T				
Civil Engineering	**2415402**	Theory of structures	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

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C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Board of Study	Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Assessment (TA)		Term Work & Self Learning Assessment (TWA)		Lab Assessment (LA)		
			Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
Civil Engineering	**2415402**	Theory of structures	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2415402

Major Theory Session Outcomes (TSOs)	Units	Relevant Cos Number(s)
TSO.1a. Calculate stresses developed due to axial and eccentric loads in the given structural elements. TSO.1b. Compare the limit of eccentricity and core of the given rectangular and circular section. TSO.1c. Calculate resultant stresses at the base of a given column and chimney under given loading condition. TSO.1d. Draw stress distribution diagram for the given column and chimney under given loading condition.	**Unit – 1: Direct and Bending Stresses** 1.1 Introduction to direct and eccentric loads, eccentricity about one principal axis, nature of stresses, maximum and minimum stresses, resultant stress distribution diagram. 1.2 Condition for no tension or zero stress at extreme fiber, limit of eccentricity, core of section for rectangular and circular cross sections. 1.3 Columns, pillars and chimneys of uniform section subject to lateral wind pressure, stress distribution diagram at bases.	**CO1**
TSO.2a. Explain significance of slope and deflection for a given beam. TSO.2b. Establish the relationship between bending moment, slope, deflection and radius of curvature for a given beam. TSO.2c. Determine the slope and deflection at any point of a given beam at a given loading condition using double integration method/ Macaulay's method/ Moment area method.	**Unit – 2: Slope and Deflection** 2.1 Concept of slope and deflection, Relation between bending moment, slope, deflection and radius of curvature. 2.2 Double integration method, Macaulay's method and Moment area method to find slope and deflection of determinate beam subjected to point load and uniformly distributed load.	**CO2**
TSO.3a. Explain concept of fixity and continuity in the given situation. TSO.3b. Calculate fixed end moments for a beam subjected to given loading condition using first principle.	**Unit-3: Fixed Beam** 3.1 Concept of fixity and continuity, advantages and disadvantages of fixed beam. Principle of superposition. 3.2 Fixed end moments from first principle for beam subjected to point load and uniformly distributed load over entire span.	**CO 3**
TSO.4a. Explain Clapeyron's theorem of three moments used for given continuous beam. TSO 4b. Analyze the given continuous beam using Clapeyron's theorem of three moments under given loading conditions. TSO.4c. Draw SFD and BMD for a given fixed/continuous beam given loading conditions.	**Unit-4: Continuous beam** 4.1 Clapeyron's theorem of three moments (no derivation). Application up to two spans and two unknown support moments only, Support at same level, subjected to concentrated loads and uniformly distributed loads over entire span. 4.2 Drawing shear force and bending moment diagrams for fixed and continuous beams.	**CO4**
TSO.5a. Explain Moment Distribution Method (M.D.M.) used for analyzing the given indeterminate beam. TSO.5b. Apply M.D.M. to analyze given continuous beam for the given loading condition. TSO.5c. Draw shear force (S.F.) and bending moment (B.M.) diagram for continuous beam under given loading condition.	**Unit-5: Moment Distribution Method** 5.1 Introduction, sign convention. 5.2 Carry over factor, stiffness factor, distribution factor. 5.3 Application of moment distribution method for various types of continuous beams subjected to concentrated loads and uniformly distributed load over entire span having same or different moment of inertia up to three spans and two unknown support moment only, shear force and bending moment diagrams (Supports at same level).	**CO5**

Major Theory Session Outcomes (TSOs)	Units	Relevant Cos Number(s)
TSO 6a. Classify the column on the basis of slenderness ratio. TSO 6b. Explain Euler's/Rankine's theory for the column. TSO 6c. Check the validity of Euler's theory for the given column. TSO 6d. Calculate the safe/ design load of a column for given end conditions	**Unit-6: Columns** 6.1 Definition, classification of column. Types of end conditions for column, effective length, radius of gyration, slenderness ratio. crippling load, buckling load, factor of safety, safe load. 6.2 Euler's theory and its assumptions, Rankine's theory, 6.3 Application of Rankine's and Euler theory for designing long and short columns.	**CO6**

Note: One major TSO may require more than one theory session/period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2415402

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Compare experimentally obtained values of deflection in cantilever beam with theoretical value of the same.	1.	Determination of deflection in cantilever beam subjected to point load.	CO1
LSO 2.1. Compare experimentally obtained values of deflection in fixed beam with theoretical value of the same.	2.	Determination of deflection of fixed beam subjected to point load.	CO2
*LSO 3.*1Draw resultant stress distribution diagram of the given beam section under various loading conditions.	3.	To determine Bending and tensile stress in the beam under various loading conditions.	CO2
LSO 4.1. Draw SFD and BMD of a continuous beam subjected to given loading.	4.	Analysis of a Continuous Beam using Moment Distribution Method.	CO5
LSO 5.1. Draw SFD and BMD of a continuous beam subjected to given loading.	5.	Analysis of a Continuous Beam using Clapeyron's theorem of three moments.	CO4
LSO 6.1. Observe the behavior of different types of columns subjected to given loading conditions.	6.	To find Euler's buckling load for different types of columns.	CO6
LSO 7.1. Compare experimentally obtained values of slope and deflection for the given beam with theoretical value of the same.	7.	To find slopes and deflection in the given beam and verify the value obtained with moment area method.	CO2
LSO 8.1. Compare value obtained from first principle with the computed value from standard fixed end formula.	8	To find fixed end moments from first principle for the beam subjected to point load.	CO3

L) **Suggested Term Work and Self Learning**: **S2415402** Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

b. Micro Projects:

1. Prepare a chart showing values and location of maximum bending moment and shear force in fixed and continuous beams under various loading conditions.
2. Prepare a chart showing values and location of maximum slope and deflection for determinate beams under various loading conditions.
3. Prepare a model to analyze the stresses induced in vertical members subjected to direct and bending loads.
4. Collect photographs of fixed and continuous beams from actual sites.

c. Other Activities:

1. Seminar Topics:

(a) Effect of slenderness ratio over the elastic structural steel column.
(b) Utilization of MATLAB in structural analysis.
(c) Effect of sinking of support on fixed beams.
(d) Effect of support conditions on performance of continuous beam.

2. **Self- learning topics**:

- Identify different determinate and indeterminate beams on actual sites.
- Classify different sections of column on the basis of its slenderness ratio.
- Visit site/design office to collect the reinforcement details for different types of beams under given loading.
- Search the software on the course content and prepare the report stating their applications.

M) **Suggested Course Evaluation Matrix:** The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

Cos	Course Evaluation Matrix						
	Theory Assessment (TA)**		**Term Work Assessment (TWA)**			**Lab Assessment (LA)#**	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	**End Theory Assessment (ETA)**	**Term Work & Self-Learning Assessment**			**Progressive Lab Assessment (PLA)**	**End Laboratory Assessment (ELA)**
			Assignments	**Micro Projects**	**Other Activities***		
CO-1	10%	10%	15%	10%	10%	10%	16%
CO-2	20%	20%	10%	20%	25%	40%	17%
CO-3	15%	15%	15%	20%	-	10%	17%
CO-4	25%	25%	20%	25%	30%	10%	17%
CO-5	20%	20%	20%	-	20%	20%	17%
CO-6	10%	10%	20%	25%	15%	10%	16%
Total Marks	**30**	**70**	**20**	**20%**	**10**	**20**	**30**
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of Simple cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (Cl) Hours	Relevant COs Number (s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Direct and Bending Stresses	6	CO1	8	2	2	4
Unit-2.0 Slope and deflection	8	CO2	14	4	4	6
Unit-3.0 Fixed Beam	8	CO3	10	3	3	4
Unit-4.0 Continuous beam	12	CO4	16	5	5	6
Unit-5.0 Moment distribution method	10	CO 5	14	4	4	6
Unit-6.0 Column	4	CO 6	8	2	2	4
Total Marks	**48**	**-**	**70**	**20**	**20**	**30**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number (s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA * (%)	PDA ** (%)	
1.	Determination of deflection in cantilever beam subjected to point load.	CO1	30	60	10
2.	Determination of deflection of fixed beam subjected to point load.	CO2	40	50	10
3.	Determine Bending and tensile stress in the beam under various loading conditions.	CO2	30	60	10
4.	Analysis of a Continuous Beam using Moment Distribution Method.	CO5	30	60	10
5.	Analysis of a Continuous Beam using Clapeyron's theorem of three moments.	CO4	30	60	10
6.	Find Euler's buckling load for different types of columns.	CO6	30	60	10

S. No.	Laboratory Practical Titles	Relevant COs Number (s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA * (%)	PDA ** (%)	
7.	Find slopes and deflection in the given beam and verify the value obtained with moment area method.	CO2	40	50	10
8.	Find fixed end moments from first principle for the beam subjected to point load.	CO3	40	50	10

Legend:
PRA*: Process Assessment
PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Portfolio Based Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field, Information and Communications Technology (ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Beam apparatus Uniformly distributed load setup Dial gauge Metre rod scale	Steel framed beam apparatus	Experiment no 1,2,4,7
2.	Loading frame Strain gauge Beam setup Digital force display Digital strain display	Universal loading frames	Experiment no 3, 5
3.	Column buckling apparatus Hanger loads Vernier caliper	Rigid uprights for column with top end adjustable, vernier caliper conforming to IS Codes 3651-1974	Experiment no 6

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	STRUCTURAL ANALYSIS, 10TH EDITION IN SI UNITS	R C Hibbeler	Pearson Education, ISBN-13: 978-9354497841, ISBN-10: 9354497845
2.	Theory of Structures	S. Ramamrutham R.Narayan	DHANPAT RAI PUBLISHING COMPANY (P) LTD-NEW DELHI, ISBN-10 9789352164752 : ISBN-13 978-9352164752 :
3.	Theory of Structures (Si Units)	R.S. Khurmi N. Khurmi	S Chand; Twelfth edition, ISBN-10 8121905206 : ISBN-13 978-8121905206 :

4.	Structural Analysis Vol-1	S S Bhavikatti	Vikas Publishing House; Fourth edition ISBN-10 9788125942696 : ISBN-13 978-8125942696 :

(b) Online Educational Resources:

1. https://archive.nptel.ac.in/courses/105/105/105105109/
2. https://youtube.com/playlist?list=PLUogGZJOiMtNOus85Tq1zNvg9EU3aJ8VO
3. https://bsa-iiith.vlabs.ac.in/
4. https://www.scribd.com/document/377110577/Deflection-Nptel
5. https://en.m.wikipedia.org/wiki/Moment_distribution_method
6. https://en.wikipedia.org/wiki/Theorem_of_three_moments

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others: Nil

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A) Course Code : **2415403(T2415403/P2415403/S2415403)**

B) Course Title **:** Building Planning and Drawing with Auto CAD

C) Pre-requisite Course(s) **:** Engineering Graphics

D) Rationale :

Building Planning and Drawing is a major course of civil engineering that deals with the principles of planning for drafting the building components into graphical form and thereafter enables the execution of construction work. Drawings are the medium of passing the views and concepts of an architect or engineer into reality. The course deals with the principle of planning for buildings, drawing load-bearing and framed structures, perspective drawings, and drawing of buildings using manual drawings as well as CAD drawings. The knowledge of this course will help the students to read, understand, interpret, and prepare building drawing for easy execution of the construction work. Also, the students are required to use Computer Aided Drafting Software like AutoCAD as a drafting tool to prepare the building drawings. This will help students to edit the existing drawings or create new 2D or 3D drawings as per the requirements with more speed and accuracy. A civil engineer must have sound knowledge of building planning and drawing as well as the skill of using CAD software for efficient construction and development works.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of the following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/laboratory/workshop/field/industry.

After completion of the course, the students will be able to-

CO-1 Interpret the conventions, symbols, types of line and types of scale from the given drawings.

CO-2 Prepare line plans of given buildings using the principals of building planning.

CO-3 Prepare drawing of load bearing structures as per the given requirements.

CO-4 Prepare drawing of framed structures as per the given requirements.

CO-5 Prepare two-point perspective plan for given small objects such as steps, monuments, pedestals.

CO-6 Prepare 2D and 3D drawings as per the given requirements using CAD software.

F) Suggested Course Articulation Matrix (CAM):

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

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Board of Study	Course Code	Course Title	Scheme of Study (Hours/Week)					
			Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
			L	T				
Civil Engineering	**2415403**	Building Planning and Drawing with Auto CAD	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Board of Study	Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Assessment (TA)		Term Work& Self Learning Assessment (TWA)		Lab Assessment (LA)		
			Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
Civil Engineering	**2415403**	Building Planning and Drawing	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2415403

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO1a. Draw the symbols of the given building materials. TSO1b. Explain the significance of lines used in building drawing. TSO 1c. Use the relevant types of scale for the given types of building drawing. TSO 1d. Draw the building drawings to the required scale on the relevant size of drawing sheet.	**Unit-1.0 Conventions and Symbols** 1.1 Conventions as per IS 962-1989, symbols for different materials such as earth work, brick work, Stone work, concrete, wood work and glass. 1.2 Graphical symbols for doors and windows, Abbreviations, symbols for sanitary and electrical installations. 1.3 Types of lines- visible lines, centre line, hidden line, section line, dimension line, extension line, pointers, arrow head or dots. Appropriate size of lettering and numerals for titles, sub-titles notes and dimensions. 1.4 Types of scale, criteria for proper selection of scale for various types of drawing. Sizes of drawing sheets.	**CO1**
TSO 2a. Explain the principles of building planning for the given types of building. TSO 2b. Fix the dimensions for the given element of the building. TSO 2c. Use the relevant building bylaws in the design of the given building structure. TSO 2d. Explain the terms, “Plot area”, “built up area”, “plinth area”, “carpet area “and “Floor area ratio” used in building construction.	**Unit-2.0 Planning of Building** 2.1 Principles of planning for Residential and Public building: Aspect, Prospect, Orientation, Grouping, Privacy, Elegance, Flexibility, Circulation, Furniture requirements, Sanitation, Economy. 2.2 Space requirement and norms for minimum dimension of different units in the residential and public buildings as per IS 962-1989. 2.3 Rules and bye-laws of sanctioning authorities for construction work. 2.4 Terms used in building planning- Plot area, built up area, super built-up area, plinth area, carpet area, floor area and FAR (Floor Area Ratio). 2.5 Line plans for residential building of minimum three rooms including water closet (WC), bath and stair case as per principles of planning. 2.6 Line plans for public building-school building, primary health centre, hostel and Library.	**CO2**
TSO 3a. Justify the need of elevation, top view (plan), side view and sectional view of plan the given building structure. TSO 3b. Draw the plan, elevation with section at given cross section for the given building drawing. TSO 3c. Draw the section of stair case of given	**Unit-3.0 Drawing of Load Bearing Structure** 3.1 Drawing of single-story load bearing residential building (2BHK) with staircase. 3.2 Data drawing–plan, elevation, section, site plan, schedule of openings, construction notes with specifications, area statement, Planning and design of stair case- Rise and Tread for	**CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
building structure.	residential and public building. 3.3 Working drawing– Developed plan, elevation, section passing through staircase or WC and bath. Foundation plan of Load bearing structure.	
TSO 4a. Compare the load bearing structure with framed structure. TSO 4b. Draw the plan, elevation and section view of the given framed structure. TSO 4c. Show the reinforcement details for the given structural elements of building structure.	**Unit-4.0 Drawing of Framed Structure** 4.1 Drawing of two storied framed structure (G+1), residential building (2BHK) with staircase. 4.2 Data drawing developed plan, elevation, section, site plan, schedule of openings, construction notes with specifications, area statement. 4.3 Working drawing of framed structure– developed plan, elevation, section passing through staircase or WC and bath. 4.4 Foundation plan of Framed Structure. 4.5 Details of RCC footing, Column, Beam, Chajjas, Lintel, Staircase and slab.	**CO4**
TSO 5a. Explain the importance of perspective drawing in civil construction. TSO 5b. Explain the principle of perspective drawing. TSO 5c. Draw a given type of building in the two-point perspective.	**Unit-5.0 Perspective Drawing** 5.1 Definition of terms, “perspective drawing with its types” including the principles used in perspective drawing. 5.2 Realistic drawings using Two-point perspective method.	**CO5**
TSO 6a. Explain the basic features of CAD software. TSO 6b. Justify the utility of drawing in CAD drawing. TSO 6c. Use the relevant command to modify the given CAD drawing. TSO 6d. Explain the utility of layer command in given situation. TSO 6e. Explain the types of dimension styles used in CAD drawing. TSO 6f. Explain the procedure of preparing 3D drawing of given simple object.	**Unit-6.0 Drawing with CAD** 6.1 Introduction to Computer Aided Drawing (CAD) software, various drafting software used for civil engineering drawing such as AutoCAD, QCAD, LibreCAD, TinkerCAD, etc. 6.2 Feature of CAD screen, Coordinate systems used in CAD. 6.3 Drawing commands: Line, poly line, construction line, rectangle, polygon, circle, ellipse, hatch, boundary, text, arc, point. 6.4 Modify commands: erase, copy, mirror, offset, trim, move, extend, rotate, array, lengthen, scale, chamfer, fillet, explode, stretch, join, brake and divide. 6.5 Changing properties of entity-line, type, color, scale, font size, style. 6.6 Layer command- Create layer within a drawing. 6.7 Dimension command: quick dimension, linear dimension and continuous dimension; align dimension, angle dimension, radius and diameter. 6.8 3D drawing: use of extrude, press full command.	**CO6**

Note: One major TSO may require more than one theory session/period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2415403

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO1.1. Draw conventions and symbols of given building materials and components.	1.	Draw graphical symbols for materials such as earthwork, brickwork, stonework, concrete, woodwork, glass, doors and windows, symbols for sanitary, water supply and electrical installation and write abbreviations as per IS 962:1989 on full Imperial drawing sheet.	CO1
LSO2.1. Draw lettering, titles, dimension styles, types of lines and types of scale.	2.	Draw lettering, titles, dimension styles, types of lines and types of scale on full Imperial size drawing sheet.	CO1
LSO3.1. Draw line plan of an existing building (Load Bearing/Framed Structure) to the suitable scale.	3.	Draw line plan of an existing building (Load Bearing/Framed Structure) to the suitable scale on full Imperial size drawing sheet.	CO2
LSO4.1. Draw line plan to suitable scale for a Public Building.	4.	Draw line plans to suitable scale for any one Public Buildings from the following (School Building, Primary Health Centre, Hostel and Library) on full Imperial size drawing sheet.	CO2
LSO5.1. Draw the drawing to the scale of a single storied load bearing residential building (2BHK) with flat roof with staircase.	5.	Draw the drawing to the scale 1:100 of a single storied load bearing residential building (2BHK) having flat roof with staircase showing the following details: (a) Plan and elevation (b) Foundation plan (c) Site plan (1:200), area statement on full Imperial size drawing sheet.	CO3, CO4
LSO6.1. Draw the drawing to the scale of (G+1) Framed Structure Residential Building (2BHK) with flat roof and staircase.	6.	Draw the drawing to the scale of 1:100 of (G+1) Framed Structure Residential Building (2BHK) with flat roof and staircase showing: a) Plan. b) Elevation. c) Site plan (1:200) and area statement. on full Imperial size drawing sheet.	CO3, CO4
LSO7.1. Draw the drawing for Foundation plan, Detailed enlarged section of RCC column and footing with plinth filling, RCC Beam, Lintel, Chajjas, RCC staircase and slab.	7.	Draw the drawing for above mentioned drawing at **serial number 05** showing: a) Foundation plan to the scale 1:50 b) Detailed enlarged section of RCC column and footing with plinth filling. c) Detailed enlarged section of RCC Beam, Lintel and Chajjas. d) Detailed enlarged section of RCC staircase and slab; on full Imperial size drawing sheet.	CO3, CO4
LSO8.1. Draw two-point perspectives drawing of small objects.	8.	Draw two-point perspectives drawing of small objects – step or pedestals (any one) to the scale 1:50. a) Draw plan, elevation, eye level, picture plane and vanishing points, b) Draw perspective view; on full Imperial drawing sheet.	CO5
LSO9.1. Reproduce the given shape in the AutoCAD drawing using appropriate command.	9.	Reproduce the given shape in the AutoCAD drawing using appropriate command (minimum 05 shapes) and enclose the print out in A3/A4 size paper.	CO1, CO6
LSO10.1 Draw the sectional elevation at a given section for given plan and elevation of a building.	10.	Draw the sectional elevation at a given section for given plan and elevation of a building and enclose the print out in A3/A4 size paper.	CO1, CO6

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO11.1 Prepare of line plan of any given residential building or public building using AutoCAD software.	11.	Prepare of line plan of any given residential building or public building using AutoCAD software and enclose the print out in A3/A4 size paper.	CO2, CO6
LSO12.1 Draw the drawing to the scale of a single storied load bearing residential building (2BHK) with flat roof and staircase using AutoCAD software.	12.	Draw the above-mentioned drawing at **serial number 05** using AutoCAD software and enclose the print out in A3/A4 size paper. a) Plan. b) Elevation. c) Section passing through Staircase. d) Foundation plan. e) Site plan (1:200), area statement.	CO3, CO4, CO6
LSO13.1 Draw the drawing to the scale of (G+1) Framed Structure Residential Building (2BHK) with flat roof and staircase using AutoCAD software.	13.	Draw the above-mentioned drawing at **serial number 06** using AutoCAD software and enclose the print out in A3/A4 size paper. a) Plan. b) Elevation. c) Section passing through Staircase. d) Foundation plan. e) Site plan (1:200), area statement.	CO3, CO4, CO6

L) **Suggested Term Work and Self Learning: S2415403** Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

1. Draw neat labeled sketch for following lines: (a) Section line, (b) Hidden Line, (c) Construction Line, (d) Extension Line.
2. List out the documents and drawings required for submitting plan to the sanctioning authorities.
3. Draw graphical symbols for following: earthwork, brickwork, stonework, concrete work, woodwork, glass, doors and windows.
4. Draw the line plan of a hostel building for 200 students showing different units with their sizes, position of doors and windows.
5. Draw developed plan to a suitable scale for a given line plan of building with given data. Show all dimensions and label the parts. Assume suitable data if necessary.

b. Micro Projects:

1. Draw developed plan, elevation, section, site plan, and area statement, schedule of opening and construction notes for public buildings.
2. Prepare report on the working drawings of buildings from local builders, architect and engineer.
3. Prepare report on the provisions of National Building Code, Building Bye laws, rules and regulation for planning as per local development authority.
4. Measure the units of existing load bearing or framed buildings and draw line plan for the same.
5. Prepare a model of simple building using suitable material showing different component of buildings.
6. Draw plan, cross section and longitudinal section of a culvert (Pipe culvert/Box culvert) using CAD software.
7. Draw section of an Earthen Dam using CAD software.
8. Draw Cross Section of Retaining wall using CAD software.
9. Draw Plan and Elevation for English bond and Flemish bond for one brick thick wall using CAD software.
10. Draw line plan of residential bungalow to suitable scale using CAD software.

c. Other Activities:

1.Seminar Topics:

- Overview of Computer Aided Drafting.
- Drawings used in Civil Engineering.
- Load Bearing and Framed Structures.
- 3-Dimensional Drawing using CAD software.

2. Visits: Visit to under construction site to collect detailed information about layout, line plans, drawings of buildings.

3. Self-learning topics:
   - Computer aided design and drawing software.
   - Latest software for Structural Drawings.
   - Perspective Drawing.
   - Details of RCC building components.

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work& Self-Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	10%	10%	10%	10%	10%	10%	10%
CO-2	20%	20%	20%	20%	20%	10%	10%
CO-3	22%	22%	25%	25%	25%	25%	25%
CO-4	22%	22%	25%	25%	25%	25%	25%
CO-5	16%	16%	10%	10%	10%	10%	10%
CO-6	10%	10%	10%	10%	10%	20%	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number (s)	Total Marks	ETA(Marks)		
				Remember (R)	Understanding (U)	Application & above(A)
Unit-1.0 Conventions and Symbols	04	CO1	06	2	2	2

Unit-2.0 Planning of Building	08	CO2	14	4	4	6
Unit-3.0 Drawing of Load Bearing Structure	12	CO3	16	6	-	10
Unit-4.0 Drawing of Framed Structure	12	CO4	16	4	4	8
Unit-5.0 Perspective Drawing	06	CO5	10	2	4	4
Unit-6.0 Drawing with CAD	06	CO6	08	2	2	4
Total Marks	**48**	**-**	**70**	**20**	**16**	**34**

Note: Similar table can also be used to design class/mid-term/internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number (s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Draw graphical symbols for materials such as earthwork, brickwork, stonework, concrete, woodwork, glass, doors and windows, symbols for sanitary, water supply and electrical installation and write abbreviations as per IS 962:1989 on full Imperial drawing sheet.	CO1	40	50	10
2.	Draw lettering, titles, dimension styles, types of lines and types of scale on full Imperial size drawing sheet.	CO1	40	50	10
3.	Draw line plan of an existing building (Load Bearing/Framed Structure) to the suitable scale on full Imperial size drawing sheet.	CO2	40	50	10
4.	Draw line plans to suitable scale for any one Public Buildings from the following (School Building, Primary Health Centre, Hostel and Library) on full Imperial size drawing sheet.	CO2	40	50	10
5.	Draw the drawing to the scale 1:100 of a single storied load bearing residential building (2BHK) having flat roof with staircase showing the following details: (a) Plan and elevation (b) Foundation plan (c) Site plan (1:200), area statement on full Imperial size drawing sheet.	CO3, CO4	40	50	10
6.	Draw the drawing to the scale of 1:100 of (G+1) Framed Structure Residential Building (2BHK) with flat roof and staircase showing: a) Plan. b) Elevation. c) Site plan (1:200) and area statement. on full Imperial size drawing sheet.	CO3, CO4	40	50	10
7.	Draw the drawing for above mentioned drawing at **serial number 05** showing: a) Foundation plan to the scale 1:50 b) Detailed enlarged section of RCC column and footing with plinth filling. c) Detailed enlarged section of RCC Beam, Lintel and Chajjas. d) Detailed enlarged section of RCC staircase and slab; on full Imperial size drawing sheet.	CO3, CO4	40	50	10

S. No.	Laboratory Practical Titles	Relevant COs Number (s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
8.	Draw two-point perspectives drawing of small objects – step or pedestals (any one) to the scale 1:50. a) Draw plan, elevation, eye level, picture plane and vanishing points, b) Draw perspective view; on full Imperial drawing sheet.	CO5	40	50	10
9.	Reproduce the given shape in the AutoCAD drawing using appropriate command (minimum 05 shapes) and enclose the print out in A3/A4 size paper.	CO1, CO6	40	50	10
10.	Draw the sectional elevation at a given section for given plan and elevation of a building and enclose the print out in A3/A4 size paper.	CO1, CO6	40	50	10
11.	Prepare of line plan of any given residential building or public building using CAD software and enclose the print out in A3/A4 size paper.	CO2, CO6	40	50	10
12.	Draw the above-mentioned drawing at **serial number 05** using CAD software and enclose the print out in A3/A4 size paper. a) Plan. b) Elevation. c) Section passing through Staircase. d) Foundation plan. e) Site plan (1:200), area statement.	CO3, CO4, CO6	40	50	10
13.	Draw the above-mentioned drawing at **serial number 06** using CAD software and enclose the print out in A3/A4 size paper. a) Plan. b) Elevation. c) Section passing through Staircase. d) Foundation plan. e) Site plan (1:200), area statement.	CO3, CO4, CO6	40	50	10

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/ practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Portfolio Based Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field, Information and Communications Technology (ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Drawing board with stand	Drawing board full imperial size with adjustable stand, wooden board and mild steel and powder coated stand.	1 to 8
2.	Computer	Computer with specification with i7 processor, 4GB RAM, HDD 1TB, LCD monitor with latest operating software complete in all as per the requirements.	9 to 13
3.	CAD Software	Latest CAD software for 2D and 3D Drawings.	9 to 13
3.	Printer	Laser printer suitable for printing A4/A3 size papers.	9 to 13
4.	LCD Projector with wall mount screen	LCD Projector with wall mount motorized projector white screen.	9 to 13

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Building Drawing	Shah. M.G. Kale, CM, Patki, S.Y.	McGraw-Hill Publishing Company Ltd., New Delhi, 6th Edition, 2019, ISBN-13: 9780074638767
2.	Civil Engineering Drawing	Malik and Mayo	Computech Publication Ltd New Asian Publishers, 2021, New Delhi, ISBN-13: 9788173180026
3.	Building Planning and Drawing	Bhavikatti, S. S., Chitawadagi, M. V.	I.K. International Publishing House Pvt. Limited, 2014, ISBN-13:9789382332565
4.	Building Planning and Drawing	Dr. N. Kumara Swamy, A. Kameswara Rao	Charotar Publishing House Pvt. Ltd. 2023 (9th Revised Edition), ISBN-13 : 9789385039386
5.	Building Construction	Bhavikatti, S.S.	Vikash Publication House Pvt. Ltd., New Delhi, 2015, ISBN-13: 9789385039126
6.	Introduction to AutoCAD 2023 for Civil Engineering Applications	Yasmin, Nighat	SDC Publications, USA, 2022, ISBN-13: 9781630575212
7.	AutoCAD 2014 for Engineers Volume 1 (For Polytechnic Student)	Dey, Sankar Prasad	Vikash Publication House Pvt. Ltd., New Delhi, 2014, ISBN-13: 9789325983373
8.	Engineering Drawing with Primer on AutoCAD	Siddiquee Arshad N., Zahid A. Khan, Mukhtar Ahmad	PHI Learning Private Limited, Delhi, ISBN -13: 9788120324404
9.	Engineering Drawing	Bhatt, N.D.	Charotar Publishing House Pvt. Ltd. Gujrat, 54th Edition, 2023, ISBN-13: 9789385039706
10.	AutoCAD and Its Applications—Basics 2020	Terence M. Shumaker, David A. Madsen, and David P. Madsen	Goodheart-Willcox Publishers, 27th Edition, 2020, ISBN-13: 9781631264252

(b) Online Educational Resources:

1. https://youtube.com/playlist?list=PL5S3o0bbDTuJIe7LYSD2YZG7pdt98JnFL
2. https://youtube.com/playlist?list=PLe_I-JWckL7FQkOK96farWhoq4Cyn4FJA
3. https://www.smartdraw.com/
4. https://www.autodesk.com/education/students
5. https://mohua.gov.in/upload/uploadfiles/files/MBBL.pdf
6. https://law.resource.org/pub/in/bis/S03/is.962.1989.pdf
7. https://law.resource.org/pub/in/bis/S03/is.sp.7.1.2005.pdf

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. National Building Code 2016.
2. IS 962:1989 Code of practice for architectural and building drawings.
3. IS 9609: Part 1 : 2006 Technical product documentation - Lettering: Part 1 latin alphabet, numerals and marks (Second Revision).
4. IS 10713: 1983Scales for use on technical drawings (ISO Title : Technical Drawings - Scales).
5. IS 10714: 1983General principles of presentation on technical drawings.
6. IS 10720: 1999Technical drawings - Simplified representation of bars and profile sections.
7. IS 7973: 1976 Code of practice for architectural and building working drawings.

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A) Course Code : 2415404(T2415404/P2415404/S2415404)

B) Course Title : Soil Mechanics and foundation

C) Pre- requisite Course(s) :

D) Rationale

Soil mechanics and foundation engineering form essential branches of civil engineering, focused on understanding soil behavior in diverse applications. It provides critical insights into the behavior of soil, which is a complex blend of fluids and particles. Soil mechanics serves as the foundation for geotechnical engineering and engineering geology, enabling the analysis of deformations and fluid flow in structures resting on or buried in soil. This knowledge supports the design and construction of various structures such as foundations, retaining walls, dams, and pipelines. Additionally, soil mechanics principles find application in geophysical and coastal engineering, agricultural engineering, hydrology, and soil physics, contributing to safe and efficient infrastructure development.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1 Classify different types of soil used in engineering applications.

CO-2 Compute physical and index properties of given sample of soil for the given construction site.

CO-3 Determine the permeability of the given sample of soil using relevant laboratory test method.

CO-4 Calculate the shear strength parameters for field condition using relevant laboratory/ field test method.

CO-5 Determine the bearing capacity of the given soil sample using the relevant laboratory/field test method as per the provision of IS Code.

F) Suggested Course Articulation Matrix (CAM):

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

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Board of Study	Course Code	Course Title	Scheme of Study (Hours/Week)					
			Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
			L	T				
Civil Engineering	**2415404**	Soil mechanics and foundation	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Board of Study	Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Assessment (TA)		Term Work & Self Learning Assessment (TWA)		Lab Assessment (LA)		
			Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
Civil Engineering	**2415404**	Soil mechanics and foundation Engg.	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2415404

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Explain type and classification of soil. TSO 1b. Classify the rocks based on their formation. TSO1c. Discuss the importance of soil as a construction material. TSO 1d. Explain field application/s of soil engineering.	**Unit-1.0 Overview of Soil Mechanics.** 1.1 Definition of soil, soil mechanics and rock mechanics. 1.2 Types of soil and its classification, soil formation and deposition. 1.3 Types of rocks, its classification, and their formation. Comparison between soil and rock. 1.4 Importance of soil in Civil Engineering as construction material. 1.5 Brief introduction of field application of soil engineering: Foundation design, Pavement design, Design of earth retaining structures and Earthen dams.	**CO1**
TSO 2a. Explain three phase system of soil TSO 2b. Define the term water content, void ratio, porosity, degree of saturation and density index. TSO 2c. Determine water content of given soil sample by oven drying method TSO 2d. Explain the terms, "unit weight of soil, dry unit weight of soil, saturated unit weight of soil, submerged unit weight of soil" TSO 2e. Determine the specific gravity of given soil sample by pycnometer method TSO 2f. Calculate Atterberg limit of consistency for the given data. TSO 2g. Interpret the particle size distribution curve for the given data.	**Unit-2.0 Physical and Index Properties of Soil** 2.1 Soil as a three-phase system. 2.2 Water content, Determination of water content by oven drying method as per IS code. 2.3 Determination of Void ratio, porosity, degree of saturation and density index. 2.4 Unit weight of soil mass – bulk unit weight, dry unit weight, unit weight of soil solids, saturated unit weight, submerged unit weight. 2.5 Determination of bulk unit weight and dry unit weight by core cutter method and sand replacement method as per IS code. 2.6 Specific gravity, determination of specific gravity by pycnometer. 2.7 Consistency of soil, Atterberg's limits of consistency: Liquid limit, plastic limit, shrinkage limit and plasticity index. 2.8 Determination of liquid limit, plastic limit and shrinkage limit as per IS code. 2.9 Particle size distribution, mechanical sieve analysis as per IS code, particle size distribution curve, effective diameter of soil, Uniformity coefficient and coefficient of curvature.	**CO1, CO2**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 3a. Identify the factors affecting permeability of given type of soil sample. *TSO 3b* Apply the Darcy's law in the given situation TSO 3c. Compute the coefficient of permeability of given soil sample data. *TSO 3d.* Use the application of flow-net in the given situation.	**Unit-3.0 Permeability of Soil** 3.1 Definition of permeability and factors affecting permeability. 3.2 Darcy's law of permeability, coefficient of permeability, typical values of coefficient of permeability for different soil. 3.3 Determination of coefficient of permeability by constant head and falling head permeability tests, simple problems to determine coefficient of permeability. 3.4 Seepage through earthen structures, seepage velocity, seepage pressure, phreatic line, flow lines and equipotential lines. 3.5 Flow net, characteristics of flow net, application of flow net (only basic numerical Problems).	**CO3, CO4**
TSO 4a. Compute the shear strength of soil sample for the given data. TSO 4b. Interpret shear failure of soil sample for the given data. *TSO 4c.* Describe the process of compaction in the given situation *TSO 4d.* Describe the relevant compacting equipment used for the given type of soil sample with justification TSO 4e. Compute the CBR value for the given data of soil sample.	**Unit-4.0 Compaction, Consolidation and Shear Strength of Soil** 4.1 Concept and purpose of compaction & consolidation with their field application. 4.2 Standard and Modified proctor test – test procedure as per IS code, Compaction curve, optimum moisture content, maximum dry density, zero air voids line. 4.3 Field methods of compaction – rolling, ramming & vibration. 4.6 California bearing ratio, CBR test. 4.7 Shear failure of soil, field situation of shear failure 4.8 Concept of shear strength of soil. 4.9 Components of shearing resistance of soil– cohesion, internal friction. 4.10 Mohr-coulomb failure theory, Strength envelope, strength equation for purely cohesive and cohesion less soils. 4.11 Laboratory determination of shear strength of soil – Direct shear test, Unconfined compression test & vane shear test, plotting strength envelope.	**CO3, CO4**
TSO 5a. Describe the process of stabilization in the given situation. TSO 5b. Select the relevant method of soil stabilization for the given situation with justification. TSO 5d. Calculate the soil parameter to determine bearing capacity of given soil sample with justification. TSO 5e. Suggest the method for determination of bearing capacity of the given soil with justification.	**Unit-5.0 Stabilization and Bearing Capacity of Soil** 5.1 Concept of soil stabilization, necessity of soil stabilization. 5.2 Different methods of soil stabilization – Mechanical soil stabilization, lime stabilization, cement stabilization, bitumen stabilization and fly-ash stabilization 5.3 Concept of bearing capacity, ultimate bearing capacity, safe bearing capacity and allowable bearing pressure. 5.4 Terzaghi's analysis and assumptions. 5.5 Effect of water table on bearing capacity.	**CO4, CO5**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 5f. Compute the earth pressure for the given earthen retaining structures	5.6 Field methods for determination of bearing capacity – Plate load test and standard penetration test. Test procedures as Per IS:1888 & IS:2131. 5.7 Definition of active earth pressure and passive earth pressure, structures subjected to earth pressure in the field. Rankine's theory and assumption made for non-cohesive soils.	

Note: One major TSO may require more than one theory session/period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2415404

Practical/Lab Session Outcomes (LSOs)		S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1.	Calculate water content of the given soil sample.	1.	Determination of water content of given soil sample by oven drying method as per IS Code. IS 2720-2 1973	CO1
LSO 2.1.	calculate unit weight of the given soil sample in given soil condition.	2.	Determination of bulk unit weight, dry unit weight of soil in field by core cutter method as per IS Code.	CO1
		3	Determination of bulk unit weight, dry unit weight of soil in field by sand replacement method as per IS Code.	CO1
LSO 3.1.	calculate specific gravity of given soil sample.	4	Determination of specific gravity of soil by Pycnometer method. IS 2720-3-1 1980	CO1
LSO 5.1.	Calculate liquid limit & plastic limit for given soil sample.	5.	Determination of Liquid limit & Plastic limit of given soil sample as per IS Code. IS 2720-5 1985	CO3, CO4, CO5
LSO 6.1.	Draw grain size distribution curve for given soil samples.	6.	Determination of grain size distribution of given soil sample by mechanical sieve analysis as per IS Code. IS 2720-4 1985	CO3, CO4, CO5
LSO 7.1.	Calculate coefficient of permeability of sandy & gravel sand.	7.	Determination of coefficient of permeability by constant head method. IS 2720-17 1986	CO3, CO4, CO5
LSO 8.1.	Calculate coefficient of permeability for fine grained soil.	8.	Determination of coefficient of permeability by falling head test IS 2720-17 1986	CO3, CO4, CO5
LSO 9.1.	Calculate shear strength for given soil sample	9.	Determination of shear strength of soil using direct shear test. IS 2720-13 1986	CO4, CO5
LSO *10.1.*	Draw graph of given soil sample for different water content.	10.	Determination of MDD & OMC by standard & modified proctor test on given soil sample as per IS Code	CO5
LSO *11.1.*	Calculate CBR value of given soil sample.	11.	Determination of CBR value of given soil sample. IS 2720-16 1987	CO5

L) Suggested Term Work and Self Learning: S2415404 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted Cos

Any four of the following

1. Prepare the inspection report on bearing capacity of soil strata available in your area inspecting the nearby excavation for foundation of the buildings using your own judgement.

2. Collect the soil samples available in your area.
3. Visit the soil engineering laboratory of your polytechnic and prepare a report with photographs of machines used for different purposes in soil engineering.
4. Prepare a brief report on the contribution of the scientists reflected in your curriculum of soil mechanics and foundation engineering.
5. Analysis of the chart showing engineering properties of soil along with IS specification
6. Show the details of soil deposits available in your district through map/graph/pie chart/excel/bar chart etc.
7. Select a soil sample containing greater percentage of the clayey particles/greater dry unit weight from given samples of soils.
8. Determination of the bearing capacity of a soil sample with known SPT values at different depths of strata.

b. Micro Projects:

Any one of the following

1. Analysis of a case study reflecting the effects of Groundwater Level on Soil Settlement and Bearing Capacity of soil.
2. Prepare a report on impact of Moisture Content on Soil Compaction and Stability
3. Prepare a report on Significance of Soil Permeability in Drainage Design based on the tests conducted on given soil sample using relevant method in the laboratory.
4. Prepare a comparative chart of the bearing capacity calculated based on various tests conducted in laboratory.
5. Influence of Soil Liquefaction on the Stability of Shallow and Deep Foundations w.r.t a case study.
6. Report of internet survey on Improvements in Soil Characteristics seen through compacting and stabilization techniques based on various case studies.
7. Analysis of Soil Organic Matter Content and its Influence on Soil Fertility and Water Holding Capacity
8. Write a report on role on the roles and responsibilities of a soil engineer in construction practices.

c. Other Activities:

1. Seminar Topics:
    - Applications of Physical and Index Properties of Soil.
    - Importance of soil Permeability in soil engineering.
    - Shear Strength and its significance in civil engineering.
    - Techniques for Enhancing Soil Performance.
    - Bearing Capacity and its practical significance in foundation engineering
    - SPT and Bearing Capacity

2. **Visits**: Visit nearby Construction Site. Prepare report of visit with special comments on soil bearing capacity and types of foundation used.

3. Self- learning topics:
    - Soil classification systems
    - Criteria for classifying soils based on their particle sizes, plasticity, and engineering properties.
    - Soil improvement methods
    - Principles of foundation design including estimation of load, bearing capacity and settlement.

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self-Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	10%	15%	-	-	20%	20%
CO-2	10%	20%	10%	25%	-	10%	20%
CO-3	15%	20%	15%	25%	33%	15%	20%
CO-4	30%	20%	30%	25%	33%	15%	20%
CO-5	30%	30%	30%	25%	34%	40%	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number (s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Overview of Soil mechanics.	04	CO1	07	4	1	2
Unit-2.0 Physical and Index Properties of Soil	10	CO2	14	4	4	6
Unit-3.0 Permeability of Soil	10	CO3	14	4	4	6
Unit-4.0 Compaction and Consolidation and Shear Strength of Soil	10	CO4	14	4	4	6
Unit-5.0 Stabilization and Bearing Capacity of Soil	14	CO5	21	4	6	11
Total Marks	**48**	**-**	**70**	**20**	**19**	**31**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant Cos Number (s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Determination of water content of given soil sample by oven drying method as per IS Code. IS 2720-2 1973	CO1	30	60	10
2.	Determination of bulk unit weight, dry unit weight of soil in field by core cutter method as per IS Code.	CO1	40	50	10
3.	Determination of bulk unit weight, dry unit weight of soil in field by sand replacement method as per IS Code.	CO1	30	60	10
4.	Determination of specific gravity of soil by Pycnometer method. IS 2720-3-1 1980	CO2	30	60	10
5.	Determination of Liquid limit & Plastic limit of given soil sample as per IS Code. IS 2720-5 1985	CO3, CO4, CO5	30	60	10
6.	Determination of grain size distribution of given soil sample by mechanical sieve analysis as per IS Code. IS 2720-4 1985	CO3, CO4, CO5	30	60	10
7.	Determination of coefficient of permeability by constant head method. IS 2720-17 1986	CO3, CO4, CO5	30	60	10
8.	Determination of coefficient of permeability by falling head test IS 2720-17 1986	CO3, CO4, CO5	40	50	10
9.	Determination of shear strength of soil using direct shear test. IS 2720-13 1986	CO4, CO5	40	50	10
10.	Determination of MDD & OMC by standard proctor test on given soil sample as per IS Code	CO5	40	50	10
11.	Determination of CBR value of given soil sample. IS 2720-16 1987.	CO5	30	60	10

Legend:
PRA*: Process Assessment
PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to beprepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ ImplementationStrategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Portfolio Based Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field, Information and Communications Technology (ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Electronic Balance	upto 500g, and 5kg	ALL
2.	Laboratory hot air over	Digital laboratory over (18''x18''x18''), Hot oven 450mm digital	1
3.	Cutter	As per IS:2720 (Part 29), Min. 100 mm dia x 130 mm long, Steel Dolly 25 mm high and 100 mm dia,Rammer with Steel Rod.	2

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
5.	Pycometer	As perIS:2386 (Part 3) Consists of a 1 kg Glass Jar with Brass Cone	3
6.	A Casagrande Apparatus	Casagrande grooving tools and gauge block with AC Supply Compliance with IS:2720 (Part 5), IS:9259 Consists of a hard rubber base Casagrande Grooving Tool Gauge Block	5
7.	Sieve with Lid and sieve shaker	Sieve Shaker, Motorized, with Built-in Digital Timer, • A digital timer adjustable from 0-99 minutes is incorporated as an integral part of the equipment. • The Sieve Shaker can carry up to 8 sieves of 20cm diameter, also supplied with 30cm adaptor. It is driven by a ¼ HP geared motor. , • The Sieve Table is inclined from the vertical axis and the direction of inclination changes progressively in the clockwise direction. In addition to the gyratory motion of the table, there is a tapping motion as well. Suitable for operation on 220 V, 50 Hz, Single Phase, AC supply.	6
8.	IS Sieve Set	IS Sieves 20 cm diameter brass Aperture size 4.75 mm, 2.36 mm, 1.18mm, 600micron, 300 micron,150 micron and 75 microns as per IS 460	6
9.	Laboratory Permeability Apparatus (Constant head and falling head)	Stand with min 3 glass tubes of 6 mm, 10 mm and 20 mm dia 9pprox.. Mould of 100 mm dia x 127.3 mm height, and 1000 ml volume. Drainage Cap with recess for a Porous Stone. Rubber Connection Tube of min. 3m long, with Pinch Cock, overhead Tank.	7
10	Direct shear apparatus	Microprocessor based load frame 2 kN Capacity with proving ring and dial gauges, with related software Ref. Standards IS :11229, 2720 (Part 13) Supplied complete with carriage, loading hanger and 10:1 lever loading device. Suitable for specimens of size 60×60×25mm. Membrane keypad and the 40×2 LCD display. Precision loading rate of 0.00001 to 9.99999mm / minute. Suitable for operation on 220 V, 50 Hz, Single phase, AC Supply. Microprocessor control Accepts specimen 60mm square Shear Box Assembly, This assembly comprises of: Halves of the Shear Box 2 Nos. Plane Gripper Plate – 2 Perforated Gripper Plate – 2 Porous Stone – 2 Top Loading Pad – 1 Base Plate – 1 Specimen Cutter – 1 Min normal stress – 3 kg/cm2 Operation: Motorized Variable Rates of Strain Specimen Size: 60 x 60 x 25 mm Compression – Tension Proving Min Ring, 2 kN capacity Dial Gauge – 2	9
11.	Standard proctor test apparatus	As per the IS:2720 (Part 7), Compaction mound: Dia – 100 mm, Height – 127.3 mm, Volume – 1,000 ml. Rammer: - 2.6 kg	10
12.	CBR Test Apparatus	As per the IS Code 9669, Digital Load Frame with LCD 50 kN Capacity with min 4 Speed 1.5, 1.25 2.5 mm/min and true speed control upto 15mm/min • Two pillar type.	11

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
		• Horizontal Clearance-265mm min • Vertical clearance-700mm min • Maximum Platen dia-130mm with Hardness of material(platen): 60 RHC. • Ram Dia 50mm • The lower platen moves up and down • A dial gauge mounting bracket is provided on one of the two pillars. • Suitable for operation on 220 V, 50 Hz, single phase, AC supply Paint quality: -Powder coating 70-80 micron thick Material of Construction: Special quality low carbon mild steel Mould – MS150mm ID x 175 mm H, Perforated Base Plate – MS Extension Collar – MS150 mm ID x 50 mm high Penetration Piston 50 mm face dia Circular Metal Spacer Disc, with detachable handle, 148 mm dia x 47.7 mm high, Annular Metal Weight 2.5 kg, 147 mm dia with 53 mm dia central hole Slotted Metal Weight 2.5 kg, 147 mm dia, with 53 mm dia slot Rammer 2.6 kg, 310 mm controlled drop Rammer 4.9 kg, 450 mm controlled drop Proving Ring Capacity 50 kN Dial Gauge 25 mm travel, 0.01 mm least count. Load frame pillar thread M30 X 600mm. Suitable for operation on 220 V, 50 Hz, single phase, AC supply.	

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Soil Mechanics and Foundation Engineering	Punmia, B.C	Laxmi Publication, Delhi. ISBN:978-8170087915
2.	A text book of soil mechanics and foundation Engineering	Murthy, V.N.S	CBS Publishers ISBN:978-8123913629
3.	Geotechnical Engineering (Soil Mechanics)	Ramamurthy, T.N. & SitharamT.G	S Chand and Company LTD., New Delhi. ISBN:978-8121924573
4.	Soil Mechanics and Foundation Engineering	Raj, P. Purushothama	Pearson India, New Delhi. ISBN:978-8131711774
5.	Soil Mechanics and Foundation Engineering	Arora K R	Standard Publisher. ISBN: 978-8180141126

(b) Online Educational Resources:

1. https://archive.nptel.ac.in/courses/105/105/105105168/
2. https://archive.nptel.ac.in/courses/105/105/105105176/
3. https://www.youtube.com/watch?v=V1m3cB-Aqy8&list=PL940DD62E8781E147&ab_channel=nptelh
4. https://www.youtube.com/watch?v=hNNilk-OKaw&list=PL9gC9b3b4pMvoQ4Sj8imonJgfDW2GxPTF&ab_channel=NCTEL
5. https://www.youtube.com/watch?v=lsYFtwwlHIw&list=PLbRMhDVUMngeiZjKPTPEFl1CByXmYX3Kv&ab_channel=IITKharagpurJuly2018

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. IS 2720 BIS, Bureau of Indian Standards, New Delhi.
2. IS 2131 (1981), Bureau of Indian Standards, New Delhi.
3. Lab Manuals

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A) Course Code : 2415405(T2415405/P2415405/S2415405)

B) Course Title : Transportation Engineering

C) Pre-requisite Course(s) : Basic Engineering Mechanics

D) Rationale :

Historically, the growth of society has been greatly aided by transportation, both in terms of land and air based systems, as well as trade routes and harbors. The use of science and contemporary technology to the planning, creation, and upkeep of transportation networks is known as transportation engineering. The discipline of transportation engineering leverages the most recent advancements in transportation, like driverless cars and transportation management systems, to design the most effective and efficient solutions for a range of environments. Major terminals and the networks that link them fall within the purview of transportation engineering. Transportation engineering encompasses any method or product that transports people and cargo between locations.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/laboratory/workshop/field/industry.

After completion of the course, the students will be able to-

CO-1 Classify the types of roads as per Indian Road Congress (IRC) recommendations.

CO-2 Design the geometric characteristics of the given road.

CO-3 Carry out the relevant test required for selection of the pavement material.

CO-4 Justify the need of Permanent way in the Railway Engineeri3 ng.

CO-5 Rectify the defects normally observed in the given railway Track

F) Suggested Course Articulation Matrix (CAM):

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

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Board of Study	Course Code	Course Title	Scheme of Study (Hours/Week)					
			Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
			L	T				
Civil Engineering	**2415405**	Transportation Engineering	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Board of Study	Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
Civil Engineering	**2415405**	Transportation Engg.	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2415405

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO1.1 Explain the need of relevant type of roads for the given situation. TSO1.2 Compare the three modes of transportation system with their merits, demerits. TSO 1.3 Classify the given type of road as per IRC guidelines. TSO 1.4 Explain the factors considered in deciding the Alignment of the given type of road.	**Unit 1.0 - Overview of Highway Engineering** 1.1 Role of transportation in the development of nation, Scope and Importance of roads in India. 1.2 Different modes of transportation–roadway, waterway, air way. Merits and demerits of roadway and railway. 1.3 General classification of roads as per Indian Road Congress (IRC). 1.4 Road Alignment – Factors affecting road alignment.	CO1
TSO 2.1 Explain the geometric design of the given highway. TSO 2.2 Explain the role of physical and topographical feature in the geometric design of the given type of road. TSO 2.3 Describe all Guidelines as per IRC for Geometric design. TSO 2.4 Explain the terms associated with Geometric Design Elements. TSO 2.5 Sketch the cross section of roads. TSO2.6 Describe Various Factors in context to Sight distance. TSO 2.7 Calculate Super elevation for the given situation of road. TSO 2.8 Classify the different types of gradient. TSO2.9 Classify curves and point out the differences in between horizontal and vertical curve. TSO2.10 Explain the need for extra widening on curves for the given situation.	**Unit 2.0 -Geometric Design of Highway** 2.1 Need and importance of geometric design 2.2 Topography and physical feature 2.3 Geometric design provision for various transportation facilities as per IRC guidelines, 2.4 Geometric design elements: Road formation, Camber, Kerbs, Road margin, Right of way, Design speed. 2.5 Standard cross section of road in embankments and cutting. 2.6 Sight Distance and various factors affecting sight distance. 2.7 Super elevation: Definition, need and calculation of super elevation. 2.8 Gradient and its types. 2.9 Horizontal and Vertical curves. 2.10 Extra widening on curves.	CO2
TSO 3.1 Explain the suitability of soil as a sub-grade for formation of Road. TSO 3.2 Describe the various type of test for determining the mechanical properties of stone aggregate. TSO 3.3 Enlist & discuss the various test conducted to determine the grade of bituminous material. TSO 3.4 Describe the mechanical properties of cement & concrete for a given Sample TSO 3.5 Define & draw a labeled sketch of Pavement showing its various components TSO3.6 Explain the different Methods for Construction of a given type of Flexible Pavement TSO3.7 Describe the different Methods for	**Unit 3.0 -Highway Material and Construction Technique:** 3.1 Soil Sub-grade: Suitability of soil as a sub-grade material as per IRC guidelines, Group index (GI) method. 3.2 Stone Aggregates: Types and its Suitability, Test on Aggregates: Flakiness and elongation test, Impact test, abrasion test, crushing test and absorption test. 3.3 Bituminous Material: Bitumen and its types, properties, Test on Bitumen: Softening point test, penetration test, Ductility test, Flash and fire test. 3.4 Portland cement and cement concrete: Properties	CO3

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
Construction of a Given type of Rigid Pavement TSO3.8 Select a suitable type of Joints used for a given Rigid Pavement	and its requirement in pavement design. 3.5 Pavement–Definition, Types, Structural Components of pavement and their functions. 3.6 Flexible pavement construction: WBM road, Earthen road, Bituminous road, Merits and demerits of each type of pavements and method of construction. 3.7 Rigid pavement construction: PCC and RCC road, Merits and demerits of each types of road and method of construction. 3.8 Joints in Rigid pavement: Construction of joints, Filler and Sealer.	
TSO4.1 Classify different zones of Indian Railway. TSO4.2 Describe Permanent Way. TSO4.3 Describe various component parts used in rail track. TSO4.4 Discuss different types of Gauges used in Rail Track. TSO4.5 Describe rail joints used in Rail Track. TSO4.6 Explain the rail defects occurring in rail alignment. TSO4.7 Explain the factors affecting rail alignment. TSO4.8 Draw the Standard cross -section of rail track in cutting and embankment.	**Unit 4.0 -Basics of Railway Engineering** 4.1 Classification of Indian Railways, zones of Indian Railways. 4.2 Permanent way: Ideal requirement 4.3 Components: Rail, Sleepers, Ballast, Formation, Fastening and Fixtures (Requirement, Types and its function) 4.4 Gauge, types, factors affecting selection of a gauge, Importance of singular gauge 4.5 Rail Joints -Requirements, Types 4.6 Creep of rail: Definition causes and it's Prevention. 4.7 Alignment: Factors governing rail alignment 4.8 Standard cross section of single and double line in cutting and embankment.	CO4
TSO 5.1 Describe various factors governing geometrics of Rail track. TSO 5.2 Describe various arrangements like point and crossing, crossover, turnout to divert rolling stock from one track to another. TSO 5.3 Explain factors affecting site selection, for different types of Railway stations with its purpose. TSO 5.4 Describe the functions of different types of Railway Station Yards.	**Unit 5.0 -Track Geometrics, Construction and Maintenance** **5.1 Railway Track Geometrics:** Coning of wheels, tilting of rails, Gradient & its types, Super elevation, limits of Super elevation on curves, cant deficiency, negative cant, grade compensation on curves **5.2 Branching of Tracks:** Definition of point & crossing, Turnout, a simple split switch turnout consisting of points and crossing. Different components of Points and Crossing, their functions & working. Track junctions-Crossovers, Scissor cross-over, Diamond crossing, Track –triangle Inspection and maintenance of points and crossings **5.3 Railway Station:** Types of railway station, Purpose, requirement of railway station, important technical terms, factors affecting site selection for railway station. **5.4 Station yard**: Classification–Passenger, goods, locomotive and marshalling yards. Function & draw backs of marshalling yards.	CO5

Note: One major TSO may require more than one theory session/ period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2415405

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/ Practical Titles	Relevant Cos Number (s)
LSO 1.0 Students will be able to draw standard cross-section of given type of roadway.	1.	Draw the sketch showing standard cross sections of Express ways, NH, SH, MDR, ODR.	CO1
LSO 2.0 Students will be able to assess suitability of aggregates for use in given types of road pavement.	2.	To Determine the Crushing Value of Coarse Aggregates.	CO1
LSO 3.0 Students will be finding out the impact value of given type of coarse aggregate.	3.	To Determine the Impact Value of Coarse Aggregates.	CO1
LSO 4.0 Students will be able to judge the suitability of coarse aggregate as per finding out Flakiness Index and Elongation Index	4.	To determine the Flakiness Index and Elongation Index of Coarse Aggregates.	CO2
LSO 5.0 Determine the Los Angeles abrasion value for the given Coarse aggregate	5.	To determine the Los Angeles Abrasion Value of Coarse Aggregates.	CO2
LSO 6.0 Calculate the penetration value of given bitumen	6.	To determine the penetration Value of Bitumen.	CO3
LSO 7.0 Calculate the softening point of given bituminous material	7.	To determine the Softening Point of Bituminous material.	CO3
LSO 8.0 Carryout the Ductility test on bitumen to determine its value.	8.	To determine the Ductility Value of Bituminous material.	CO3

L) Suggested Term Work and Self-learning: S2415405 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/ Problems/ Numerical/ Exercises to be provided by the course teacher in line with the targeted COs.

1. Enlist the Role of Transportation
2. As an engineer in-charge work out the exact quantities of all the materials required for a proposed railway track of 1km.Assume the suitable data
3. Discuss the theories to explain probable causes of creep? What can be done to arrest creep?
4. Explain with sketches the various factors controlling the alignment of roads.
5. Discuss the special care to be taken while aligning hill roads.
6. Derive an expression for finding the stopping sight distance at level and at grades

b. Micro Projects:

1. Visit to Railway Track & Identify total Rail Infra Structure & prepare a PPT
2. Identify different types of Roads & Make a sketch showing all types of Roads
3. Automated Highway Systems
4. Study on Self Stabilizing Track
5. Factors leading to Road Re Alignment
6. Highway Failure & Their Maintenance
7. Traffic Monitoring System
8. Case study of environmental assessment of transportation services
9. Review and restructuring plan of old and outdated transportation planning
10. Applications of modern survey techniques like GIS, GPS, Remote sensing for better precision and speed in laying out geometric alignment of highway elements like horizontal and vertical curves, etc

c. Other Activities:

1. Seminar Topics:

   - Maintenance of Road/Highways
   - Railway Track Maintenance
   - Types of Roads
   - Types of Sleepers

2. Visits: Visit nearby Civil engineering office of Indian Railway to know to maintenance of existing railway track.

3. Self-learning topics:

   - Different type of Sleepers & their Advantages & Disadvantage.
   - Construction of different types of Roads according to uses & Climatic Condition

M) Suggested Course Evaluation Matrix: The Course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate CO attainment.

COs	Course Evaluation Matrix						
	Theory Assessment(TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Semester Test	End Theory Assessment (ETA)	Term Work & Self-Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	10%	15%	-	-	10%	20%
CO-2	25%	25%	25%	25%	25%	10%	20%
CO-3	20%	20%	25%	25%	25%	40%	20%
CO-4	20%	20%	15%	25%	25%	20%	20%
CO-5	20%	25%	20%	25%	25%	20%	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (Cl) Hours	Relevant COs Number (s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit 1.0 - Overview of Highway Engineering	04	CO1	08	2	2	4
Unit 2.0- Geometric Design of Highway	12	CO2	18	4	6	8
Unit 3.0 -Highway Material and Construction	12	CO3	16	4	6	6
Unit 4.0- Basics of Railway Engineering	10	CO4	14	4	4	6
Unit 5.0 - Track geometrics, Construction and Maintenance	10	CO5	14	4	6	6
Total	**48**	**-**	**70**	**20**	**18**	**32**

Note: Similar table can also be used to design class/ mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant Cos Number (s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Draw the sketch showing standard cross sections of Express ways, NH, SH, MDR, ODR.	CO1	40	50	10
2.	To Determine the Crushing Value of Coarse Aggregates.	CO3	40	50	10
3.	To Determine the Impact Value of Coarse Aggregates.	CO3	30	60	10
4.	To determine the Flakiness Index and Elongation Index of Coarse Aggregates.	CO3	30	60	10
5.	To determine the Los Angeles Abrasion Value of Coarse Aggregates.	CO3	30	60	10
6.	To determine the Penetration Value of Bitumen.	CO3	30	60	10
7.	To determine the Softening Point of Bituminous material.	CO3	30	60	10
8.	To determine the Ductility Value of Bituminous material.	CO3	40	50	10

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/ practical to assess the student performance.

P) Suggested Instructional/ Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/ outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Portfolio Based Learning, Role-Play, Live Demonstrations in Classrooms, Lab, Field, Information and Communications Technology (ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/ Practical Number
1.	Crushing Machine	The apparatus of the aggregate crushing value test as per IS: 2386 (Part IV) – 1963 consists of: a. A 15cm diameter open ended steel cylinder with plunger and base plate, of the general form and dimensions as shown in Fig 1. b. A straight metal tamping rod of circular cross-section 16mm diameter and 45 to 60 cm long, rounded at one end. c. A balance of capacity 3k, readable and accurate up to 1 g. d. IS Sieves of sizes 12.5,10 and 2.36 mm e. A compression testing machine capable of applying a load of 40 tones and which can be operated to give a uniform rate of loading so that the maximum load is reached in 10 minutes. The machine may be used with or without a spherical seating f. For measuring the sample, cylindrical metal measure of sufficient rigidity to retain its form under rough usage and of the following internal dimensions: Diameter 11.5cm Height 18.0cm	1, 2
2	Impact Testing Machine,	The apparatus of the aggregate impact value test as per IS: 2386 (Part IV) – 1963 consists of: a. A testing machine weighing 45 to 60 kg and having a metal base with a plane lower surface of not less than 30 cm in diameter. It is supported on level and plane concrete floor of minimum 45 cm thickness. The machine should also have provisions for fixing its base. b. A cylindrical steel cup of internal diameter 102 mm, depth 50 mm and minimum thickness 6.3 mm. c. A metal hammer p weighing 13.5 to 14.0 kg the lower end is cylindrical in shape, is 50 mm long, 100.0 mm in diameter, with a 2 mm chamfer at the lower edge and case hardened. The hammer should slide freely between vertical guides and be concentric with the cup. The free fall of the hammer should be within 380 ± 5 mm. d. A cylindrical metal measure having internal diameter of 75 mm and depth 50 mm for measuring aggregates. e. Tamping rod 10 mm in diameter and 230 mm long, rounded at one end. f. A balance of capacity not less than 500 g, readable and accurate up to 0.1 g.	3
3	Flakiness Index and Elongation Index of Coarse Aggregates.	The apparatus shall consist of the following: a. A balance – The balance shall be of sufficient capacity and sensitivity and shall have an accuracy of 0.1 percent of the weight of the test sample	4

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/ Practical Number
		b. Metal Gauge – The metal gauge shall be of the pattern as per thickness gauge c. Sieves – The sieves of sizes as shown in Table 6. Inside Diameter 70cm	
4	Los Angeles Abrasion Machine	The apparatus as per IS: 2386 (Part IV) – 1963 consists of: a. Los Angeles Machine: It consists of a hollow steel cylinder, closed at both the ends with an internal diameter of 700 mm and length 500 mm and capable of rotating about its horizontal axis. A removable steel shaft projecting radially 88 mm into cylinder and extending full length (i.e. 500 mm) is mounted firmly on the interior of cylinder. The shelf is placed at a distance 1250 mm minimum from the opening in the direction of rotation. b. Abrasive charge: Cast iron or steel balls, approximately 48 mm in diameter and each weighing between 390 to 445 g; 6 to 12 balls are required. c. Sieve: The 1.70 mm IS sieve d. Balance of capacity 5 kg or 10 kg e. Drying oven f. Miscellaneous like tray etc	5
5	Penetration Value of Bitumen -Penetrometer	a. Container: A flat bottomed cylindrical metallic dish 55 mm in diameter and 35 mm in depth is required. If the penetration is of the order of 225 or more deeper dish of 70 mm diameter and 45 mm depth is required. b. Needle: A straight, highly polished, cylindrical hard steel rod, as per standard dimensions c. Water bath: A water bath maintained at 25.0±0.10C containing not less than 10 litres of water, the sample being immersed to a depth not less than 100 mm from the top and supported on a perforated shelf not less than 50 mm from the bottom of the bath. d. Transfer dish or tray: It should provide support to the container and should not rock the container. It should be of such capacity as to completely immerse the container during the test. e. Penetration apparatus: It should be such that it will allow the needle to penetrate without much friction and is accurately calibrated to give results in one tenth of a mm f. Thermometer: Range 0- 440 C and readable up to 0.20C g. Time measuring device: With an accuracy ± 0.1 sec	6
6	Softening Point of Bituminous material- Ring and Ball Apparatus	a. Steel balls-two numbers each of 9.5 mm dia. and weighing 3.5 0.05g. b. Brass rings-two numbers each having depth of 6.4 mm. The inside diameter at bottom and top is 15.9 mm and 17.5 mm respectively. c. Ball guides to guide the movement of steel balls centrally. d. Support- that can hold rings in position and also allows for suspension of a thermometer. The distance between the bottom of the rings and the top surface of the bottom plate of the support is 25 mm. e. Thermometer that can read up to 100oC with an accuracy of 0.2degree C f. Bath- A heat resistant glass beaker not less than 85 mm in diameter and 1220 mm in depth. g. Stirrer.	7

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/ Practical Number
7	Ductility Value of Bituminous material- Ductility Testing Machine	a. Briquette mould: It is made up of brass. The circular holes are provided in the clips to grip the fixed and movable ends of the testing machine. The moulds when properly assemble form a briquette specimen of the following dimensions. Total length 75.0 ± 0.5 mm Distance between clips 30.0 ± 0.3 mm Width at mount of slip 20.0 ± 0.2 mm Width at minimum cross-section (half way between clips) 10.0 ± 0.1 mm Thickness throughout 10.0 ± 0.1 mm b. Water bath. A bath maintained within ±0.1oC of the specified test temperature, containing not less than 10 liters of water, the specimen being submerged to a depth of not less than 10 cms and supported on a perforated shelf and less than 5 cms. from the bottom of the bath. c. Testing machine. For pouring the briquette of bituminous material apart, any apparatus may be used which is so constructed that the specimen will be continuously submerged in water while the two clips are being pulled apart horizontally at a uniform speed of 50 ± 2.5 mm per minute.	8

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	A Text Book of Highway Engineering	SK Khanna & C.E.G. Justo	Nem Chand & Sons- ISBN-10 -8185240930 ISBN-13 978-8185240930
2.	Highway Engineering	L.R. Kadiyali	Khanna Book Publishing ISBN-10 9386173131 ISBN-13 978-9386173133
3	Railway Engineering	S C RANGWALA	Charotar Publishing House Pvt. Ltd. ISBN-10 : 9380358776 ISBN-13 : 978-9380358772
4.	HIGHWAY ENGINEERING	S C RANGWALA	Charotar Publishing House Pvt. Ltd. ISBN-10 : 9385039571 ISBN-13 : 978-9385039577
5.	Relevant IRC Code	IRC Code	IRC Code

(b) Online Educational Resources:

1. https://nptel.ac.in/courses/105101087
2. https://www.youtube.com/watch?v=5zKC_aq4ypM&list=PLE88643285BC70E0F
3. https://ts-nitk.vlabs.ac.in/List%20of%20experiments.html

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. Engineers Hand book
2. Practice and Design of Highway Engineering
3. Lab Manuals

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