GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-III

Course Title: Construction Material and Technology
(Course Code: 4330603)

Diploma programme in which this course is offered	Semester in which offered
Civil Engineering	Third

1. RATIONALE

In any Civil Engineering Project, material cost plays prime role in the total project cost. Therefore, selection of appropriate material is very much important. To suggest/ select appropriate material, first and for most necessary is to know materials' properties and characteristics. Moreover concepts, Principles and procedures are equally important to have a desired project life. Construction processes of sub structure, super structure and building finishes are core to the execution of any building. This course will enrich knowledge about materials and civil engineering techniques with the use of various construction equipments in to the students to make them competent performing their jobs with ease and confidence.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competencies:

- **To select appropriate building material supported by conceptual knowledge about building material.**
- **To develop awareness about latest/ green building materials.**
- **Implement civil engineering projects using state of the art technology in construction works following safety norms.**
- **Deploy appropriate construction machineries.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

a) Appreciate important properties of different building materials & function of various building components.
b) Select appropriate locally available brick/stone as per the requirement.
c) Select appropriate binding materials and /or concrete in building construction.
d) Deploy the ancillary material(s) such as Timber, Glass, PVC, paints, Varnish etc. as per the requirement.
e) Select the appropriate type(s) of foundation required for structure as per site/ soil condition.
f) Implement various construction activities like masonry, concreting, formwork, temporary structure, plastering, D.P.C, Anti termite treatment and Plumbing/ Electrical fittings etc using construction machinery, as per need.
g) Describe the importance of maintenance work and inculcate safety measures to be adopted in civil engineering activities.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T/2+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA*	ESE	CA	ESE	
3	-	2	4	30	70	25	25	150

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

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

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. *Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Conduct local market survey for common civil engineering materials to tabulate cost and quality.	I	Home* assignment
2	Perform tests on given sample of brick such as • Soundness • Water absorption • Compressive strength	II	06*
3	Conduct field test on given sample of brick and cement.	II, III	2
4	Perform lab tests on given sample of cement • Initial and final setting time • Compressive strength	III	4*
5	Perform test on given sample of fine aggregate. • Sieve analysis • Silt and clay content.	III	2*
6	Assess the quality of different types of timber and timber products (please arrange to visit nearby saw mill or timber mart).	IV	2
7	Identify components of building and /structures in the given model.	I	2
8	Draw foundation plan and mark layout on the ground for a building of Two room load bearing structure from the given line out plan.	V	2*
9	Draw foundation plan and mark layout on the ground for a building of Four room load bearing structure from the given line out plan.	V	4
10	Arrange the bricks to make $1\frac{1}{2}$ brick thick wall in English	VI	2*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
	and Flemish bond. (Minimum 3 Course)		
11	Prepare a visit report to the construction site where activities such as Excavation, Foundation, Masonry, Scaffolding, Formwork, Centering and Concreting are being executed considering standard safety procedure.	V, VI and VII	4*
12	Prepare a visit report to the construction site where activities such as Flooring, Plastering/ Pointing and Painting are being executed considering standard safety procedure.	VI	2*
13	Identify various components of staircase and doors and windows from the model.	VI	2*
14	Draw sketches for Foundations-Various types, Doors & Windows and timbering in Trenches in sketch book.	V, VI	4*
		Total	**28**

Note

*i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

*ii. The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency..*

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

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
	For PrOs 14	
1	Neatness, Cleanness on drawing sheet	10
2	Uniformity in Drawing and line work	10
3	Creating given drawing	40
4	Dimensioning the given drawing and writing text	20
5	Answer the question	10
6	Submission of drawing in time	10
	Total	**100**

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
	For PrOs 1, 8, 9, 11, 12	
1	Discipline	10
2	Involvement of construction at site	20
3	Data collection at site	20
4	Organization of report	20
5	Answer the question	10
6	Timely submission of report	20
	Total	**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practicals in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Bricks, Compressive strength testing machine, Oven, Digital Balance, tray.	02
2	Vicat apparatus conforming to IS : 5513-1976, Balance, Gauging Trowel, Digital Stop Watch.	04
3	Cube moulds- 7.06 cm size (9 no.s), Vibrating machine, Enamel trough, Measuring cylinder- 100 ml/ 200 ml capacity, Trowels, Nonporous plates, Weighing balance of accuracy 0.02 gm, Grease/ lubricating oil, compression testing machine.	04
4	I.S Sieve set (Sizes- 80 mm, 40 mm, 20 mm, 10 mm, 4.75 mm, 2.36 mm, 1.18 mm, 600 µ, 300 µ, 150 µ) sieve shaker with adaptors.	05
5	Experimental set up for silt and clay content for fine aggregates as per IS 2386-2 (1963)	05
6	Measuring Tape, Pegs, Arrows, Line dori, Lime powder, Hammer of standard size and specification as per civil engineering application.	8, 9
7	Brick, Line dori, Hammer of standard size, Level tube, Plumbs, Mason square.	10
8	Models: • Model of a civil engineering structure depicting various components. • Cut section of building showing different components • Types of Bonds in Brick masonry • Types of Door and Windows • Types of Stairs	07, 13, 14

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs and PrOs. More could be added to fulfill the development of this competency.

a) Work as a team member/ individual.
b) Follow ethical practices.
c) Follow safe practice on site.
d) Practice of environmental friendly methods and processes.

The ADOs are best developed through the laboratory/ field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

Only the major Underpinning Theory is formulated as higher level UOs of *Revised Bloom's taxonomy* in order development of the COs and competency is not missed out by the students and teachers. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit – I **Introduction**	1a.Describe important properties of building materials used in civil engineering construction. 1b.Classify the building on the basis of the occupancy and type of construction. 1c.Develop concept of components of building.	1.1 Physical, chemical and engineering properties of building materials. 1.2 Application of different building materials. 1.3 Alternative materials for the common items in building construction. 1.4 Introduction of various Civil Engineering structures. 1.5 Functions of various components of building and other structures.
Unit – II **Bricks, Rocks and Stone**	2a.Select appropriate brick products for different uses in building construction. 2b.Select appropriate rock/ stone products for different uses in building construction.	2.1 Classification of clay products 2.2 Types of bricks 2.3 Manufacturing process of bricks 2.4 Test on bricks. 2.5 Standard requirements and grades of bricks as per BIS. 2.6 Classification of rocks. 2.7 Rock products. 2.8 Characteristics of stones. - Structure, texture, strength, gravity, porosity, absorption, hardness, durability, weight etc. 2.9 Standard requirement of building stone. 2.10 Important stones used in construction with its suitability.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit– III **Binding Materials and Concrete**	3a. Appreciate the uses of lime and Pozzolana products in building construction. 3b. Select appropriate ingredients of proper quality for cement concrete as per required BIS codes. 3c. Get prepared different types of concrete and its type.	3.1 Sources and classification of Lime 3.2 Uses of lime with specific field situation 3.3 Types of pozzolanic materials 3.4 Advantages of addition of pozzolonic Material. 3.5 Types of cement with their specific use 3.6 Grade of cement as per BIS 3.7 Engineering properties of cement 3.8 Field and laboratory tests of cement as per BIS. 3.9 Methods of storing the cement. 3.10 Types of aggregate as per BIS 3.11 Requirements of aggregate as per BIS. 3.12 Engineering properties of aggregate 3.13 Test on aggregate 3.14 Ingredients of concrete. 3.15 Production of concrete, transportation, placing, compaction, curing. 3.16 Concrete in different situations viz. hot weather, cold weather, under water etc.
Unit– IV **Timber And Miscellaneous material**	4a. Describe timber and wood products and its uses in building construction. 4b. Explain different types of advanced building materials and their uses in construction.	4.1 Types of timber 4.2 Uses and application of timber 4.3 Defects in timber and wood 4.4 Seasoning, 4.5 Wood products with specific uses. 4.6 Plastics and PVC 4.7 Paints and Varnish 4.8 Materials for anti termite treatment 4.9 Glass and fiber. 4.10 Steel and iron materials 4.11 Ceramic products 4.12 Concrete blocks 4.13 Refractory
Unit– V **Sub structure**	5a. Know type of foundation and its suitability to different type of soil. 5b.Explain the failure of foundation and remedial measures.	5.1 Classification and types of foundations 5.2 Selection of the suitable type of foundation for required structure and as per situation 5.3 Foundations in black cotton soil,

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
		loose soils etc. 5.4 Timbering in trenches 5.5 Failures in foundation, Precautions & remedial measures.
Unit– VI **Building items, Building construction & machinery**	6a. Appreciate the different types of building items. 6b. Explain various construction activities like damp proof course (D.P.C) and anti termite treatment. 6c. Able to know the different types of plumbing and electric fittings and laying procedure. 6d. Develop concept of different types of brick and stone masonry. 6e. Explain construction procedure. 6f.Develop concept about various type of form work for Beam, Slab, Column.	6.1 Plastering & pointing- its purpose, 6.2 Various types, construction procedures, advantages and disadvantages, suitability of each. 6.3 Damp proof course (DPC), water proofing 6.4 Anti-termite measures and treatments 6.5 Construction joints- need and materials used. 6.6 Plumbing and electrification- various types of fittings and laying procedure. 6.7 Brick and stone masonry. 6.8 Selection of suitable type of masonry 6.9 Construction procedures. 6.10 Purpose & types of scaffolding and centering. 6.11 Suitability of scaffolding as per situations and type of structures. 6.12 Erection of centering for different component.
Unit-VII **Building maintenance & Safety measures**	6a. Describe concept about the maintenance work, know causes, types and its remedial measures 6b. Understand about the important laws/norms and act of safety. 6c. Explain precautions and precautionary measures of safety.	7.1 Purpose, need, importance, methods. 7.2 Causes and types of defects in buildings. 7.3 Preparation of report on maintenance work. 7.4 Remedial measures and execution 7.5 Procedure of any one type of building maintenance work. 7.6 Importance of various Laws/ Norms/ Regulations/ Acts for safety. 7.7 Safety equipment used in building construction and maintenance. 7.8 Precautions and precautionary Measures. 7.9 Post- accident procedures

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction	04	02	04	00	06
II	Bricks, Rocks and stone	07	03	05	04	12
III	Binding Materials and Concrete	07	03	06	06	15
IV	Timber And Miscellaneous material	05	02	03	04	09
V	Sub structure	04	02	02	04	08
VI	Building items, Building construction & machinery	09	03	05	06	14
VII	Building maintenance & Safety measures	06	02	02	02	06
Total		**42**	**17**	**27**	**26**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary slightly from above table.*

10. SUGGESTED STUDENT ACTIVITIES

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

a) Visit a nearby construction site and collect samples of material being used with justification.
b) Collect samples of alternative Green building material and prepare a report.
c) Visit a nearby building and identify its type, and its components.
d) Visit a nearby building and prepare a report on arrangements of horizontal, vertical movement & ventilation.
e) Visit a construction site where green building technologies are being implemented and prepare report.
f) Undertake micro-project.
g) Give seminar on any relevant topic.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4*** means different types of teaching methods that are to be employed by teachers to develop the outcomes.

d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Guide students on how to address issues on environment and sustainability.

12. SUGGESTED MICRO-PROJECTS

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

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

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) **Green Building material:** Prepare a report suggesting replacement of atleast 10 nos. of conventional building materials with Green building materials and justify it in terms of cost and environmental impact.
b) **Acoustic Material:** Prepare a report on application of acoustic materials and present with portfolio of sample materials.
c) **Refractory Material:** Prepare a report on application of refractory materials and present with portfolio of sample materials.
d) **Foundation:** Prepare a report on types of foundation (atleast 02) adopted in any near by building(s).
e) **Construction Technology:** Collect the information of latest technologies in building construction and prepare report on it.
f) **Maintenance:** Prepare a report on remedial measures that can be taken to repair the cracks in the nearby building.
g) **Miscellaneous material:** Carry out market survey for identifying various waterproofing materials and prepare a report including application procedure.
h) **Safety:** Prepare posters/ charts for the awareness of safety in various activates of civil engineering construction.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Construction Materials	D.N Goshe	Tata McGraw Hill, New Delhi.

S. No.	Title of Book	Author	Publication with place, year and ISBN
2	Civil Engineering Construction Materials	S.K Sharma	Khanna Publishing House, New Delhi.
3	Building Materials	P.C Varghese	PHI learning, New Delhi.
4	Engineering Materials	S.C Rangwala	Charotar Publisher, Ahmedabad.
5	Civil Engineering Materials	Somayaji, Shan	Pearson education, New Delhi.
6	Engineering Materials	R.K Rajput	S. Chand and Co. New Delhi.
7	Engineering Materials	C.P Sharma	PHI Learning, New Delhi.
8	Building Materials	S.K Duggal	New International, New Delhi.
9	Engineering Materials	Dr. Janardan Jha	Publisher. Khanna Publishers, Delhi
10	Building Construction	S. P. Arora and Bindra	Dhanpat Rai Publication, Delhi Edition 2013.1SBN: 9788189928803
11	Building construction illustrated	Francis D.K. Ching	Standard Publishers Distributors, Delhi
12	Building Construction	S. C. Rangawala	Charotar Publication, Dist-Anand (ISBN-13: 978-8185594859)
13	Building Construction	B. C. Punrnia and AK, Jain	Firewall Media, 2005 (ISBN 9788170080534)
14	Building Construction	S.K. Sharma	S. Chand and Co. Pvt. Ltd., New Delhi (ISBN:978-81-219-0479-7)
15	Building Construction	DrJanardan Zha	Khanna Publication, New Delhi 2007, ISBN —8174091106
16	Building Construction	S. S. Bhavikatti	Vikas Publication House Pvt. Ltd., New Delhi (ISBN: 978-93259-6079-41)
17	A to Z Building Construction	Sandip Marini	Satya Prakashan; New Delhi (2015) (ISBN-13: 978-8176849692)
18	PWD Handbooks for Materials, Masonry. Building, Plastering and Pointing-Foundation	All India Council for Technical Education	All India Council for Technical Education (AICTE)
19	Practical Civil Engineering Handbook	Khanna	Khanna Publication
20	National Building Code	BIS	Bureau of Indian Standard, New Delhi
21	BIS 962-1989 Code of Architectural and Building Drawing	BIS	Bureau of Indian Standard, New Delhi
22	BIS 1038- 1983 Steel Doors. Windows and Ventilators	BIS	Bureau of Indian Standard, New Delhi

14. SOFTWARE/LEARNING WEBSITES

a) www.nptel.iitm.ac.in

b) http://www.learningconstruction.comi
c) http://www.understandconstruction.corni
d) http://www.constructionknowledge.netiwww.learn-to–draw.com
e) https://www.khanacademy.org/
f) www.igbc.in
g) www.grihaindia.org

15. PO-COMPETENCY-CO MAPPING

Semester III	Construction Material and Technology (Course Code:4330603) POs and PSOs									
Competency & Course Outcomes	**PO 1 Basic & Discipline specific knowledge**	**PO 2 Problem Analysis**	**PO 3 Design/ development of solutions**	**PO 4 Engineering Tools, Experimentation &Testing**	**PO 5 Engineering practices for society, sustainability & environment**	**PO 6 Project Management**	**PO 7 Life-long learning**	**PSO 1**	**PSO 2**	**PSO 3** (If needed)
Competency	i. To select appropriate building material supported by conceptual knowledge about building material. ii. To develop awareness about latest/ green building materials. iii.Implement civil engineering projects using state of the art technology in construction works following safety norms. iv. Deploy appropriate construction machineries.									
Course Outcomes CO a) Appreciate important properties of different building materials & function of various building components .	3	-	-	-	-	-	2	-		
CO b) Select appropriate locally available brick/stone as per the requirement.	3	2	2	2	2	-	2			
CO c) Select appropriate binding materials and /or concrete in building construction..	3	2	2	3	2	-	2			
CO d) Deploy the ancillary material(s) such as Timber, Glass, PVC, paints, Varnish etc. as per the requirement.	2	-	-	-	2	-	1			
CO e) Select the appropriate type(s) of foundation required for structure as per site/ soil condition.	3	2	2	-	2	-	2			
CO f) Implement various construction activities like masonry, concreting, formwork, temporary structure, plastering, D.P.C, Anti termite treatment and Plumbing/ Electrical fittings etc using construction machinery, as per need.	3	-	-	-	2	2	2			
CO g) Describe the importance of maintenance work and inculcate safety measures to be adopted in civil engineering activities	3	-	-	-	2	-	-			

Legend: '**3**' for high, '**2**' for medium, '**1**' for low or '**-**' for the relevant correlation of each competency, CO, with PO/ PSO

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
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