GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Cement Technology
(Course Code: 4365204)

Diploma programme in which this course is offered	Semester in which offered
Ceramic Technology	Sixth

1. RATIONALE

A diploma ceramic engineer have to deal with manufacturing of Cement, they have to work with formulation, calculation of different compositions of cement and sintering process. Hence the course has been designed to develop these competencies and its associated with cognitive, practical and effective domain learning out comes. Cement technology is a subject that imparts Knowledge of the above mentioned topics. Hence the course has been design to develop these skills and its associated cognitive, practical and effective domain learning out comes.

2. COMPETENCY

The course should be taught and curriculum should implement with the aim to develop required skills so that students are able to acquire following competency leading to the achievement of the following competency:-

Plan and supervise process of manufacturing of Cement to achieve desired quality cement.

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). Analyze the role of raw materials and phases in cement.
b). Illustrate the manufacturing of cement by dry and wet methods.
c). Discuss the hydration process of various phases in cement and effects of additives.
d). Analyze & interpret the quality of cement by conducting various tests.
e). Select various types of cements based on requirements.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (CI+T/2+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
CI	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) that are the sub-components of the COs. *Some of* the PrOs marked '*' are compulsory*, as they are crucial for that particular CO. These PrOs need to be attained at least at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Determination of fineness of by sieve test.	IV	2
2	Determination of specific gravity of cement powder.	IV	2
3	Determination of normal consistency of cement.	III	2
4	Determination of initial setting time of OPC & White cement.	III	2
5	Determination of final setting time of OPC and White cement.	III	4
6	Determination of CCS of cement.	IV	2
7	Determination of tensile strength of OPC.	IV	2
8	Determination of soundness of OPC.	IV	2
9	Determination of CCS of OPC with curing	IV	6
10	Determination of CCS of cement + sand mix (with 1:6, 1:8 ratio) and curing	IV	6
	Minimum Practical Exercises required #		**28 hrs**

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 %
1	Prepare of experimental setup	20
2	Perform the practical	30

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
3	Follow safe practices measures	10
4	Record observations correctly	20
5	Interpret the result and conclude	20
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS AND SOFTWARE REQUIRED

These major equipment/instruments and Software required to develop PrOs are given below with broad specifications to facilitate procurement of them by the administrators/management of the institutes. This will ensure conduction of practical in all institutions across the state in proper way so that the desired skills are developed in students.

S. No.	Equipment Name with Broad Specifications	Pr.No.
1	Sieve shaker with sieve set	1
2	Picnometer	2
3	Vicat apparatus	3,4,5
4	Universal testing machine	6,7,9,10

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 leader/a team member.
b) Follow ethical practices.
c) Practice 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.

7. UNDERPINNING THEORY

The major Underpinning Theory is formulated as given below and only higher level UOs of *Revised Bloom's taxonomy* are mentioned for development of the COs and competency in the students by the teachers.(Higher level UOs automatically include lower level UOs in them). 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) (4 to 6 UOs at Application level)	Topics and Sub-topics
Unit – I **Introduction, Raw Material and Calculations**	1a. Explain the history of cement and its applications 1b.List different Raw Materials 1c. Explain the Batch calculations	1.1 Define Cement and explain the history of cement technology.. 1.2 Describe Lime, sources of lime, calcinations of limestone, slaking of lime, types of lime and its role in cement. Describe role of Silica, alumina,Iron oxide – their sources of each raw material in the manufacture of cement. 1.3 Calculation of Lime Saturation Factor (LSF), Alumina Modulus, Silica modulus and their importance. Describe various phases present in cement with their composition and role in cement.
Unit – II **Manufacturing process**	2a. Describe the Types of process. 2b. Explain the Burning of cement mixture. 2c. Describe Cooling. 2d. Describe Grinding of clinker.	2.1 Illustrate Dry Process, Wet Process and Semi-Dry Process of making cement with sequential flow diagram. Describe raw mill grinding, mixing and homogenization. Enumerate the advantages and limitations of different processes. 2.2 Describe Constructional aspects of rotary kiln (both wet & dry), types of Pre-calciners, Sketch Showing Cyclone Separators, Pre-heaters. Refractories used in each zone, construction of Burner pipe with sketch & fuel used. Importance of Shape of the Flame, Secondary Air & Coating formation. Discuss the reactions occurring in different Zones during firing. 2.3 Importance of cooling, illustrate various types of coolers like rotary, grate and planetary coolers. 2.4 Illustrate the clinker grinding in tube mill & ball mill; study the effect of temperature on gypsum during grinding of clinkers.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application level)	Topics and Sub-topics
Unit– III **Hydration**	3a. Describe the hydration & heat of hydration. 3b. Explain the Phases. 3c. Explain Setting time	3.1 Describe the hydration & heat of hydration of cement. various phases 3.2 C_2S, C_3S, C_3A Describe retarding and accelerating of setting time, types of set retarders and set accelerators with examples, Define flash set / quick set and false setting.
Unit– IV **Properties & Testing of Cement**	4a. Describe physical testing methods. 4b. Describe chemical testing methods	4.1 Illustrate physical testing methods: Normal consistency, Setting time – Initial and final setting time, Compressive strength, Soundness by Le-chatelier's and autoclave method and Fineness by Blains air permeability method. 4.2 Chemical Testing: Determination of various oxides in cement CaO, SiO_2, Al_2O_3, Fe_2O_3, MgO, SO_3, Insoluble residue and Loss on Ignition
Unit– V **Types of Cement and its applications.**	5a. List out Various Types of Cement and their uses.	5.1Generalise Ordinary Portland cement of different grades (33, 43 & 53) with technical data sheet. Describe Blended cement: Portland Pozzolona cement, Portland slag cement, advantages of blended cement. Describe White cement, Sulphate resisting cement, Oil well cement, Rapid hardening Cement, High alumina cement, Low heat cement, quick setting Cement, hydrophobic cement and IRS-T special grade Cement (53S cement). And its applications.

***Note**:TheUOs need to be formulated at the 'Application Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.*

8. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	**Introduction, Raw Material and Calculations**	10	4	6	4	14
II	**Manufacturing process**	8	3	7	4	14
III	**Hydration**	8	3	7	4	14
IV	**Properties & Testing of Cement**	8	4	4	6	14

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
V	**Types of Cement and it applications.**	8	4	4	6	14
Total		**42**	**18**	**28**	**24**	**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 from above table.*

9. 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 small reports (of 1 to 5 page for each activity). For micro project report should be as per suggested format, for other activities students and teachers together can decide the format of the report. Students should also collect/record physical evidences such as photographs/videos of the activities for their (student's) portfolio which will be useful for their placement interviews:

a) List the Cement manufacturing industries in India.
b) Undertake micro-projects in teams
c) Give seminar on any relevant topic.
d) List different uses of Cement.
e) List the raw materials used in cement manufacturing.

10. 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) ***'CI" 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 assessing during different assessment methods.
e) With respect to ***section No.11***, 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 using the knowledge of this course.
g) Guide students for using data manuals.

13. 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 is

group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, 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 work load on each students due to the micro-project should be about ***14 to 16(Fourteen to sixteen) student engagement hours*** (i.e. about one hour per week) during the course. The students ought to submit micro-project by the end of the semester (so that they develop the industry-oriented COs).

A suggestive list of micro-projects is given here. This should relate highly with competency of the course and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Prepare a report on ordinary Portland cement.
b) Prepare a report on Plant layout of cement manufacturing industry.
c) Prepare a report on raw materials used for manufacturing of cement.
d) Prepare a note on applications of cement.
e) Prepare a report on types of cement and their properties.
f) Collect different types of cements available in local market and make a report on it.

14. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Text book of Cement and Concretes	Lee	Butterworth-Heinemann Ltd ISBN-10-0340565896
2	Advances in Cement technology	S.N. Ghosh	ABI Books Pvt. Ltd., NewDelhi. ISBN-13-978-0080286709
3	Cement Engineer's Handbook	Von Otto Labahn,	Intl Public Service
4	Cement Production Technology	Anjan Kumar Chatterjee	CRC Press ISBN-10 -1138570664

15. SUGGESTED LEARNING WEBSITES

1. Advances in Cement Technology(1st Edition): Critical Reviews and Case Studies on Manufacturing, Quality Control, Optimization and Use
2. 2.Cement Production Technology(1st Edition):Principles and Practice

PO-COMPETENCY-CO MAPPING

Semester VI	Cement Technology **(Course Code:** 4365204**)**						
	POs						
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
Competency	**Plan and supervise process of manufacturing of Cement to achieve desired quality cement.**						
Course Outcomes CO a) Analyze the role of raw materials and phases in cement.	1	2	0	1	1	0	1
CO b) Illustrate the manufacturing of cement by dry and wet methods.	2	2	2	1	2	1	1
CO c) Discuss the hydration process of various phases in cement and effects of additives.	2	1	2	2	1	1	1
CO d) Analyze & interpret the quality of cement by conducting various tests.	2	1	2	3	1	1	1
CO e) Select various types of cements based on requirements.	1	2	2	1	1	1	1

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

17. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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