GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2022 (COGC-2022)
Semester-III

CourseTitle: Glass-1
(Course Code: 4335204)

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

1. RATIONALE

Diploma ceramic students have wide scope in glass industries. So they should familiar with Basic knowledge of Glass.Glass-1 subjects contain Definition, Batch preparation process, Melting process and forming process of glass articles. Glass-1 is essential foundation for next curriculum of Glass-2.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:
Plan for detail manufacturing of glass articles with safety.

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) Define glass, state properties and uses of glass.
b) Classify glass making oxides with their functions.
c) Identify suitable batch preparation process for glass.
d) Identify suitable furnace and manufacturing process for different glass articles.
e) Describe the suitable recycling method for glass waste.

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	-	4	5	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	Prepare list of different types of glass with their properties and examples.	I	4
2	Prepare list of various raw materials used in glass industry.	II	4
3	Identify effect of various oxides in glass melting process.	II	4
4	List out occurrences of glass making materials in India.	III	4
5	Perform grading, washing and drying of glass sand.	II	4
6	Perform Dry sieve analysis of Sand.	II	2
7	Perform wet sieve analysis of Sand.	II	4
8	Determine moisture content in raw materials	III	4
9	Examine iron content in given raw materials.	III	4
10	List out various machineries used in glass batch preparation.	III	4
11	Identify suitable methods for Handling and Mixing of Raw materials.	III	4
12	Perform melting of prepared glass batch.	IV	6
13	Draw glass pot furnace and tank furnace and explain functions of each part.	IV	4
14	Prepare list of heat saving devices used in glass industries.	IV	4
15	Identify suitable manufacturing methods for Jar, sheet glass, Tube, bulb, plate glass etc.	V	4
16	Prepare glass article by mouth blowing process.	V	6
17	Identify suitable methods to recycle broken glass.	VI	4
18	Visit glass industry and prepare report of all processes.	I to VI	6
	Minimum Practical Exercises required #		**56 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	20
3	Follow safe practices measures	10
4	Record observations correctly	20
5	Interpret the result and conclude	30
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	PrO.No.
1	Sieve shaker with sieve set	5,6,7
2	Digital weight balance	6,7,8,9,12
3	Bar magnet	9
4	Hot air oven	5,7,8
5	Glass Melting Furnace	15,16
6	Electric Raising Hearth furnace	12,15
7	Pastel and Mortar	11
8	Glass blowing equipment like blow pipe ,block, jacks, shears, paddles ,moulds ,benches ,yokes etc.	16

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.

8. 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	1a. Define glass. 1b. Able to explain Properties and use of glass. 1c. Able to explain various types of glass with examples.	1a. Definition of glass. 1b. General properties and uses of glass. 1c. Chemical composition of glass. 1d. Description in brief about different types of glass with examples.
Unit – II Raw materials	2a. Identify various raw materials used in glass industry. 2b. Classify glass making oxides with their functions. 2c. List out various Occurrences of glass making raw materials in India. 2d. Able to explain grading and washing of sand.	2.1. 1Details regarding various materials used in glass making 2.2. Classify glass making oxides with their functions. 2.3. Glass essential raw materials like forming oxides, fluxes, Oxidizing agent, Reducing agent, Refining agent, coloring and discoloring agent etc. 2.4. Occurrences of various glass making raw materials in India. 2.5. Grading and washing of sands used in glass making
Unit– III Batch Preparation	3a. Able to explain batch preparation process. 3b. Select various machineries used in Batch preparation. 3c. Select suitable processing methods for raw materials before batch making 3d. Able to explain handling and mixing process of raw materials.	3.1 Methods of batch preparation. 3.2 Description of machines used for batch preparation and mixing. 3.3 Processing of raw materials before batch making 3.4 Process of handling and mixing of raw materials.
Unit– IV Glass	4a. Select suitable furnace for glass melting.	4.1 Various types of furnaces used for glass melting.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application level)	Topics and Sub-topics
Furnaces	4b. Compare Regenerator and Recuperator. 4c. Sketch glass furnaces and show its various parts. 4d. Able to explain reaction occurs during melting of glass batch.	4.2 Construction and functions of pot furnace. 4.3 Construction and functions of Tank furnace. 4.4 Construction and functions of regenerator and Recuperator. 4.5 Description regarding various parts of glass melting furnaces. 4.6 Details description regarding melting process of glass batches.
Unit– V Manufacturing process of Glass articles	5a.Select suitable manufacturing process for Hollow ware. 5b. Select suitable manufacturing process for sheet glass. 5c. Select suitable manufacturing process for scientific glass articles. 5d Select suitable manufacturing process for container glass article.	5.1 Manufacturing hollow ware articles by Mouth blowing process, semi automatic process or automatic process. 5.2 Manufacturing process of sheet glass and plate glass. 5.3 Manufacturing scientific glass apparatus by blowing process. 5.4 Manufacturing process of container glass article.
Unit– V Recycling of Industrial Wastes	6a. Justify the need of understanding recycling of industrial waste like Cullet. 6b Relate sustainability and recycling of industrial waste. 6c Suggest methods for recycling cullet with examples.	6.1Concept of recycling waste. 6.2Sustainability and recycling 6.3 Methods to recycle Glass waste.

***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.*

10. 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	4	2	4	4	10
II	Raw Materials	9	4	7	7	18
III	Batch Preparation	8	2	4	4	10

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
IV	Glass Furnaces	9	2	7	6	15
V	Manufacturing process of glass article	9	2	5	5	12
VI	Recycling of industrial waste	03	1	2	2	5
Total		**42**	**13**	**29**	**28**	**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.*

11. 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) Prepare list of some glass articles.
b) Undertake micro-projects in teams
c) Give seminar on any relevant topic.
d) Undertake a market survey for glass article.
e) Prepare showcase portfolios.
f) Prepare charts containing details of various raw materials.

12. 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) **Glass industries in India**: Identify the different glass industries located in different parts of India and prepare the report. (**Duration: 8-10 hours**)
b) **Raw materials:** prepare a chart or report of glass raw materials with formula and Collect different types of glass raw material samples from local industries.
c) **Glass Melting Furnaces:** prepare charts of glass melting furnaces and show its parts.
d) **Glass manufacturing process**: prepare charts of different glass manufacturing processes.

14. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Glass Engineering Hand Book	E.B.Shand	McGraw-Hill book co
2	Glass manufactures Vol. I & Vol. II	F.V.Tooley	New York, N.Y., Ashlee Pub. Co.,
3	Modern Glass Practice	Samuel R. Schole	Boston : Cahners Books, [1975]

15. SUGGESTED LEARNING WEBSITES

a) https://gharpedia.com/blog/raw-materials-used-in-glass-manufacturing-process
b) https://en.wikipedia.org/wiki/Glass
c) https://www.britannica.com/topic/glass-properties-composition-and-industrial-production-234890/Properties-of-glass
d) **https://mechanicalland.com/explanation-of-glass-shaping-operations-and-product-types**
e) **https://www.engineeringenotes.com/engineering/glass/how-to-manufacture-glass-glass-manufacturing-process/46790**
f) **https://www.believersinglass.com/GlassMaking.php#**

16. PO-COMPETENCY-CO MAPPING

Semester II	Glass-1 (Course Code: 4335204)								
	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
Competency Plan for detail manufacturing of glass articles with safety.	3	1	2	2	2	2	2	2	2
Course Outcomes CO a) Define with state properties and use of glass.	3	1	1	1	1	-	1	1	1
CO b) Classify glass making oxides with their function.	3	1	2	1	1	1	2	2	2
CO c) Identify suitable batch preparation process for glass.	3	2	2	2	2	2	2	2	2
CO d) Identify suitable furnace and manufacturing process for different glass articles.	3	1	2	2	2	2	2	2	2
CO e) Describe the suitable recycling method for glass waste.	2	1	1	2	3	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

15. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
1	Mr. B B Patel (I/C HOD)	L E College(poly) Morbi.	8160590472	bharat.lecollege@gmail.com
2	Mr. Murali N (Lecturer)	L E College(poly) Morbi	9714464688	mceramic44@gmail.com