GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Vitreous Enamel
(Course Code: 4335202)

Diploma programmer in which this course is offered	Semester in which offered
Ceramic Technology	THIRD

1. RATIONALE

A ceramic engineer has to use vitreous enamel in coating metallic surface. For the purpose s/he should be informed about raw materials, preparation of metal surface for enameling, batch calculation, processing and application of enamel. Hence the course has been design to develop these competencies and its associated cognitive, practical and effective domain learning out comes.

2. COMPETENCY

The course should be taught and curriculum should be implemented with the aim to develop different types of skills so that students are able to acquire following competency leading to the achievement of the following competencies.

Plan and supervise application of vitreous enamel on metallic surfaces.

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) Distinguish various types of enamel.
b) Define enamels and its properties.
c) Explain uses of different types of enamel products.
d) Prepare enamel batch composition.
e) Distinguish various defects in enamel bodies.
f) Define various tests required for enamels.

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	0	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: CI**-Class Room Instructions; **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	Identify various Raw materials used in enamel	II	2
2	Clean a given metal surface for enameling	III	2
3	Prepare frit for enamel making.	IV	4
4	Prepare ground coat enamel	IV	4
5	Prepare cover coat enamel	V	4
6	Apply enamel on given metal surface	V	2
7	Prepare color enamel of given composition.	V	4
8	Apply color enamels on given ware.	V	2
9	Identify various defects occur in enameled wares with their remedies	VI	2
10	Identify various properties of enameled wares	VII	2
11	Visit frit industry and prepare report of all processes.	IV	6
	Minimum Practical Exercises required #		**28hrs**

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	10
2	Perform the practical	30
3	Follow safe practices measures	10
4	Record observations correctly	20

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
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	4,5,7
2	Digital weight balance	3,4,5,7
3	Pot mill	4,5,7
4	Hot air oven	3,4,5
5	Muffle Furnace	3,2,6,8
6	Spray gun	6,8

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 includes 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 Types of Enamel	1a. Define enameling 1b. choose utility of enamels on metal surface. 1c. List out types of enamel. 1d. Differentiate the various types of enamels	1.1 Definition of enamels. 1.2 Utility of enamels with special reference to enamels on metals. 1.3 Types of enamel
Unit – II Raw-Materials	2a. Able to explain various raw materials used for enamel. 2b. Classify the various raw materials and additives of enamels.	2.1 Various raw materials used for enamel. 2.2 Classification of enamel making raw materials such as, Refractory materials, Fluxes, Colors, Opacifiers, Floating agents, Electrolytes Milling of enamel raw materials
Unit – III Preparation of Metal Surface for Enamelling	3a. Select suitable cleaning method for metal surface.	3.1 Various methods adopted for cleaning metal surfaces such as annealing scaling, chemical pickling, and electrolytic cleaning. 3.2 Neutralization
Unit – IV Batch Composition and Calculation	4a. Able to write Empirical formula and chemical composition. 4b. Calculate Ground coat. 4c. Prepare frit.	4.1 The chemical composition and empirical formula of enamel. 4.2 Methods of calculation of ground coats and covered coats. 4.3 Frits, Necessity and Process of frit making.
Unit –V Process for Enamelling	5a. Distinguish various coating process of enamels 5b. Able to explain enamel slip controlling parameter. 5c. Apply various coats. 5d. select suitable drying process for enamel coats.	5.1 Dry process coating of enamels and Wet process coating of enamels 5.2 Control of enamel slip 5.3 Methods of application of ground coats and cover coats 5.4 Drying of enamel coats
Unit –VI	6a. List out the types of furnaces	6.1 The types of furnaces used in

Firing of Enamel Coats	used in enameling. 6b. Suggest solution for defects arise during firing of enamel coats	enameling. 6.2 The defects during firing of enamel coats and their remedies.
Unit –VII Properties and Tests of Enamel	7a. Able to explain various properties of enamel. 7b. Conduct various test for enamel coats.	7.1 Thermal properties of enamel. 7.2 Thermal expansion and contraction of enamels 7.3 Thermal shock tests 7.4 Thermal conductivity 7.5 Adherence, hardness, elasticity, compressive strength, abrasion.

***Note**: The UOs 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.*

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	3	5	0	0	5
II	Raw-materials	6	3	4	3	10
III	Preparation of metal surface for enameling	6	2	4	4	10
IV	Batch composition and calculation	8	3	6	6	15
V	Process for enameling	6	2	3	5	10
VI	Firing of enamel coats	6	2	4	4	10
VII	Properties and tests of enamel	7	3	3	4	10
Total		**42**	**20**	**24**	**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 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 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) Collect some YouTube videos related to topics.
b) Give seminar on any relevant topic.
c) Prepare chart on different raw materials of enamels.
d) Collect samples of various enamel products.
e) Search internet to collect different applications of enamel products.
f) Prepare any kind of enamel batch.

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) ***'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 assessed using 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.

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 (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 ***16 (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) Collect different types of Enamels samples.
b) Collect different types of frit.
c) Explain the different application of enamel.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Vitreous Enameling	K.A.Maskall	Pergamon Pr ISBN : 978-0080334288
2	The Art of Fine Enameling	Karen L. Cohen	Stackpole Books ISBN : 978-0811737920
3	Metalwork and Enameling	Herbert Maryon	Hassell Street Press ISBN: 978-1015218093
4	Enamelling on Copper	Pat Johnson	The Crowood Press Ltd ISBN : 978-1785002328

14. SUGGESTED LEARNING WEBSITES

a) https://en.wikipedia.org/wiki/Vitreous_enamel
b) https://www.vea.org.uk/what-is-enamel/
c) https://www.thecrucible.org/guides/enameling-6/vitreous/
d) https://www.vitrex.co.za/ve_applications.html
e) https://www.wgball.co.uk/vitreous-enamel/
f) https://www.ajwells.com/services/vitreous-enamel/

.

15. PO-COMPETENCY-CO MAPPING

Semester III	VITREOUS ENAMEL (Course Code: 4335202)								
	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 and supervise application of vitreous enamel on metallic surfaces.	2	1	1	1	1	0	3	2	2
Course Outcomes CO a) Distinguish various types of enamel.	2	1	1	1	1	0	2	2	1
CO b) Define enamels and its properties.	2	1	1	1	1	0	2	2	1

CO c) Explain uses of different types of enamel products.	3	1	1	1	1	1	2	2	2
CO d) Prepare enamel batch composition.	2	2	2	1	1	1	0	1	2
CO e) Distinguish various defects in enamel bodies.	2	2	1	1	1	1	0	2	1
CO f) Define various tests required for enamels.	2	1	2	2	0	0	0	2	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
1	Ashita S. Pareek (Lecturer)	**L.E.College,Morbi**	**9887087525**	**ashita3112@gmail.com**
2	Jyothi H.Koti (Lecturer)	**L.E.College,Morbi**	**7359664653**	**Jyothikoti.lec@gmail.com**