

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

**COURSE CURRICULUM
COURSE TITLE: VITREOUS ENAMEL
(Code: 3345203)**

Diploma Programme in which this course is offered	Semester in which offered
Ceramic Technology	4 th semester

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 enamelling, 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 OUTCOME

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

- Differentiate the various types of enamels
- Select raw materials for different enamels
- Process for application of enamels

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
			C	ESE	PA	ESE	PA	
3	0	2	5	70	30	20	30	150

Legends: L - Lecture; T - Tutorial/Teacher Guided Student Activity; P - Practical; C - Credit; ESE - End Semester Examination; PA - Progressive Assessment

5. COURSE DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Types of Enamel	1a. Define enameling 1b. Describe 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. List out various raw materials used for enamel. 2b. Classify the various raw materials and additives of enamels. 2c. Select raw materials for different 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. Describe various cleaning process. 3b. Explain neutralization.	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. State Empirical formula and chemical composition. 4b. Calculate Ground coat. 4c. Explain process of fritting.	4.1 The chemical composition and empirical formula of enamel. 4.2 Methods of calculation of ground coats and covered coats. 4.3 Frit and frit making, necessity and process of frit making.
Unit –V Process for Enamelling	5a. Distinguish various process of enamels 5b. Explain control enamel slip. 5c. Apply various coats. 5d. Identify equipment used for enameling. 5e. Describe drying process for enamel coats.	5.1 Dry process enamels and Wet process enamels 5.2 Control of enamel slip 5.3 Methods of application of ground coats and cover coats 5.4 Equipment's used for the purpose 5.5 Drying of enamel coats
Unit –VI Firing of Enamel Coats	6a. List out the types of furnaces used in enameling. 6b. Describe furnace atmosphere for firing enamel coats. . 6c. Explain maintaining the furnace temperature for firing enamel coats.. 6d. List the defects during firing of enamel coats 6e. List the steps to remove defects during firing of enamel coats.	6.1 The types of furnaces used in enameling. 6.2 The effect of furnace atmosphere on enamel coats. 6.3 Maintenance of temperature for firing enamel coats. 6.4 The defects during firing of enamel coats and their remedies.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit –VII Properties and Tests of Enamel	7a. Describe 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 Optical properties of enamel such as gloss, color etc. a. Adherence, hardness, elasticity, compressive strength, abrasion b. Chemical properties and tests

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	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 enamelling	6	2	4	4	10
IV	Batch composition and calculation	8	3	6	6	15
V	Process for enamelling	6	2	3	5	10
VI	Firing of enamel coats	7	2	4	4	10
VII	Properties and tests of enamel	6	3	3	4	10
Total Hrs		42	20	24	26	70

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

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills (**outcomes in psychomotor and affective domain**) so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

Note: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes** (as given in a common list at the beginning of curriculum document for this programme) would be assured.

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical/Exercise (Outcomes in Psychomotor Domain)	Hours
1	II	Identify various Raw materials used in enamel	2
2	III	Clean a given metal surface for enamelling	2
3	IV	Prepare frit for enamel making.	4
4	IV	Prepare ground coat enamel	4
5	V	Prepare cover coat enamel	4
6	V	Apply enamel on given metal surface	2
7	V	Prepare colour enamel of given composition.	4
8	V	Apply colour enamels on given ware.	2
9	VI	Identify various defects occur in enamelled wares with their remedies	2
10	VII	Identify various properties of enamelled wares	2
Total			28

8. SUGGESTED LIST OF STUDENT ACTIVITIES

- i. Library survey to study about vitreous enamel.
- ii. Industrial visit to observe enamelling operation on metal surface.
- iii. Collect different enamel ware sample for study.
- iv. Net surfing to collect data related to enamel.

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

Show video films/animations/photographs for enameling process and enameling defects.

10. SUGGESTED LEARNING RESOURCES

A. List of Books

S. No.	Title of Books	Author	Publication
1	Porcelain Enamels	A. I. Andrews	Pavillion IV Books (Shepherdstown, WV, U.S.A.
2	Advances in Porcelain Enamel Technology	Charles Baldwin	Wiley-American Ceramic Society
3	Porcelain (vitreous) enamels And Industrial Enamelling Processes	Silvano Pagliuca (Italy) William D. Faust (USA	International enamellers Institute Via v. Lancetti, 43 – 20158 milano - Italy

B. List of Major Equipment/Materials

- i. Required raw materials and additives, dilute acid, Brush
- ii. Digital weighing balance, pans, refractory crucible
- iii. Lab type sieve shaker machine with sieve, Pot mill, mixer, stirrer, agate mortar
- iv. Lab type oven, Muffle furnace, frit making furnace
- v. Different enamel defected wares

C List of Software/Learning Websites

- i. http://en.wikipedia.org/wiki/Vitreous_enamel
- ii. <http://www.vea.org.uk/what-is-enamel>
- iii. http://www.hytechenamellers.co.uk/vitreous_enamel.php
- iv. <http://www.iei-world.org/pagine/enamel03.asp>

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE**Faculty Members from Polytechnics**

- **Prof. B.B.Patel**, Lecturer L.E.College, Morbi
- **Prof. H.B.Dedania**, Retired Lecturer L.E.College, Morbi
- **Prof.S.Prasaad**, Retired Lecturer L.E.College, Morbi

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. Abhilash Thakur**, Associate Professor, Department of Applied Sciences
- **Dr. Bashirullah Shaikh**, Assistant Professor, Department of Applied Sciences