GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Quality Control
(Course Code: 4365201)

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

1. RATIONALE

Quality control is a crucial process in various industries and sectors, designed to ensure that products or services meet specified quality standards and criteria. It involves monitoring and evaluating the characteristics, performance, and attributes of a product or service throughout its production or delivery process. Diploma Ceramic engineer have to deal with the Processing of raw materials, Manufacturing process, raw materials testing, quality control of green articles, testing of finished products etc. Quality control 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:-

Apply quality control techniques on raw materials and finished products.

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 Quality control and Quality assurance with examples.
b) Select suitable parameters to control quality of raw materials.
c) Select required parameters to control quality during mixing, forming and drying process.
d) Select required parameters to control quality during glazing and firing process.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)	Total Credits (CI+T/2+P/2)	Examination Scheme		
		Theory Marks	Practical Marks	Total

CI	T	P	C	CA	ESE	CA	ESE	Marks
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 particle size distribution by sieve analysis of ceramic raw materials.	II	4
2	Determination of plasticity of clay.	II	4
3	Determination of moisture content of ceramic raw materials.	II&III	4
4	Determination of the density of ceramic product sample.	VI	6
5	Determination of the viscosity of casting slip.	III	6
6	Determination of drying shrinkage of given sample.	IV	6
7	Determination of Green strength of ceramic sample.	IV	6
8	Determination of glaze fluidity.	V	6
9	Determination of thermal shock resistance of ceramic sample.	VI	4
10	Determination of fired strength of ceramic sample.	VI	6
11	Determination of water absorption of ceramic wares.	VI	6
12	Determination of modulus of rupture of ceramic sample.	VI	4
13	Determine Cold Crushing Strength of a given ceramic sample.	VI	4
14	Perform Coating of ceramic article by glazing process.	V	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
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	Pot mill,B4 cone	5,6,7
3	Digital weighing balance	1,4,6,7,11
4	Universal testing machine	7,10,12,13
5	Autoclave testing machine	11,
6	Water Bath with capacity (0 to 200 centigrade temp.)	9
7	Dryer and Muffle furnace	1,3,7,8,11
8	Spray gun for coating glaze and enamel	14
9	Portable air compressed unite	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 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	1a. Define about quality control and quality assurance.	1.1 Define quality control and quality assurance with examples. 1.2 Theory of sampling for testing specimen.
Unit – II Raw Materials Inspection	2a. Identify various parameters to check quality of raw materials.	2.1. Chemical composition 2.2. Particle size distribution 2.3. Moisture content 2.4. Impurities and contaminations 2.5. Consistency and Homogeneity 2.6. Purity and Quality standard 2.7. Packaging and Transportation 2.8. Documentation and Record keeping 2.9. Sample Techniques 2.10. Supplier Relationship
Unit– III Mixing and forming process	3a. Select required parameters to control quality during mixing process. 3b. Select required parameters to control quality during forming process.	3.1 Batch consistency 3.2 Uniform distribution 3.3 Moisture control 3.4 Mixing time and speed 3.5 Die and Mould Inspection 3.6 Pressure and Temperature control 3.7 De-airing process 3.8 Visual Inspection 3.9 Quality of formed products 3.10 Employee training
Unit– IV Drying process	4a. Select required parameters to control quality during drying process.	4.1 Moisture content control 4.2 Drying environment 4.3 Drying time 4.4 Drying racks and Shelves

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application level)	Topics and Sub-topics
		4.5 Ventilation 4.6 Visual Inspection 4.7 Temperature monitoring 4.8 Humidity control 4.9 Employee training
Unit– V Glazing process	5a. Select required parameters to control quality during glazing process.	5.1. Glaze material Inspection 5.2. Batch consistency 5.3. Application Thickness 5.4. Uniformity check 5.5. Drying time and conditions 5.6. Glaze composition testing 5.7. Adherence to safety standards 5.8. Colour evaluation 5.9. Surface Inspection
Unit– VI Firing process	6a. Select required parameters to control quality during firing process.	6.1. Kiln Inspection 6.2. Loading and Unloading 6.3. Firing schedule 6.4. Temperature monitoring 6.5. Uniformity check 6.6. Ventilation 6.7. Cooling process 6.8. Visual inspection 6.9. Dimension checks 6.10. Dimensional stability 6.11. Kiln furniture inspection 6.12. Density and Porosity testing 6.13. Crazing and shivering evaluation

***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	2	2	2	0	4
II	Raw Materials Inspection	9	2	4	7	13
III	Mixing and forming process	8	2	3	8	13
IV	Drying process	8	2	4	8	14
V	Glazing process	7	2	4	6	12
VI	Firing process	8	2	4	8	14

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
Total		**42**	**12**	**21**	**37**	**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) Prepare list of ceramic articles with their utilization.
b) Undertake micro-projects in teams
c) Give seminar on any relevant topic.
d) Undertake a market survey regarding advance machinery available for quality control in ceramic industries.
e) Identify various quality control techniques used by local industries.
f) Prepare list of Quality control techniques follow by various countries.

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) Collect information regarding quality control techniques used in Tile industries and prepare a report.
b) Collect information regarding quality control techniques used in sanitary ware industries and prepare a report.
c) Collect information regarding quality control techniques used in Refractory industries and prepare a report.
d) Collect information regarding quality control techniques used in Insulator industries and prepare a report.
e) Collect information regarding quality control techniques used in glass industries and prepare a report.

14. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Industrial Ceramics	Felix Singer , Sonja S. Singer	Springer Dordrecht 978-94-017-5257-2
2	Fine ceramics	F.H.Norton	Ohmsha, 1988 with ISBN 10: 0444011935 ISBN 13: 9780444011930.
3	Principles of Ceramic Processing	James.S Reed	John Wiley & Sons with **ISBN 13** 9780471597216
4	Properties of Ceramic Raw Materials	W.RYAN	1978 Elsevier Ltd with ISBN no. 978-0-08-022113-7

15. SUGGESTED LEARNING WEBSITES

a) https://www.qualicer.org/recopilatorio/ponencias/pdfs/9813071e.pdf
b) https://www.researchgate.net/publication/325498738_Quality_control_in_porcelain_industry_based_on_computer_vision_techniques
c) https://www.ceramicindustry.com/articles/88882-quality-control
d) https://www.lucideon.com/consultancy/process-optimisation/ceramics-manufacturing-process-optimisation

PO-COMPETENCY-CO MAPPING

Semester V	**Applied Ceramic (Course Code:** 4355201**)**						
	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	**Apply quality control techniques on raw materials and finished products.**						
Course Outcomes CO a) Define Quality control and Quality assurance with examples.	1	2	0	0	0	0	1
CO b) Select suitable parameters to control quality of raw materials.	2	1	2	2	1	1	1
CO c) Select required parameters to control quality during mixing, forming and drying process	2	1	2	2	1	1	1
CO d) Select required parameters to control quality during glazing and firing process.	2	1	2	2	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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