# GUJARAT TECHNOLOGICAL UNIVERSITY

**Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)**

**Diploma Engineering Syllabus (Semester VII)**

**Subject Code : 4372303**

**Subject Name : Plastic Testing and Quality Management**

| Diploma Programme in which this course is offered | Semester in which offered |
|---|---|
| Plastics Engineering (Sandwich Pattern) | Seventh |

## 1. RATIONALE

Plastics being widely used in diversified applications, it is necessary to test the material properties before deciding to use them for each application. By testing of plastics, the product design and the area of application can be explored. Diploma Plastic engineer has to deals with the production of various types of plastics as a responsible technician and first line supervisor in the industries. Hence, the course has been design to develop these competencies and its associated cognitive, practical and effective domain learning out comes. This course also aims to create awareness about quality control and quality management methods.

## 2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- Test plastics, analysis various properties and maintain quality of production using SQC and SPC techniques.
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## 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:

- Identify factors affecting the tests.
- Perform various mechanical tests.
- Interpret thermal properties.
- Measure electrical and optical properties.
- Observe rheological and weather tests.
- Use SQC and SPC techniques for quality control.
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## 4. TEACHING AND EXAMINATION SCHEME

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

| Sr. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. required |
|---|---|---|---|
| 1 | Measure the tensile strength of a given plastic. | 2 | 02 |
| 2 | Measure the flexural strength of a given plastic. | 2 | 02 |
| 3 | Measure the impact strength of a given plastic. | 2 | 02 |
| 4 | Measure the hardness of a given plastic. | 2 | 02 |
| 5 | Measure the HDT of a given plastic. | 3 | 02 |
| 6 | Measure the VST of a given plastic. | 3 | 02 |
| 7 | Measure the Dielectric strength of a given plastic. | 4 | 02 |
| 8 | Measure the ESCR of a given plastic. | 4 | 02 |
| 9 | Measure the Melt Flow Index of a given plastic. | 5 | 02 |
| 10 | Measure the Oxygen Index of a given plastic | 5 | 02 |
| 11 | Measure the Specific Gravity. | 5 | 02 |
| 12 | Interpret process control charts. (for two different cases) | 6 | 04 |
| 13 | Interpret given test data and take decisions based on SQC techniques | 6 | 02 |
| | **Total** | | **28** |

***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 | Operate the equipment setup or circuit | 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 REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practicals in all institutions across the state.

| S. No. | Equipment Name with Broad Specifications | PrO. No. |
|---|---|---|
| 1 | Universal Testing Machine | 1 |
| 2 | Rockwell Hardness Tester | 4 |
| 3 | Abrasion tester | 2 |
| 4 | Dielectric strength and constant tester | 7 |
| 5 | HDT cum VST tester | 6 |
| 6 | MFI tester | 9 |
| 7 | Viscometer | 5 |
| 8 | Refractometer | 4 |
| 9 | Oxygen Index tester | 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 fulfil the development of this competency.

a) Work as a leader/a team member.
b) Follow ethical practices.
c) Practice environmental friendly methods and processes to avoid metal waste.

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

Only the major Underpinning Theory is formulated as higher level UOs of *Revised Bloom's taxonomy* in order development of the COs and competency is not missed out by the students and teachers. 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 and above level) | *Topics and Sub-topics* |
|---|---|---|
| **Unit – I Introduction** | 2a. Define testing<br>2b. List out the standards<br>2c. List out the purpose of specifications<br>2d. List out the organizations for standards and quality<br>2e. Explain conditioning procedure | 2.1 Definition<br>2.2 Reasons for testing<br>2.3 Purpose of standard & specification<br>2.4 various organization dealing with standards and quality<br>2.5 Conditioning of samples |

| *Unit* | *Unit Outcomes (UOs)* (4 to 6 UOs at Application and above level) | *Topics and Sub-topics* |
|---|---|---|
| **Unit – II Mechanical Properties** | 2a. Operate various Testing equipments.<br>2b. Determine/calculate strength of plastic materials.<br>2c. Compare materials | 2.1 Tensile strength test<br>2.2 Stress-Strain curve<br>2.3 Creep & stress relaxation<br>2.4 Flexural strength test<br>2.5 Impact strength test<br>• Izod impact<br>• Dart impact test<br>2.6 Hardness & Abrasion resistance |
| **Unit –III Thermal Properties** | 3a. Perform the standard test procedures<br>3b. Interpret test results.<br>3c. Classify the material. | 3.1 Determination of Heat Deflection Temperature (HDT)<br>3.2 Determination of Vicat Softening Temperature (VST)<br>3.3 Thermal expansion test |
| **Unit – IV Electrical and Optical Properties** | 4a. Measure electric properties<br>4b. Classify materials based on electrical properties<br>4c. Apply optical properties in selection of material | 4.1 Die electric strength<br>4.2 Die electric constant<br>4.3 Arc resistance<br>4.4 Definition of volume resistance and surface resistance<br>4.5 Refractive index<br>4.6 Definition of haze, gloss, light transmission, clarity |
| **Unit – V Miscellaneous Tests** | 5a. Understand flow behaviour of plastics<br>5b. Identify flow behaviour of thermosets.<br>5c. Perform ESCR test.<br>5d. Identify the flame resistance.<br>5e. Measure the density of material.<br>5f. Measure the weather resistance of the material.<br>5g. Differentiate between conventional and non destructive testing | 5.1 Melt flow index<br>5.2 Cup flow test and Spiral flow test<br>5.3 Environmental Stress Cracking Resistance<br>5.4 Oxygen index test<br>5.5 Specific gravity test<br>5.6 Outdoor and accelerated weather resistance tests.<br>5.7 Non-destructive test -Ultrasonic testing |

| *Unit* | *Unit Outcomes (UOs)* (4 to 6 UOs at Application and above level) | *Topics and Sub-topics* |
|---|---|---|
| **Unit - VI Failure Analysis and Quality Control** | 6a. Classify failures<br>6b. Analyse failures<br>6c. Explain meaning and purpose of quality control<br>6d. Explain SPC and SQC procedures. | 6.1 Types of failures<br>6.2 Failure Analysis techniques<br>6.3 Importance of quality control<br>6.4 Statistical Quality Control(SQC) 6.5 Quality assurance manual<br>6.5 Statistical Process Control (SPC) |

***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 |
| 1 | Introduction | 03 | 03 | 03 | 00 | 06 |
| 2 | Mechanical Properties | 10 | 04 | 03 | 09 | 16 |
| 3 | Thermal Properties | 03 | 02 | 02 | 02 | 06 |
| 4 | Electrical and Optical Properties | 08 | 03 | 03 | 06 | 12 |
| 5 | Miscellaneous Tests | 08 | 03 | 03 | 08 | 14 |
| 6 | Failure Analysis and Quality Control | 10 | 04 | 08 | 04 | 16 |
| **Total** | | **42** | **19** | **22** | **29** | **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 slightly 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 reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

1. Study the test results of various tests on different samples and find out the reasons for variation in results (beyond expectation variation if any) and try to find out the reasons for these variations.
2. Study the SQC and SPC procedures being adopted by different plastic product manufacturers and prepare a report.

## 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) ***'L' 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.
g) Arrange expert lecture on SQC and SPC by Quality Manager/Engineer of a plastic industry.
h) Arrange a visit to nearby plastic industry and show students different testing procedure being carried out there.

## 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. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, 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 duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs.

- Draw tensile test specimen and collect tensile specimen sample
- List MFI for various plastic materials and decide their processing grade
- Draw and collect izod impact strength test specimen sample and give importance of impact strength
- Give oxygen index of various material and correlate it with their flammability

## 13. SUGGESTED LEARNING RESOURCES

| Sr. No. | Title of Book | Author | Publication with place, year and ISBN |
|---|---|---|---|
| 1. | Hand Book of Plastics Testing Technology | Vishu Shah | Wiley Inter-science publication |
| 2. | Hand Book of Polymer testing | R.P.Brown (roger brown) | Marcel- Dekker Inc. |
| 3. | Statistical Quality Control | O.P.Khanna | Khanna publishers |
| 4. | Hand book of plastics & elastomers | C.A.Harper | Wiley publication |
| 5. | Plastics processing data hand book | D.V.Rosato | Springer Berlin Heidelberg |

## 14. SOFTWARE/LEARNING WEBSITES

1. http://www.ipolytech.com/
2. http://www.ulttc.com/
3. www.intertek.com
4. http://www.labtesting.com/
5. www.nslanalytical.com/testing/polymer
6. http://www.exova.com/capabilities/polymer-testing/
7. http://www.chemir.com/plastic-polymer-testing.html

## 15. PO-COMPETENCY-CO MAPPING

| Semester VII | Plastic Testing and Quality Management (Course Code: 4372303) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 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** An ability to apply principles of material selection, product & mold/die design and development in plastic engineering. | **PSO 2** An ability to conduct safe and environment friendly manufacturing and recycling of plastic products. | **PSO 3** (If needed) |
| **Competency** • **Test plastics, analysis various properties and maintain quality of production using SQC and SPC techniques.** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | - |
| **Course Outcomes 1.Identify factors affecting the tests.** | **2** | **3** | **1** | **1** | **1** | **1** | **1** | **1** | **3** | **-** |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 2. **Perform various mechanical tests.** | **2** | **2** | **2** | **2** | **2** | **2** | **2** | **2** | **2** | **-** |
| 3.**Interpret thermal properties.** | **2** | **1** | **2** | **2** | **2** | **1** | **1** | **2** | **2** | **-** |
| 4.**Measure electrical and optical properties.** | **2** | **1** | **2** | **2** | **2** | **1** | **1** | **2** | **2** | **-** |
| 5.**Observe rheological and weather tests.** | **2** | **1** | **2** | **2** | **2** | **1** | **1** | **1** | **2** | **-** |
| 6.**Use SQC and SPC techniques or quality control.** | **2** | **2** | **1** | **2** | **1** | **2** | **2** | **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**

| Sr. No. | Name and Designation | Institute | Contact No. | Email |
|---|---|---|---|---|
| 1 | Shri Dharmendra M. Makwana<br>Head of Plastic Engineering | G.P., Valsad | 9426359006 | 1224dmm@gmail.com |
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