# GUJARAT TECHNOLOGICAL UNIVERSITY

## METALLURGY ENGINEERING (21)
## MATERIAL SELECTION AND FAILURE ANALYSIS
## SUBJECT CODE: 2182102
## B.E. 8thSEMESTER

**Type of course:** Engineering

**Prerequisite**: Students must be aware about the basic concept of Metallurgy .

**Rationale:** Selection of materials and failure analysis have an important role in selection of engineering materials and it's applications. Metallurgy engineers can design and enhance materials properties and select the best material for a particular application, monitor its performance and figure out why a material failed and bring expertise on the properties of materials. To do this, Metallurgy engineers need to understand that how components fail, what are investigations techniques and what are different types of failures. The Selection of Materials and Failure Analysis course is to prepare students for careers in metallurgy engineering where they can apply knowledge of fracture analysis and investigation of failed component.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credits | Examination Marks | | | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Theory Marks | | | Practical Marks | | | |
| | | | | ESE (E) | PA (M) | | ESE (V) | | PA (I) | |
| | | | | | PA | ALA | ESE | OEP | | |
| 4 | 0 | 2 | 6 | 70 | 20 | 10 | 20 | 10 | 20 | 150 |

**Content:**

| Sr. No. | Content | Total Hrs | % Weightage |
|---|---|---|---|
| **1** | Philosophy of material selection, motivation for selection, relationship to available resources, concept of resource base, Criteria for selection of engineering materials – service requirements, ease of manufacturing, availability of materials and cost effectiveness. | **6** | **10%** |
| **2** | Selection for mechanical properties like strength, toughness, stiffness, fatigue, creep and temperature resistance. | **4** | **8%** |
| **3** | Selection for surface durability like corrosion resistance, wear resistance. Relationship between material selection and material processing. | **4** | **8 %** |
| **4** | Identification of required properties. Selection of materials based on available property data and optimization to select the best material. | **6** | **10 %** |
| **5** | Case studies in material selection like materials for bearings, gears, automobile structures, aircraft components, ship structures. | **8** | **15 %** |
| **6** | Importance of failure analysis and its relationship to material selection, fundamental causes of failure. General practice in failure analysis. | **6** | **8%** |
| **7** | Failure- types and characteristics:<br>Identification, characterization, fracture mechanism, fracture modes and microfractographic features of ductile, brittle and fatigue failures. | **10** | **17%** |
| **8** | Corrosion Failures: Galvanic Corrosion, Uniform Corrosion, Crevice Corrosion, Corrosion fatigue, hydrogen embrittlement and stress corrosion cracking. | **8** | **12 %** |

| | | | |
|---|---|---|---|
| **9** | Elevated-Temperature Failures: Creep, Elevated-Temperature Fatigue, Thermal Fatigue, Metallurgical Instabilities, Environmentally Induced Failure, Cooling Methods. | **8** | **12 %** |
| | Total | **60** | **100%** |

**Suggested Specification table with Marks (Theory):**

| **Distribution of Theory Marks** | | | | | |
|---|---|---|---|---|---|
| R Level | U Level | A Level | N Level | E Level | C Level |
| **10** | **15** | **20** | **20** | **15** | **20** |

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's 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.

**Reference Books:**


1. Selection and Uses of Engineering Materials – F.A.A. Cranes & J.A. Charles, Butterworth & Com.Ltd., London.
2. Materials Selection in Mechanical Design, Ashby, M.F., New York: Pergamon, 1992.
3. Engineering Materials-Selection and Value Analysis –H.J. Sharp, Elsevier Publishing Company Inc., New York.
4. Metallurgy of Failure Analysis – A.K. Das, McGraw Hill, New York.
5. Understanding How Components Fail- Donald J. Wulpi, ASM international
6. Failure Analysis of Engineering Materials – Charlie R. Brooks and Ashok Chaudhary, McGraw Hill, New York.
7. Analysis of Metallurgical Failures- V.J. Colangelo & F.A. Heiser, John Wiley & Sons, NewYork.
8. Metals Handbook – Eighth edition – Failure Analysis and Prevention, American Society of Metals, Metals Park, Ohio.
9. ASM Handbook, Vol.1 & 2, Properties and Selection: Metals Park, Ohio.
10. Handbook of materials selection - Myer Kutz, John Wiley & Sons, New York.
11. Handbook of materials selection for engineering applications- G.T. Murray, M. Dekker


**Course Outcome:**

After learning the course the students should be able to:

1. provide knowledge about the basic concept of material selection.
2. impart the importance of material selection in metallurgy.
3. understand all procedure for failure investigations.
4. understand types and mechanism of different failure.
5. study material selection for particular mechanical properties & its overall importance in selecting components.
6. How newer materials can be developed and investigated for failure analysis and which can be useful in new technologies and development.

**Design based Problems (DP)/Open Ended Problem:** Case study base on on-service and In-process failure which are related with material selections, component applications, component manufacturing process and environmental effects.

**List of Open Source Software/ learning website:**

www.nptel.in

**ACTIVE LEARNING ASSIGNMENTS**: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should be submitted to GTU.