# GUJARAT TECHNOLOGICAL UNIVERSITY

**Bachelor of Engineering**
**Subject Code: 3172114**
**Semester – VII**
**Subject Name: Failure Analysis**

**Type of course**: Engineering/science

**Prerequisite**: Basic fundamentals of introduction to materials engineering, Physical Metallurgy and Materials degradation.

**Rationale**: The syllabus is designed to learn factors governing the failure of materials, types of failure, identifying various failures occur in materials processing. The course also covers the preventive methods of failure.

**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) | |
| 3 | 1 | 0 | 4 | 70 | 30 | 00 | 00 | 100 |

**Content:**

| Sr. No. | Content | Total Hrs |
|---|---|---|
| **1** | Aims of failure analysis. Important factors causing the premature failure of metallic components and structures. Tools and techniques in failure analysis. | **05** |
| **2** | Types of failures, fractographic characteristics and mechanisms of ductile, brittle, fatigue, creep and wear failures. | **15** |
| **3** | Corrosion Failures: Pitting Corrosion, Crevice Corrosion, Intergranular Corrosion hydrogen embrittlement and stress corrosion cracking. | **10** |
| **4** | Failures due to faulty heat treatments. Failures in metal forming and welding. | **06** |
| **5** | Failure analysis case study of engineering component. | **06** |
| | TOTAL | **42** |

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

| **Distribution of Theory Marks** | | | | | |
|---|---|---|---|---|---|
| R Level | U Level | A Level | N Level | E Level | C Level |
| **20%** | **20%** | **35%** | **20%** | **05%** | **0%** |

**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. Understanding How Components Fail- Donald J. Wulpi, 3rd Edition, ASM international Publication.
2. Failure Analysis: Fundamentals and Applications in Mechanical Components, Jose Luis Otegui, Springer, 2016
3. Materials Selection in Mechanical Design, Ashby, M.F., New York: Pergamon, 1992.
4. Metallurgy of Failure Analysis – A.K. Das, McGraw Hill, New York, 1997
5. Failure Analysis of Engineering Materials, Charles Brooks, Ashok Choudhury, Charlie R. Brooks, McGraw-Hill Education; 2001
6. Analysis of Metallurgical Failures- V.J. Colangelo & F.A. Heiser, John Wiley & Sons, NewYork.
7. Metals Handbook – Vol. 11, Ninth edition – Failure Analysis and Prevention, American Society of Metals, Metals Park, Ohio.
8. ASM Handbook, Vol. 1 & 2, Ninth edition , Properties and Selection: Metals Park, Ohio.

**Course Outcomes**
After completing this course, students will able to,

| Sr. No. | CO statement | Marks % weightage |
|---|---|---|
| CO-1 | Understand the material selection & techniques to perform failure analysis. | 25 |
| CO-2 | Identify different types and mechanisms of failures. | 40 |
| CO-3 | Analyze material failure mechanism / investigations by case-Studies. | 35 |

**List of Tutorials:**

1. Procedural steps of failure investigation of engineering component.
2. Failure analysis of Shaft.
3. Failure analysis of Bearing.
4. Failure analysis of Cast Components.
5. Failure analysis of Heat exchanger.
6. Failure analysis of Welded joints,
7. Material failure during high temperature service application.
8. Failure due to Hydrogen Embrittlement
9. Failures in corrosive atmosphere.
10. Report writing on visual examination of a failed engineering component

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

1. https://onlinecourses.nptel.ac.in/noc20_me26/preview
2. https://atslab.com/training/failure-analysis-training-course/
3. https://www.researchgate.net/publication/329060449_Failure_Analysis_Course