

GUJARAT TECHNOLOGICAL UNIVERSITY

BE-7 SEMESTER – OLD PAPER – S22 TO W24 – QUESTION BANK

Subject Name & Code:

Advanced Machine Design- 3171925

Chapter 1: Fracture Mechanics

Repeated Questions:

1. **Define/Explain Linear Elastic Fracture Mechanics (LEFM), its application, and limitations.**
 - **Appeared in:** WIN 2023 (Q1a, 03 Marks), SUM 2022 (Q1b-i, part of 04 Marks), WIN 2024 (Q3a-i, part of 03 Marks).
2. **Explain Griffith's theory of fracture.**
 - **Appeared in:** SUM 2023 (Q1b, 04 Marks), WIN 2023 (Q1b, 04 Marks).
3. **Explain the three modes of crack displacement with neat sketches.**
 - **Appeared in:** WIN 2023 (Q2b, 04 Marks), WIN 2022 (Q5b, 04 Marks), SUM 2022 (Q5b, 04 Marks), WIN 2024 (Q3b, 04 Marks).
4. **Define Stress Intensity Factor (SIF) and Fracture Toughness (K_{IC}). Why is evaluating SIF important?**
 - **Appeared in:** SUM 2023 (Q4a, 03 Marks), WIN 2022 (Q4a, 03 Marks), SUM 2022 (Q5a, 03 Marks), WIN 2024 (Q4c, 07 Marks), SUM 2024 (Q4b, 04 Marks).
5. **Derive the relationship between Crack Tip Opening Displacement (CTOD) and SIF (K_I) for small-scale yielding.**
 - **Appeared in:** WIN 2022 (Q3c, 07 Marks), SUM 2024 (Q1c, 07 Marks), WIN 2024 (Q3c, 07 Marks).
6. **Numerical on calculating SIF for a center-cracked plate.**
 - **Appeared in:** WIN 2022 (Q2c, 07 Marks), SUM 2022 (Q5c, 07 Marks).

Other Important Questions:

1. What is deformation in material? Explain two types of deformations in brief. (SUM 2023, Q1a, 03 Marks)
2. Discuss Griffith's explanation on "stress concentration at the tip of a crack" with a figure. (SUM 2023, Q1b, 04 Marks)
3. Explain the concepts of (a) Crack resistance (b) Stable and unstable crack growth. (WIN 2023, Q1c-ii, part of 07 Marks)
4. Critical SIF of a material depends on many factors? Discuss. (WIN 2022, Q3a, 03 Marks)
5. For the C-frame as shown in Figure 1, calculate the safe load... [Fracture Mechanics Numerical] (SUM 2023, Q2c, 07 Marks)
6. A wide plate of mild steel is subjected to a uniform tensile load... Calculate the critical crack length... [K_{IC} Numerical] (SUM 2022, Q5c, 07 Marks)
7. Explain the Maximum Principal Strain theory. (SUM 2022, Q5a, 03 Marks; SUM 2024, Q3a, 03 Marks)

Chapter 2: Surface Failures

Repeated Questions:

1. **Explain different types of wear (Adhesive, Abrasive, Corrosive) in detail.**
 - **Appeared in:** WIN 2023 (Q2c, 07 Marks), SUM 2024 (Q2b, 04 Marks), WIN 2024 (Q2b, 04 Marks).
2. **Explain Hydrodynamic, Hydrostatic, and Elastohydrodynamic Lubrication.**
 - **Appeared in:** SUM 2022 (Q4a, 03 Marks), WIN 2024 (Q3a-ii, part of 03 Marks).
3. **Describe the consequences of surface fatigue and factors to control it.**
 - **Appeared in:** WIN 2022 (Q5a, 03 Marks), SUM 2024 (Q1b, 04 Marks), WIN 2024 (Q4a, 03 Marks).
4. **Define fretting and distinguish between fretting fatigue, wear, and corrosion.**
 - **Appeared in:** WIN 2022 (Q5b, 04 Marks), WIN 2024 (Q2c, 07 Marks).
5. **Numerical on calculating maximum contact stress for spherical/ball contact (Hertzian Contact).**
 - **Appeared in:** WIN 2022 (Q4c, 07 Marks), SUM 2022 (Q4c, 07 Marks), SUM 2024 (Q2c, 07 Marks), WIN 2024 (Q3c, 07 Marks).
6. **Numerical on calculating the size of the contact patch for cylindrical contact (e.g., crane wheel on rail).**
 - **Appeared in:** SUM 2023 (Q2b, 04 Marks).

Other Important Questions:

1. List five general categories of surface failure and explain any one in brief. (SUM 2023, Q2a, 03 Marks)
2. Explain design precautions to avoid surface failure. (WIN 2023, Q2c, part of 07 Marks)
3. What is wear? Explain any one mechanism in detail. (SUM 2022, Q4b, 04 Marks)
4. Discuss the effect of roughness, velocity, and lubrication on friction. (SUM 2022, Q4b, 04 Marks; WIN 2024, Q4b, 04 Marks)
5. A pin-on-disk friction testing apparatus... Compute the wear coefficients. [Wear Numerical] (SUM 2022, Q4c, 07 Marks; WIN 2024, Q4c, 07 Marks)
6. Define (1) Fretting fatigue and (2) Fretting wear. (SUM 2024, Q5a, 03 Marks)

Chapter 3: Creep and Damping

Repeated Questions:

1. **Define creep. Explain the three stages of a creep curve with a diagram.**
 - **Appeared in:** WIN 2022 (Q3a, 03 Marks), SUM 2022 (Q3a, 03 Marks).
2. **Explain the Larson-Miller parameter for creep deformation and life estimation.**
 - **Appeared in:** SUM 2022 (Q3b, 04 Marks), SUM 2023 (Q4b-OR, 07 Marks), SUM 2024 (Q3b, 04 Marks), WIN 2024 (Q4b, 04 Marks).
3. **Distinguish between Creep, Creep Rupture, and Stress Rupture.**
 - **Appeared in:** WIN 2022 (Q2a, 03 Marks), SUM 2024 (Q2a, 03 Marks).
4. **Numerical on using Larson-Miller/Sherby-Dorn parameters to find life or safe stress.**
 - **Appeared in:** SUM 2022 (Q3c, 07 Marks), SUM 2022 (Q3c-OR, 07 Marks).

Other Important Questions:

1. Explain in brief: i. Failure due to Creep ii. Failure due to Damping. (SUM 2023, Q4a, 03 Marks)
2. Draw and explain the strain vs. time behavior during creep under constant force. (SUM 2023, Q4a-OR, 03 Marks)
3. Explain creep deformation under varying stress. (SUM 2023, Q5a, 03 Marks)
4. Explain stress relaxation. (SUM 2022, Q3b-OR, 04 Marks; WIN 2024, Q4a, 03 Marks)
5. Explain energy dissipation in material under damping. (SUM 2023, Q5b-OR, 04 Marks)
6. Explain: (i) Transient creep (ii) True stress (iii) Steady-state creep. (WIN 2023, Q3a, 03 Marks; SUM 2022, Q3a-OR, 03 Marks)
7. Refer to the Figure 5 and write three points on the effect of temperature on stress versus steady-state strain rate... (SUM 2023, Q5a-OR, 03 Marks)
8. Draw a creep curve “strain versus time” and write three points of discussion on it. (SUM 2024, Q4b-OR, 04 Marks)

Chapter 4: Fatigue Failure

Repeated Questions:

1. **Explain the Palmgren-Miner rule (Linear Cumulative Damage Rule) for variable amplitude loading.**
 - **Appeared in:** WIN 2022 (Q3c, 07 Marks), SUM 2024 (Q3c, 07 Marks), WIN 2024 (Q1c, 07 Marks).
2. **Distinguish between High-Cycle Fatigue (HCF) and Low-Cycle Fatigue (LCF).**
 - **Appeared in:** WIN 2022 (Q4a, 03 Marks), WIN 2023 (Q4a-OR, 03 Marks), SUM 2024 (Q4a-OR, 03 Marks), WIN 2024 (Q4a, 03 Marks).
3. **Discuss the factors that affect the endurance limit/S-N curve.**
 - **Appeared in:** SUM 2022 (Q2b, 04 Marks), WIN 2024 (Q1b, 04 Marks), SUM 2024 (Q1a, 03 Marks), WIN 2024 (Q5a, 03 Marks).
4. **Explain the cumulative damage concept with an S-N diagram.**
 - **Appeared in:** WIN 2023 (Q3a, 03 Marks), WIN 2023 (Q3a-OR, 03 Marks).
5. **Explain the rain-flow cycle counting method.**
 - **Appeared in:** SUM 2023 (Q1c, 07 Marks), WIN 2022 (Q4b, 04 Marks).
6. **Numerical on fatigue life estimation using S-N data and Miner's rule.**
 - **Appeared in:** SUM 2023 (Q3c, 07 Marks), WIN 2022 (Q4c, 07 Marks).

Other Important Questions:

1. Discuss the effect of material composition, operating temperature, and grain size on fatigue strength. (SUM 2023, Q3a, 03 Marks)
2. Explain the crack initiation phase in detail. (SUM 2023, Q3b, 04 Marks)
3. Draw and discuss any two types of mean zero stress-time patterns. (SUM 2023, Q3b-OR, 04 Marks)
4. Define fatigue life, enlist various fatigue life methods, and explain any one. (WIN 2023, Q3c, 07 Marks)
5. A machine component is subjected to a flexural stress... Determine the value of minimum ultimate strength according to 1. Gerber... [Fatigue Failure Criteria Numerical] (WIN 2023, Q3c-OR, 07 Marks)
6. Explain the strain-based approach to determine fatigue life. (WIN 2023, Q4c-ii, part of 07 Marks)
7. Explain fatigue crack propagation and life estimation for variable amplitude stress. (WIN 2023, Q4b-OR, 04 Marks)
8. Derive the following condition for “failure is predicted to occur if (FIPTOI)”. (SUM 2024, Q3c-OR, 07 Marks)

Chapter 5: Multiaxial Stresses

Repeated Questions:

1. **What are the important theories of elastic failure? Explain why they are required.**
 - **Appeared in:** SUM 2022 (Q1a, 03 Marks), SUM 2024 (Q3a, 03 Marks), WIN 2024 (Q3a, 03 Marks).
2. **Numerical on bolt design using Maximum Shear Stress Theory and Distortion Energy Theory under combined loading.**
 - **Appeared in:** SUM 2022 (Q1c, 07 Marks), SUM 2024 (Q2c-OR, 07 Marks), WIN 2024 (Q2c-OR, 07 Marks).
3. **Explain Sines method for fluctuating simple multiaxial stresses.**
 - **Appeared in:** SUM 2023 (Q5b, 04 Marks), WIN 2023 (Q5c, 07 Marks).

Other Important Questions:

1. Explain the effect of complex multiaxial stress on a machine element. (SUM 2023, Q4b, 04 Marks)
2. A hollow cylindrical 4340 steel member... determine the principal stresses σ_1 , σ_2 , and σ_3 . [Multiaxial Stress Numerical] (SUM 2023, Q4c, 07 Marks)
3. Explain Linear Elastic Fracture Mechanics for fatigue crack growth under multiaxial loading. (SUM 2023, Q4c-OR, 07 Marks)
4. What are simple multiaxial stresses and complex multiaxial stresses? (WIN 2023, Q5b, 04 Marks)

Chapter 6: Housings

Repeated Questions:

1. **What is Mechanical Housing? Explain its functions/importance.**
 - **Appeared in:** WIN 2023 (Q5a, 03 Marks), SUM 2022 (Q5b, 04 Marks), WIN 2024 (Q5a, 03 Marks).
2. **Differentiate between Split and Non-split Housing.**
 - **Appeared in:** SUM 2023 (Q5c-iii, part of 07 Marks), SUM 2024 (Q5b, 04 Marks), WIN 2024 (Q5b, 04 Marks).
3. **Explain Contact Seals and Non-Contact Seals.**
 - **Appeared in:** WIN 2022 (Q5c, 07 Marks), SUM 2024 (Q4c-OR, 07 Marks).

Other Important Questions:

1. Write two main functions of housings. Write two most general materials used for housing. Write three points of difference between split housing and non-split housing. (SUM 2023, Q5c, 07 Marks)
2. Describe various types of housing seals. Discuss stresses and deformation induced in housing. (SUM 2023, Q5c-OR, 07 Marks)
3. Explain housings split at right angle to the axes of the shafts with a suitable example. (WIN 2022, Q5c, 07 Marks; SUM 2024, Q5c, 07 Marks)
4. Discuss different types of materials used for Mechanical Housings. (SUM 2024, Q5c, 07 Marks; WIN 2024, Q5c, 07 Marks)
5. Define functions of Mechanical Housing Seals. Enlist the different types of Mechanical Housing Seals. (WIN 2024, Q5c, 07 Marks)
6. Explain three-stage gear deformation under load attached with a foundation with a neat sketch. (WIN 2022, Q5b, 04 Marks; SUM 2024, Q5b, 04 Marks)
7. What is the need for combined seals? (WIN 2022, Q4a, 03 Marks)
8. State the desirable properties of material for a mechanical seal. (WIN 2023, Q5a-OR, 03 Marks)
