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K 4009

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2009.

Eighth Semester

Aeronautical Engineering

AE 1011 — FATIGUE AND FRACTURE

(Regulation 2004)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Explain the terms :
 - (a) Endurance limit
 - (b) Endurance strength and
 - (c) Notch sensitivity.
2. What is meant by stress concentration? Explain how its value can be reduced.
3. Draw a typical S-N curve and demarcate it with high cycle and low cycle fatigue.
4. What is the need to count the cycles?
5. Discuss the miner's cumulative damage theory,
6. What are "clam shell markings"?
7. What are the three modes of loading in fracture mechanics? Explain with neat sketches.
8. What are the disadvantages of using LEFM theory?
9. What is Fretting Fatigue?
10. Explain :
 - (a) safe-life and
 - (b) fail safe design philosophies.

PART B — (5 × 16 = 80 marks)

11. (a) Explain the following terms :

- (i) (1) Stress amplitude
 - (2) Mean stress
 - (3) Stress range
 - (4) Stress Ratio.
- (ii) Bending stress in a structural member fluctuates between a tensile stress of 280 MPa and compressive stress of 140 MPa. What should be the minimum ultimate stress for the member to carry this fluctuation? Assume the factor of safety to be 2 and the endurance strength to be 50% of the ultimate strength of the material.

Or

- (b) (i) What is the effect of mean stress and what are the empirical relations developed to account for the mean stress effects.
- (ii) Determine the thickness of a 120 mm wide uniform plate for safe continuous operation if it is subjected to a varying maximum tensile load of 250 kN and a minimum of 100 kN for a factor of safety 1.5. The endurance strength and a yield strength of the material are 225 MPa and 300 MPa respectively.

12. (a) (i) Explain :

- (1) Level crossing
 - (2) Rain flow counting techniques.
- (ii) Derive the expression for fracture stress using Griffith's theory.
- (iii) Write notes on :
- (1) Brittle fracture
 - (2) Ductile fracture.

Or

15. (a) Write notes on the following :

- (i) Surface Rolling
- (ii) Shot Peening Process.

Or

(b) (i) Discuss a few fatigue problems encountered in subsonic and supersonic aircraft.

(ii) Discuss the following :

- (1) Probit Method.
 - (2) PROT Method.
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(b) (i) Write notes on :

(1) Fatigue-Fracture surfaces

(2) Torsional Fatigue surfaces.

(ii) Sketch the following specimens geometry as per standards.

(1) Three-point Bend specimen.

(2) Four-Point Bend specimen

(3) Compact Tension specimen

(4) C-shaped specimen.

13. (a) (i) Sketch a Few fatigue test specimens.

(ii) What are the various factors influencing fatigue behavior?

(iii) What are the effects of the following on the fatigue behavior?

(1) Effect of size and stress gradient

(2) Effect of stress concentration.

Or

(b) For an infinite biaxially loaded plate, containing a crack length of "2a" derive the relations for (i) σ_x (ii) σ_y .

14. (a) Starting from "J" integral prove the equivalence of $J = G$, strain energy release rate for plane stress and strain conditions.

Or

(b) Compare the following methods :

(i) S-N approach

(ii) S- ϵ approach and

(iii) Fracture mechanics approach.