B.E. DEGREE EXAMINATIONS NOV/DEC 2012

Seventh & Fifth Semester

AERONAUTICAL ENGINEERING

AER146 - Fatigue and Fracture

Time: Three Hours   **Maximum Marks: 100**

Answer ALL questions

PART A (10×1=10 Marks)

1. S-N curve is otherwise called as

    a. Stress-strain curve   b. Wöhler curve   c. Neuber curve   d. Gerber curve

2. In a completely reversed sinusoidal stress cycle, the mean stress is
    a. 1.0   b. 0.5   c.0   d.2.0

3. Stress amplitude is defined as

    a. $\sigma_{max} - \sigma_{min}$

    b. $\dfrac{\sigma_{max} - \sigma_{min}}{2}$

    c. $\dfrac{\sigma_{max} + \sigma_{min}}{2}$

    d. $\dfrac{\sigma_{max}}{\sigma_{min}}$

4. Soderberg relation is based on
    a. Tensile strength   b. Fatigue strength

    c. Yield strength   d. Mean stress

5. Low cycle fatigue deals with
    a. Microscopic elastic deformation   b. Macroscopic elastic deformation
    c. Microscopic plastic deformation   d. Macroscopic plastic deformation

6. Cyclic strain hardening shows

    a. Increasing stress amplitude   b. Decreasing stress amplitude

    c. Increasing strain amplitude   d. Decreasing strain amplitude

7. Coffin-Mason relationship is based on
   a. Stress-strain curve
   b. Stress-life curve
   c. Strain-life curve
   d. Load-deflection curve

8. The unit for stress intensity factor is

   a. $MPa\sqrt{m}$
   b. $MPa - m$
   c. $\dfrac{MPa}{\sqrt{m}}$
   d. $\sqrt{MPa - m}$

9. Energy release rate is defined as
   a. Energy release per unit time
   b. Energy release per unit increase of area
   c. Energy release per number of cycles
   d. Energy release per unit strain

10. Which design criteria is used in pressure vessel design and jet engine design?
   a. Infinite life design
   b. Safe-life design
   c. Fail-safe design
   d. Damage tolerant design

PART B (10x2=20 Marks)

11. Define fatigue.

12. Define fatigue life, fatigue strength and fatigue limit.

13. Define transition life.

14. List the various cycle counting techniques.

15. Name the different phases in fatigue.

16. How do you recognize fatigue failure?

17. Name and sketch the three modes of fracture.

18. Differentiate between brittle fracture and ductile fracture.

19. What is damage tolerant design?

20. Give two examples how fatigue occurs in aircraft structures.

PART C (5×14=70 Marks)

21. a) (i) List the different mechanical failure modes of metals. (6)

    (ii) Explain the effect of mean stress on fatigue behavior with neat sketches. (8)

(OR)

    b) (i) Explain the effects of notches on fatigue behavior with neat sketches.

    (ii) Explain the effects of mean stress on notched parts undergoing fatigue. Also sketch the High diagram with and without notch.

22. a) (i) Differentiate between high cycle fatigue and low cycle fatigue. (4)

    (ii) Explain the Coffin-Mason relations and its applications. (10)

(OR)

    b) (i) What is cumulative damage? (4)

    (ii) With a neat sketch, explain Miner's theory and its modifications. (10)

23. a) With neat sketches, explain the microscopic and macroscopic characteristic features of fatigue fracture surfaces and fatigue failures.

(OR)

    b) Explain the crack initiation and crack growth phases in fatigue life with neat sketches.

24. (a) Explain Griffith's analysis of a center cracked plate and show that the critical stress depends on Young modulus, surface energy and crack length.

(OR)

    b) (i) Define energy release rate and derive an expression for the same. (8)

    (ii) With neat sketches, explain the effect of thickness on fracture toughness. (6)

25. a) Explain the following fatigue design criteria with examples.

    (i) Infinite-life design (2)

    (ii) Safe-life design (6)

    (iii) Fail-safe design (6)

(OR)

b) Explain how the fatigue and fracture mechanics concepts apply to composite materials and   structures.

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