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DEPARTMENT OF AEROSPACE ENGINEERING

Faculty Name	:	**Dr.P.GOPI KRISHNAN, ASP/ AERO**	Academic Year	:	**2024-2025 (EVEN)**
Year & Branch	:	**III AERO**	Semester	:	**VI**
Course	:	**19ASE310 FATIGUE AND FRACTURE MECHANICS**			

Question Bank

1: S-N Curves & Endurance Limits

Basic Questions

1. Define **S-N curves** and explain their significance in fatigue analysis.
2. What is meant by **endurance limit**, and how does it differ from fatigue strength?
3. Differentiate between **low-cycle fatigue** and **high-cycle fatigue** using S-N curves.
4. Explain why ferrous materials exhibit a clear endurance limit, whereas non-ferrous materials do not.

Conceptual Questions

5. How do S-N curves change for different materials such as steel, aluminum, and composites?
6. Discuss the role of **stress amplitude** and **number of cycles** in determining fatigue failure.
7. What factors influence the endurance limit of a material?
8. Why do some materials not have a distinct fatigue limit?

Application-Based Questions

9. A steel component has an endurance limit of **250 MPa**. If a cyclic load of **300 MPa** is applied, estimate its fatigue life using an S-N curve.
10. Using experimental data, how would you construct an S-N curve for a new material?

2: Effect of Mean Stress and Goodman, Gerber, and Soderberg Relations

Basic Questions

11. What is **mean stress**, and how does it influence fatigue life?
12. Explain the **Goodman relation** and its application in fatigue analysis.
13. How does the **Gerber relation** differ from the Goodman relation?
14. Define the **Soderberg criterion** and explain its significance in conservative fatigue design.

Conceptual Questions

15. Compare the Goodman, Gerber, and Soderberg relations in terms of their assumptions and limitations.
16. Why is the Gerber relation considered more accurate for ductile materials?
17. In which situations would an engineer prefer using the **Soderberg equation** over the **Goodman equation**?
18. How does the presence of compressive mean stress affect fatigue life?

Application-Based Questions

19. A steel component has a yield strength of **400 MPa** and an endurance limit of **200 MPa**. Determine the maximum allowable alternating stress using the **Goodman equation** if the mean stress is **100 MPa**.
20. Using the Gerber relation, determine the fatigue strength of a material subjected to fluctuating loads.

3: Notches and Stress Concentrations

Basic Questions

21. Define **stress concentration** and explain its effect on fatigue failure.
22. What is a **stress concentration factor (K_t)**? How is it determined?
23. Explain how notches influence the fatigue strength of a material.
24. Why do sharp corners and keyways in mechanical components reduce fatigue life?

Conceptual Questions

25. Discuss the role of **geometric discontinuities** in increasing fatigue failure risk.
26. How does **fillet radius** influence stress concentration in mechanical components?
27. Why is the actual fatigue strength lower than the theoretical value in notched components?
28. Explain how engineers minimize stress concentrations in real-world designs.

Application-Based Questions

29. A plate with a circular hole is subjected to a tensile load. Calculate the **stress concentration factor (K_t)** and its effect on fatigue life.
30. A shaft with a keyway has a stress concentration factor of **2.2**. If the endurance limit for the unnotched shaft is **300 MPa**, estimate its new endurance limit.

4: Neuber’s and Plastic Stress Concentration Factors

Basic Questions

31. What is **Neuber’s stress concentration factor**, and how does it differ from the theoretical stress concentration factor?
32. Explain the term **plastic stress concentration factor** and its significance.
33. How does plastic deformation affect stress concentration in fatigue loading?
34. What assumptions are made in **Neuber’s rule** for stress-strain concentration?

Conceptual Questions

35. Compare **Neuber’s rule** with the elastic stress concentration approach.
36. Why does Neuber’s rule provide more accurate predictions in ductile materials?
37. How does **plasticity redistribution** reduce effective stress concentration?
38. In what scenarios does the **plastic stress concentration factor** become important?

Application-Based Questions

39. Using **Neuber’s rule**, determine the actual stress-strain response for a notched specimen subjected to cyclic loading.
40. A notched aluminum specimen has a theoretical KtK_t of **3.0**. If plastic deformation occurs, estimate the **actual stress concentration factor** using Neuber’s method.

5: Notched S-N Curves

Basic Questions

41. Define **notched S-N curves** and explain their importance in fatigue analysis.
42. How do **notches** alter the fatigue life of a material?
43. What is the **fatigue strength reduction factor (K_f)**, and how is it related to notch sensitivity?
44. How does notch sensitivity influence fatigue performance?

Conceptual Questions

45. Why does fatigue life decrease significantly in notched components?
46. Discuss how different materials (metals vs. composites) respond to notches in fatigue loading.
47. Explain the role of **surface roughness** in notched fatigue behavior.
48. How do experimental S-N curves differ for **smooth** and **notched** specimens?

Application-Based Questions

49. A notched steel specimen has a notch sensitivity factor of **0.8** and a theoretical KtK_t of **2.5**. Calculate its **fatigue strength reduction factor (K_f)**.
50. Given an unnotched fatigue strength of **300 MPa**, estimate the fatigue strength of the **notched** specimen using **K_f**.

6: Fatigue of Composite Materials

Basic Questions

51. Define **fatigue failure** in composite materials.
52. How does fatigue behavior in composites differ from that in metals?
53. List the primary fatigue failure mechanisms in composite materials.
54. What factors influence fatigue performance in fiber-reinforced composites?

Conceptual Questions

55. Why does **delamination** occur in composite materials under cyclic loading?
56. How does **fiber orientation** affect fatigue life in composites?
57. Explain how **environmental conditions** impact composite fatigue behavior.
58. Why is fatigue testing of composite materials more complex than that of metals?

Application-Based Questions

59. A composite laminate is subjected to cyclic tensile loading. Predict its fatigue life based on **fiber layup and stress amplitude**.
60. A carbon fiber-reinforced composite exhibits matrix cracking at **10^5 cycles** under a **stress range of 150 MPa**. How would a change in **fiber orientation** affect its fatigue resistance?