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BE/B. TECH (FULL TIME} DEGREE END SEMESTER EXAMINATIONS NOV/ DEC 2011
MATERIAL S SCIENCE AND ENGINEERING BRANCH
SIXTH SEMESTER
ML 9352 –CREEP AND FATIGUE BEHAVIOUR OF MATERIALS.
(REGULATIONS 2008)

Time: 3 Hours Max. Marks: 100

ANSWER ALL QUESTIONS

PART– A (10X2=20 Marks)

1. List the types of defects in a crystal structure.
2. What are the essential conditions required for deformation to take place by slip in metals?
3. Define Creep Strength and list the factors that influence this property in metals.
4. Which grain size would you recommend for elevated temperature applications and why?
5. What is "LIFE FRACTION RULE" for fatigue state?
6. Define Endurance Limit.
7. What is a S- N curve and is it independent of materials?
8. Why is an edge crack considered more dangerous than a central crackin a plate Subjected to fatigue loading?
9. What is "Forensic Engineering" and what is its importance in failure analysis?
10. List some of the tools used for failure analysis of materials.

PART– B (5X16=80 Marks)

1.

i. With a neat sketch, describe in detail, the Griffith's theory of fracture with its concepts and limitations. (10)

ii. Determine the fracture stress of a glass plate , if it contains a series of micro cracks with a maximum dimension of 10μm. Assume that E for glass plate is 70GPa and the surface energy is 0.6J/m² . What would be the likely fracture stress for the glass plate if a fine scratch with a depth of 0.3mm was made on the surface? Give your inference. (6)

2a

i. With necessary sketches, explain in detail the mechanism of creep and establish a relationship between the strain rate and the log time in hours both at low temperature and elevated temperature of a material that undergoes deformation. (8)

ii. Calculate the stress exponent for the creep deformation rate for a material that deforms at 600° C (strain rate 10^{-5}/sec at 100 MPa and 10^{-7}/sec at 50 MPa) .At which part of the creep curve does the strains rates have to be measured? (8)

OR

2b.

i. For a given steel specimen, explain in detail, the contributions of various factors on its creep strength. (8)

ii. In which way is the Larsen Miller concept useful for creep studies? Creep of a cylindrical sample caused failure at a constant stress of 60Mpa in 1000 hours at a temperature of 627 deg C. Calculate the time to failure at 527 deg C using LM rule.(LMP=23000, c=20) (8)

3a.

i. Discuss in detail, the causes of fatigue failure and how to improve the fatigue strength of materials. (8)

ii. How does a fatigue fractured surface analysed? Which are the typical micro structural features? (8)

OR

13b.

i. Discuss in detail, the theories put forth by various researchers on fatigue phenomenon. (8)

ii. Three regions of a fatigue behavior can be identified. Which are these and what are the processes in these regions? (8)

14a.

i. What is the effect of a surface notch on fatigue properties of a rotating shaft? (4)

ii. An edge crack detected on a large plate is of length 3.1 mm under a constant amplitude cyclic load having σmax= 310Mpa and σmin= 172 Mpa . If the plate is made of Ferrite—Pearlite steel and Kic = 165MPa$\sqrt{m}$, determine (a) Propagation life up to failure and (b) Propagation life if the crack length "a" is not allowed to exceed 25 mm.
Use the following data where ever required. f(a/w)=1.12, For Pearlitic- Ferritic steel
$da/dN = 6.8 \times 10^{-12} (\Delta k)^{3.0}$ (12)

OR

14b.

i. How is fatigue crack growth rate is determined, when the amplitude of the fatigue load is varying? A large nonferrous alloy plate contains a crack of length 10mm emanating from a circular hole cut in the middle of the plate. The plate is subjected to a constant amplitude tensile cyclic loading from 6MN m^{-2} to 60MNm^{-2}. The Paris Law exponent is 3 and Δk at $da/dN = 10^{-9}$ m/cycle is 2.8 MN$m^{-3/2}$. Assuming that Q is adequately represented by a constant value of 1.02 , how many loading cycles must be applied for the crack to grow to 20mm? (12)

ii. Super Plasticity is a special case of high temperature deformation. In which way is it different from creep? Elaborate your answer. (4)

5a.

i. What is a fracture and how many types of fractures are normally encountered in engineering applications?.Compare and contrast between creep and fatigue curves. (8)

ii. How can creep damage of a microstructure be analysed? What is the procedure and what are the typical microstructural features? (8)

OR

5b.

i. What is Fractography and explain in detail as to how to carry out this analysis? (6)

ii. Describe in detail , as a material scientist, how you would carry out a failure analysis study on a field complaint reported by your customer? (10)