

M.TECH MATERIAL ENGINEERING FIRST YEAR
FIRST SEMESTER - 2018

DEFORMATION AND DAMAGE

Time: Three hours

Full Marks: 100

Answer Question No. 1 and any Four from the following
(All parts of a question must be answered chronologically)

1. Answer any five from the following:

5 x 4 = 20

- (a) How would you prove the irreversible phenomenon of plastic deformation?
- (b) "Springs are not made of aluminium" - Justify.
- (c) In the creep range whether would you prefer fine or coarse grained materials? Give reasons in support of your answer.
- (d) What are the differences between "slip" and "twinning"?
- (e) "What hardness testing method would you recommend for Grey Cast Iron? Give reason in support of your answer.
- (f) Grey cast iron is brittle but nodular cast iron is ductile – Explain.
- (g) What are the differences between "slip" and "twinning"?
- (h) "Griffith's Theory cannot be directly applied to Metals and Alloys" – Justify whether the statement is True or False.

2 (a) A tensile stress of 10 MPa is applied along [112] direction of an iron crystal. What is the shear stress in the [010] direction lying on the (001) plane?

(b) After drawing the stress – strain curve of annealed low carbon steel explain the inhomogeneous yielding phenomenon in terms of dislocation theory.

(c) For a steel with ASTM grain size 3, what reduction in grain size would double the yield stress? Express as both average grain diameter and ASTM number. 6 + 8 + 6 = 20

3(a) Find the relation between True Stress and Engineering Stress, and True Strain and Engineering Strain.

(b) Give an account for ductile fracture mechanism of a material under tensile loading.

(c) Explain the "leak before break" criterion for designing of a pipe carrying poisonous gas. 6 + 8 + 6 = 20

4 (a) Derive the condition for tensile instability during uniaxial tensile testing of a ductile material.

(b) What is "mechanical equation of state? What do you understand by strain rate sensitivity of a material? Give an account for "strain ageing 8 + 3 + 4 + 5 = 20

- 5 (a) What is known as SIF? Comment on the significance of SIF in Cracked body.
- (b) State and explain Griffith's Theory for Brittle Fracture. Find the relationship for Griffith Fracture stress of a material and make comment on Griffith's formulation.
- (c) Discuss Wood's model for fatigue crack initiation in a specimen under push-pull loading condition.

5 + 3 + 7 + 5 = 20

- 6 (a) Discuss the Notch strengthening phenomenon in case of ductile material. Why does the presence of a notch increases the tendency of a material to fail in a brittle manner? Explain.

- (b) The half length of cracks in a steel is 2 micron. Taking $E = 200$ GPa, estimate the brittle fracture strength at low temperatures, if the true surface energy is 1.5 J/m^2 . If the actual fracture strength is found to be 1200 MPa explain the difference, if any, between this and your test result.

- (c) Give an example of creep phenomenon at room temperature and justify your answer.

12 + 5 + 3 = 20

- 7 (a) Using fracture mechanics principle derive a general expression for the number of cycles required for failure of a component subjected to fatigue loading.

- (b) Find a relation between plastic zone size and specimen thickness for determining valid plane strain fracture toughness of a material.

- (c) Derive Larsen-Miller parameter and comment on the utility of this parameter?

8 + 5 + 7 = 20