Ref. No.: Ex/Met/T/225/2017

## B.E. METALLURGICAL ENGINEERING, SECOND YEAR, SECOND SEMESTER EXAM 2017

## SUBJECT: MECHANICAL TESTING OF MATERIALS

**Time: Three Hours** **Full Marks: 100**

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(Answer Question No. 1 and any four from the rest; All parts of a question should be answered chronologically)

**Q 1. Answer any four from the following with justification: 4 x 5 = 20**

**(a)** Brinell hardness of a material is load dependent
**(b)** Hardness testing method of Gray Cast Iron
**(c)** Influence of gauge length in tensile elongation
**(d)** Role of grain size on creep deformation resistance of a material
**(e)** Role of grain size on impact toughness of a material
**(f)** Effect of strain rate on equicohesive temperature

**Q 2. (a)** Give instruction to a machinist-cum-operator in steps for doing tensile test out of round bar of 16 mm diameter and tabulate the required tensile properties. Consider that the machinist-cum-operator will simply follow the steps that you mention.

**(b)** What is impact transition temperature? How would you determine the impact transition temperature of a metal? 12 + 8 = 20

**Q 3. (a)** Find the condition for tensile instability.
**(b)** What is meant by strain rate sensitivity of a material? – discuss.
**(c)** Write down the "constitutive Equation" correlating strain, strain rate and temperature. How would you experimentally determine the individual term of the "constitutive Equation" that relates the tensile flow stress of a material? Discuss.
**(d)** On what factor does tensile uniform elongation of a material depend? – Explain. 5+5+5+5 = 20

**Q 4.(a)** Discuss the law relating to fatigue crack growth rate.
**(b)** What is Coffin-Manson relationship? How would you extract the data required for Coffin-Manson plot?
**(c)** "True fatigue endurance behavior is not observed in all types of materials" – Justify.
**(d)** A steel bar is subjected to a fluctuating axial loa that varies between +330 kN and -110 kN. The mechanical properties of the steel are: $\sigma_u$ = 1050 MPa; $\sigma_o$ =910 MPa; and $\sigma_e$ = 475 MPa.
Determine the bar diameter to give infinite fatigue life based on a safety factor of 2.5. 4+6+5+5=20

**Q 5. Write short notes on the following:**
**(a)** Stress rupture test; **(b)** Brinell Hardness Testing method; **(c)** Corrosion fatigue; **(d)** Resilience. 6+5+5+4 = 20

**Q6. (a)** What is Larsen-Miller parameter and what is the utility of this parameter? Derive the Larsen-Miller parameter. 2+2+6 = 10
**(b)** Arrange in increasing order of creep resistance of a material with justification –
**(i)** Single crystal; **(ii)** polycrystal; **(iii)** Directionally solidified crystal 5
**(c)** Derive the relationship between – **(i)** True Stress and Engineering Stress; **(ii)** True strain and Engineering Strain. 5

**Q 7. (a)** Draw and explain the nature of constant load creep curve of a material.
**(b)** Prove that in case of tensile tests the condition of tensile instability can be expressed as: $\frac{d\sigma}{de} = \frac{\sigma}{1+e}$
**(c)** Why does fatigue failure start from the surface even in case of push-pull uniaxial cyclic loading of very good surface finish.
**(d)** How can you prove that tensile yield strength is a material property? 6+6+4+4 = 20