

**III B.Tech. I Semester Supplementary Examinations, April/May -2005**  
**MECHANICAL METALLURGY**  
**(Metallurgy & Material Technology)**

**Time: 3 hours****Max Marks: 80**

**Answer any FIVE Questions**  
**All Questions carry equal marks**

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1. (a) Explain how do changes in the dislocation density affect the strength and ductility of metals.  
(b) Compute the line energy of dislocations in FCC Aluminium. The Burger's vector in Aluminium is  $\frac{1}{2} < 110 >$ . The shear modulus of Aluminium is 28.4 Gpa.
2. (a) What are the limitation of Brinnell's hardness test? Why should we adopt Rockwell hardness test? What necessiates employment of A, B & C scales in Rockwell test.  
(b) An engineer claims that metal 1 is harder then metal II when tested by Brinell test, But metal II is harder than metal 1 when tested by Rockwell test. Justify his claim and explain the reasons.
3. (a) Explain the various factors to be considered in the selection of materials.  
(b) Draw the engineering stress - strain curve for the following material and explain the same for their variation
  - i. Mild steel
  - ii. Cast iron
  - iii. Concrete
  - iv. glasses
  - v. Rubber.
4. (a) Explain how temper embrittlement can be avoided.  
(b) Explain the factors that affect ductile to Brittle transition temperature for steels.
5. Derive an expression to show that the critical stress required for fracture in brittle material with a small crack is very less compared to what we get on theoretical calculation.
6. (a) Describe in detail any one test for evaluating the fatigue strength and explain how the data is used to obtain fatigue limit.  
(b) Explain various mechanisms of fatigue failure.
7. (a) Draw an ideal Creep curve and explain the various stages on it.  
(b) With the sketch of a creep test set up explain how creep rupture tests are conducted.

8. (a) Explain the principle of Magnetic particle inspection.
- (b) What are the limitations of this method?
- (c) What are the methods available for demagnetization of inspected components?  
Explain them

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1. (a) An annealed metal contains a dislocation density of  $10^6$  and the dislocation density increases to  $10^{12}$  on cold working. How this can be explained.  
(b) Diagrammatically represent the intersection of two edge dislocations creating a jog and explain the phenomenon.
2. (a) Explain the principle of working of Rockwell superficial hardness test with the help of a neat sketch. What are the advantages and limitations of this method?  
(b) In vicker's hardness test, on a steel sample the length of the diagonal of indentation was found to be 750 microns for a load of 30 kgs. Calculate vickers hardness number.
3. Explain the following with reference to tensile test.
  - (a) What is meant by strain hardening index.
  - (b) Derive an expression for condition of necking in a tensile specimen.
  - (c) Explain how strain rate sensitivity would affect neck formation.
  - (d) Explain what do you mean by mechanical HYSTERESIS.
4. Discuss the different types of notched bar impact test specimens with neat sketches and standard dimensions.
5. (a) Under what conditions a ductile material may fail in a brittle manner? Explain about Ductile-Brittle transition temperature.  
(b) What do you mean by fracture toughness? Explain.
6. (a) What are the various types of fatigue cycles that are possible? Explain them.  
(b) What are the metallurgical variables which control fatigue? Explain.
7. (a) Draw an ideal Creep curve and explain the various stages on it.  
(b) With the sketch of a creep test set up explain how creep rupture tests are conducted.
8. What the Nondestructive tests you advise for the following. Give reasons for selection of such a process.
  - (a) Aviation components.

- (b) Weldments of steel used in pressure vessels.
- (c) Forged axels.
- (d) Cold rolled bars of Titanium.
- (e) Surface cracks on tubes.

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1. What is a slip systems. Calculate the number of slip systems in simple cube, BCC, FCC and CPH unit cells. Draw a neat sketch to show slip systems in FCC structures.
2. (a) Explain the specific advantages of Vicker's hardness test.  
(b) What are the units of Rockwell hardness?
3. (a) Distinguish clearly between ductility and malleability.  
(b) Explain the conditions for the formation neck in a tensile test.  
(c) Explain how strain hardening can be observed in a tensile test.
4. (a) Giving the dimensions of the standard specimens used, explain the operation of notched bar impact test.  
(b) Giving reasons explain temper embrittlement phenomenon.
5. (a) A sample of glass has a crack of half length  $2\mu\text{m}$ . The young's modulus of glass  $70\text{GN/m}^2$  is and specific surface energy is  $1\text{J/m}^2$ . Estimate the fracture strength and compare it with its young's Modulus.  
(b) Explain Ductile-Brittle transition temperature in metals.
6. (a) Describe in detail any one test for evaluating the fatigue strength and explain how the data is used to obtain fatigue limit.  
(b) Explain various mechanisms of fatigue failure.
7. Write about  
(a) Various types of creep resistant materials.  
(b) Importance of creep at high temperature.
8. (a) Explain the principle and working of Radiographic NDT with a neat sketch.  
(b) Explain various methods of Mafnetization.

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1. (a) Explain how yield strength is related to grain size of polycrystalline materials.  
 (b) Explain how dislocation energy can be expressed in terms of Burger's vector.
2. (a) What are the limitations of Brinell's hardness test? Why should we adopt Rockwell hardness test? What necessitates employment of A, B & C scales in Rockwell test.  
 (b) An engineer claims that metal 1 is harder than metal II when tested by Brinell test, But metal II is harder than metal 1 when tested by Rockwell test. Justify his claim and explain the reasons.
3. (a) Define ductility in terms of a tensile test. Explain why percentage elongation depends on gauge length of testing specimen.  
 (b) Discuss the relationship between flow stress and dislocation density for BCC materials.
4. (a) What does impact test signify? Explain with necessary formulations, the procedure to be adopted in the impact test, conducted on a pendulum type impact testing machine.  
 (b) Describe ductile to brittle transition temperature.
5. (a) Why brittle materials are used more often in compression than in tension in structural design?  
 (b) Prove that the theoretical cohesive strength of metals is  $\sigma_{\max} = \left[ \frac{E\gamma_s}{a_o} \right]^{1/2}$   
 Where  $\sigma_{\max}$  = maximum stress  
 E = Young's Modulus  
 $\gamma_s$  = surface energy  
 $a_o$  = distance between two atoms.
6. (a) What do you mean by fatigue of metals? What factors aid fatigue failure?  
 (b) Draw S-N curve for a mild steel, Al-alloy and a Nickel alloy. Discuss about their endurance limits.
7. (a) Draw an ideal Creep curve and explain the various stages on it.  
 (b) With the sketch of a creep test set up explain how creep rupture tests are conducted.

8. Explain the following N.D.T Processes.

- (a) Magnetic particle inspection
- (b) Ultrasonic flaw detection

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