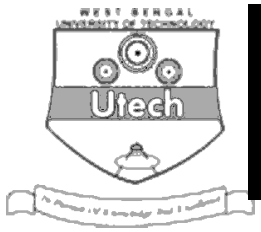
ENGINEERING MATERIAL SCIENCE (SEMESTER - 6)

CS/B.TECH (CT)/SEM-6/MS(CT)-601/09



1. .....
Signature of Invigilator

2. .....
Signature of the Officer-in-Charge

Reg. No.

Roll No. of the Candidate

CS/B.TECH (CT)/SEM-6/MS(CT)-601/09
ENGINEERING & MANAGEMENT EXAMINATIONS, JUNE – 2009
ENGINEERING MATERIAL SCIENCE (SEMESTER - 6)

Time : 3 Hours] [Full Marks : 70

INSTRUCTIONS TO THE CANDIDATES :

1. This Booklet is a Question-cum-Answer Booklet. The Booklet consists of **32 pages**. The questions of this concerned subject commence from Page No. 3.
2. a) In **Group – A**, Questions are of Multiple Choice type. You have to write the correct choice in the box provided **against each question.**
   b) For **Groups – B** & **C** you have to answer the questions in the space provided marked 'Answer Sheet'. Questions of **Group – B** are Short answer type. Questions of **Group – C** are Long answer type. Write on both sides of the paper.
3. **Fill in your Roll No. in the box** provided as in your Admit Card before answering the questions.
4. Read the instructions given inside carefully before answering.
5. You should not forget to write the corresponding question numbers while answering.
6. Do not write your name or put any special mark in the booklet that may disclose your identity, which will render you liable to disqualification. Any candidate found copying will be subject to Disciplinary Action under the relevant rules.
7. **Use of Mobile Phone and Programmable Calculator is totally prohibited in the examination hall.**
8. You should return the booklet to the invigilator at the end of the examination and should not take any page of this booklet with you outside the examination hall, **which will lead to disqualification**.
9. Rough work, if necessary is to be done in this booklet only and cross it through.

No additional sheets are to be used and no loose paper will be provided

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Marks Obtained

	Group – A										Group – B			Group – C				
Question Number																	***Total Marks***	***Examiner's Signature***
Marks Obtained																		

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Head-Examiner/Co-Ordinator/Scrutineer

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GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following : $10 \times 1 = 10$

i) End centred lattice is not possible in case of a/an

a) orthorhombic system b) cubic system

c) tetragonal system d) monoclinic system.

ii) Rhomboidal system is a special case of

a) trigonal system b) hexagonal system

c) triclinic system d) none of these.

iii) Which of the following is not *true* in respect of the environments causing stress corrosion cracking of metals and alloys ?

a) Cu-Zn alloys crack in chloride environments

b) Al-alloys crack in NaCl-H_2O_2 solutions

c) Ti-alloys crack in red fuming HNO_3

d) None of these.

iv) In selecting corrosion resistant metals and alloys for engineering applications, which of the following combinations is not suitable ?

a) For oxidising conditions — chromium containing alloys

b) For extremely powerful oxidising conditions — aluminium alloys

c) For reducing conditions — copper alloys

d) For non-oxidising conditions — nickel alloys.

v) Which corrosion occurs in the lower surfaces of an engineering equipment ?

a) Fretting corrosion b) Crevice corrosion

c) Cavitation damage d) None of these.

vi) Which of the following statements is not correct ?

a) In eutectic change, one liquid phase on cooling produces two solid phases

b) In eutectoid change, one solid phase on cooling yields two solid phases

c) In peritectic change, one solid phase on heating yields two liquid phases

d) none of these.

vii) Which of the following ceramics show both polymorphism and polytypism ?

a) SiC b) Al_2O_3

c) ZrO_2 d) Si_3N_4.

viii) In sintered SiC, a higher fracture toughness indicates

a) smaller crack length

b) fewer small cracks on the surface

c) larger radius of curvature between the sintered grains

d) all of these.

ix) Pick out the correct order of activation energy (Q) for diffusion :

a) $Q_{surface} < Q_{grain\ boundary} > Q_{lattice}$

b) $Q_{surface} > Q_{grain\ boundary} < Q_{lattice}$

c) $Q_{surface} < Q_{grain\ boundary} < Q_{lattice}$

d) $Q_{surface} > Q_{grain\ boundary} > Q_{lattice}$.

x) For detecting the presence and contents of the surface atoms, we perform

a) Anger electron spectroscopy b) Electron spin resonance

c) Mossbauer spectroscopy d) All of these.

GROUP – B

(Short Answer Type Questions)

Write explanatory notes on any *three* of the following. 3 × 5 = 15

2. Selective leaching.

3. Cathodic protection of metals

4. Tensile fracture of metals

5. Primary and secondary recrystallization.

6. Differences between slip and twinning.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following questions. 3 × 15 = 45

7. Prove that $\tau_{max} = \frac{G}{2\pi}$, where the notations have usual meanings. What is the role of dislocations in the plastic deformation of metals ? Calculate the shear strain rate in terms of dislocation density in a crystal. 6 + 2 + 7

8. a) "Real materials tend to fracture at a much lower stress than the theoretical strength value." Discuss and derive the Griffith's models alongwith the modifications of the atomistic crack propagation process by which the discrepancy between the observed and the theoretical strength values can be explained.

   b) Estimate the surface energy of a surface etched sodium silicate glass which has a fracture strength of 100 MNm^{-2} and a Young's modulus of 70 MNm^{-2}. Assume that etching has removed all surface cracks. A number of cracks are also present inside the glass sample and they vary in length from 1 μm to 5 μm. 10 + 5

9. a) Discuss the mechanism of strain (work) hardening of metals.

   b) Discuss recovery, recrystallization and grain growth. How do they affect physical properties of metals ?

c) Discuss 'solution hardening' and state why in respect of solution hardening of a material, the yield point is characterised by a sudden drop in the stress. 4 + 6 + 5

10. a) Define and discuss corrosion polarisation with reference to the electrode kinetic behaviour of pure zinc in acid solution.

b) A mild steel tank 80 cm high with 25 cm × 25 cm sq. bottom is fitted with aerated water upto the 50 cm level and shows a corrosion loss of 256 gm over a 5 week period. Calculate :

i) the corrosion current

ii) the C.D. associated with corrosion current

[At mass of Fe = 55·85 g/mol.]

c) A galvanic cell consists of an electrode of iron in a 0·02 m solution of $FeSO_4$ and an electrode of Cu in a solution of 0·05 M $CuSO_4$ at 25° C. What is the *emf*. of the cell when a switch between the two electrodes is just closed ?

$$\begin{bmatrix} \text{Given } E_{0\ Cu^{2+}/Cu} = +\cdot 337 \text{ V} \\ E_{0\ Fe^{2+}/Fe} = -\cdot 440 \text{ V} \end{bmatrix}.$$

7 + 4 + 4

11. a) What is Pilling-Bedworth ratio ? How do its values determine as to whether an oxide of a metal might be protective ? What other factors are important if a metal is to form a protective oxide ?

b) Discuss the diffusion assisted mechanism of oxidation of metals with sketches.

c) Calculate the Pilling-Bedworth ratio for the oxidation of metallic iron oxide. The density of iron = 7·86 g/cm^3 and that of iron oxide = 5·24 g/cm^3.

$$\begin{bmatrix} \text{At. wt. of iron} = 55\cdot 85 \\ \text{At. wt. of oxygen} = 16 \end{bmatrix}$$

Comment on whether the oxide formed would be protective or not ? 5 + 5 + 4 + 1

END