L-3/T-1/MME Date : 10/05/2014

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2012-2013

Sub : **MME 321** (Crystal Defects, Deformation and Fracture)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **EIGHT** questions in this section. Answer any **SIX.**

1. (a) What do you understand by Cottrell Atmosphere? **(7)**
   (b) Explain the reasons for strain aging and serrated stress-strain curve of engineering materials. **(10 ½)**

2. (a) Derive Schmid Law. **(8)**
   (b) A single crystal of FCC copper is deformed in tension. The loading axis is [112]. Calculate the Schmid factors for the different slip systems. If the critical resolved shear stress is 50 MPa, what is the tensile stress at which the material will start to deform plastically? **(9 ½)**

3. What do you understand by twinning? Discuss the mechanisms of twinning of a polycrystalline material. **(17 ½)**

4. (a) Using diagrams, explain how cross-slip can act as a Frank-Read source for dislocation generation. **(7)**
   (b) "Interstitial atoms such as C and N in iron lead to an exceptional strengthening effect in steel than commonly used substitutional atoms such as Mn and Si". Explain. **(10 ½)**

5. What do you understand by Peierls-Nabarro stress? Explain its significance on slip in crystals. **(17 ½)**

6. Illustrate and discuss the formation of jogs in edge dislocations for the following two cases: (a) two edge dislocations with Burgers vectors at right angles to each other, and (b) edge dislocations with parallel Burgers vectors. **(17 ½)**

7. (a) Derive an expression for stress field around screw dislocations using both rectangular and polar coordination systems. **(10)**
   (b) What is Shockley partial? How are they formed in FCC crystals? **(7 ½)**

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8. (a) Lead has a lattice parameter of 0.4949 nm and contains one vacancy per 500 Pb atoms. Atomic weight of lead is 207.19 gm/mol. Calculate the number of vacancies per gram of lead. **(8)**

(b) A niobium alloy is produced by introducing tungsten substitutional atoms into the BCC structure; eventually an alloy is produced that has a lattice parameter of 0.32554 nm and a density of 11.95 g cm^{-3}. Calculate the fraction of the tungsten atoms in the alloy. Atomic weights of niobium and tungsten are 92.91 and 183.85 gm/mol, respectively. **(9 ½)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE.**

9. (a) Derive the modified Griffith equation of fracture stress for elastic-plastic material. **(18)**

(b) Calculate the fracture stress for a metal with the following properties **(7)**

$E = 70$ GPa

$\gamma_p = 200$ J m^{-2}

$C = 0.2$ mm

(c) Explain the phenomenon of ductile to brittle transition. **(10)**

10. (a) Illustrate the stage of crack initiation under cyclic loading for a initially defect free smooth specimen. **(12)**

(b) Draw a crack growth curve ($\frac{da}{dN}$ vs. cyclic stress intensity factor ΔK) and discuss the different characteristic regions in the curve. **(12)**

(c) A mild steel plate is subjected to constant amplitude uniaxial fatigue load to produce stresses varying from $\sigma_{max} = 180$ MPa to $\sigma_{min} = -40$ MPa. The static properties of the steel are $\sigma_o = 500$ MPa, $S_u = 600$ MPa, $E = 207$ GPa and $k_c = 100$ MPa $m^{1/2}$. If the plate contains an initial through thickness edge crack of 0.5 mm, how many fatigue cycles will be required to break the plate? **(11)**

(Assume any missing data. All the symbols have their usual meaning).

Given, for mild steel $\frac{da}{dN} = 6.9 \times 10^{-12} (\Delta k)^3$ and $\alpha = 1.12$

$$\left[N_f = \frac{1}{A\sigma_r^p \pi^{p/2}} \int_{a_i}^{a_f} \alpha(a)^{-p} \, a^{-p/2} \, da \right]$$

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11. (a) Briefly discuss the crack-deformation mode using schematic diagrams. **(10)**

(b) Derive the following expression for fracture toughness, $G_c = \frac{1}{2} P_{max}^2 \frac{\partial (1/M)}{\partial a}$, where all the symbols have their usual meanings. **(13)**

(c) A steel plate with a through thickness crack of length 2a = 20 mm is subjected to a stress of 400 MPa normal to the crack. If the yield strength of the steel is 1500 MPa, what is the plastic zone size and the stress intensity factor for the crack? Assume that the plate is infinitely wide. Also assume any missing data. **(12)**

12. (a) Draw and discuss a typical creep curve showing three stages of creep. **(12)**

(b) Using schematic diagrams, write down the mechanisms of Coble creep and Nabarro-Herring creep. Also, briefly discuss the significances of diffusion creep. **(12)**

(c) Write down the reasons for cavity formation at grain boundaries during high temperature deformation. **(11)**

L-3/T-1/MME **Date : 24/05/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2012-2013

Sub : **MME 341** (Refractories and Furnaces)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Give a neat sketch and describe the working principles of a stationary regenerator. **(15)**

   (b) With the help of appropriate diagrams, write in details how waste heat recovery from the flue gas improves the furnace efficiency in terms of fuel savings. **(20)**

2. (a) List various type of converters and describe them in brief using free hand neat sketches. **(20)**

   (b) What are the main differences between shaft furnaces and hearth furnaces? **(15)**

3. (a) Write down the differences between a recuperator and a regenerator. **(10)**

   (b) Write short notes on (i) induction furnace and (ii) parallel flow recuperator. **(15)**

   (c) Write down the working principles and sequence of operations of electric arc furnaces. **(10)**

4. (a) Describe in detail the refractories that are used in different parts of blast furnace and stove. **(15)**

   (b) A blast furnace stove burns B.F. gas at the rate of 760 m^3/minute with 15% excess air. B.F. gas analysis is CO = 24%, CO_2 = 14%, H_2 = 4%, N_2 = 58%. Waste gas leaves the stove at 150°C. The net calorific value of the gas is 798 Kcal/m^3. Cold air blast at 180°C is preheated to 1000°C in a period equal to the heating time of the stive at a rate of 1980 m^3/minute. The specific heat of both air and gas may be taken as 0.320 Kcal/m^3 °C. The total heat loss from the stove may be assumed to be 33000 Kcal/minute. **(20)**
   Calculate the heat balance and thermal efficiency of the stove using ambient temperature of 15°C.

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Define the term 'refractory'. List and explain important properties that are considered during its selection for a particular use. **(20)**

   (b) Classify refractory materials and describe any two of them. **(15)**

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6. (a) What is firing shrinkage? Why must this shrinkage be reduced? How can one reduce it? **(15)**

   (b) What is spalling? Illustrate the effect of various factors on spalling. Describe the spalling fractures that are found in service. **(20)**

7. (a) Mention the manufacturing process of silica refractories. List the changes that occur during firing siliceous materials. **(20)**

   (b) Write about dolomite refractories giving their properties and uses. **(15)**

8. (a) Describe a tunnel kiln with the help of a neat sketch. How does it differ from a compartment kiln? **(20)**

   (b) Write four advantages and four disadvantages of a tunnel kiln as compared to compartment kiln. **(15)**

L-3/T-1/MME **Date : 31/05/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2012-2013

Sub : **MME 351** (Principles of Ore Dressing and Extractive Metallurgy)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Recycling of metals have become an important source of metals – justify. Classify scrap metals in terms of availability. **(15)**

   (b) Oceans are important source of metals – Explain. **(8)**

   (c) Why is drying an expensive process? Explain the drying operation in a rotary cylindrical dryer. **(12)**

2. (a) What are the advantages of toothed roll crusher over smooth roll crusher? **(8)**

   (b) How does a jaw crusher works? Explain the important characteristics of a jaw crusher. **(15)**

   (c) Differentiate between crushing mills and revolving mills. **(12)**

3. (a) Define recovery and ratio of concentration. Derive an expression of recovery using two product formula. **(15)**

   (b) "Both horizontal and vertical movements are required for an efficient screening operation" – explain. **(9)**

   (c) What is classification? Explain the principle of classification. **(11)**

4. (a) Draw a neat sketch and explain the functioning of a disc magnetic separator. **(15)**

   (b) What are collectors? **(5)**

   (c) Explain the basic principle of floation process. **(15)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Distinguish between smelting and matte smelting. Outline, with appropriate chemical reactions, the process of extraction of copper by matte smelting. **(18)**

   (b) What is zone refining? Explain, with a suitable phase diagram, the principles of zone refining. **(10)**

   (c) What is a predominance area diagram? What are its uses and limitations? **(7)**

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6. (a) What are the essential features of successful hydrometallurgical process? Under what conditions would it be preferred to a pyrometallurgical process? **(15)**

   (b) What are the common types of leaching regents? Discuss the criteria for the selection of an effective leaching regent. **(12)**

   (c) Discuss the importance of potential/p^H diagrams in leaching operations. **(8)**

7. (a) Draw neat sketches and explain the situations that can arise when a mineral surface dissolves in a leaching regent. Identify the kinetic steps in each case and explain how the leaching reaction can be accelerated. **(20)**

   (b) Explain, with appropriate chemical reactions, the purification of leach liquors by the ion exchange method. **(15)**

8. (a) List the basic conditions that an electrolyte must satisfy. **(5)**

   (b) Consider the relative activity of metals with respect to hydrogen and explain why all metals are not amenable to electrowinning from aqueous solutions. **(15)**

   (c) Discuss the production of aluminium by the Hall process. **(15)**

L-3/T-1/MME Date : 17/05/2014

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2012-2013

Sub : **MME 325** (Corrosion and Degradation of Materials)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) What is the significance of hydrogen overvoltage in the corrosion of metals in aquous solution? **(7)**

   (b) What is "stray-current effect" in cathodic protection systems? Explain how this effect can be prevented? **(13)**

   (c) The idealized lattice structure of pure nickel oxide is shown in figure 1(a). What will be the effect on overall electrical conductivity if this oxide is doped with substantial ions of Li^+ and Cr^{3+} as shown in figure 1(b) and figure 1(c) respectively? **(15)**

2. (a) The active-passive metal shows as unusual corrosion behavior when they are immersed in electrolyte with redox agents. Explain this unusual corrosion behavior with the help of mixed-potential theory. **(15)**

   (b) With suitable diagram, explain the effect of oxidizer concentration on the electrochemical behavior of an active-passive metal. Hence prove that the amount of oxidizer necessary to cause passivation is greater than that required to maintain passivity. **(20)**

3. (a) Briefly discuss the mechanism of corrosion prevention by alteration of environment and inhibitors. **(20)**

   (b) List the design rules that should be followed for best corrosion resistance. What, in your opinion, is the most general rule for protection? **(15)**

4. (a) What are the main differences between corrosion of metals and degradation of polymers? **(5)**

   (b) List and explain the types of degradation generally observed in polymers. **(20)**

   (c) Two gas pipelines, each 50 km long and 0.5 m diameter, are laid in different parts of Chittagong-Comilla zone at the same time. Pipeline A receives a very poorly applied coal tar epoxy coating, while pipeline B is given a high quality protective coat. Each line is further protected by an impressed current installation which uses a 220 V, 80 A (17.6 kW) rectifier system to cover the whole length of the line. **(10)**

   After several years, it is found that pipeline A required a current density 2.0 mA m^{-2} to achieve the protection potential, while line B required 95 μA m^{-2}. The recommended current density 140 μA m^{-2}. For each pipeline, comment upon any excess or shortfall in the capacity of the protection system.

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MME 325

SECTION – B

There are **EIGHT** questions in this section. Answer any **SIX.**

5. (a) Shortly discuss the methods for minimising intergranular corrosion in austenitic stainless steels. **(10 ½)**

   (b) What do you understand by knife line attack? Describe the mechanism of knife line attack in Type 347 (18-8+cb) steel drum. **(7)**

6. (a) Using schematic diagrams, explain the autocatalytic nature of pitting. **(12 ½)**

   (b) How are pitting damages evaluated? **(5)**

7. (a) With schematic diagram explain the mechanism of crevice corrosion. **(12 ½)**

   (b) Galvanic corrosion has several beneficial applications – explain. **(5)**

8. (a) Two plates of copper and steel are exposed in the ocean for 15 months. The copper plate has steel rivets and the steel plate has copper rivets. Compare the two plates in terms of area effect of galvanic corrosion. **(12 ½)**

   (b) Write down four procedures for preventing or minimising crevice corrosion. **(5)**

9. (a) With schematic representation of sequential steps, explain how cavitation damage is formed. **(11 ½)**

   (b) Explain the characteristics of dezincification. **(6)**

10. (a) Briefly discuss the effect of velocity and impingement on erosion corrosion. Draw schematic diagram if necessary. **(12 ½)**

    (b) Briefly illustrate the interaction between corrosion filaments. **(5)**

11. (a) What are the basic requirements for the occurence of fretting corrosion? Explain the oxidation-wear theory of fretting corrosion. **(4+9 ½)**

    (b) Write down the crack morphology of stress corrosion cracking (SCC). **(4)**

12. (a) Write short notes on the following: **(2×6 ½)**

    (i) Caustic embrittlement of steel

    (ii) Hydrogen Blistering

    (b) Explain the effect of the nature and properties of the protective film on the resistance to erosion corrosion. **(4 ½)**

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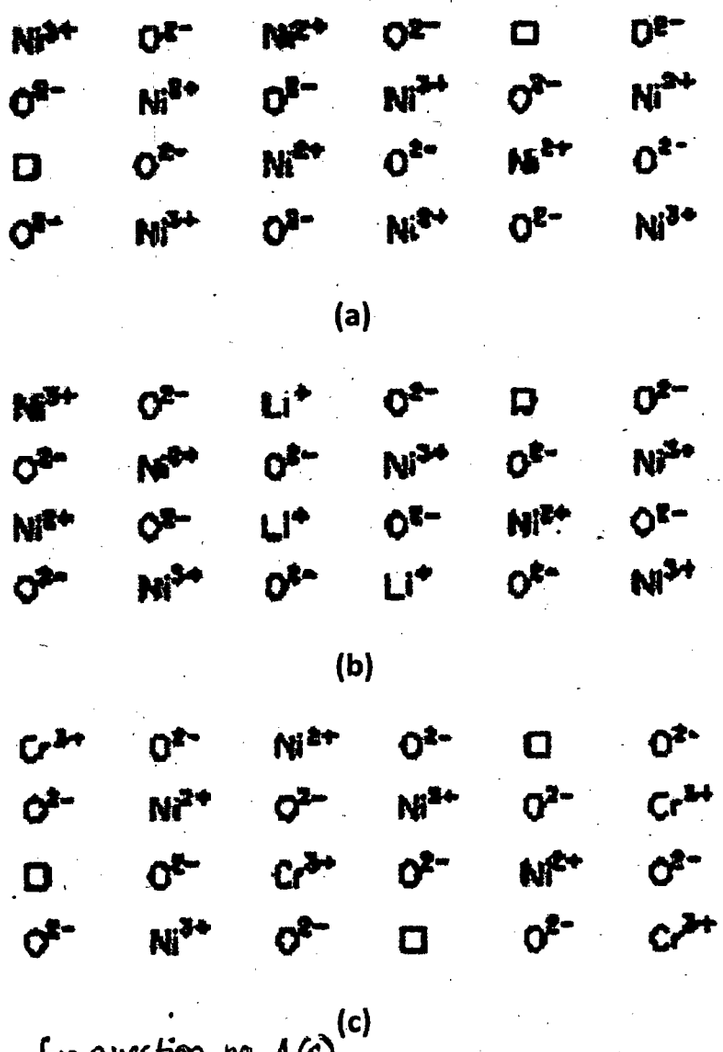

for question no. 1(c)

Figure 1: Idealized lattice structure of nickel oxide (a) pure NiO; (b) Li^{+} addition and (c) Cr^{3+} addition