L-3/T-1/MME **Date : 28/02/2012**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2010-2011

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) What is refractory? Write short notes on refractoriness under load (RUL) and pyrometric cone equivalent (PCE). **(11)**

   (b) Classify refractories based on chemical composition. **(12)**

   (c) Describe fining process of firebrick manufacturing. **(12)**

2. (a) Explain action of heat on silica. **(15)**

   (b) Draw a Al_2O_3 — SiO_2 equilibrium phase diagram showing all important phases on it. **(10)**

   (c) Which raw materials are generally used for the production of silica refractories? **(10)**

3. (a) Mention the changes, those take place during heating of fireclay refractories. Explain the changes occur during firing of fireclays. **(15)**

   (b) Explain how firing shrinkage can be reduced. **(20)**

4. (a) How are impurities removed by purification during the production of magnesite refractories ? **(8)**

   (b) Explain drying and firing of magnesite refractories. **(17)**

   (c) Write short notes on insulation refractories. **(10)**

SECTION – B

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

5. (a) List various types of crucible furnaces and describe them in brief using free hand neat sketches. **(25)**

   (b) Define furnace and write the factors on which furnaces are classified. **(10)**

6. (a) What are the advantages of liquid fuels? Describe the characteristics of commonly used liquid fuels. **(25)**

Contd P/2

MME 341

Contd ... Q. No. 6

(b) What do you mean by kiln efficiency? Draw the heat balance diagrams of a recuperative kiln with 66% efficiency and 100% efficiency. **(10)**

7. (a) Mention the differences between a compartment kiln and a tunnel kiln. In your opinion, which one is more thermally efficient for a large scale refractory industry? Give reasoning of your answer. **(20)**

   (b) What is the principle of oil-fired burners? Draw the different types of oil-fired burners. **(15)**

8. (a) Give a neat sketch and describe the working principle of a recuperator burner. **(17)**

   (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 saving. **(18)**

L-3/T-1/CHE **Date : 28/02/2012**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2010-2011

Sub : **MME 391** (Fundamentals of 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) Describe various chemical reactions that occur in stack, bosh and hearth regions of a blast furnace. **(20)**

   (b) How does a dust catcher remove dust from blast furnace gas? Explain with necessary sketch. **(10)**

   (c) What are the main five components of a modern blast furnace plant? **(5)**

2. (a) Describe briefly how steel is produced in an open hearth furnace. **(15)**

   (b) Distinguish between Beseemer and L-D processes of steel making. **(12)**

   (c) Why is an electric furnace now-a-days utilized during steel making process? **(8)**

3. (a) Compare hot metal working process with cold metal working process. **(12)**

   (b) Select and describe a cold metal working process suitable for producing a conical shaped product from a thick flat metal plate. **(16)**

   (c) Calculate the amount of pressure applied to a steel part (3 in. × 3 in.) during hot working process using a press forging machine having a capacity of 1.5 ton. **(7)**

4. (a) Mention different types of stainless steel along with their composition, properties and uses. **(18)**

   (b) Briefly describe the process of producing electrolytic tough pitch copper. **(12)**

   (c) List five advantages of alloy steel. **(5)**

SECTION – B

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

5. (a) Define the three isothermal reactions with respect to the Fe-Fe_3C equilibrium diagram. **(12)**

   (b) Sketch and label the steel part of the Fe-Fe_3C equilibrium diagram upto temperature 1130° C on graph paper. You have been given samples of the following materials: **(23)**

Contd P/2

MME 391

Contd ... Q. No. 5(b)

(i) 0.4 wt% carbon steel

(ii) 0.8 wt% carbon steel

(iii) 1.2 wt% carbon steel

You may assume that each specimen has been coolled very slowly to room temperature from a temperature of 1100° C.

Compute the mass fractions of phases that form in the above mentioned three samples at room temperature.

6. (a) Discuss the influence of the following elements on the structure and properties of cast iron **(12)**

(i) silicon (ii) manganese (iii) sulphur (iv) phosphorus

(b) Describe the method of producing ferritic malleable cast iron showing the gradual microstructural changes in each step. **(23)**

7. (a) Differentiate between **(18)**

(i) Malleability and ductility

(ii) Toughness and hardness

(iii) Yield strength and tensile strength

(b) What do you understand by ductile to brittle transition of materials? With necessary diagram, explain its importance for designing engineering materials. **(17)**

8. (a) Define case hardening. Name some engineering components that need case hardening for their uses. List the various case hardening processes and describe briefly any one of them. **(15)**

(b) Mention the NDT methods used in engineering purposes. Describe, with necessary figures, how an internal defect is located by the method of ultrasonic testing technique. **(20)**

L-3/T-1/MME **Date : 23/02/2012**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2010-2011

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) Define n-type and p-type oxides. Give examples. **(8)**

   (b) 'Li has virtually no resistance to oxidation but Li improves the oxidation resistance of Ni when added in small amounts. On the contrary, Cr invariably presents in oxidation resistant alloys but small aditions of Cr in Ni deteriorates its oxidation resistance.' — Justify with necessary figures. **(27)**

2. (a) What is active-passive metal? Explain, with suitable diagram, the effect of oxidizer concentration on the electrochemical behaviour of an active-passive metal. Hence prove that the amount of oxidizer necessary to cause passivation is greater than that required to maintain passivity. **(27)**

   (b) Discuss the velocity effect of electrolyte on the corrosion rate of (i) a normal metal and (ii) an active-passive metal both corroding under diffusion control. **(8)**

3. (a) Compare the Zn-pt and Zn-Au galvanic couples as shown in Fig.1. Hence make the concluding remark. **(10)**

   (b) 'Galvanic couples containing active-passive metals produce unusual effects under certain conditions.' — Explain the statement with necessary figures, examples and conditions. **(25)**

4. (a) Explain how you could reduce corrosion by the selection of proper materials. **(15)**

   (b) What is stray-current effect in cathodic protection system? Explain how this effect can be prevented. **(15)**

   (c) Compare and contrast cathodic protection to anodic protection. **(5)**

SECTION – B

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

5. (a) Write the possible oxidation and reduction half cell reactions that occur when magnesium is immersed in each of the following solutions **(18)**

Contd P/2

MME 325

Contd ... Q. No. 5(a)

(i) HCl, (ii) HCl solution containing dissolved oxygen (iii) HCl solution containing dissolved oxygen and Fe^{2+} ions.

In which of these solutions would you expect the most rapid oxidation to magnesium. Why?

(b) What is Pilling-Bedworth ratio? Pilling-Bedworth ratio does not accurately predict oxidation resistance. Do you agree? Explain your answer. **(17)**

6. (a) With schematic diagram explain the mechanism of crevice corrosion. **(20)**

   (b) 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. **(15)**

7. (a) How can you prevent erosion corrosion? **(15)**

   (b) With schematic representation of sequential steps, explain how cavitation damage is formed. **(20)**

8. (a) Differentiate between stress corrosion cracking and hydrogen embrittlement. **(15)**

   (b) Write short notes on the following: **(20)**

   (i) Dezincification

   (ii) Knife line attack

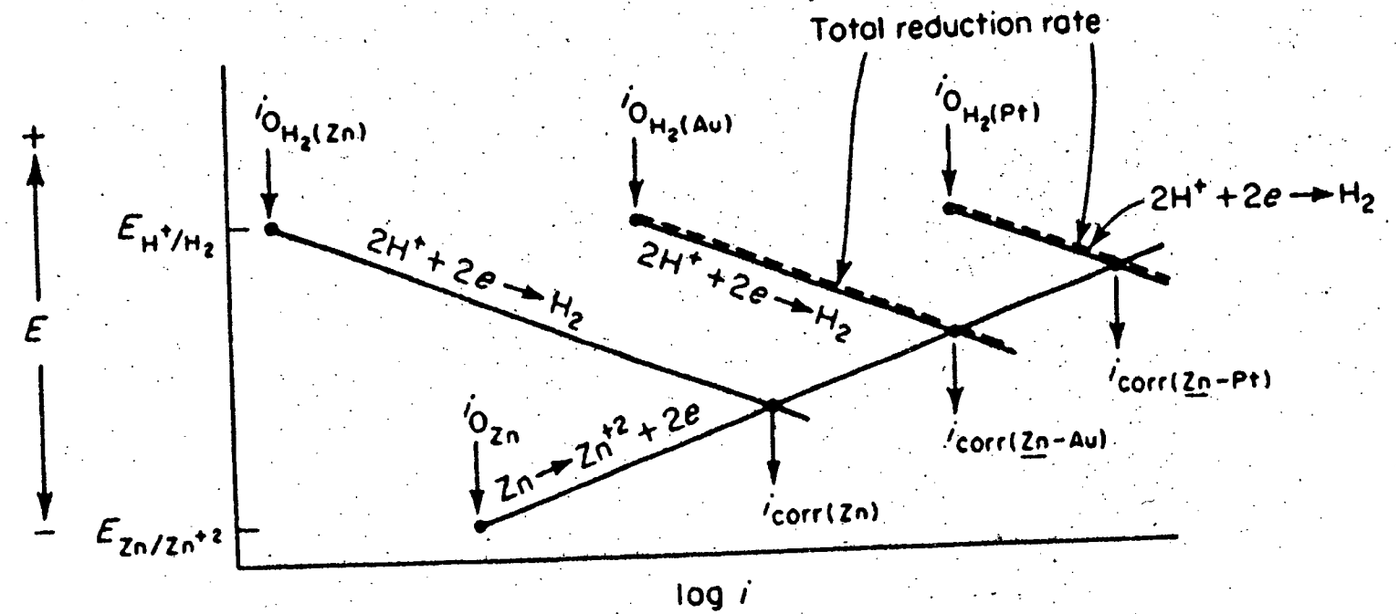

Fig. 1 : Figure for Q. No. 3(a)

L-3/T-1/MME **Date : 16/02/2012**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2010-2011

Sub : **MME 323** (Physical Properties 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 **EIGHT** questions in this Section. Answer any **SIX**.

1. Derive a solution for Schrödinger's equation for a particle in two dimension box, bound by infinite potential. **(17.5)**

2. Explain the variations in Energy vs wave vector (E – k) diagram for both zero and non-zero potential energy of the system. **(17.5)**
   What do these two conditions mean for a system consisting of nucleus and electrons.

3. Derive continuity equation from Schrödinger's equation and show that probability current density $J = \frac{\hbar k}{m} \psi\psi^*$ **(17.5)**
   where each term expresses their usual meaning.

4. For a system with spherical symmetry derive the following expression -- **(17.5)**
   $$E\, f(r) = -\frac{\hbar^2}{2m}\frac{\partial^2}{\partial r^2} f(r) - \frac{Zq^2}{4\pi \epsilon_0 r} f(r)$$
   where both θ and ϕ are held constant.

5. Using finite difference method derive an expression for energy of a particle, based on Schrödinger's equation. **(17.5)**

6. Describe degenerate levels. Explain how degenerate level play their role in availing the number of states in the channel region of a device. **(17.5)**

7. Discuss the I-V characteristics for different gate voltages with respect to the changes in inversion channel for a MOS transistor. **(17.5)**

8. Discuss the similarities and differences between JFET and MOSFET. Explain how the energy band structure changes from source to drain terminal for both JFET and MOSFET. **(17.5)**

Contd P/2

MME 323

SECTION – B

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

9. (a) What is superconductivity? What benefits could its application make possible? **(10)**

   (b) Discuss how BCS theory explains superconductivity at temperatures close to absolute zero. **(15)**

   (c) Explain why ceramic superconductor materials are so exciting and have opened up new opportunities. **(10)**

10. (a) Draw the V-I characteristics of a typical semiconductor upon biasing. Discuss how the characteristics would change when conduction occurs through tunneling. **(20)**

    (b) Calculate the equilibrium contact potential difference and depletion layer width for a pn junction in silicon, given that the impurity concentrations are $N_a = 1 \times 10^{23}\ m^{-3}$ and $N_d = 1 \times 10^{22}\ m^{-3}$ respectively, while $n_i = 1.6 \times 10^{16}\ m^{-3}$ at T = 300 K and $\epsilon_0 = 8.85 \times 10^{-12}\ kg^{-1}m^{-3}s^4A^2$ and $\epsilon_r = 12$. Briefly discuss the factors that control the width of the depletion layer. **(15)**

11. (a) Show the Fermi level in an n-type semiconductor in relation to the electron distribution function, at a temperature T > 0 K. How will the position of Fermi level of n type semiconductor change with temperature? **(20)**

    (b) Explain the relation between recombination and energy momentum characteristics in a semiconductor. Mention the application of this concept and how it affects that application. **(15)**

12. (a) Show that the solution for time independent one dimensional Schrödinger's equation is **(20)**

$$\psi(x) = \sqrt{\frac{2}{a}} \sin \frac{n\pi x}{a}$$

    (b) Explain how energy bands of atoms respond when distance between them is reduced. **(15)**

L-3/T-1/MME **Date : 02/02/2012**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B.Sc. Engineering Examinations 2010-2011

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

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this Section. **Q. No.** 1 is compulsory. Answer any two from the rest of the questions in Section A. The figures in the margin indicate full marks.

1. Answer any ten questions of the following thirteen: **(10 × 4=40)**

(a) Write down the Burgers vectors for a perfect and a partial dislocation in the ccp structure.

(b) What are the partial dislocations formed when a dislocation of $\frac{a}{2}[10\bar{1}]$ moves on the {111} plane in an fcc crystal?

(c) What kind of crystal imperfection results from the dissociation of a perfect dislocation of an fcc crystal?

(d) What determines the distance of separation of the Shockley partials due to dislocation dissoriation?

(e) What is the slip plane of the Lomer-Cottrell barrier formed by combining the $\frac{a}{2}[\bar{1}01]$ on (011) with the $\frac{a}{2}[101]$ on $(0\bar{1}\bar{1})$?

(f) What is the climb force on a dislocation when it hits the precipitate out of its mid-plane?

(g) What is the difference between the motion of a jog on an edge and a jog on a screw dislocation?

(h) What is the minimum length of a dislocation segment required to act as Frank-Read source for dislocation multiplication?

(i) Write down the approximate dislocation density of a completely annealed and a heavily cold worked metal.

(j) Mention the energy required to form a vacancy and an interstitial due to jog dragging in an fcc metal.

(k) What are the prerequisites for the recrystallization process?

(l) What is the reason behind a low carbon steel shows upper and lower yield points in its load versus elongation curve?

(m) What are two main sources of dislocation in a freshly grown crystal?

Contd P/2

MME 321

2. The following data were obtained for a carbon steel and an aluminium alloy.

Carbon steel		Aluminium alloy	
d (μm)	σ_y (MN/m^2)	d (μm)	σ_y (MN/m^2)
406	93	42	223
106	129	16	225
75	145	11	225
43	158	8.5	226
30	189	5.0	231
16	233	3.1	238

(a) Show that the behaviour of the steel and aluminium alloy is consistent with the Hall-Petch relation and determine σ_0 and k_y for each material. **(18)**

(b) Microalloyed steels contain small additions of vanadium or niobium that permit the grain size to be reduced to about 1 μm if the processing of the steel is carefully controlled. Likewise, advanced aluminium alloys containing special types of particles can be processed to yield a grain size of about 1 μm. Suppose you are able to reduce the grain size of steel and aluminium from 150 μm to 1 μm by treatments of these types. Would you expect to see a substantial increase in the strength of these materials as a result? Comment on your answer. **(14½)**

3. (a) By taking a thermodynamic approach, develop an expression for the equilibrium number of vacancies in a crystal as a function of temperature. With the help of above analysis make a comment on the fact that vacancies are an equilibrium feature of crystal but dislocations are not. **(18)**

(b) A crystal of ferrous oxide Fe_yO (based on NaCl structure) is found to have a lattice parameter a = 0.43 nm and a density of 5.72 g/cm^3. What is the composition of the crystal (i, e, the balue of y in Fe_yO)? For $Fe_{0.98}O$, the density is 5.7 g/cm^3. Calculate the site fraction of iron vacancies and the number of iron vacancies per cubic centimeter. **(14½)**

4. (a) List major differences between deformation by twinning and deformation by slip relative to mechanism, conditions of occurrence and final result. **(8)**

(b) Explain why HCP metals are typically move brittle than FCC and BCC metals. **(6)**

(c) Briefly explain why small angle grain boundaries are not as effective in interfering with the slip process as are high angle grain boundaries. **(6)**

(d) Write short note on strain aging. **(12½)**

Contd P/3

MME 321

SECTION – B

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

The questions are of equal value.

5. Draw a typical fracture mechanism map for body centered cubic metal molybdenum and explain its various features.

6. How is cyclic stress-strain curve drawn? Compare and contrast the monotonic and cyclic stress-strain curves of a typical strain hardenable metal.

7. Define low cycle fatigue failure. Give some example of practical applications where low cycle fatigue failures take place and discuss the mechanisms that impose the low cycle fatigue conditions upon those structures.

8. A high strength low alloy steel plate is subjected to a constant amplitude uniaxial fatigue load to produce stresses varying from σ_{max} = 180 MPa to σ_{max} = – 40 MPa. The plate contains a through thickness edge crack and that it fails after 280,000 cycles. Determine the length of the crack. Given: σ_u = 600 MPa, E = 207 GPa, and K_c = 100 MPa $\sqrt{m}$. All symbols have their usual meanings. Assume reasonable value for any missing data.

9. What do you understand by the term "equicohesive temperature"? Discuss why single crystal provides appreciable creep resistance at relatively high temperature.

10. Mention various fracture modes. Discuss various parameters that might influence the low temperature fracture behavours of materials under different loading modes.

11. With schematic diagrams discuss how decrease in temperature changes the micro-mechanisms of brittle fracture in a notched specimen under tensile loading.

12. Discuss the model proposed by Cottrel for ductile brittle transition of materials. The ductile-brittle transition behavior of BCC structure metals is very sensitive to temperature – why?
