L-3/T-1/MME Date : 16/01/2016

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2014-2015

Sub : **MME 449** (Ferrous Production Metallurgy)

Full Marks : 280 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) With the help of neat sketches show how solid charge materials are fed into iron blast furnace with double cup and cone arrangement. **(20)**

   (b) Give a neat sketch of iron blast furnace and explain how and where impurities (C. Si. Mr. P and S) are picked up in liquid iron. **(26 2/3)**

2. (a) Mini blast furnace and electro thermal process are two established processes of producing liquid pig iron in small quantities. Out of these two processes which one do you think most suitable for Bangladesh? Justify your answer and explain how liquid iron can be produced by your proposed process. **(26 2/3)**

   (b) Mention the modern trends (with their effects) now a days are practiced in iron blast furnace operation to increase the productivity and lower coke consumption. **(20)**

3. (a) For the production of DRI explain why natural gas alone can not be used as a reductant. **(10)**

   (b) Show graphically the relationship between degrees of reduction (α) and degree of metallization (DOM). Why is DOM always less than α? **(16)**

   (c) Mention the physico-chemical principles of ferro-silicon smelting. **(20 2/3)**

4. The kinetic data for isothermal reduction of iron ore by coal at three different temperatures are given in Fig. 1. The kinetics of reduction of Fig. 1 where found to follow 'first order' reaction mechanism which is expressed by the equation **(46 2/3)**

   $$G(\alpha) = [-\ln(1-\alpha) = kt]$$

   where α is degree of reduction, t is time and k is a constant.

   Estimate the activation energy value for the reduction reactions.

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MME 449

SECTION – B

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

5. (a) Differentiate between vertical type continuous casting process and curved-mould (S type) continuous casting process. **(26 2/3)**

   (b) Why is continuous casting gradually replacing conventional ingot casting? **(10)**

   (c) Mention five functions of vacuum degassing. **(10)**

6. (a) Compare and contrast electric arc furnace stainless steel making process with electric arc furnace-argon oxygen decarburization stainless steel making process. **(25 2/3)**

   (b) Write short notes on ladle degassing, batch degassing circulation degassing. **(21)**

7. (a) Discuss the sources and role of slag in steel making processes. **(20 2/3)**

   (b) Describe the sequence of operation of a LD steel making process. **(18)**

   (c) Oxidation may create problems during high alloy steelmaking – explain. **(18)**

8. (a) Using induction furnace and ladle refining furnace, is it possible to produce good quality steel in Bangladesh? Justify your answer. **(30 2/3)**

   (b) How are sulphur and phosphorus removed during the refining period of steel making? **(16)**

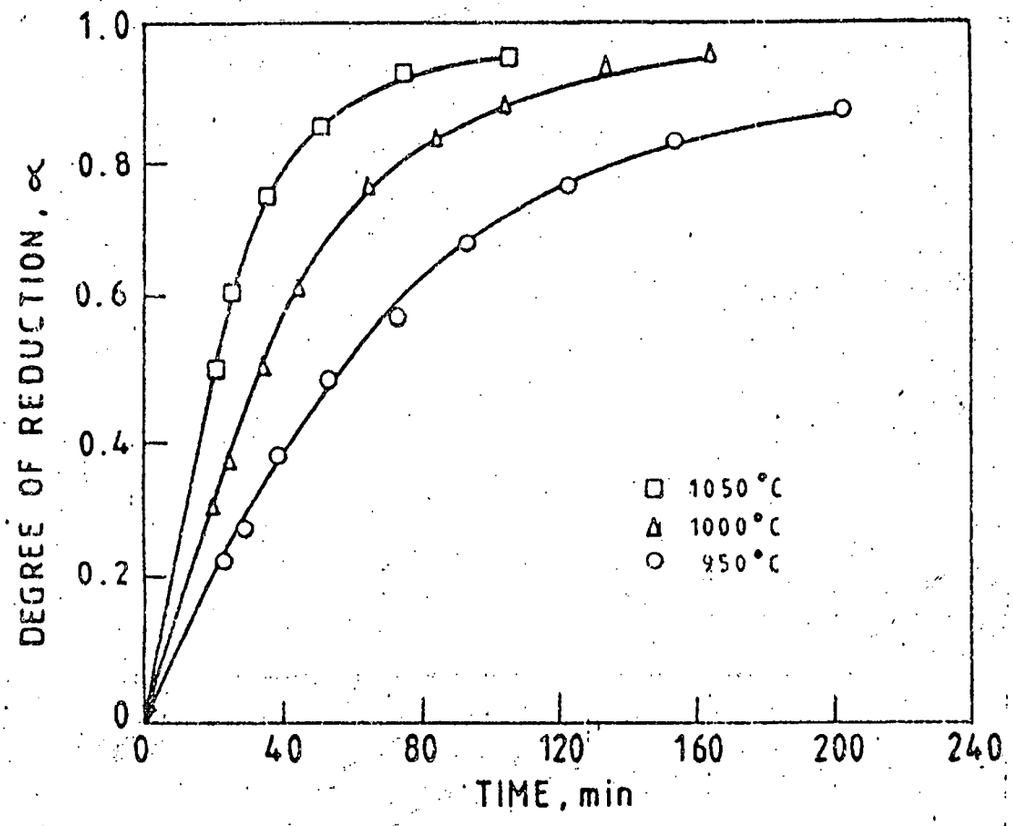

Fig (1) Kinetics of isothermal reduction of iron ore by coal.

Figure for Q. No. 4

L-3/T-1/MME **Date : 21/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2014-2015

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

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

The figures in the margin indicate full marks.

1. What do you understand by cross slip? Explain the reasons why screw dislocations can move by this method, while edge dislocations cannot. **(17 ½)**

2. Climb is a non-conservative motion of dislocations. Explain the reasons. **(17 ½)**

3. Describe how dissociation of unit dislocations leads to formation of stacking fault and partial dislocations. **(17 ½)**

4. Explain the differences between jogs and kinks. Briefly narrate jogs and kinks in screw dislocations. **(17 ½)**

5. Describe the mechanism of dislocation loop formation by Frank-Read mechanism. **(17 ½)**

6. Discuss the following scenarios of arrangement of edge dislocations with parallel Burgers vectors lying in parallel slip planes. **(17 ½)**

   (a) Like dislocations on the same slip plane,
   (b) Unlike dislocations on the same slip plane, and
   (c) Unlike dislocations on closely spaced neighboring slip plane.

7. A 4340 steel bar is subjected to a fluctuating axial load that varies from a maximum of 330 kN tension to a minimum of 110 kN compression. Determine the diameter of the bar to give infinite fatigue life based on a factor of safety of 2.5. Consider Goodman line for fatigue data. Mechanical property data: σ_u = 1090 MPa, σ_o = 1010 MPa and σ_e = 510 MPa. **(17 ½)**

8. (a) Using a schematic plot of distribution of fatigue life at constant stress, discuss statistical nature of fatigue. **(9)**

   (b) An infinitely wide 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 stress intensity for the crack? **(8 ½)**

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MME 321

SECTION – B

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

The questions are of equal value.

9. Briefly discuss the mechanisms of formation of Frenkel and extrinsic defects. The equilibrium concentration of vacancies of a metal at room temperature is 4.5×10^{-15}. Calculate the activation enthalpy for the formation of vacancies in the metal. Assume reasonable value for any missing data.

10. Define dilational misfit interaction in strengthening of materials. Discuss the effects of interstitial solute additions on the tensile strength of steel.

11. What do you understand by the term 'strain aging'? Discuss the effects of temperature on the tensile behaviour of a precipitation hardenable nickel base alloy.

12. With neat sketches show different crystallographic relationship between matrix and second phase particles. Discuss why polycrystalline zinc is ductile at high temperature.

13. What do you understand by the term "particle shear" and "particle bypass" mechanisms of strengthening? An alloy containing Al_2Mg precipitates of surface energy 1600 mJ/m^2. The atomic radii of aluminium and magnesium are, respectively, 0.145 nm and 0.160 nm. If the shear modulus of aluminium is 26.0 GPa, calculate the critical spacing of precipitates at which particle shear mode of strengthening will change to particle bypass mode. Assume reasonable value for any missing data.

14. What are heat resistant materials? In terms of various microstructural constituents discuss why nickel base superalloys are very good heat resistant materials.

15. Mathematically prove that the fracture stress of glassy material is inversely proportional to the square root of the crack length. Is it possible to apply this relationship to metallic materials? Discuss the reason.

16. Consider a low alloy steel plate having elastic energy and plastic energy, respectively, 10 J/m^2 and 3000 J/m^2. If the plate contains crack like defects as long as 1 mm, what will be the breaking stress of the plate? Assume reasonable value for any missing data.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2014-2015

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) 'Gaseous oxidation may be considered as analogous to aqueous galvanic corrosion' – explain it. **(8)**

   (b) Discuss the common equations that express the scale thickness formed on any metal during corrosion with time. **(12)**

   (c) Explain how a diffusion controlled oxidation rate can be decreased by doping in p-type oxide. **(15)**

2. (a) Discuss, with suitable examples, the possible cases that may occur when an active-passive metal is exposed to a corrosive environment. **(12)**

   (b) With schematic diagrams, describe the effect of oxidizer concentration on corrosion rate of active-passive metal. Hence, prove that required amount of oxidizer concentration to cause passivation is greater than that required to maintain passivity. **(23)**

3. (a) 'Galvanic couples containing active-passive metals produce unusual effects under certain conditions'. – Explain the statement with necessary figures, examples and conditions. **(23)**

   (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. **(12)**

4. (a) Explain design rules that should be followed for corrosion prevention. **(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)**

Contd P/2

MME 325

SECTION – B

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

5. (a) Define 'a pit'. Describe with necessary figures, how pit depth and specimen area would affect the evaluation of pitting damage. **(20)**

   (b) Two riveted plate specimens of copper and steel both are exposed in the ocean for 15 minutes at the same time. One specimen is steel plate with copper rivets; another specimen is copper plates with steel rivets. Which one will you prefer and why? **(15)**

6. (a) Mention where and under which conditions crevice corrosion usually occurs. With schematic diagram explain the mechanism of crevice corrosion. **(18)**

   (b) What is meant by selective leaching? Outline the commonly accepted mechanism of dezincification. **(17)**

7. (a) Discuss the importance and limitations of emf series. **(18)**

   (b) Explain different types of concentration cells. **(17)**

8. (a) Explain the mechanism of knife line attack. How can you prevent this type of attack? **(20)**

   (b) Discuss the differences between stress corrosion cracking and hydrogen embrittlement. **(15)**

L-3/T-1/MME **Date : 30/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2014-2015

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 rotary heat 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) Draw short notes on (i) induction furnace and (ii) radiation recuperator. **(15)**

   (c) Write down the requirements of heating elements. Give name of two materials that can be used as heating elements in reducing environment. **(10)**

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

   (b) A steel reheating furnace has 10% external loss and receives 10000 m^3/hr of mixed gas. Waste gas passes through air recuperator and then through mixed gas recuperator. **(20)**

   Mean temperature of:

   Air after recuperator = 600° C

   Mixed gas after recuperator = 380° C

   flue gas after reheating furnace = 1100° C

   Flue gas after Air after recuperator = 700° C

   Flue gas after mixed gas recuperator = 500° C

   Air/mixed gas ratio = 2.9

   Flue gas/mixed gas ratio = 3.67

   Net calorific value of mixed gas = 2300 kcal/m^3

   Mean specific heats (kcal/m^3.°C) are as follows:

Gases	Air	Mixed gas	Flue Gases		
Temperature, °C	600	380	1100	700	500
Specific heat, kcal/m^3.°C	0.325	0.353	0.377	0.36	0.351

Contd P/2

MME 341

Contd ... Q. No. 4(b)

Mean specific heat of steel is 0.162 kcal/kg.°C. Steel leaves the furnace at a temperature of 1220° C. Calculate

(i) the useful heat per m^3 of mixed gas

(ii) the thermal efficiency of the furnace

(iii) the throughput of steel

(iv) the thermal efficiency of gas heat exchanger

SECTION – B

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

5. (a) Write down the similarities and dissimilarities between periodic kiln and tunnel kiln. **(15)**

   (b) What types of problems usually occurred during designing a kiln? Explain the ways of minimization of these problems. **(15)**

   (c) Write a short note on shuttle kiln. **(5)**

6. (a) What are the roles of chemical additives to doloma ore? **(10)**

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

   (c) How does silica refractory change during heating? **(15)**

7. (a) Illustrate the effect of baking and vitrifying on kaolin. **(10)**

   (b) "Impurities of fireclay control its various properties". Explain this statement with examples. **(10)**

   (c) Which refractories can be produced by melting? Describe their manufacturing process and practical applications. **(15)**

8. (a) Draw the equilibrium phase diagram of Al_2O_3-SiO_2. What types of information can you extract from this diagram? **(15)**

   (b) Select a suitable refractory for glass melting furnace. Justify your choice. **(10)**

   (c) What are insulating refractories? Mention their advantages and disadvantages. **(10)**

L-3/T-1/MME Date : 04/02/2016

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2014-2015

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) What is roasting? What is the principal object of most roasting reactions? **(10)**

   (b) The removal of the last of the sulphur in roasting is quite difficult – explain why? **(5)**

   (c) Discuss the different methods of roasting. Describe the five stages involved in fluidized bed roasting. **(20)**

2. (a) What is hydrometallurgy? Under what conditions would it be preferred to pyrometallurgy? State the essential steps in hydrometallurgy. **(17)**

   (b) Draw neat sketches and explain the situations that can arise when a mineral surface dissolves in a leaching reagent. Identify the kinetic steps in each case and explain how the leaching reaction can be accelerated. **(18)**

3. (a) Draw a neat sketch and explain how leaching is accomplished in a Pachuca Vat. **(15)**

   (b) Explain, with appropriate chemical reactions, the purification of leach liquors by the ion exchange method. **(20)**

4. (a) Explain the mechanism of electrolysis. What are the essential requirements for electrochemical reactions to occur? **(10)**

   (b) Explain the situations towards the electrodeposition of metal less reactive than hydrogen and of metals more reactive than hydrogen. **(15)**

   (c) Discuss the behaviour of impurities in electrolysis. **(10)**

SECTION – B

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

5. (a) Define ore-dressing. Mention the benefits of ore-dressing. **(10)**

   (b) 'The delineation between ores and minerals is not a fixed division and alters with economic and technological factors change'. – Explain with examples. **(8)**

   (c) 'Recycling of metals has become an important source of metals'. – Justify. Classify scrap metals in terms of availability. **(17)**

Contd P/2

MME 351

6. (a) List the principal types of size reduction machines. **(5)**

   (b) Derive an expression to show that in a Blake jaw crusher, the most powerful forces are applied nearest the pivot where the largest particles are crushed. **(18)**

   (c) What is critical speed of a ball mill? Derive an expression for the critical speed of a ball mill. What will happen when the rotation of a ball mill is too high or too low than the critical speed? **(12)**

7. (a) What is classification? Explain the principle of classification. **(10)**

   (b) What are frothers, collectors, depressors, activators and conditioners? Discuss their roles in the separation of particles by froth flotation. **(25)**

8. (a) Describe, with a neat sketch, how minerals having a wide range of electrical conductivities are separated. **(18)**

   (b) 'Compared with thickening and filtration, drying is expensive'. – Explain. Describe the drying operation in a rotary cylindrical drier. **(17)**
