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09.09.13

L-4/T-1/MME

Date : 06/07/2013

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2011-2012

Sub : **MME 467** (Ceramics for Advanced Applications)

Full Marks: 210

Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION - A

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

1. (a) What are Schottky defects and Frenkel defects? Deduce a relation for the equilibrium concentration of Schottky defects that may form in ceramic material at a given temperature. (16)
- (b) Write the possible Kroger-Vink defect reactions of the following: (6)
 - (i) Incorporate Al into Al_2O_3
 - (ii) Doping MgO with Al_2O_3
 - (iii) Doping SiO_2 with P_2O_5
- (c) Using suitable schematic diagrams, explain the influence of T_c , J_c and H_c on the superconducting behaviour of ceramic materials. (5)
- (d) What is Meissner effect? Explain how this principle is used in the development of 'bullet train'. (8)
2. (a) Electrical conductivity of ceramics can be classed as metallic, semiconducting and insulating. Briefly describe these three classes of materials behaviour in terms of the atomic structure, bonding, and band structure. How ionic conductivity fit into these classes of ceramics? (20)
- (b) For intrinsic silicon, the electron and hole mobilities are 0.135 and 0.048 $\text{m}^2/\text{V.s.}$, respectively. A phosphorous-doped silicon wafer has an electronic resistivity of $8.33 \times 10^{-5} \Omega\text{-m}$ at 300 K. (i) Is this material n-type or p-type? (ii) Calculate the majority-carrier concentration for complete ionisation, assuming that electron and hole mobilities are the same as for the intrinsic material. (iii) What is the ratio of phosphorous to silicon atoms in this material? (Density and atomic mass of silicon are 2.33 g/cm^3 and 28.08 g/mol , respectively. $q = 1.60 \times 10^{-19} \text{ C.}$) (15)
3. (a) Discuss briefly when and how a ceramic material becomes dielectric. Explain the effect of temperature and frequency of applied electric field on dielectric constant of a material. (20)
- (b) Calculate the maximum polarization per cubic centimeter and the maximum charge that can be stored per square centimeter for barium Titanate. (See Figure 1 for reference.) (15)

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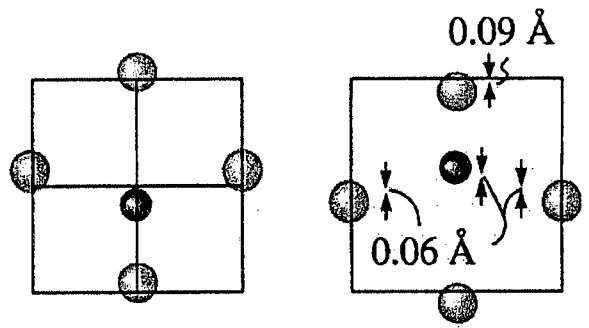
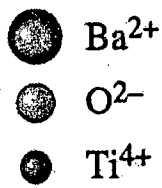
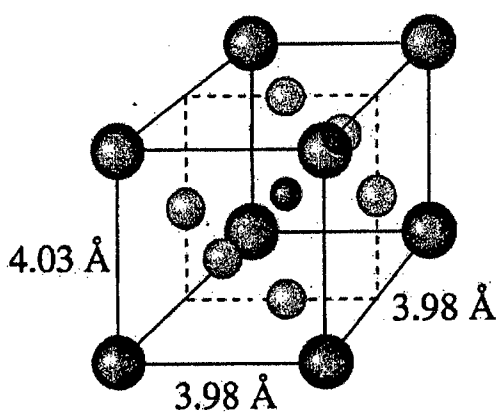
MME 467

4. (a) Using suitable examples, explain the source of magnetism in ceramic materials? Indicate the principal characteristics of ferromagnetic, antiferromagnetic, and ferromagnetic materials. (10)
- (b) Explain why Fe_2O_3 is magnetic while FeO is not. (10)
- (c) Barium titanate is an important ceramic material for electronic applications. Examine briefly its dielectric and ferroelectric behaviour giving special attention to its crystal structure. List a few practical uses of this material. (15)

SECTION – B

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

5. (a) Write notes on any two of the following toughening mechanisms– (20)
- (i) Pre-stressing
 - (ii) Crack bridging
 - (iii) Fibre pull out
- (b) What are the effects of porosity and surface flaws on the mechanical properties of ceramic materials? (15)
6. (a) With respect to processing and properties differentiate between self-reinforced Si_3N_4 and self-reinforced ZrC . (15)
- (b) Discuss the advantages and limitations of transformation toughened zirconia ceramics. (10)
- (c) Describe, in brief, the properties of some common commercially available fibers. (10)
7. (a) Describe the response of some ceramic materials at high temperature in an air or oxygen environment. (15)
- (b) Explain 'condensed-phase corrosion' in terms of ceramic materials. (10)
- (c) Discuss the application of ceramics in automobile and aerospace industries. (10)
8. (a) Write a short review on Sialons giving special reference to its structure, processing, properties and applications. (20)
- (b) A series of tests on a ceramic component indicate that 25% of the samples fail at stresses below 207 MPa whereas only 10% fail at stresses below 198 MPa. (15)
- Determine the Weibull modulus and the maximum allowable stress if only 1 failure per 1000 specimens can be tolerated.
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(b)

Fig.1 for Q.3: (b)

- (a) The oxygen ions are at face centers, Ba^{+2} ions are at cube corners and Ti^{+4} is at cube center in cubic BaTiO_3 .
- (b) In tetragonal BaTiO_3 , the Ti^{+4} is off-center and the unit cell has a net polarization.

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L-4/T-1/MME

Date : 23/07/2013

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2011-2012

Sub : **MME 443** (Physical Metallurgy of Steels and Heat-Treatment)

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 meant by the term 'thermo-mechanical treatment of steels? (7)
(b) Explain the role of controlled rolling in grain size refinement of high-strength, low-alloy steels. (15)
(c) Distinguish between 'ausforming' and 'isoforming'. Mention the effect of composition of the steel on ausforming. (13)
2. (a) What is carburization? Describe briefly how a mild steel piston pin is carburized by the process of pack carburization. Discuss the factors that control the transfer of carbon from the source to the surface of the piston pin during carburization. (20)
(b) Suggest a suitable heat-treatment process with a neat sketch for the pack carburized piston pin. Explain the process with detailed microstructural changes and hardness produced. (15)
3. (a) Distinguish between low temperature cyaniding and high temperature cyaniding. Discuss the processes with chemical reactions involved. (15)
(b) With reference to the iron-nitrogen equilibrium diagram explain how a nitrided case is formed. Write a note on properties of the nitrided case. (20)
4. Answer any two of the following: (17 ½ × 2)
(a) What type of heat-treatment is generally applied to gray cast iron? Discuss them briefly.
(b) How does a ferritic malleable cast iron differ from a ferritic ductile cast iron? Discuss with a typical heat-treatment cycle how a ferritic malleable cast iron is produced from white cast iron. Show the microstructural changes in different stages of the heat-treatment cycle.
(c) Discuss the structure-property relationship of plain low carbon-manganese steels and austenitic stainless steel.

Contd P/2

MME 443

SECTION - B

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

5. Explain how refinement of grains leads to strengthening of steels. (17 ½)
6. (a) Briefly discuss Lüder Band formation phenomenon in steels. (10 ½)
(b) Explain the stress-strain curve behavior of mild steel samples after tensile testing at different test temperature. (7)
7. (a) Write down different morphologies of ferrite occurred when the γ/α transformation temperature is lowered. (10 ½)
(b) Explain shortly pearlite growth model proposed by Zener. (7)
8. Discuss the characteristics and causes of the following defects in steels due to faulty heat treatment and mention the remedies. (17 ½)
(i) Quenching crack (ii) Black fracture (iii) Soft spots (iv) Insufficient hardness after quenching.
9. Using schematic diagrams, superimpose surface-cooling curve and centre-cooling curve on I-T diagram for shallow-hardened steels and explain it. (17 ½)
10. Discuss the major characteristics of martensitic transformation. (17 ½)
11. Draw a typical cooling curve for a 0.30% C steel quenched at 45°C in water. Explain the reasons for the changes in the curve during cooling. (17 ½)
12. A hot rolled 0.50% C steel was full annealed and normalised separately. Draw the microstructures and mention the optimum temperature ranges for these heat treatment processes. Also explain which heat treatment will yield higher strength. (17 ½)
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Opinion
21/09/13

L-4/T-1/MME

Date : 21/09/2013

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2011-2012

Sub : **MME 411** (Principles of Materials Characterization)

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 questions are of equal value.

1. Define characterization. Is it possible to have an idea about the toughness and transition temperatures of materials by observing their fracture surfaces? Discuss your opinion with necessary sketches and diagrams.
2. Explain the importance of proton affinity of chemical ionization gases in mass spectroscopy. Discuss the mechanisms involved in the matrix assisted laser desorption ionization method for test sample ionization.
3. Mention different light sources that are used for visible light spectroscopy. What do you understand by "Conjugate system" for hydrocarbon? Discuss how visible spectroscopy helps us to detect the conjugated hydrocarbon.
4. Compare and contrast the dispersive IR and FTIR spectrometers. What do you understand by reversing and non-reversing events in the DSC Curves?
5. In TGA analysis, there is possibility of getting any one of the seven different types of curves as shown in the figure for Q. No. 5. Discuss the reasons of TGA curves of these various patterns and give some related examples.
6. For a typical pressure vessel application, the initial carbide particle sizes in the initially selected steel were studied under a very high resolution FEG-SEM. The data concerning the carbide particle size distributions are:

Size of carbide particles, nm	Proportion of carbide particles, %
50	50
100	35
150	15

If the service temperature causes the carbide particles of the steel structures to grow by 10% in every year, calculate the proportions of the carbide particles that will be possible to observe under a high resolution metallurgical (optical) microscope after five years of continuous service and explain the reason.

MME 441

7. Discuss the interaction of electron beam with any test sample during surface study by SEM. For revealing grain boundaries and/or carbide/matrix interfaces what type of electron will be better? Why?
8. With neat sketches discuss the working principle of AFM. Discuss the advantages and disadvantages of EDS and WDS for chemical analysis of materials.

SECTION - B

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

The figures in the margin indicate full marks.

9. (a) Distinguish between Compton and coherent scattering. (10)
(b) Why is monochromatic X-ray beam needed for X-ray diffraction? Explain how monochromatic X-ray beams are produced by using a suitable filter. (13)
(c) How will you estimate the particle size using X-ray diffraction technique? (12)
10. (a) What is atomic scattering factor? (5)
(b) Discuss how diffraction occurs in Lane method. (20)
(c) X-ray pattern of a metal (cubic structure) showing a peak of (200) at a diffraction angle ($2\theta = 37.6^\circ$). X-ray radiation wavelength is 0.1542 nm. Calculate the interplanar spacing for this set of planes and the lattice parameters of the plane. (10)
11. (a) Derive an expression for structure factor. (25)
(b) Calculate the structure factor of base-centered cubic cell and show the five possible reflections. (10)
12. (a) Compare between optical emission spectroscopy (OES) and atomic absorption spectroscopy (AAS). Describe the working principle of OES. (25)
(b) Suggest a suitable spectroscope for a steel industry to be used to determine the chemical composition of the product. Justify your suggestion. (10)

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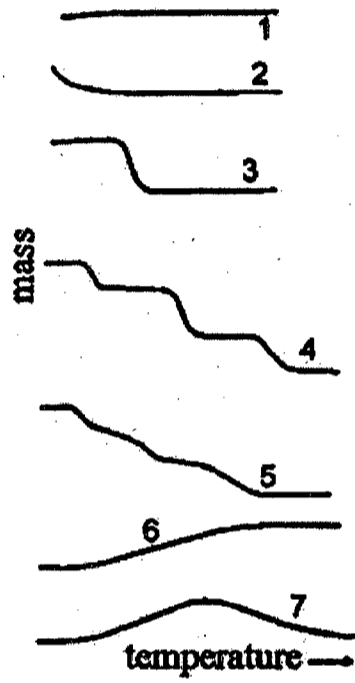


Figure for Question No. 5.

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28-9-2013

L-4/T-1/MME

Date : 28/09/2013

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2011-2012

Sub : **MME 475** (Polymers and Composites)

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: Filament, Yarn, Tow and Fabric. (8)
(b) Describe the 'Hand Lay-Up' method for processing of fibre reinforced materials. (15)
(c) Deduce an equation to measure indirectly the volume fraction of voids in a composite. (12)

2. (a) What is critical fibre length? How composite behaviour depends on the critical fibre length? (7)
(b) Deduce an equation for minimum volume fraction of fibre, V_{min} for effective fibre reinforcement and critical volume fraction of fibre, V_{crit} to ensure that composite strength is higher than matrix ultimate strength in isolation. Also show that V_{min} is always smaller than V_{crit} . (18)
(c) Write the conditions of single and multiple fracture mode of a composite when (i) Fibre fracture strain is smaller than matrix fracture strain and (ii) Matrix fracture strain is smaller than fibre fracture strain. (10)

3. (a) Define the different toughening mechanisms of CMCs. (10)
(b) Describe ~~merit~~^{melt} infiltration and chemical vapour infiltration process for CMCs processing. (18)
(c) What is the effect of hot-pressing temperature and pressure on carbon fibre reinforced glass. (7)

4. (a) Explain the mechanism of function of coupling agent containing silane molecule at PMC interface. (12)
(b) What are in situ MMCs? Differentiate between 'combination type properties' and 'morphology-dependent properties' for in situ MMCs. (13)
(c) Describe different types of bonding at matrix-reinforcement interface of MMCs. (10)

Contd P/2

MME 475

SECTION - B

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

5. (a) Outline the main features of injection molding process with the aid of injection molding cycle. (13)
- (b) Design and describe an injection molding manufacturing process suitable for PVC plastic production. (22)
6. (a) Differentiate between (i) block copolymer and graft copolymer, (ii) branched polymer and crosslinked polymer and (iii) syndiotactic polymer and atactic polymer. (8+8+8)
- (b) "Glass transition temperature is important during in-service applications of polymer" – explain. (6)
- (c) The density for two polytetrafluoroethylene materials are $2.144 \frac{g}{cm^3}$ and $2.215 \frac{g}{cm^3}$ respectively, while the associated percent crystallinity of those two materials are 51.3 and 74.2 respectively. Calculate the density of totally crystalline polytetrafluoroethylene material. (5)
7. (a) Compare and contrast thermoplastic polymer with thermoset polymer. (17)
- (b) Explain the importance of crazing in polymer. (10)
- (c) Mention four roles of additives in plastics. (8)
8. (a) Select and describe a manufacturing process suitable for plastic film production. (18)
- (b) What is sandwich injection molding? Why is sandwich injection molding preferred for plastic production? (10)
- (c) Mention the importance of venting zone in an extruder. (7)
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*MMA 05/10***SECTION – A**There are **FOUR** questions in this section. Answer any **THREE**.

1. Mary has just been diagnosed as having a cancer at a fairly advanced stage. So she is to receive the radiation therapy which involves using an external beam treatment machine to pass ionizing radiation through the patient's body, damaging both cancerous and healthy tissues. After thorough analysis, the medical team has carefully estimated the data needed to design Mary's treatment, as summarized in Table 1:

(35)

Table 1 : Data needed to design Mary's treatment

Area	Fraction of entry does absorbed by area (Average)	
	Beam 1 (Kilorads)	Beam 2 (Kilorads)
Healthy anatomy	0.4	0.5
Critical tissues	0.3	0.1
Tumor region	0.5	0.5
center of tumor	0.6	0.4

The average dosage absorption for healthy anatomy must be minimized, the critical tissues must not exceed 2.7 kilorads, the average over the tumor region must equal 6 kilorads and the center of the tumor must be at least 6 kilorads.

- (a) Formulate a linear programming model for this problem.
 (b) Using the Big M method, construct the complete first simplex tableau for the simplex method.
 (c) Work through the simplex method step by step to solve problem.
2. (a) Powerco has three electric power plants that supply the needs of four cities. The shipping costs, supply and demand for Powerco is given in table 2.

(30)

Table 2 : Data of shipping costs, supply and demand for Powerco

From	To				Supply (million kwh)
	City 1	City 2	City 3	City 4	
Plant 1	\$ 8	\$ 6	\$ 10	\$ 9	35
Plant 2	\$ 9	\$ 12	\$ 13	\$ 7	50
Plant 3	\$ 14	\$ 9	\$ 16	\$ 5	40
Demand (million kwh)	45	20	30	30	

IPE 491 (MME)

Contd ... Q. No. 2(a)

- (i) Use the Vogel's Approximation Method to find the basic feasible solution.
- (ii) Develop the iterations that lead to the optimum solution.
- (b) Differentiate 'efficiency' and 'effectiveness' with example. (5)
- 3. (a) What is an organization? What are the common characteristic of an organization? (10)
- (b) Who are managers? How does the managerial skills related to the management levels? (10)
- (c) According to Henry Mintzberg, what are the roles that managers play at work? (15)
- 4. (a) Why people are driven by particular needs at particular times? (10)
- (b) Describe Herzberg's theory of motivation. (10)
- (c) Most companies are turning to micro marketing at one of four levels – explain these levels with appropriate example. (15)

SECTION – B

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

- 5. (a) Differentiate between pure project, functional project and matrix project organization structure. (10)
- (b) Consider the following project (times given in days) (25)

Activity	Optimistic Time	Most Likely Time	Pessimistic Time	Predecessors
A	1	4	7	---
B	2	2	2	---
C	2	5	8	A
D	3	4	5	A
E	4	6	8	C, B
F	0	0	6	C, B
G	3	6	9	D, E

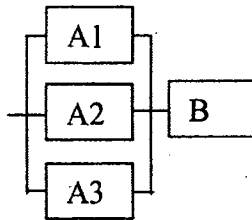
Find:

- (i) The network
- (ii) All expected activity times, variances and slacks
- (iii) The critical path and expected completion time
- (iv) The probability the project will be done in 23 days.

IPE 491 (MME)

6. (a) Equipment failure rate is a function of time – justify this statement by the use of bath tub curve. (20)

Let us consider a system where three components are in parallel and one in series. Reliabilities of components for 100 hours of operation are $A_1 = A_2 = A_3 = 0.75$, $B = 0.97$. Find out the system failure rate and MTBF for the system per 10000 hours.



- (b) What are the common types of respiratory protective equipments? Describe the working principle of closed circuit type SCBA. (15)

7. (a) What are the benefits of Kaizen? Suppose you are a manager in the production planning division of XYZ Company. You noticed that the production volume of the company is not satisfactory for the last few months. You believe that there must be some problems, if solved, will certainly increase the production rate. Illustrate the steps you must go through to get from 'problem faced' to 'problem solved'. (20)

(b) Striving for zero defects through a program of continuous improvement is not always a company's best economic interest – justify this statement with the help of Juran Model. Also illustrate the point of view of other experts with this explanation. (15)

8. (a) What are the similarities and dissimilarities between Halsey plan and Rowan plan. Write down the characteristic of a good incentive plan. (20)

(b) Calculate the total earnings of a worker and the earning per hour where payment of bonus is under (i) the Halsey (50%) scheme and (ii) the Rowan scheme from the below mentioned particulars: (15)

Basic wage rate per hour is \$ 10.80, Time allowed for the job is 48 hours, Actual time taken is 36 hours.
