L-4/T-1/MME Date : 02/11/2019

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2018-2019

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

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) Which X-ray diffraction method is used in the field of materials characterization? "Monochromatic X-ray radiation is required for X-ray diffraction analysis of material"- Justify the statement. **(10)**

   (b) Cite the characterization tools that can be used to investigate the surface and interface chemistry of materials. **(5)**

   (c) Explain how ring type diffraction pattern in a polycrystalline material is formed and from this pattern how would you identify the crystal planes. **(20)**

2. (a) Explain why matching of relative intensities is not always possible even when the examined specimen has the same crystalline structure as the standard of X-rd analysis. **(10)**

   (b) A high carbon steel (1.15%C) part was quenched and tempered. The microstructure of the sample revealed martensite (α) and austenite (γ). X-rd test was conducted and different diffraction peaks from the planes of martensite and austenite were identified. Calculate the mass fraction of martensite and austenite of the hardened sample. Consider the position of peaks for martensite and austenite are $2\theta_{\alpha(211)} = 35.5^0; 2\theta_{r(311)} = 37.8^0$ respectively. Peaks intensity found $I_{r(311)} = 79$ unit $I_{\alpha(211)} = 63$ unit: X-ray radiation was Mo Kα= 0.711Å **(25)**

3. (a) Distinguish between mass-thickness contrast and diffraction contrast in transmission electron microscopy. How does image of crystalline solid form in TEM by diffraction contrast mode? **(15)**

   (b) Are secondary electrons or backscattered electrons to be preferred for imaging a fracture surface? Explain your reasoning. **(10)**

   (c) Why do people often increase acceleration voltage to obtain better resolution in SEM? Is there any negative effect of increasing acceleration voltage on SEM imaging? **(10)**

4. (a) Why, in you opinion, are people more likely to use an AFM than an STM for topographic examinations? **(8)**

   (b) Why would you expect a fracture surface to be a difficult sample for microanalysis in the scanning electron microscope? What purpose might be served by comparing microanalysis from a fracture surface with that from a polished and etched specimen of the same material? **(15)**

   (c) Explain a characterization method to be used for the identification and distribution of different phases in a sample. **(12)**

Contd P/2

MME 411

SECTION – B

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

5. (a) Why do Auger lines appear in the XPS spectrum? [Hint: Auger is a relaxation process.] **(8)**

   (b) What is the approximate sampling depth in XPS and what control this depth. **(9)**

   (c) What is the peak area ratio of the spin-orbital splitting between T_i 2p ½ and T_i 2p ⅔. **(9)**

   (d) Why is an Auger spectrum presented as a derivative plot? **(9)**

6. (a) The IR spectrum for acetylene (C_2H_2) contains a strong absorbance at 3423 cm^{-1}, but the Raman spectrum contains absorbance at 3476 cm^{-1} and 2181 cm^{-1}. **(13)**

   (i) What are the number of vibrational modes for acetylene

   (ii) Explain, in detail, the source of the differences in the IR and Raman spectra.

   (b) Explain how sampling with Reflectance examination techniques of FTIR works and what advantage it has over transmission IR sampling. **(10)**

   (c) What do you understand by "Conjugate system" for hydrocarbon? Discuss how visible spectroscopy helps us to detect the conjugated hydrocarbon. **(12)**

7. (a) Sketch the heat flux versus temperature plot for a semi-crystalline polymer such as PET, showing the glass transition, crystallization and melting regions. In your sketch indicate which direction is endothermic. **(15)**

   (b) How does the rate of heating affect the DSC curves? **(8)**

   (c) Consider a semi-crystalline sample such as nylon that is hydroscope, melts at 120°C and degrades at 250°C. Sketch the weight versus temperature curve you would expect from a TGA instrument. **(12)**

8. (a) Explain how internal cracks of a non-ferrous component are identified by a suitable NDT technique. **(12)**

   (b) Illustrate the secondary ion generation process during the collision of primary ion with a typical solid. **(13)**

   (c) Explain the purposes of pre-discharge phase for the chemical composition analysis with optical emission spectrometer. **(10)**

Substance	Type of structure	Lattice parameters (A)	Spacing of cleavage planes (A)
Fe_3C (cementite)	Orthorhombic	a = 4.525 b = 5.088 c = 6.740	
Austenite	FCC, A1	a = 3.555 + 0.044 x (x = weight percent carbon)	
Martensite	BC Tetragonal	a = 2.867 − 0.013 x c = 2.867 + 0.116 x (x = weight percent carbon)	

Table 1a for Question 2(b)

Cubic:	$\frac{hkl}{48^*}$	$\frac{hhl}{24}$	$\frac{0kl}{24^*}$	$\frac{0kk}{12}$	$\frac{hhh}{8}$	$\frac{00l}{6}$	
Hexagonal and Rhombohedral:	$\frac{hk\cdot l}{24^*}$	$\frac{hh\cdot l}{12^*}$	$\frac{0k\cdot l}{12^*}$	$\frac{hk\cdot 0}{12^*}$	$\frac{hh\cdot 0}{6}$	$\frac{0k\cdot 0}{6}$	$\frac{00\cdot l}{2}$
Tetragonal:	$\frac{hkl}{16^*}$	$\frac{hhl}{8}$	$\frac{0kl}{8}$	$\frac{hk0}{8^*}$	$\frac{hh0}{4}$	$\frac{0k0}{4}$	$\frac{00l}{2}$
Orthorhombic:	$\frac{hkl}{8}$	$\frac{0kl}{4}$	$\frac{h0l}{4}$	$\frac{hk0}{4}$	$\frac{h00}{2}$	$\frac{0k0}{2}$	$\frac{00l}{2}$
Monoclinic:	$\frac{hkl}{4}$	$\frac{h0l}{2}$	$\frac{0k0}{2}$				
Triclinic:	$\frac{hkl}{2}$						

Table 1b for Question 2(b)

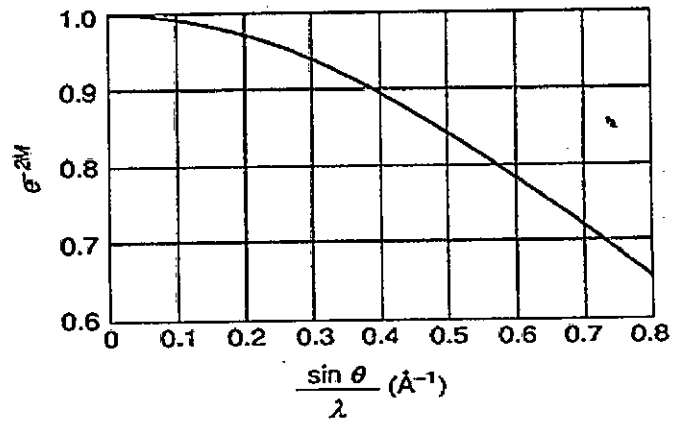

Figure 1 for Question 2(b)

L-4/T-1/MME **Date : 19/10/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2018-2019

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

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 equal value.

1. A hyper eutectoid steel having carbon content 1.5% is to be machined by a conventional shaper machine. Suggest a suitable heat treatment that will make the process easier. Explain your opinion in terms of various possible microstructural features associated with this steel.

2. Do you think that phosphorus is absolutely a detrimental element for any structural steel? Explain the underlying reasons in detail.

3. With sketches explain how hardening takes place in steel on quenching. Why austenitic stainless steel in not possible to harden by conventional heat treatment process?

4. Explain why full austenization at high temperature results reduction in M_s temperature as well as martensite proportion in hardened high carbon steel. A 1050 steel is alloyed by adding 3.0% Cr, 1.0% Ni, and 0.6% Cu. What will be the change in M_s temperature of the steel?

5. For a particular application AISI 1080 steel component of 6 inch diameter needs to be used in hardened condition and the microstructures must contain 50% lower bainite, 40% martensite and 10% retained austenite. Use the Figure for Question No. 5 and design the heat treatment schedule mentioning austenitizing temperature, soaking time, cooling rate at various stages and isothermal cooling time.

6. As a quenching media oil is a better selection for components of intricate shape-Why? Referring to Figure for Question No. 6 explain various stress states that a sample usually experiences during quenching.

7. What are the main challenges in hardenability control of high carbon high alloy steel? To satisfy the service condition a hardened steel component should have 100% martensitic microstructures with a hardness value of 60 HRC. Calculate the carbon content needed to satisfy the service conditions.

Contd P/2

MME 443

8. Briefly explain how S and Mn contents mutually influence the microstructures of cast iron? Is it possible to control the temper embrittlement in this cast iron? How?

SECTION – B

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

The figure in the margin indicate full marks.

9. (a) Describe vacuum carburizing process. What if propane is used instead of methane for the thermal decomposition process during vacuum carburizing? **(15)**

(b) Show the effect of nitriding temperature and time on final hardness of the hardened surface. **(5)**

(c) Differentiate between surface hardening process by induction method and using LASER. Discuss critical issues for both the process. **(15)**

10 (a) Eutectoid temperature and composition of steel is strongly dependent on its alloying elements-explain with necessary graphs. **(10)**

(b) How the tempering stages differ from each other? **(15)**

(c) Carbides formed in tool steel show quite different structures-explain. **(10)**

11. (a) How martensitic stainless steel is prepared? Discuss the role of different alloying elements. How the tempering process effects its mechanical properties. **(20)**

(b) Discuss structure-property relationship for duplex steel. **(15)**

12. (a) Describe the effects of aging time and temperature on the tensile and yield strength of Al-4% Cu alloy. **(10)**

(b) List the functions of Mg and Si in Al-Si-Mg alloys. **(5)**

(c) Why Titanium alloys are usually heat treated? **(8)**

(d) How to identify if an alloy can be hardened by precipitation hardening mechanism – explain with necessary phase diagram. **(12)**

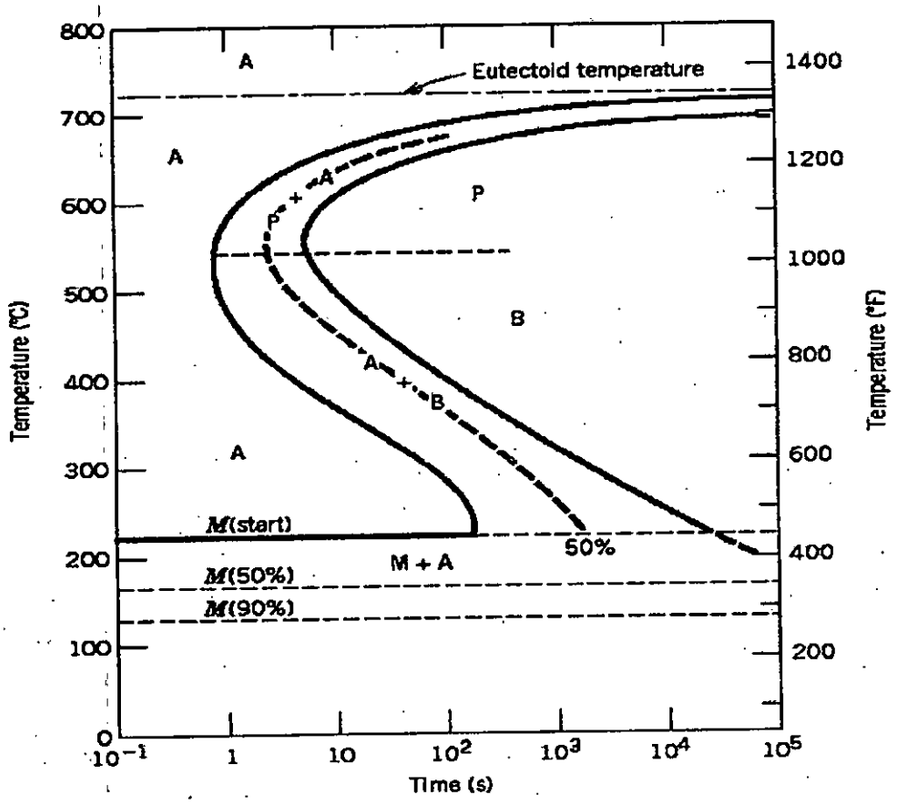

Figure for Question No.5

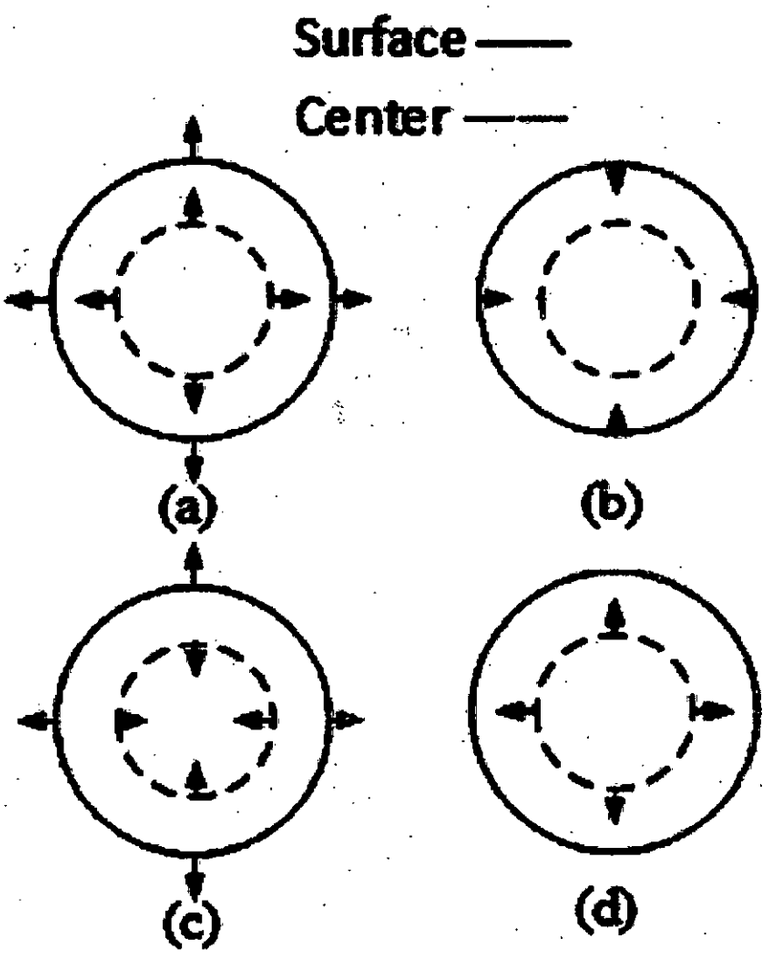

Figure for Question No.6

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B.Sc. Engineering Examinations 2018-2019

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

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

The figures in the margin indicate full marks.

1. (a) Outline the main features of extrusion process with an aid of a schematic diagram. **(13)**

   (b) Design and describe an injection molding process suitable for simultaneous PVC tyres production. **(22)**

2. (a) Compare and contrast thermoplastic polymer and thermoset polymer. **(14)**

   (b) Two monomers of same proportions are polymerized to form a block co-polymer and a graft co-polymer separately. Among these two co-polymers, which one has higher density? Justify your answer. **(7)**

   (c) Discuss the factors that influence mechanical properties of polymer. **(14)**

3. (a) Differentiate between liquid crystal polymer and thermoplastic elastomer. **(14)**

   (d) Why are creep, impact and fatigue testing important for polymer? **(12)**

   (c) The density of two polypropylene materials are 0.904 g/cm^3 and 0.895 g/cm^3 respectively, while the associated percent crystallinity of those two materials are 62.8 and 54.4 respectively. Calculate (i) density of totally crystalline and totally amorphous polypropylene and (ii) density of a specimen having 74.6% crystallinity. **(9)**

4. (a) Select and outline a manufacturing process suitable for plastic film production. **(17)**

   (b) What is dual sheet thermoforming? Why is dual sheet thermoforming preferred for plastic production? **(10)**

   (c) Mention the roles of flame retardant and plasticizer in enhancing properties of polymer. **(8)**

SECTION – B

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

The questions are of equal value.

5. Mention various secondary effects due to incorporation of reinforcement in matrix during making composites. Discuss the purposes of treatment of glass fibers with size.

6. How does aspect ratio affect the compressive strength of a fibre? Explain why the compressive strength of a Kevlar^{TM} fibre is only twenty percent of its tensile strength while it is almost 100% for glass fibre.

Contd P/2

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7. What are various reasons of void formation in making composites? Discuss the scopes and challenges of void characterization in composites by density measurement.

8. What do you understand by the term "stress transfer length" and "Stress transfer aspect ratio" for composites? The n values for polymer matrix composite and metal matrix composite, respectively-are 0.1 and 0.4. Find out the stress transfer aspect ratios for them.

9. Mention various wet forming process for composite fabrication. With neat sketches discuss the complete composite fabrication process by resin transfer moulding.

10. What are the purposes of development of ceramic matrix composites? Discuss the main advantages and disadvantages of CMC products produced by reaction bonding process.

11. Discuss the underlying reasons why the composite made from glass fibres and epoxy resin matrix has a fracture energy comparable to those of metals or their alloys?

12. What are the critical factors to be considered by an design to get quality composite products? Discuss at least two of these factors with necessary diagrams and sketches.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2018-2019

Sub: **MME 323** (Physical Properties of Materials)

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) The electron drift mobility in silver has been measured to be 56 $cm^2V^{-1}s^{-1}$ at 27°C. The atomic mass and density of Ag are given as 107.87 $gmol^{-1}$ and 10.50 gcm^{-1}, respectively. Wiedemann-Frenz-Lorenz constant is $2.44*10^{-8}$ $W\Omega k^{-2}$.

   (i) Assuming that each Ag atom contributes one conduction electron, calculate the resistivity of Ag at 27 °C. **(10)**

   (ii) Calculate the thermal conductivity of silver at 27 °C and 0 °C. **(10)**

   (b) Derive an equation that relates microscopic electronic polarization, α_e to the macroscopic relative permittivity, ε_r. **(15)**

2. (a) What is the physical meaning of wave function? Derive the time independent Schrodinger equation for one dimension. **(18)**

   (b) Consider the one-dimensional potential function shown in Figure 1 for Q. 2(b). Assume the total energy of an election is $E<V_0$. **(6+6+5=17)**

   (i) Write the time-independent Schrodinger equation for each region

   (ii) Write the general solution of the time independent Schrodinger equation for each region when $E<V_0$ and denote the physical significance (i.e. reflected electron, transmitted electron etc.) of each term in each solution.

   (iii) What is the probability of transmission through the two potential barrier? Transmission is defined as a travelling electron in region II ending up as a travelling electron in region I and III.

3. (a) Diamond has a dielectric constant of 5.68. **(6+7=13)**

   (i) According to Clausius-Mosotti relation, what is the electronic polarizability due to valence electrons per diamond atom?

   (ii) Calculate the displacement and dielectric susceptibility when diamond is exposed to an electric field 1 V/mm.

   (b) Mention the processes which attenuate the waves of fiber-optic communication. Discuss these processes with the help of proper equations. **(12)**

Contd P/2

MME 323

Contd. ... Q. No. 3

(c) Consider a ferromagnetic particle consisting of 10^6 atoms, each of which has a magnetic dipole moment of two Bohr magnetrons. In an H-field of 10^6 A/m, if the total magnetic dipole moment of the particle rotates from antiparallel to the field to parallel to the field, by how much does its energy decrease? For what temperature will this be equal to k_BT? **(10)**

4. (a) Consider two superconducting wires, tin (Sn; Typel) and Nb_3Sn (Type II) each 1 mm in thickness. The magnetic field on the surface of a current-carrying conductor is given by

$$\frac{B = \mu \circ I}{2\pi r}. \qquad \textbf{(6+6=12)}$$

(i) Assuming that Sn wire loses its superconductivity when the field at the surface reaches the critical field (0.2 T), calculate the maximum current and hence the critical current density that can be passed through the Sn wire near absolute zero temperature.

(ii) Calculate the maximum current and critical current density for the Nb_3Sn wire using the same assumption as in part (a) but taking the critical field to be the upper critical field, B_{c2}, which is 24.5 T at 0 K.

(b) Illustrate the magnetic structure of mixed state of Type-II super conductors. Explain how the introduction of microstructural inhomogeneities affects the crystal structure and supercurrent of Type-II superconductors. **(15)**

(c) Why you should remove the wrap of aluminum foil before reheating your dinner in the microwave oven? – describe with the concept of skin depth. **(8)**

SECTION – B

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

5. (a) Schematically show the E vs k diagrams of GaAs and Si and explain the disadvantages of using Si for use in semiconductor lasers and other optical devices. **(10)**

(b) Demonstrate that the first derivative of E with respect to k is related to velocity and the second derivative is related to the mass of a free electron. Use these results to introduce the concept of effective mass and prove that the effective mass of an electron near the top of the valence band is negative. **(15)**

(c) A parabolic E versus k relationship in the valence band for a hole in two particular semiconductor materials is shown in Figure 2. Determine the effective mass (in units of the free electron mass) of the two holes. **(10)**

MME 323

6. (a) Derive an expression for the density of states for a 2D infinite square well. **(18)**

   (b) Calculate the energy range (in eV) between which the probability of occupying by an electron is 0.95 and 0.05 at (a) T = 200 K and (b) T = 400 K. Assume EF = 5.0 eV. **(17)**

7. (a) Derive the thermal equilibrium electron and hole concentrations for p-type compensated semiconductors and also determine the position of the Fermi level as a function of the doping concentrations and as a function of temperature. **(15)**

   (b) Given that at room temperature the density of states related effective masses of electrons and holes in Si are approximately 1.08 me and 0.60 me respectively. Assume, bandgap energy for Si, Eg = 1.10 eV. **(20)**

   (i) Calculate the intrinsic concentration of Si.

   (ii) Determine the position of the intrinsic Fermi energy level with respect to the center of the bandgap.

   (iii) Impurity atoms are added so that the Fermi energy level is 0.45 eV below the center of the bandgap. Are acceptor or donor atoms added? What is the concentration of impurity atoms added?

8. (a) Using the concept of screening explain why the degeneracy of the 2s and 2p orbitals is lifted in all atoms except hydrogen. **(10)**

   (b) Show that the maximum in the radial probability function for the 1s electron state in hydrogen occurs at $r=a_0$. **(10)**

   (c) Briefly explain the working principle of an LED. If the structure and operating condition of the LED are modified, the device can operate as LASER, how can you do that? **(15)**

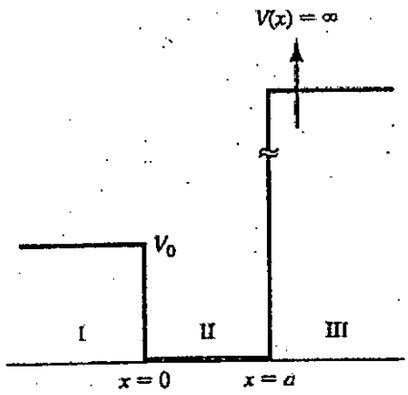

Figure for ques 2(b)

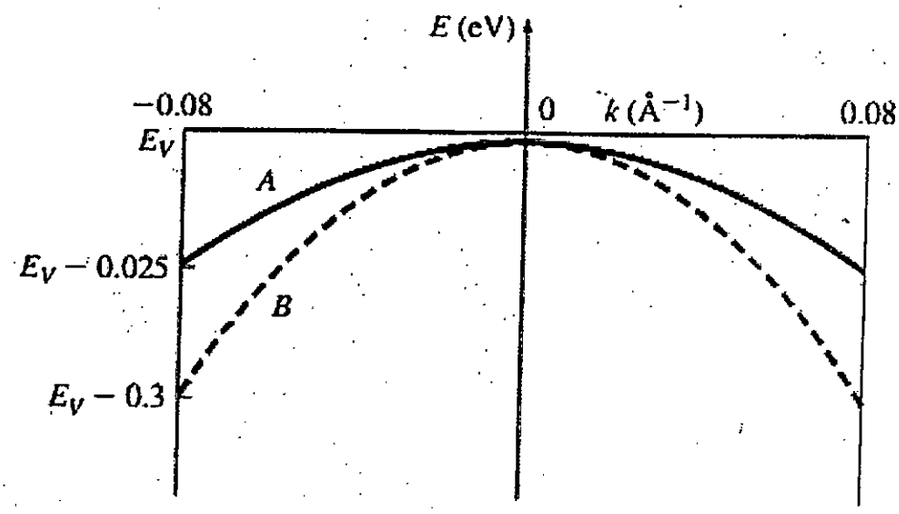

Fig. 2 for Q.5(c)

L-4/T-1/MME **Date : 06/11/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **IPE 491** (Engineering Management)

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) Explain the significance of accurate demand forecasting in any supply chain. **(5)**

   (b) For Project C, exponential smoothed forecast for the month of September was 9590 units. Trend element for September was 310 units. But actual demand turned out to be 10040 units. Determine forecast including trend for the month of October. The values of α and δ are 0.90 and 0.40, respectively. **(10)**

   (c) Quarterly sales data from 2016 to 2018 are given below: **(20)**

2016	Sales	2017	Sales	2018	Sales
1st Quarter	780	1st Quarter	1290	1st Quarter	1790
2nd Quarter	770	2nd Quarter	1370	2nd Quarter	1800
3rd Quarter	960	3rd Quarter	1380	3rd Quarter	2050
4th Quarter	1300	4th Quarter	1850	4th Quarter	2560

   Forecast sales for each quarter of 2019 using appropriate method.

2. (a) Differentiate different types of manufacturing firms. **(10)**

   (b) Determine the economic order quantity and re-order point for the following information: **(15)**

   Weekly demand = 8400; Lead time = 12 days; Ordering cost to carry out 2 orders = Tk. 30000 orders; Holding cost = 3% of the purchase price per quarter; Purchase price = Tk. 700 per unit if order quantity is 0 to 10000 units; Tk. 650 if order quantity is 10001 to 15000 units; Tk. 610 if order quantity is more than 15000 units.

   (c) Mention the assumptions of the fixed order quantity model. Differentiate between fixed order and fixed time period inventory models. **(5+5)=10**

3. (a) Define the following terms: **(5)**

   (i) Payback Period; (ii) Internal rate of return.

   (b) A manufacturing company is planning to introduce a new product in the market. The related financial data are given below: **(20)**

Contd P/2

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Contd...Q. No. 3(b)

Facilities and Equipment cost = Tk. 60 cr.
Working capital required = Tk. 10 cr.
Expected profit = Tk. 6 cr from year 1 to 2; Tk 10 cr from year 3 to 8; Tk. 12 cr from year 9 to 12; Tk. 8 cr from year 13 to 18
Yearly maintenance cost = Tk. 2 cr
Repair cost at the end of 6^{th} year = Tk. 5 cr
Overhauling cost at the end of 12^{th} year = Tk. 20 cr
Salvage value of the equipment = Tk. 15 cr
Working capital will be released at the end of 18^{th} year.

Decide whether the new product should be introduced or not if desired rate of return is 14%.

(c) How can you determine effective span of control for an organization? **(10)**

4. (a) Briefly describe the organizational characteristics when more decentralized structure is required to perform management functions effectively. **(12)**

(b) Describe the contingency factors that influence structural decisions in an organization. **(15)**

(c) Mention advantages and disadvantages of work specialization. **(8)**

SECTION – B

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

5. (a) What are the four management functions? Discuss briefly. **(10)**

(b) Describe the rewards and challenges of being a manager. **(10)**

(c) What are the propositions of "Equity Theory"? Discuss the employee responses to perceived inequalities. **(5+10=15)**

6. (a) Write down the characteristics of contemporary organization. **(10)**

(b) Discuss briefly about "Maslow's hierarchy of needs theory" with illustration. **(10)**

(c) What are the seven traits associated with leadership? Discuss elaborately. **(15)**

7. (a) What are the five forms of managing power of a leader? Discuss briefly. **(10)**

(b) How can students be motivated towards achieving good grades? Discus in light of "Expectancy Theory". **(10)**

(c) Who conducts the performance appraisal of employees in a workplace? How are their performance appraisals done? Discuss elaborately. **(15)**

Contd P/3

IPE 491

8. (a) List the motivators and hygiene factors according to Herzberg's theory. **(10)**

(b) What are the reasons behind conducting performance appraisals? How should performance appraisals be scheduled? **(10)**

(c) What are the five primary job characteristics according to Job Characteristics Model (JCM)? Briefly discuss the suggestions to be followed for using the JCM. **(5+10=15)**
