L-1/T-2/IPE **Date : 16/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2015-2016

Sub : **EEE 167** (Basic Electrical and Electronic Circuits)

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) Using phasor approach, determine the voltage $v(t)$ that follows the differential equation given below. **(20)**

$$\int v dt - 2v + \frac{dv}{dt} - 3\frac{d^2v}{dt^2} = 10\sin(3t - 45^\circ)$$

(b) Find i_0 in the circuit shown in Fig. 1(b). **(26⅔)**

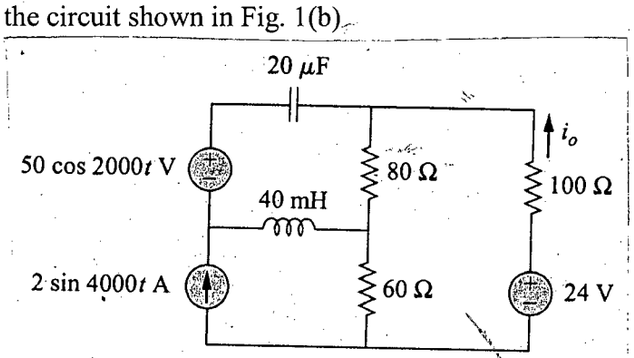

Figure for Q. 1(b)

2. (a) Consider the circuit shown in Fig. 2(a). The resistor R_L is adjusted until it absorbs the maximum average power. Calculate R_L and the maximum average power absorbed by it. **(20)**

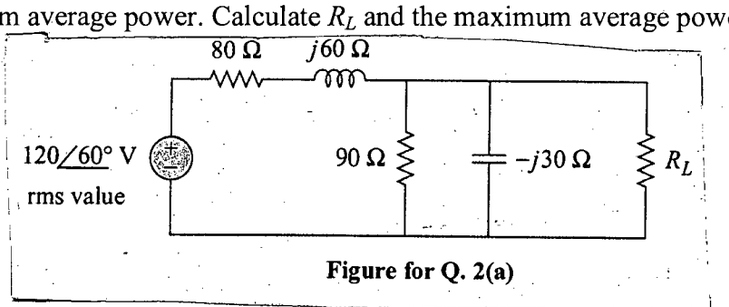

Figure for Q. 2(a)

(b) Determine the rms value for the waveform shown in Fig. 2(b). **(16⅔)**

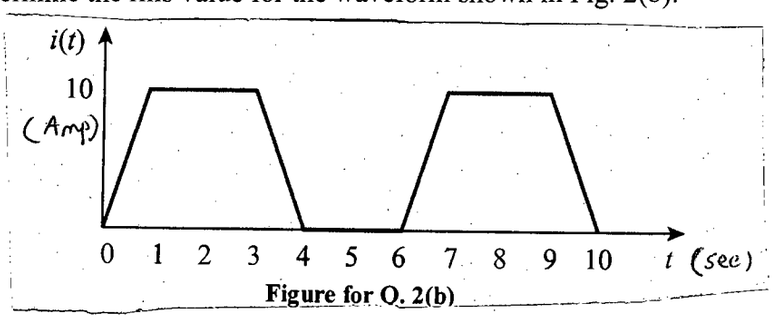

Figure for Q. 2(b)

(c) Obtain the power factor for the circuit shown in Fig. 2(c). Specify whether the power factor is leading or lagging. **(10)**

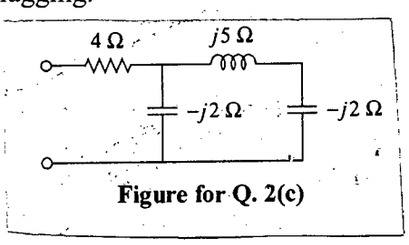

Figure for Q. 2(c)

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EEE 167(IPE)

3. (a) Find I_0 and the overall complex power supplied by the voltage source in the circuit shown in Fig. 3(a). **(16⅔)**

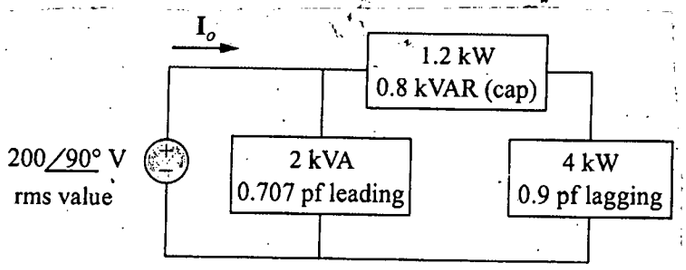

Figure for Q. 3(a)

(b) Find the line current I_L and the average power delivered by the voltage sources in the circuit shown in Fig. 3(b) **(20)**

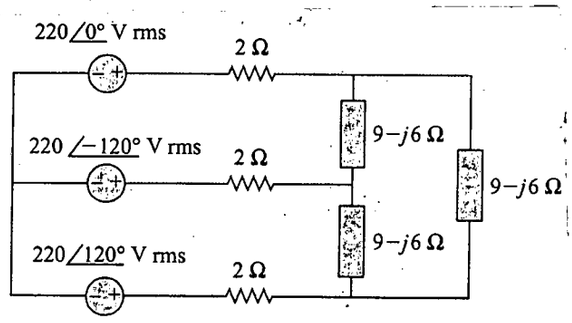

Figure for Q. 3(b)

(c) Draw the phasor diagram of a Y-connected balanced 3-ϕ system. Prove that, VL=$\sqrt{3}V_\phi$. **(10)**

4. (a) Find the values of R_1 and R_2 for the circuit shown in Fig. 4(a) so that it exhibits I_E = mA, and V_{BC} = 7 V. Assume, β = 100 in active mode. **(20)**

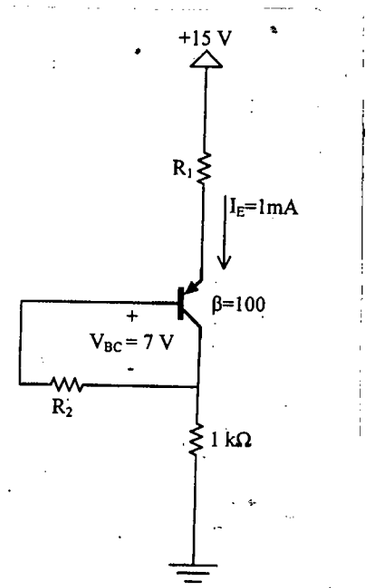

Figure for Q. 4(a)

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EEE 167(IPE)

Contd ... Q. No. 4

(b) For the circuit shown in Fig. 4(b), find the node voltages labeled as V_C, V_B and V_E. Assume, $\beta = 100$ when the BJT operates in active mode. **(26⅔)**

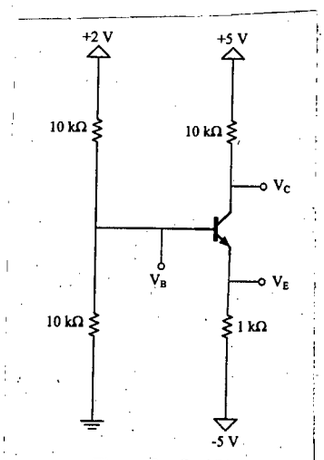

Figure for Q. 4(b)

SECTION – B

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

5. (a) Use nodal analysis to find v_0 and i_0 for the circuit shown in Fig. for Q. 5(a) **(23⅔)**

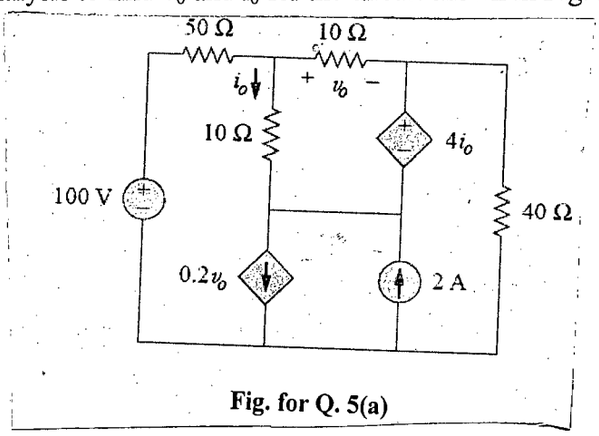

Fig. for Q. 5(a)

(b) Using mesh analysis determine the currents i_1, i_2, i_3 and the voltage, v_o for the circuit shown in Fig. for Q. 5(b) **(17)**

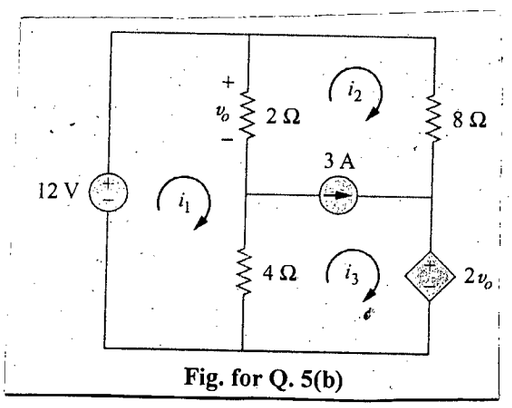

Fig. for Q. 5(b)

6. (a) Determine the power supplied by current source, I_x for the circuit shown in Fig. for Q. 6(a). **(17)**

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EEE 167(IPE)

Contd ... Q. No. 6(a)

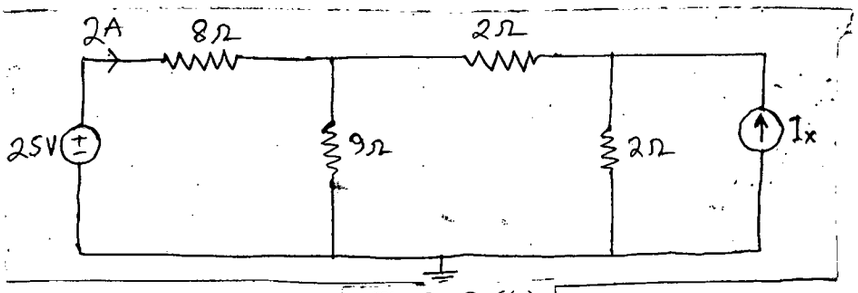

Fig. for Q. 6(a)

(b) Voltage (V) and current (A) relationship of a linear circuit is shown in Fig. for Q. 6(b). Find the Thevenin voltage and resistance of the linear circuit. **(13)**

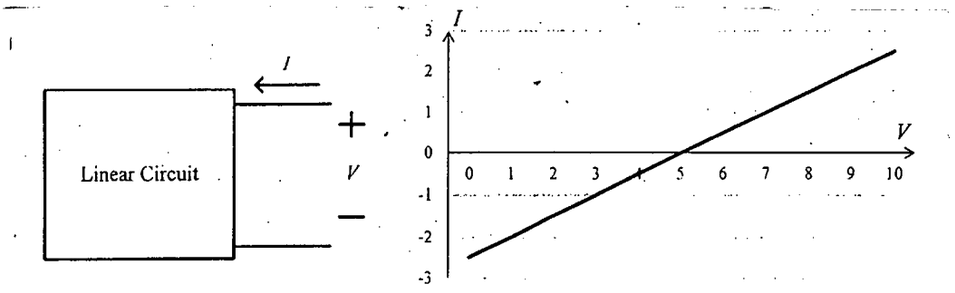

Fig. for Q. 6(b)

(c) Use superposition theorem to find current, i in the circuit shown in Fig. for 6(c) **(16⅔)**

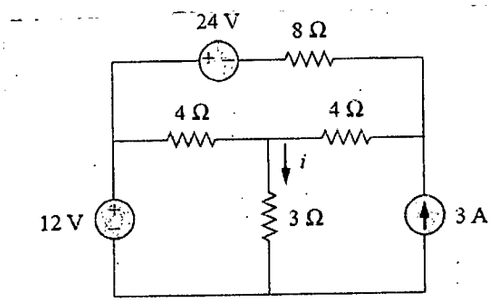

Fig. for Q. 6(c)

7. (a) For the circuit shown in Fig. for Q. 7(a), (i) determine maximum power delivered to the variable resistor R. (ii) If independent source of the circuit is deactivated, how much power will be delivered to R in maximum power transfer condition? **(20)**

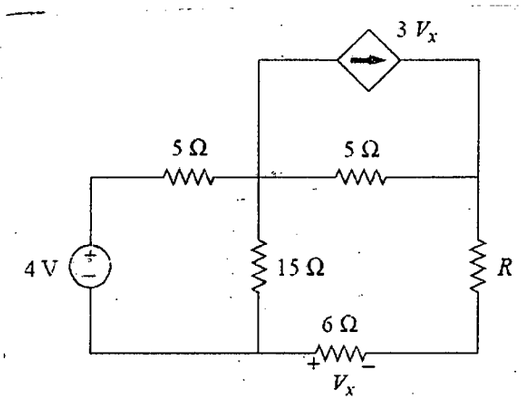

Fig. for Q. 7(a)

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EEE 167(IPE)

Contd ... Q. No. 7

(b) Find the equivalent resistance at terminals a-b for the circuit in Fig. for Q. 7(b). **(16⅔)**

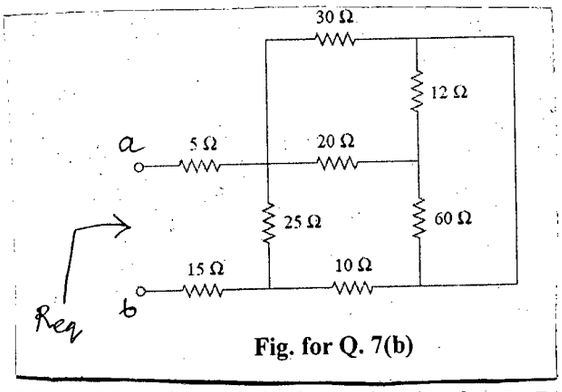

Fig. for Q. 7(b)

(c) Find the values of I and V in the circuit shown in Fig. for Q. 7(c). Assume all diodes are ideal. **(10)**

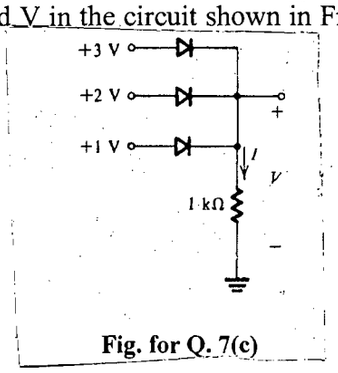

Fig. for Q. 7(c)

8. (a) Consider v_S = 10 sin(2πt) in the circuit shown in Fig. for Q. 8(a). Sketch and clearly label the waveforms of V_A and V_B. Assume a 0.7 V drop across each conducting diode. Also find the peak inverse voltage of each diode. **(20)**

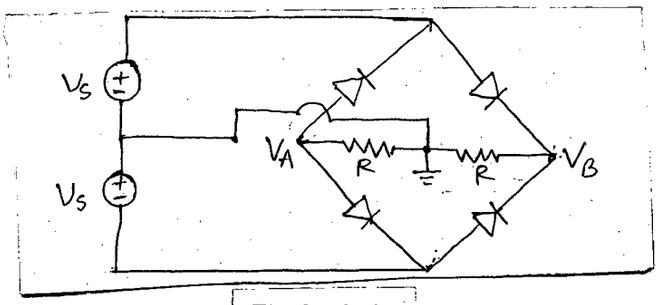

Fig. for Q. 8(a)

(b) Design a circuit for the given input and output voltage waveforms shown in Fig. for Q. 8(b). **(10)**

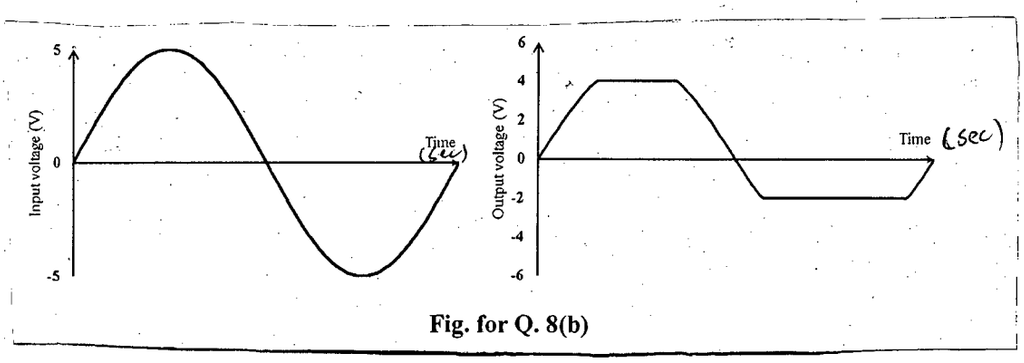

Fig. for Q. 8(b)

EEE 167(IPE)

Contd ... Q. No. 8

(c) The 6.8 V zener diode in the circuit shown in Fig. for Q. 8(c) is specified to have V_Z= 6.8 V at I_Z = 5 mA, r_Z = 20 Ω and current at knee voltage I_{ZK} = 0.2 mA, The supply voltage V^+ is nominally 10 V but can vary by ± 1 V. What is the minimum value of RL for which the diode still operates in the breakdown region? **(16⅔)**

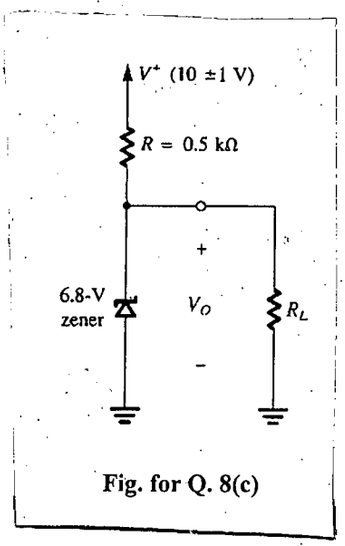

Fig. for Q. 8(c)

L-1/T-2/IPE **Date : 22/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2015-2016

Sub : **MATH 193** (Vector Matrix and Coordinate Geometry)

Full Marks : 280 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols used have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Prove vectorially that lines joining the middle points of the sides of a quadrilateral taken in order is a parallelogram. **(15)**

   (b) Determining whether the terminal points of the set of vectors

   $$\underline{a} = 2j + 2k,\ \underline{b} = i - j + 2k,\ \underline{c} = -i + 3j,\ \underline{d} = -i + 7j + 4k.$$ **(16⅔)**

   with initial points at the origin are

   (i) collinear, (ii) coplanar, (iii) both, (iv) none.

   (c) Prove the cosine formula $c^2 = a^2 + b^2 - 2ab\cos C$ for the triangle ABC – vectroially. **(15)**

2. (a) If the system of vectors $\mathbf{a}'$, $\mathbf{b}'$, $\mathbf{c}'$, is reciprocal to the system of vectors $\mathbf{a}$, $\mathbf{b}$, $\mathbf{c}$ then prove that $[\mathbf{abc}] = \dfrac{1}{\mathbf{a}'\mathbf{b}'\mathbf{c}'}$. **(16⅔)**

   (b) Find (vectorially) the shortest distance of $P(3, 2, 1)$ from the plane passing through the points $A(2, 4, 1)$, $B(-1, 0, 1)$ and $C(-1, 4, 2)$. **(15)**

   (c) Find (vectorrially) the volume of the tetrahedron bounded by the coordinate planes and the plane $x + 2y + 3z = 6$. **(15)**

3. (a) Solve the following system of linear equations, if consistent **(26⅔)**

   $$\begin{aligned} 2x + y - 2z - 2w &= -2 \\ -x + 2y - 4z + w &= 1 \\ 3x \qquad\quad - 3w &= -3 \\ x - y + 2z - w &= -1 \end{aligned}$$

   (b) State Cayley-Hamilton theorem, Fin A^{-1} by using Cayley-Hamilton theorem for the matrix $A = \begin{bmatrix} 4 & -1 & 1 \\ -1 & 4 & -1 \\ 1 & -1 & 4 \end{bmatrix}$. **(20)**

Contd P/2

MATH 193(IPE)

4. (a) Reduce the quadratic form $q = x_1^2 + 2x_2^2 - 3x_3^2 + 8x_1x_2 + 10x_1x_3 - 16x_2x_3$ to the canonical form and hence find the corresponding linear transformation, rank, index and signature. **(26⅔)**

   (b) Find the eigenvalues, eigenvactors and the corresponding eigenspaces of the matrix

$$A = \begin{bmatrix} 0 & -1 & 0 \\ 0 & 0 & -1 \\ 1 & 3 & 3 \end{bmatrix}.$$ **(20)**

SECTION – B

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

5. (a) Transform the equation $5x^2 + 4xy + 2y^2 - 2x + 4y + 4 = 0$ to one in which there is no term involving x, y and xy by suitable translation and rotation of axes. **(23)**

   (b) Reduce the equation $4x^2 - 4xy + y^2 - 8x - 6y + 5 = 0$ to the standard form. Find all its properties. **(23⅔)**

6. (a) Find the direction cosines and angle between two straight lines whose direction cosines l, m, n are connected by the relations $l - 5m + 3n = 0$ and $7l^2 + 5m^2 - 3n^2 = 0$. **(15)**

   (b) A line makes angles α, β, γ, δ with the diagonals of a cube. Find the value of $\cos^2\alpha + \cos^2\beta + \cos^2 y + \cos^2\delta$ **(15)**

   (c) A variable plane is at a constant distance p from the origin O and meets the axes in A, B and C. Find the locus of their point of intersection through A, B, C planes are drawn parallel to the co-ordinate planes. **(16⅔)**

7. (a) Find the equation of the plane through the points (2, 1, 1), (3, 2, 2) and perpendicular to the plane $x + 2y - 5z - 3 = 0$. **(12)**

   (b) Find the length of the shortest distance between the two lines $\frac{x-3}{1} = \frac{y-5}{-2} = \frac{z-7}{1}$. and $\frac{x+1}{7} = \frac{y+1}{-6} = \frac{z+1}{1}$. Also find its equation and the points in which it intersects the given lines. **(20⅔)**

   (c) Find the distance of the point (2, – 3, 6) from the plane $2x + 3y + 4z = 25$ measured parallel to the line $\frac{x}{2} = \frac{y}{3} = \frac{z}{-5}$. **(14)**

8. (a) Find the equation of the sphere which touches the sphere $4(x^2 + y^2 + z^2) + 10x - 25y - 2z = 0$ at the point (1, 2, –2) and passes through the point (–1, 0, 0). **(23⅔)**

   (b) Find the equations of the planes through the line $7x + 10y - 30 = 0 = 5y - 3z$ through the ellipsoid $7x^2 + 5y^2 + 3z^2 = 60$. **(23)**

L-1/T-2/IPE **Date : 26/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2015-2016

Sub : **CHEM 143** (Chemistry of Materials)

Full Marks : 140 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 polymer? How would you differentiate it from macromolecule? Classify the polymer based on the mechanical properties. **(2 ⅓+2+3=7 ⅓)**

   (b) How would you distinguish between the following polymers? **(9)**

   (i) Homopolymer and copolymer (ii) Organic polymer and inorganic polymer (iii) Natural polymer and synthetic polymer.

   (c) Discuss the stereospecific polymer with suitable examples. Show the structures of the common cation exchange and anion exchange resins. **(5+2=7)**

2. (a) How the monomers of the following polymers can be synthesized from the available raw materials? (i) HDPE (ii) PVC (iii) Melamine (iv) Polystyrene. **(6)**

   (b) Describe the mechanism of the ring opening polymerization. **(5⅓)**

   (c) Write down the structures of the copolymers whose monomers are: **(6)**

   (i) $CH_2 = CH - CH = CH_2$, CH_2 =CHCl (ii) $CH_2 = CCl - CH = CH_2$, ph $- CH = CH_2$ (iii) $CF_2 = CF_2$, ph $- CH = CH_2$ (iv) $H_2N - (CH_2)_6 - NH_2$, $HOOC - (CH_2)_4 - COOH$

   (d) Describe the industrial manufacturing process of the Teflon polymer. **(6)**

3. (a) What is natural rubber? Show by chemical equations how would you detect the following functional moieties present in the natural rubber. **(2+4=6)**

   (i) Hydrocarbon unit (ii) Carbon-Carbon double bond (iii) Isoprene unit (iv) Cis Carbon – Carbon double bond.

   (b) Describe the industrial manufacturing process of styrene butadiene rubber (SBR). **(6)**

   (c) Mention the basic differences between the natural rubber Gutta percha. Discuss the Process of obtaining crude Fn rubber from latex. **(6)**

   (d) Show by Chemical equations how would you synthesize silicon rubber. Mention some of its industrial applications. **(3+2 ⅓=5 ⅓)**

Contd P/2

CHEM 143(IPE)

4. (a) What is fibre? Describe the different methods of forming synthetic fibre. **(2⅓+4=6⅓)**

   (b) Discuss the preparation and properties of viscose rayon. **(5)**

   (c) How would you synthesize the following fibrous polymer? **(6)**

   (i) Nylon 6, 6 (ii) Dacron (iii) Orlon (iv) Saran

   (d) How would you synthesize the following important monomers of the fibre polymer? **(6)**

   (i) Adipic acid (ii) Hexamethylene diamine (iii) Dimethyl terepthalate

   (iv) Acrylonitrile

SECTION – B

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

5. (a) What is glass? Describe it from both physical and chemical point of view. **(3⅓)**

   (b) Give some of the important chemical properties of glass. **(4)**

   (c) Mention the various raw materials used for the manufacture of glasses. State their functions also. **(9)**

   (d) Discuss the steps in obtaining a finished glass article. **(7)**

6. (a) What are the impurities usually present in the lubricants of mineral origin? **(3⅓)**

   (b) Describe the solvent refining process of lubricating oils and also discuss the properties of various solvents used. **(8)**

   (c) Mention the advantages and disadvantages of solvent refining over acid refining of lubricating oils. **(5)**

   (d) Give a brief description of the synthetic lubricants. **(7)**

7. (a) Describe the required properties for a good paint. **(4⅓)**

   (b) What are the major constituents of paints? Discuss the functions of these constituents **(7)**

   (c) Write short notes on the following special glasses: (any two) **(6)**

   (i) High silica glass (ii) Optical glass (iii) Borosilicate glass

   (d) Discuss the effect of dissolved salts on the rate of under-water corrosion. **(6)**

8. (a) Discuss the prevention of corrosion by the following methods: **(8)**

   (i) modification of metals (ii) Modification of environment

   (b) Describe the problem and limitations of cathodic control. **(4⅓)**

   (c) Give a comparison between cathodic and anodic protections. **(7)**

   (d) Explain the process of metal spraying. **(4)**

L-1/T-2/IPE **Date : 31/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2015-2016

Sub : **MME 195** (Engineering Materials I)

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 do you understand by co-ordination number? Show that atoms are more closely packed in F.C.C lattice than B.C.C lattice by calculating atomic packing factor of each one. **(20)**

   (b) Draw (110) & (111) crystallographic planes and [110] & [111] crystallographic directions within a cubic unit cell. **(10)**

   (c) What do you understand by ductility? How can we determine ductility from the experimental result? **(5)**

2. (a) What do you understand by ductile to brittle transition? Briefly explain the metallurgical factors that affect the DBTT curve. **(15)**

   (b) What is fatigue failure? Discuss various S-N curve showing fatigue life, fatigue strength and fatigue limit in the curve. **(15)**

   (c) Aluminium alloy 7075-T6 is widely used as a light weight but strong material in aircraft and aerospace applications. Its elastic modulus is 70 GPa and yield strength is 500 MPa. Suppose that you take a 50 mm long wire of this sample, stretch it to 50.5 mm and then removed the load. What will be its final length approximately? **(5)**

3. (a) What do you understand by creep failure? Draw a typical creep curve showing the various stages of creep and explain the stages. What changes would you expect in a typical creep curve when the alloy is subjected to changing stress and temperature? **(25)**

   (b) Why is stainless steel corrosion resistant? Discuss different kinds of stainless steel according to their composition. **(10)**

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

   (b) Describe various reactions that occur in stack, bosh and hearth regions of a blast furnace. **(20)**

   (c) Write a short note on- **(10)**

   (i) Manganese steel

   (ii) Maraging steel

Contd P/2

MME 195

SECTION – B

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

5. (a) Differentiate between phase and element. **(6)**

   (b) Using the equilibrium diagram shown in Fig. 1, answer the following questions for an alloy of 70% Pb-30%Sn: **(20)**

   (i) Calculate the fractions of pro-eutectic α and eutectic α at just above and below the eutectic temperature respectively.

   (ii) Draw microstructures of the alloy at 300°, 225° and room temperature.

   (c) Non-equilibrium cooling generally results in a cored structure – explain. **(9)**

6. (a) Describe briefly how steel is produced using an electric arc furnace. **(18)**

   (b) Compare electric arc and L-D processes of steel making. **(12)**

   (c) Why an electric furnace is now-a-days utilized during steel making process? **(5)**

7. (a) Select and describe an annealing heat treatment process suitable for toughening hyper-eutectoid steel. **(15)**

   (b) Mention the effects of tempering temperature on structure and mechanical properties of a quenched carbon steel part. **(14)**

   (c) How hardenability of steel can be increased? **(6)**

8. (a) Sketch and level microstructural changes that occur in hypo-eutectoid steel during equilibrium cooling from 900°C to room temperature. **(18)**

   (b) Normalized hypo-eutectoid steel has higher hardness as compared to annealed hypo-eutectoid steel of same composition – explain. **(12)**

   (c) Why eutectoid steel has no pro-eutectoid phase in its microstructure? **(5)**

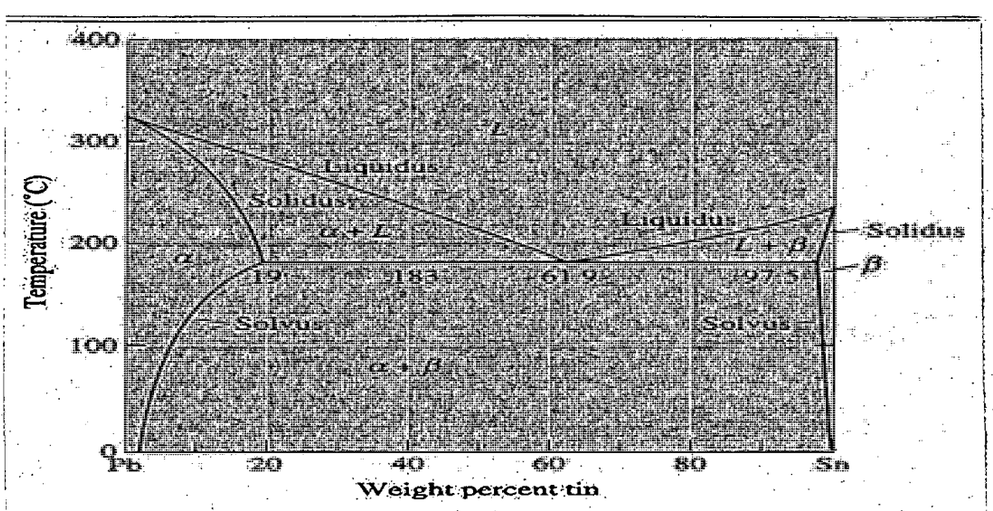

Fig. 1 for Question 5 (b)

L-1/T-2/IPE **Date : 06/02/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2015-2016

Sub : **PHY 163** (Waves and Oscillations, Physical Optics and Wave Mechanics)

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 simple harmonic motion. Write down its differential equation and show that the solution of the equation must contain a periodic function. **(3+3+12)**

   (b) Derive an expression for total energy of a simple harmonic oscillator. **(8)**

   (c) An oscillating mass spring system has its energy fully potential at the position 0.1 m from its equilibrium position. It's maximum speed is 1.0 m/sec. Find the force constant and the mass attached to the spring. At what displacement is the energy half kinetic and half potential? Total energy of the oscillator is 2.0 Joul. **(9)**

2. (a) What are Lissajous figures? On what factors do the figures depend? Deduce an expression for Lissajous figures having angular frequencies same for both the oscillations. Under what conditions the figures become (i) Circle and (ii) straight line with +ve and –ve slope. **(3+3+12)**

   (b) The displacement equation of a damped oscillator is

   $$x = ae^{-pt/2}\cos\left\{\sqrt{\frac{4\omega^2 - p^2}{2}}\,t + \varphi\right\}$$

   where p is damping coefficient and ω is angular frequency of the oscillator. From this equation what conclusions we can make about amplitude and angular frequency of the damped oscillator? What happens if $p^2 > 4\omega^2$ and $p^2 = 4\omega^2$? **(10)**

   (c) In one dimensional motion of a mass of 10 gm is acted upon by a restoring force of force constant 10 dynes/cm and a resisting force of damping coefficient 0.2 sec^{-1}. (i) Find whether the motion is oscillatory or not. If oscillatory calculate the time after which the energy becomes e^{-1} of its initial energy. (ii) Now the mass is placed in different damping medium and the motion becomes critically damped. Find the value of damping coefficient. **(7)**

3. (a) Give the theory of growth and decay of sound inside a room. Hence obtain an expression for the reverberation time. **(16+10)**

   (b) The reverberation time of a hemispherical shaped room of radius 10 m is 1.12 second. The velocity of sound is 320 m/sec. **(9)**

Contd P/2

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

(i) Calculate the number of reflections per second of the room and the absorption coefficient of the material of the room. (ii) The amount of absorbing power can be varied by using carpet in the room. To keep the reverberation time same what amount must the area of the carpet to make up exactly for entrance of 60 people, absorption coefficient of carpet is 0.3 and absorbing power of each person is 0.5 Sabin.

4. (a) Describe a physical phenomenon that can be explained only in terms of Quantum mechanics. **(5)**

(b) State Heisenberg Uncertainty principle. The speed of a bullet (m = 50 gm) and the speed of an electron (m = 9.1×10^{-28} gm) are measured to be the same, namely 300 m/sec, with an uncertainty of 0.01%. With what fundamental accuracy could we have located the position of each, if the position is measured simultaneously with the speed in the same experiment? **(12)**

(c) Explain the energy eigenfunction of an electron that is strongly bound to its atomic nucleus. Draw schematically the allowed energy levels for different n-values. **(18)**

SECTION – B

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

5. (a) Write down the required characteristics of wave function Ψ. Prove that $\Psi^*(x,t)\Psi(x,t)$ is necessarily real, and either positive or zero. **(10)**

(b) Write down the time independent and time dependent forms of Schrodinger wave equation. Draw schematically the wave function Ψ and the probability function $\Psi^*\Psi$ for an electron in a potential well for different n-values. What conclusions can be drawn from these schematic diagrams? **(15)**

(c) Derive the infinite square well energy quantization law, directly from the de Broglie relation $p = h/\lambda$, by fitting an integral number of half de Broglie wavelengths $\lambda/2$ into the width 'a' of the well. **(10)**

6. (a) Explain 'Quantum Mechanical Tunneling' effect and write down its important applications in Solid state physics. **(13)**

(b) Distinguish between Fermi Dirac and Bose-Einstein distribution functions. What are Fermion and Boson? **(12)**

(c) What is Fermi energy? Find the Fermi energy in copper on the assumption that each copper atom contributes one free electron to the electron gas. The density of copper is 8.94×10^3 kg/m^3 and its atomic mass is 63.5 u. **(10)**

Contd P/3

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7. (a) Mention three differences between interference and diffraction of light. **(10)**

   (b) In case of Young's double slit experiment, show that the resultant intensity of interfered light waves can be obtained by the equation: $I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\delta$, where the symbols have their usual meaning. According to the intensity distribution curve, explain how the law of energy remains valid in this experiment. **(15)**

   (c) The distance between the slit and the biprism and between biprism and eyepiece are 45 cm each. The obtuse angle of biprism is 178°, and the refractive index of the material of prism is 1.5. If the fringe separation is 15.6×10^{-3} cm, what is the wavelength of light used? **(10)**

8. (a) Briefly discuss polarization by (i) double refraction and (ii) dichroism. **(10)**

   (b) Discuss the Fraunhofer diffraction of light at a single slit. **(15)**

   (c) A light wave is incident on a surface of water of refractive index 1.33. If the reflected light is completely polarized, calculate the angle of polarization. Also determine the angle of incidence and angle of refraction. **(10)**
