L-1/T-2/IPE **Date : 12/03/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2016-2017

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

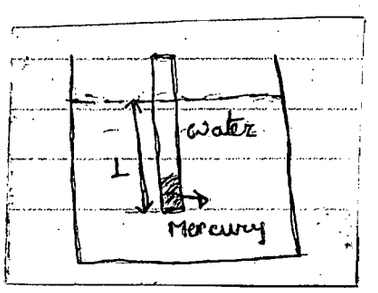
SECTION – A

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

1. (a) Define simple harmonic motion. Show that for a body vibrating simple harmonically the time period is given by $T = 2\pi\sqrt{\frac{\text{displacement}}{\text{acceleration}}}$ and the velocity of the body at the position $x = \frac{a}{2}$ is $\frac{\sqrt{3}}{2}$ V_{max}, where a = amplitude and V_{max} = maximum velocity. **(3+5+5)**

(b) What is a torsion pendulum? Obtain an expression for its period of oscillation. **(10)**

(c) A test tube of uniform cross-section A is partially filled with mercury so that it floats upright in water. The tube is pushed a little and then released, and is set into vertical oscillation. **(12)**



(i) Show that the oscillation is simple harmonic, (ii) Find the period of oscillation. Neglect the damping effect on the motion. Mass of the mercury = m. The length of the submerged portion is L = 2.5 m.

2. (a) What is forced oscillation? Establish its differential equation. What do you mean by Transient state and steady state of a forced oscillator? **(3+8+6)**

(b) Derive an expression for amplitude of a forced oscillator for steady state. **(12)**

(c) An object of mass 0.2 kg is hung from a spring whose spring constant is 80 N/m in a damping medium where the damping constant b = 4 Nm^{-1}sec. The object is subjected to a sinusoidal driving force given by $F(t) = F_0 \sin\omega_d t$ where F_0 = 1.5 N and ω_d = 10 rad/sec,
(i) What is the amplitude in the steady state? (ii) The ω_d of the driving force is varied in such a way that resonance occurs. Calculate the resonant amplitude. **(6)**

Contd P/2

PHY 163/IPE

3. (a) What are the characteristics of a mechanical wave? Deduce the differential equation of a wave. Give two examples of mechanical wave. **(5+10+2)**

   (b) What is phase velocity and group velocity? Establish the relation between phase velocity and group velocity. What is the relationship for non-dispersive medium? **(3+7+3)**

   (c) By rocking a boat, a child produces surface water waves on a quiet lake. It is observed that the boat performs 12 oscillations in 30 seconds and also that a given wave crest reaches shore 15 m away in 5.0 seconds. Find (i) the frequency (ii) the speed and (iii) the wavelength of the waves. **(5)**

4. (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) Explain the energy eigen function for an electron that is strongly bound to its atomic nucleus. Draw schematically the allowed energy levels for different n-values. **(10)**

SECTION – B

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

5. (a) 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. **(12)**

   (b) Explain 'Quantum Mechanical Tunneling' effect and write down its important applications in Solid State Physics. **(13)**

   (c) A particle limited to the x axis has the wave function $\Psi = ax$ between $x = 0$ and $x = 1$; $\Psi = 0$ elsewhere. Find the probability that the particle can be found between $x = 0.45$ and $x = 0.55$.

   (b) Find the expectation value of the particle's position. **(10)**

6. (a) Write down some of the fundamental postulates of statistical mechanics. **(7)**

   (b) Write down the mathematical expressions of the three statistical distribution functions for elementary particles by mentioning each term. Distinguish between them with examples. Draw schematically these three distributions as a function of the probability of occupancy of a state of energy. **(20)**

Contd P/3

PHY 163/IPE

Contd ... Q. No. 6

(c) What is root mean square (rms) speed? Find the rms speed of oxygen molecules at 0°C. **(8)**

7. (a) What are Newton's rings? Mention three applications of Newton's ring experiment. **(8)**

(b) In case of Young's double slit experiment, show that the wavelength of light can be determined by the equation: $\lambda = \frac{\beta d}{D}$, where the symbols have their usual meanings. **(17)**

(c) During determination of the wavelength of light by the displacement method in a Fresnel's biprism experiment, the hight/length between maximum and minimum position of interference pattern was found as 4.05 mm for a certain suitable position of convex lens placed between the screen and biprism. In the second suitable position of the convex lens adjusted through the optical bench, the length of the interference pattern became 2.9 mm. If the fringe separation was found as 0.1719 mm and the distance between the source and screen was 1 m, calculate the wavelength of light used. **(10)**

8. (a) Briefly describe (i) Fraunhofer class of diffraction, and (ii) Malu's law. **(10)**

(b) What do you mean by dispersive power of grating? Show that the dispersive power of grating can be obtained from the following equation: **(17)**

$$\frac{d\theta}{d\lambda} = \frac{1}{\sqrt{\left(\frac{b+d}{n}\right)^2 - \lambda^2}}$$

where the symbols have their usual meaning.

(c) Calculate the thickness of a quarter-wave plate of quartz for the light of wavelength 5893Å. Given that the refractive index for ordinary light is 1.544 and for extra-ordinary light is 1.553. **(8)**

L-1/T-2/IPE **Date : 18/02/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2016-2017

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

Full Marks : 280 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

Symbols have their usual meaning.

SECTION – A

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

1. (a) Prove by vector method that the straight line joining the middle points of two sides of a triangle is parallel to the third side and is half of its length. **(15)**

(b) Prove by vector method that $sin(\alpha - \beta) = sin\alpha\, cos\beta - cos\alpha\, sin\beta$. **(15)**

(c) Examine whether the vectors $5\bar{a} + 6\bar{b} + 7\bar{c}$, $7\bar{a} - 8\bar{b} + 9\bar{c}$ and $3\bar{a} + 20\bar{b} + 5\bar{c}$ are linearly independent or dependent, where $\bar{a}$, $\bar{b}$, $\bar{c}$ are non-coplanar. **(16⅔)**

2. (a) Prove that $\left[\bar{c} + \bar{a}\ \ \bar{a} + \bar{b}\ \ \bar{b} + \bar{c}\right] = 2\left[\bar{a}\ \ \bar{b}\ \ \bar{c}\right]$. **(15)**

(b) Find a set of vectors reciprocal to the set of vectors $i + 2j + 3k$, $2i - j + k$ and $3i + 2j - 5k$. **(15)**

(c) Forces of magnitude 3 and 2 in the direction of $i - 2j + 2k$ and $2i - 3j - 6k$ respectively act on a particle which is displaced from the point (2, –1, –3) to (5, –1, 1). Find the work done. **(8)**

(d) A force $\bar{F} = 3i + 2j - 4k$ is applied at a point $(1, -1, 2)$. Find the moment of the force about the point (2, –1, 3) **(8⅔)**

3. (a) Solve the following system of linear equations by converting it to matrix form: **(23⅔)**

$$x_1 + 2x_2 - x_3 - 2 = 0$$
$$3x_1 + x_2 + 2x_3 - 11 = 0$$
$$4x_1 + 4x_2 - 3x_3 - 3 = 0$$
$$2x_1 - x_2 + 3x_3 - 9 = 0$$

(b) Reduce the 'quadratic form $q = x_1^2 + 2x_2^2 - 2x_3^2 + 4x_1x_2 + 6x_1x_3$ to canonical form and find the rank, index and signature of the form. **(23)**

Contd P/2

MATH 193(IPE)

4. (a) State Cayley-Hamilton theorem and verify the theorem for the matrix

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 1 & 3 & 6 \\ 2 & 6 & 13 \end{bmatrix}$$

and hence find the inverse of A. **(23⅔)**

(b) Find the eigenvalues and corresponding eigenvectors of the matrix

$$\begin{bmatrix} 1 & 3 & 4 \\ 3 & 5 & 6 \\ 4 & 6 & 7 \end{bmatrix}$$ **(23)**

SECTION – B

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

5. (a) Transform the equation $32x^2 + 52xy - 7y^2 - 64x - 52y - 148 = 0$ in rectangular coordinates using suitable translation and rotation of axes so as to remove the terms in x, y and xy. Then identify the conic. **(23)**

(b) Show that the lines whose direction cosines are given by

$al + bm + cn = 0$, $fmn + gnl + hlm = 0$ are (i) perpendicular if $\frac{f}{a} + \frac{g}{b} + \frac{h}{c} = 0$ and (ii) parallel if $\sqrt{af} \pm \sqrt{bg} \pm \sqrt{ch} = 0$. **(23⅔)**

6. (a) A variable plane is at a constant distance p from the origin and meets the axes in A, B, C. Through A, B, C planes are drawn parallel to the coordinate planes: show that the locus of their point of intersection is $\frac{1}{x^2} + \frac{1}{y^2} + \frac{1}{z^2} = \frac{1}{p^2}$. **(23⅔)**

(b) Find the distance of the plane $7x + y + 2z - 16 = 0$ from the point (1, 1, –2) measured parallel to the line $\frac{x}{3} = \frac{y}{2} = \frac{z}{-4}$. **(23)**

7. (a) Find the equation to the perpendicular from the origin to the line $x + 2y + 3z + 4 = 0 = 2x + 3y + 4z + 5$; and find the co-ordinates of the foot of the perpendicular. **(23)**

Contd P/3

MATH 193(IPE)

Contd ... Q. No. 7

(b) Find the shortest distance (SD) between the lines

$\frac{x-6}{3}=\frac{y-7}{-1}=\frac{z-4}{1}$ and $\frac{x+3}{-3}=\frac{y+7}{2}=\frac{z-6}{4}$. **(23⅔)**

Find also the equation of SD line and points in which it meets the given lines.

8. (a) Find the equation of the sphere which passes through the circle

$x^2+y^2+z^2=5, x+2y+3z=3$ and touches the plane $4x+3y=15$. **(23)**

(b) Find the coordinates of the centre and radius of the circle of intersection of the sphere

$x^2+y^2+z^2-2y-4z=11$ and the plane $x+2y+2z=15$. **(23⅔)**

L-1/T-2/IPE **Date : 24/02/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2016-2017

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) Determine the voltages at all nodes and the currents through all branches for the circuit shown in Fig. 1(a). The minimum value of β is specified to be 30. **(26⅔)**

   (b) The transistor in the circuit of Fig. 1(b) has β = 100 and exhibits V_{BE} of 0.7 V at I_C = 1 mA. Design the circuit so that a current of 2 mA flows through the collector and a voltage of +5 V appear at the collector. **(20)**

2. (a) Assuming the diodes to be ideal, find the values of *I* and *V* in the circuit of Fig. 2(a). **(10)**

   (b) For the circuit shown in Fig. 2(b) assume V_B = 12 V, R = 100 Ω, V_γ = 0.6 V, and $v_s(t)$ = 24 sin(ωt) V. Determine the peak diode current, maximum reverse-bias diode voltage, and the fraction of the cycle over which the diode is conducting. **(20)**

   (c) For the circuit shown in Fig. 2(c), assume V_{PS} = 5 V, R = 5 kΩ, V_γ = 0.6 V, and v_i = 0.1 sin(ωt) V. Determine the DC and AC component of the output voltage v_0. **(16⅔)**

3. (a) A balanced abc-sequence Y-connected source with V_{an} = 100 ∠10° V is connected to a Δ-connected balanced load (8+j4) Ω per phase. Calculate the phase and line currents. **(16⅔)**

   (b) When connected to a 120 V (rms), 60 Hz power line, a load absorbs 4 kW at a lagging power factor of 0.8. Find the value of capacitance necessary to raise the pf to 0.95. **(10)**

   (c) For the circuit shown in Fig. 3(c), determine the total average power, reactive power, and complex power at the source and at the load. **(20)**

Contd P/2

EEE 167/IPE

4. (a) If the current waveform i(t) A, as shown in Fig. 4(a), flows through a 9 Ω resistor, calculate the average power absorbed by the resistor. **(20)**

(b) Show that a purely reactive load (L/C) absorbs power in a half cycle and returns that power in the next half cycle. **(10)**

(c) The voltage across a load is $v(t) = 60\sin(\omega t - 10°)$ V and the current through the element in the direction of the voltage drop is $i(t) = 1.5\cos(\omega t + 50°)$ A. Find: (i) the complex and apparent powers, (ii) the real and reactive powers, and (iii) the power factor and the load impedance. **(16⅔)**

SECTION – B

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

5. (a) Using nodal analysis, find v_1, v_2, v_3, v_0 and I_0 in the circuit shown in Fig. for Q. 5(a). **(20)**

(b) Using mesh analysis, find the power dissipated in the 5Ω resistor in the circuit shown in Fig. for Q. 5(b). **(16⅔)**

(c) Find the equivalent resistance R_{ab} in the circuit shown in Fig. for Q. 5(c). **(10)**

6. (a) Find the Thevenin and Norton equivalents of the circuit shown in Fig. for Q. No. 6(a). **(26⅔)**

(b) Determine the value of R for which the maximum power delivered to the load will be 3 mW in the circuit shown in Fig. for Q. 6(b). **(20)**

7. (a) Find i_0 in the circuit shown in Fig. for Q. 7(a) using superposition principle. **(20)**

(b) Using source transformation, find the voltage v_0 in the circuit in Fig. for Q. 7(b). **(16⅔)**

(c) For the circuit shown in Fig. for Q. 7(c) , determine the relationship between V_0 and I_0. **(10)**

8. (a) Find the voltage at node 'c' in the circuit shown in Fig. for Q. 8(a) **(26⅔)**

(b) The phasor current I_a in the circuit shown in Fig. for Q. 8(b) is $2\angle 0°$. Find I_b, I_c and V_g. If ω= 800 rad/s, write expressions for $i_b(t)$, $i_c(t)$ and $v_g(t)$. **(20)**

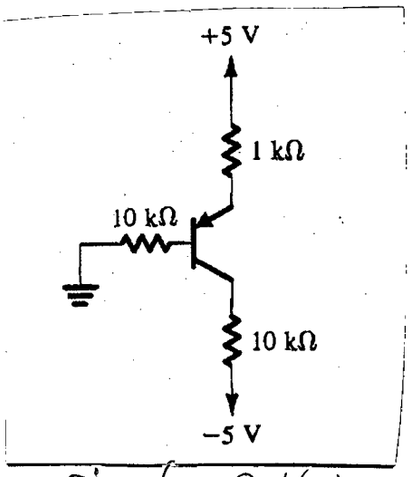


Fig. for Q. 1(a)

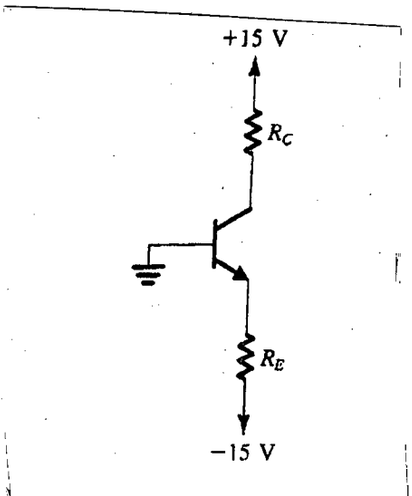


Figure for Q. 1(b)

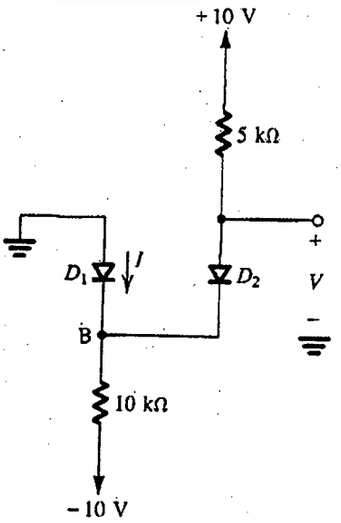


Figure for Q. 2(a)

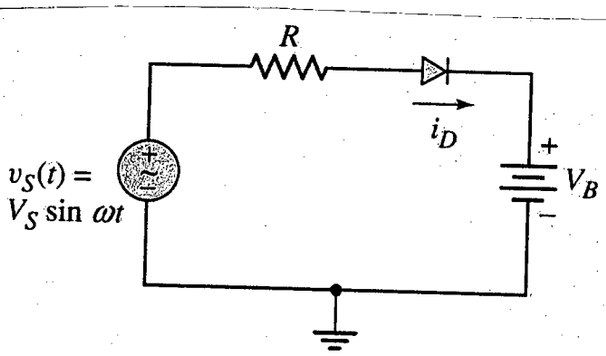


Figure for Q. 2(b)

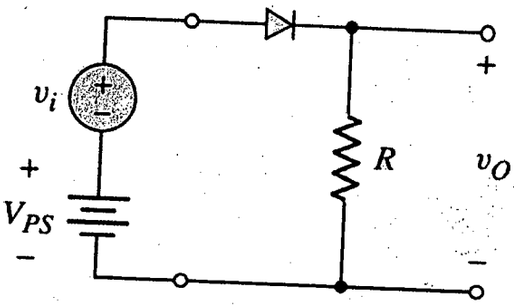


Figure for Q. 2(c)

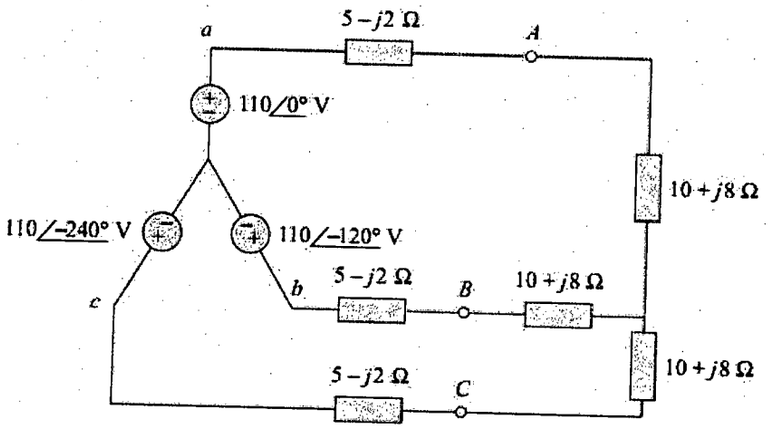


Figure for Q. 3(c)

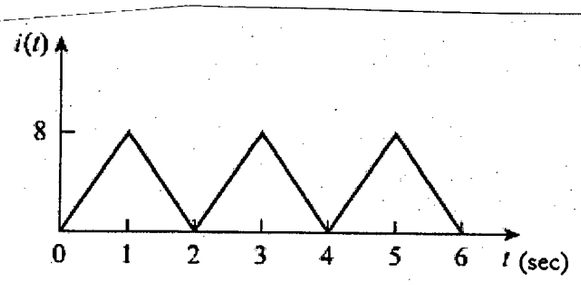


Figure for Q. 4(a)

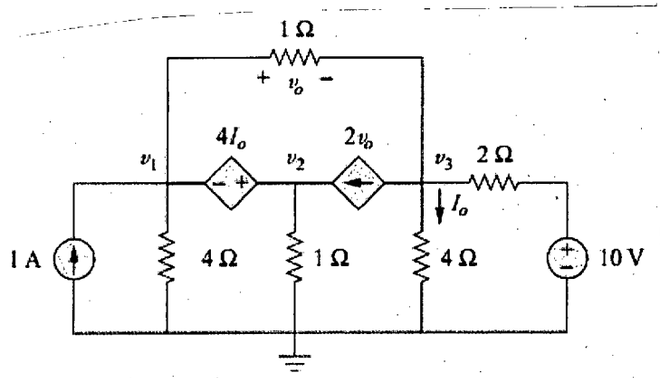


Fig. for Q. 5(a)

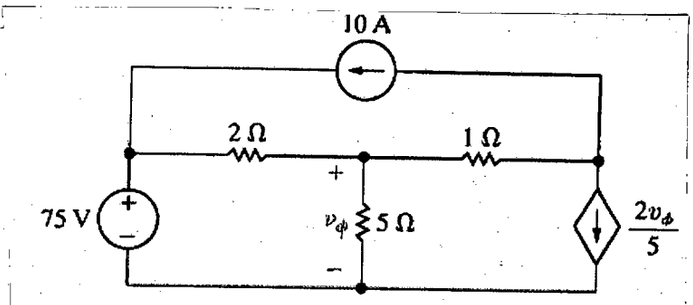


Fig. for Q.5(b)

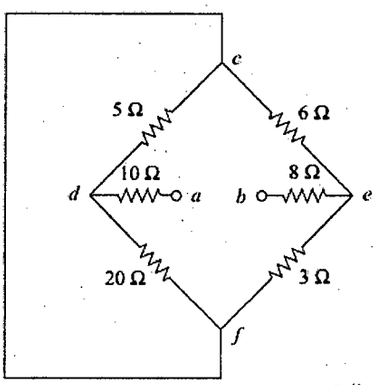


Fig. for Q. 5(c)

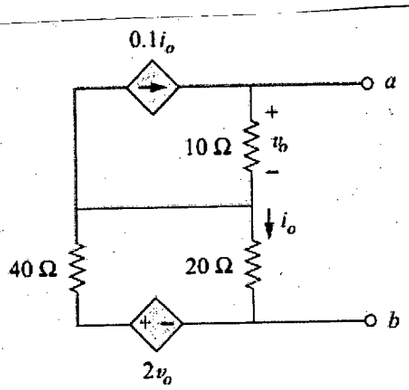


Fig. for Q. 6(a)

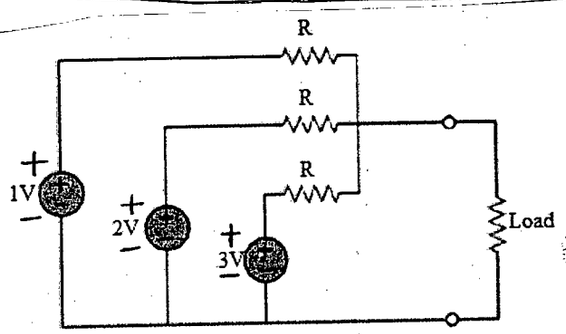


Fig. for Q. 6(b)

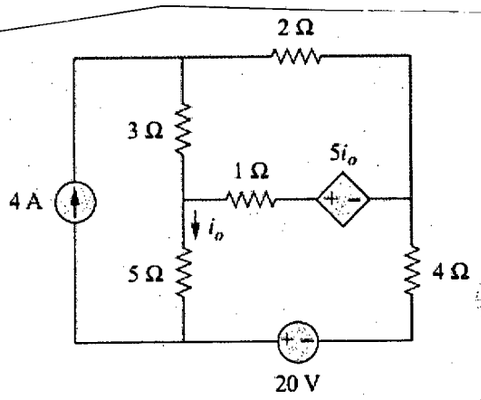


Fig. for Q. 7(a)

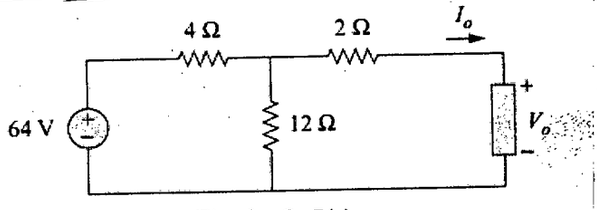


Fig. for Q. 7(c)

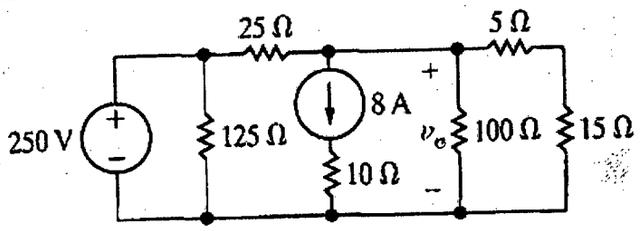


Fig. for Q. 7(b)

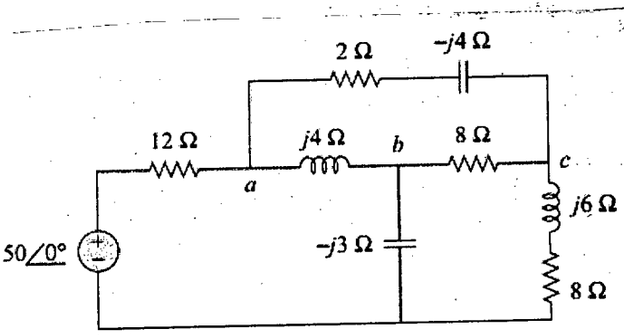


Fig. for Q. 8(a)

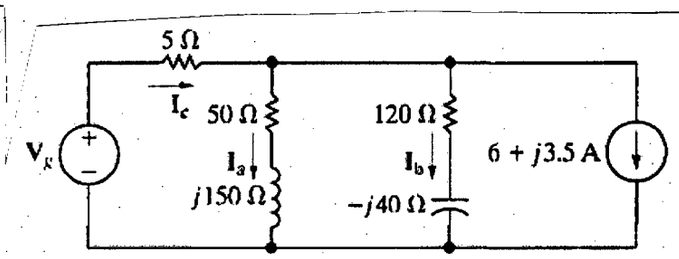


Fig. for Q. 8(b)

L-1/T-2/IPE **Date : 28/02/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2016-2017

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 are the basic raw materials of glass? Mention their sources and uses. **(7)**

   (b) Write with reaction the melting of the batch material when it is composed of red lead, potassium carbonate and silica. **(4⅓)**

   (c) Why annealing is required for almost all glassware and how annealing is usually carried out in glass industry? **(6)**

   (d) Name three different special glasses with their description and uses. **(6)**

2. (a) Explain the principle of lubrication. **(4⅓)**

   (b) Discuss the properties that are involved in lubricant analysis. **(6)**

   (c) Describe the acid refining of lubricating oil. **(6)**

   (d) Give the classification of synthetic lubricants with examples. **(7)**

3. (a) Distinguish between corrosion and erosion with suitable examples. **(4⅓)**

   (b) Give the classification of corrosion. Describe the electrochemical corrosion with examples. **(6)**

   (c) Discuss the economic aspects of corrosion. **(6)**

   (d) Describe the mechanism of microbiological corrosion. How the microbiological corrosion can be prevented. **(7)**

Contd P/2

CHEM 143/IPE

4. (a) Describe the different steps in preparation of metal surface for the application of protective coating. **(6 ⅓)**

   (b) Briefly explain the differential methods used for application of metallic coatings. **(7)**

   (c) Define paint. Give a schematic diagram for the manufacture of paint. **(6)**

   (d) What is varnish? Give the characteristics of a good varnish. **(4)**

SECTION – B

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

5. (a) What is polymer? Classify polymers based on composition and polymer tacticity. **(6)**

   (b) Discuss the advantages of inorganic polymers over organic polymers. Give some example of heterochain inorganic polymers. **(4 ⅓)**

   (c) What are the living polymers? Show the mechanism of polymerization which leads to living polymers. **(7)**

   (d) Write down the synthesis of following polymers. **(6)**

   (i) Nylon – 6, 6 (ii) Epoxy resin

6. (a) Write short notes on any two of the following: **(8)**

   (i) Biodegradable plastics (ii) Recycled plastics (iii) Conductive polymers.

   (b) Discuss the injection molding process. Why is injection molding process good for mass production? **(7 ⅓)**

   (c)Describe the industrial manufacturing process of polyethylene. **(8)**

7. (a) Write down the basic differences between natural and synthetic fibers. **(4)**

   (b) How are fibers prepared by dry spinning process? **(6)**

   (c) What are the raw materials of Dacron fiber? How are they prepared? **(4 ⅓)**

   (d) Describe the industrial manufacturing process of cuprammonium rayon. **(9)**

8. (a) Explain the chemical composition of natural rubber. **(4 ⅓)**

   (b) How is rubber recovered from latex? **(6)**

   (c) Write down some important properties and applications of silicone rubber. **(5)**

   (d) How does vulcanization work? Which additives are added during sulphur vulcanization? **(8)**

L-1/T-2/IPE **Date : 06/03/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2016-2017

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**.

Graph papers to be supplied.

1. (a) What do you understand by equilibrium diagram? What information do you get from an equilibrium diagram? Mention the limitations of equilibrium diagram. **(10)**

   (b) Metals X and Y of melting points 750°C and 920°C, respectively are mutually (completely) soluble in the liquid state but partially soluble in the solid state. At 400°C a eutectic composition is formed with 60% X and 40% Y. At eutectic temperature the solubility of Y in X is 20% and that of X in Y is 5%. Solid solution of Y in X is known as α phase and that or X in Y is known as β phase.

   (i) Draw the X-Y equilibrium phase diagram on graph paper, assuming all the liquidus and solidus lines to be straight and label all the phase fields. **(17)**

   (ii) Describe what happens when an alloy containing 85% solidifies and cools slowly to 0.°C. **(8)**

2. (a) What is the difference between modulus of resilience and toughness? Calculate, the modulus of resilience of a steel having elastic modulus of 207 GPa and yield strength of 295 MPa. **(8)**

   (b) With the help of typical engineering stress-strain diagram, describe the plastic deformation phenomenon when tensile loading continues beyond yield point. **(15)**

   (c) What do you understand by ductile to brittle transition temperature (DBTT)? Briefly explain the effects of the metallurgical factors on the DBTT curve. **(12)**

3. (a) Draw the Fe-Fe_3C equilibrium diagram on a piece of graph paper and label all the points, lines and areas. Sketch the microstructures of the steel containing 1% C at 725°C and at 720°C during slow cooling. **(23)**

Contd P/2

MME 195/IPE

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(b) Identify the steel with the carbon concentration (wt %) for which the fraction of total ferrite at room temperature is 0.94? For the idnetifed steel, calculate the wt% of the pro-eutectoid ferrite and pearlite. Also, calculate the wt % of ferrite and cementite in the pearlite. **(12)**

4. (a) What is creep? Draw a typical creep curve and explain the various steps of creep. What changes would you expect in the creep curve, when the alloy under observation is subjected to changing stress and temperature? **(17)**

(b) What do you understand by 18/8 stainless steel? Briefly explain the mechanism of integranular corrosion. How can it be prevented? **(10)**

(c) Differentiate between ductile failure and brittle failure. **(8)**

SECTION – B

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

5. (a) Explain the terms lattice and unit cell. Draw a neat sketch of body-centered cubic unit cell and determine its (i) lattice parameter in terms of atomic radius, (ii) co-ordination number, (iii) number of atoms per unit cell, (iv) atomic packing density. **(2+2+16=20)**

(b) Draw (010) and (111) crystallographic planes and [110] and [101] crystallographic directions within a unit cell. **(10)**

(c) What are the major components of material science and engineering? **(5)**

6. (a) What are the four basic heat treatment processes? In your opinion, which one is the most different from the other three? Give reason(s). **(4+6=10)**

(b) Show the major micro structural changes of 0.2% carbon steel, during very slow cooling from austenite to room temperature. **(10)**

(c) What happens during hardening of steel? What are the characteristics of martensitic transformation during hardening of steel? **(5+10=15)**

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MME 195/IPE

7. (a) What is Pig Iron? What are the charges of a blast furnace? What are the functions of limestone in blast furnace? **(3+6+6=15)**

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

8. (a) Compare LD steelmaking with EAF steelmaking in terms of their advantages and disadvantages. **(8)**

   (b) How S and P can be removed in EAF? **(7)**

   (c) What is slag? What is the role of slag in stellmaking? What are the sources of slag? **(3+6+5=14)**

   (d) "Iron making is a reductive process, while steelmaking is an oxidative process"- Justify this statement. **(6)**
