L-1/T-1/CHE **Date : 27/06/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **MATH 121** (Differential Calculus and Co-ordinate Geometry)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Sketch the graph of the function $f(x)=\begin{cases}(x+1)^2, & \text{if } x\le -1\\ \sqrt{1-x^2}, & \text{if } -1<x<1\\ x-1, & \text{if } x\ge 1\end{cases}$

and discuss continuity and differentiability of f(x) at x = –1 and at x = 1. **(25)**

(b) Test whether the limit $\lim\limits_{x\to\frac{\pi}{2}}\dfrac{e^{\tan x}-1}{e^{\tan x}+1}$ exists. If possible find the value of the limit. **(10)**

2. (a) If $y = e^{m\cos^{-1}x}$ then show that $(1-x^2)\,y_{n+2}-(2n+1)\,xy_{n+1}-(n^2+m^2)\,y_n=0$ and find the value of y_n at $x = 0$. **(20)**

(b) If a normal to the curve $x^{2/3}+y^{2/3}=a^{2/3}$ makes an angle ϕ with the axis of x, show that its equation is $y\cos\phi - x\sin\phi = a\cos 2\phi$. **(15)**

3. (a) State and prove Mean Value Theorem and verify it for the function $f(x) = 2x - x^2$ in the interval (0, 1). **(17)**

(b) If $u=\tan^{-1}\dfrac{x^3-y^3}{x+y}$; then show that $x\dfrac{\partial u}{\partial x}+y\dfrac{\partial u}{\partial y}=\sin 2u$ and evaluate **(18)**

$$x^2u_{xx}+2xyu_{xy}+y^2u_{yy}$$

4. (a) Find the maximum and minimum values of $f(x) = 5x^6 - 18x^5 + 15x^4 - 10$. Sketch the graph of f(x). **(13)**

(b) Find the radius and height of the right circular cylinder of largest volume that can be inscribed in a right circular cone with radius 6 inches and height 10 inches (show in figure). **(12)**

(c) Evaluate $\lim\limits_{x\to 0}(1+\sin x)^{1/x}$ using the rules of indeterminate forms. **(10)**

Contd P/2

MATH 121 (CHE)

SECTION – B

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

5. (a) Simplify the equation: $3x^2 + 2xy + 3y^2 - 18x - 22y + 50 = 0$ by suitable translation and rotation of axes. **(18)**

   (b) If the equation $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$ represents two straight lines, prove that, square of the distance of their point of intersection from the origin is **(17)**

$$\frac{c(a+b) - f^2 - g^2}{ab - h^2}$$

6. (a) Find the condition that the general equation of the second degree $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$ may represent a pair of straight lines, also find the condition of perpendicularity and parallelism of the lines. **(20)**

   (b) Show that, the equation $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$ represents two parallel lines if $a : h = h : b = g : f$. Also find the distance between them. **(15)**

7. (a) Identify the conic $x^2 + 12xy - 4y^2 - 6x + 4y + 9 = 0$ and reduce it to its standard form. Also find the equation of latus rectum, directrices and axes. **(18)**

   (b) Prove that, the two circles $x^2 + y^2 + 2ax + c^2 = 0$ and $x^2 + y^2 + 2bx + c^2 = 0$ touch if $\frac{1}{a^2} + \frac{1}{b^2} = \frac{1}{c^2}$, also find radial axis of the pair of circles. **(17)**

8. (a) Find the equation of the parabola referred to two tangents as axes. **(18)**

   (b) If θ_1 and θ_2 be the angles subtended by the major axis of an ellipse at the extremities of a pair of conjugate diameters, show that $\cot^2\theta_1 + \cot^2\theta_2 =$ constant. **(17)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **EEE 155** (Electrical Engineering Fundamentals)

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**.

Use any reasonable value if required.

1. (a)

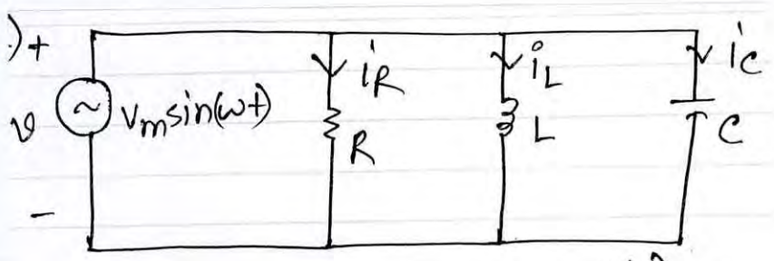

Fig. for Q. No. 1(a)

For the circuit shown in Fig. for Q. No. 1(a), plot v(t), i_R(+), i_L(+). Phase differences among these quantities should be clear. Why this phase differences occur? Explain mathematically. How reactive power is related to power factor. **(20)**

(b) A sinusoidal voltage source of 50 Hz frequency is applied to a series RLC branch. Choose a value of L and C for which source neither supply nor consume any reactive power. Do you need any more data? If yes, why? **(15)**

2. (a) Find the Thevenin equivalent looking into a-b terminals of the circuit shown in Fig. for Q. No. 2(a). **(18)**

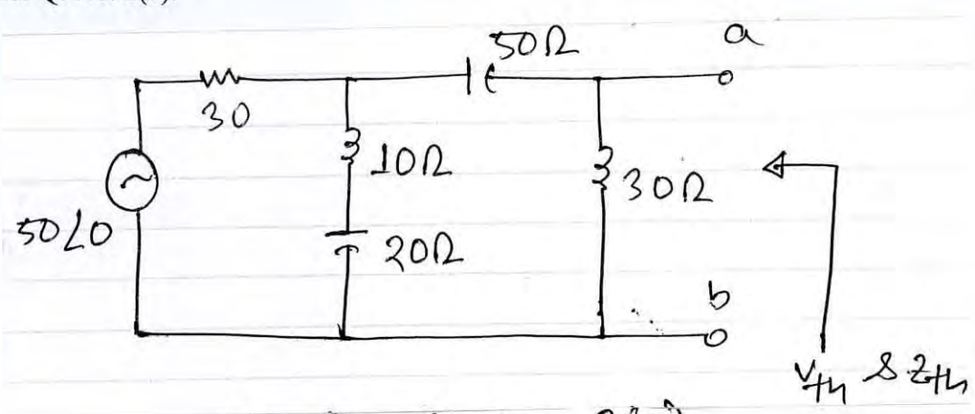

Fig for Q. No. 2(a)

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Contd ... Q. No. 2

(b)

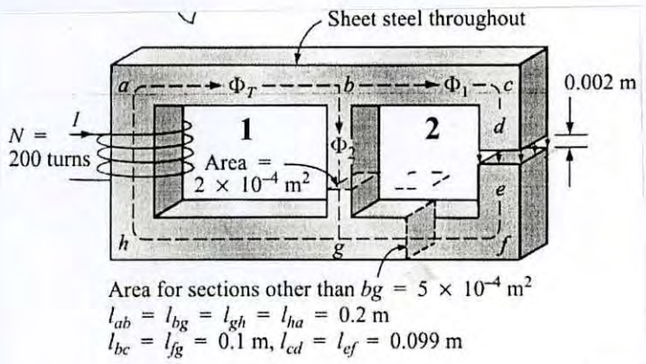

Fig. for Q. No. 2(b)

For the series-parallel magnetic circuit for Fig. for Q. No. 2(b), find the value of I required to establish a flux in the gap of $\phi_g = 1.8 \times 10^{-4}$ wb. **(17)**

3. (a) Find rms value of the signal v(t) shown in Fig. for Q. No. 3(a). **(17)**

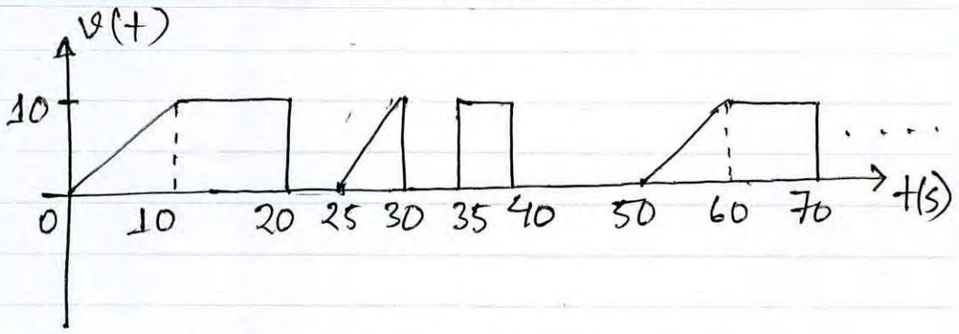

Fig. for Q. No. 3(a)

(b) A voltage v = 200 cos(157t + 30°) volts is applied to a particular circuit element and it is found that i = 5 sin(157t – 150) amperes. Sketch v and i waves. Find the nature and magnitude of the circuit parameters. **(18)**

4. (a) Draw phasor diagram of all the voltages and currents indicated in the circuit as shown in Fig. for Q. No. 4(a). **(18)**

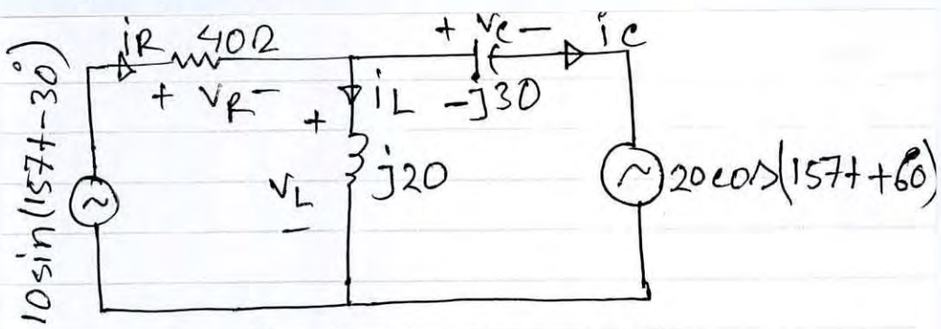

Fig. for Q. No. 4(a)

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Contd ... Q. No. 4

(b) Calculate current, power (both real and reactive) and power factor for each impedance (a-b, b-c, b-d) as shown in Fig. for Q. No. 4(b), and the total power, current and power factor for the whole combination. **(17)**

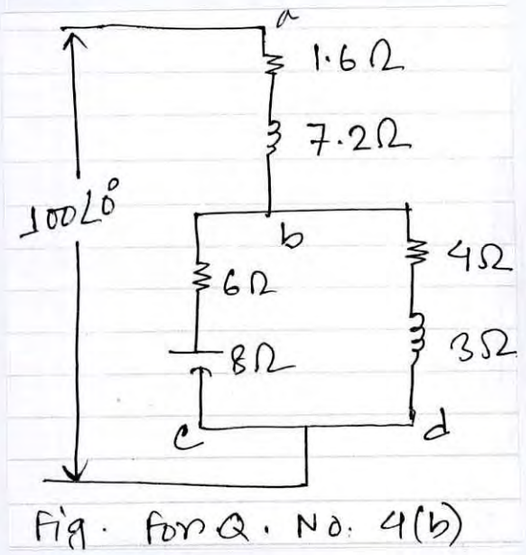

Fig. for Q. No. 4(b)

SECTION – B

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

5. (a) Find the equivalent resistance R_{ab} in the circuit given in Fig. for Q. No. 5(a). If a voltage source of 20 V is connected between a and b, what will be power dissipated in 3 Ω resistor? **(20)**

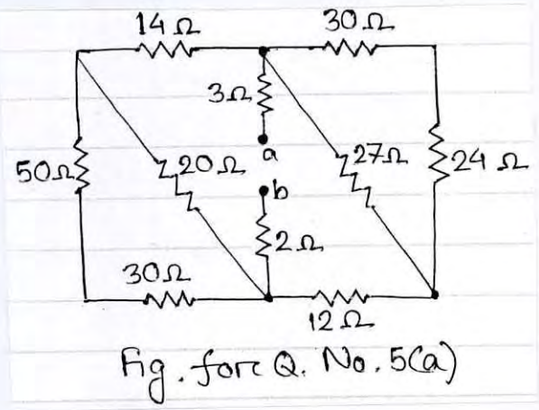

Fig. for Q. No. 5(a)

(b) Find v_0 in the circuit in Fig. for Q. No. 5(b). **(15)**

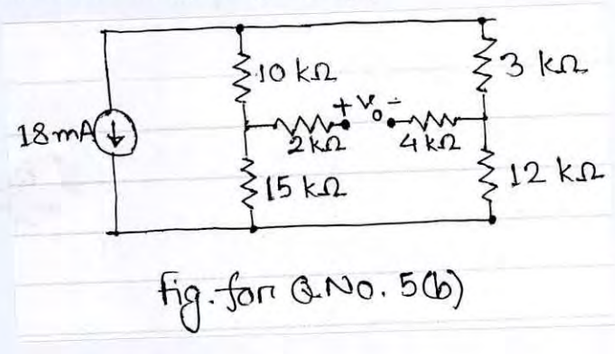

Fig. for Q.No. 5(b)

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6. (a) Find the power dissipated in the 300 Ω resistor in the circuit of Fig. for Q. No. 6(a). **(20)**

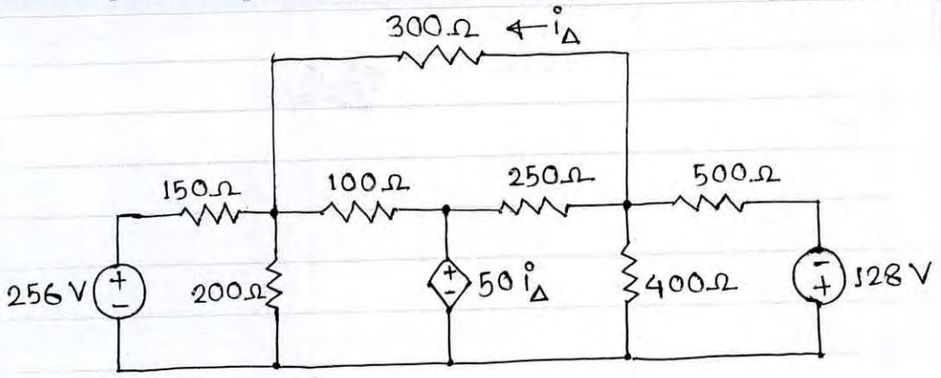

Fig. for Q. No. 6(a)

(b) For the circuit in Fig. for Q. No. 6(b) **(15)**

(i) Obtain the Thevenin equivalent at terminals a-b using source transformation.

(ii) Calculate the current through R_L if $R_L = 8\ \Omega$.

(iii) Find R_L for maximum power transfer to R_L. Determine the maximum power.

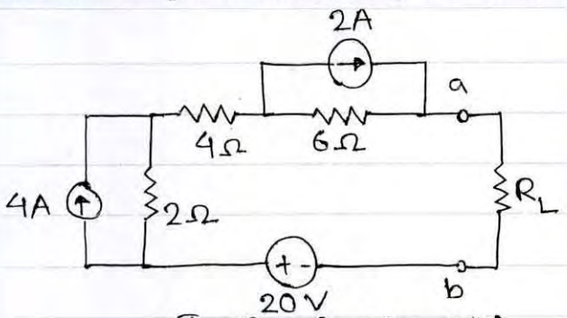

Fig. for Q. No. 6(b)

7. (a) For the circuit in Fig. for Q. No. 7(a), find the voltage v_0 using mesh analysis. **(18)**

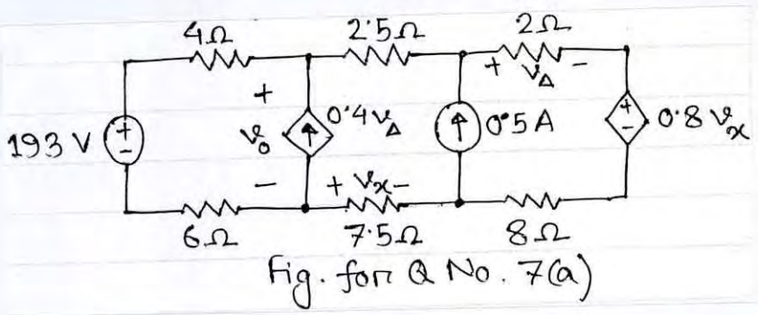

Fig. for Q No. 7(a)

(b) Use the principle of superposition to find v_0 in the circuit of Fig. for Q. No. 7(b). **(17)**

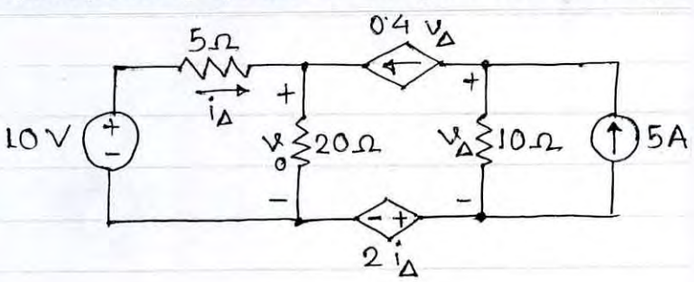

Fig for Q. No 7(b)

Contd P/5

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8. (a) For the circuit in Fig. for Q. No. 8(a), find the value of i if **(18)**

(i) $R_L = 2\ \Omega$ (ii) $R_L = 5\ \Omega$ (iii) $R_L = 12.5\ \Omega$

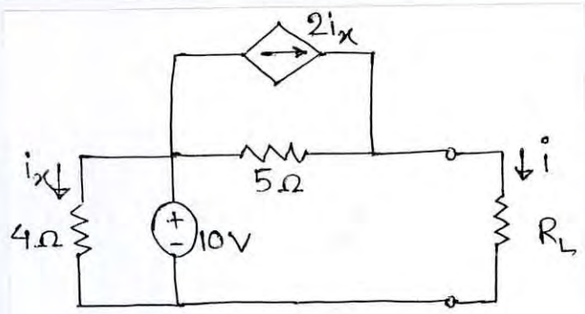


Fig. for Q. No. 8(a)

(b) The network in Fig. for Q. No. 8(b) is designed for delivering power to a 11 W load. Find the maximum allowable value of R_S. **(17)**

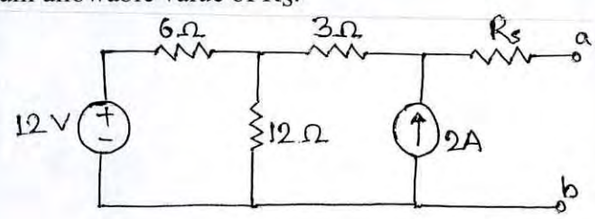
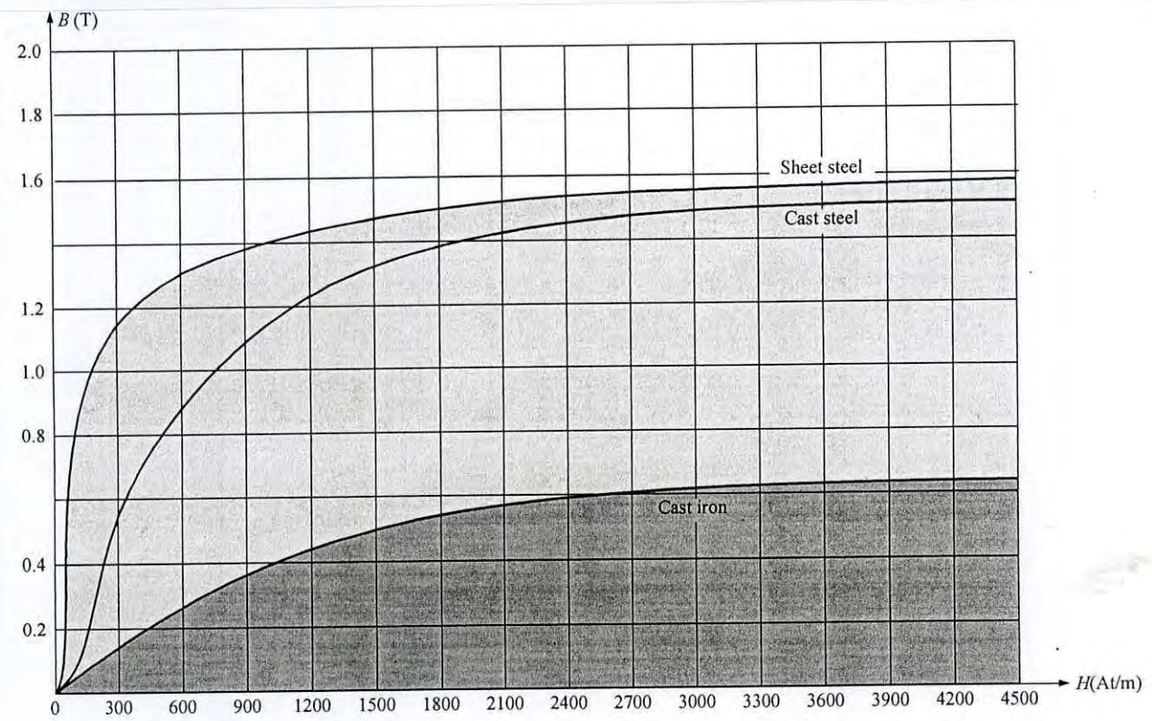
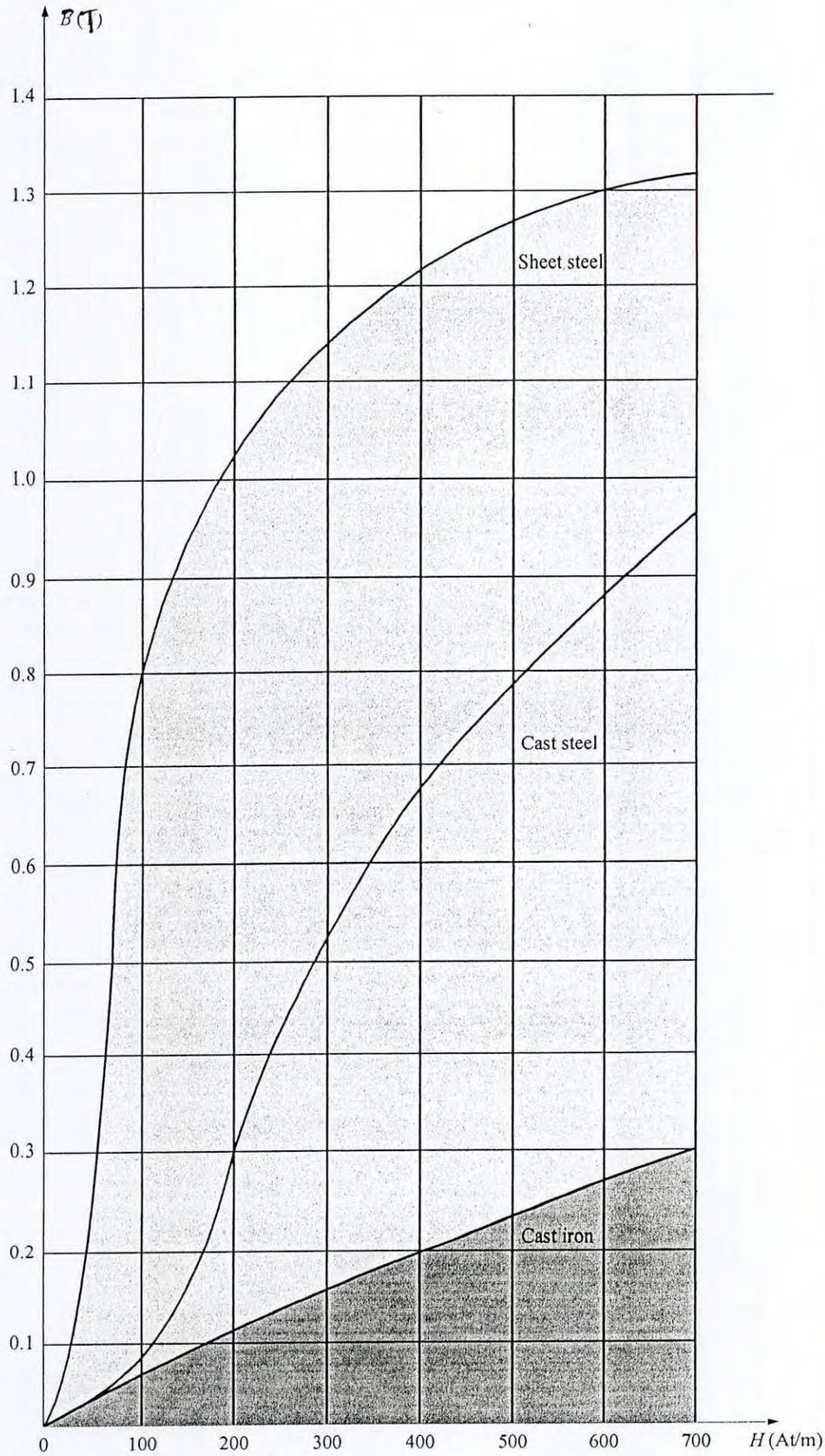


Fig. for Q. No. 8(b)



Normal magnetization curve for three ferromagnetic materials.



Expanded view for the low magnetizing force region.

L-1/T-1/CHE **Date : 30/07/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **ME 141** (Engineering 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) Collar A starts from the rest at t = 0 and moves downward with a constant acceleration of 7 cm/s^2 as shown in Fig. for Q. No. 1(a). Collar B moves upward with a constant acceleration, and its initial velocity is 8 cm/s. Knowing that collar B moves through 20 cm between t = 0 and t = 2s, determine (i) the accelerations of collar B and block C, (ii) the time at which the velocity of block C is zero, (iii) the distance through which block C will have moved at that time. **(18)**

   (b) Milk is poured into a glass of height 140 mm and inside diameter 66 mm as shown in Fig. for Q. No. 1(b). If the initial velocity of milk is 1.2 m/s at an angle of 40° with the horizontal determine the range of values of the height h for which the milk will enter the glass. **(17)**

2. (a) As shown in Fig. for Q. No. 2(a), a 10 kg block B rests on a 20 kg bracket A. The coefficient of friction are $\mu_s = 0.30$ and $\mu_k = 0.25$ between block B and bracket A, and there is no friction in the pulley or between the bracket A and the horizontal surface. Determine the maximum height of block C if block B is not to slide on bracket A. **(17)**

   (b) A small 200 gm collar C as shown in Fig. for Q. No. 2(b) can slide on a semicircular rod which is made to rotate about the vertical AB at the constant rate of 6 rad/s. Determine the minimum required value of the coefficient of static friction between the collar and the rod if the collar is not to slide when (i) $\theta = 90°$, (ii) $\theta = 45°$. Indicate the direction of impending motion in both cases. **(18)**

3. (a) A 2 kg collar is attached to a spring and slides without friction in a vertical plane along the curved rod ABC as shown in Fig. for Q. No. 3(a). The spring is undeformed when the collar is at C and its constant is 600 N/m. If the collar is released at A with no initial velocity, determine its velocity (i) as it passes through B, (ii) as it reaches C. **(18)**

   (b) Two identical balls are moving at the same speed of 3 m/s and in perpendicular directions when they strike each other as shown in Fig. for Q. No. 3(b). Assuming a coefficient of restitution, e = 0.9, determine the magnitude and direction of the velocity of each ball after impact. **(17)**

Contd P/2

ME 141/CHE

4. (a) Rod BDE is partially guided by a roller D which moves in a vertical track as shown in Fig. for Q. No. 4(a). Knowing that at the instant shown the angular velocity of crank AB is 5 rad/s clockwise and that $\beta = 25°$, determine (i) the angular velocity of the rod BDE, (ii) the velocity of point E. **(17)**

   (b) A uniform rectangular plate has a mass of 5 kg and held in position by three ropes as shown in Fig. for Q. No. 4(b). Knowing that $\theta = 30°$, determine, immediately after rope CF has been cut, (i) the acceleration of the plate, (ii) the tension in ropes AD and BE. **(18)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.
Symbols indicate their usual meaning. Assume any missing data.

5. (a) A 200 kg cylinder is hung by means of two cables AB and AC which are attached to the top of a vertical wall as shown in the Fig. for Q. No. 5(a). A horizontal force **P** perpendicular to the wall holds the cylinder in the position shown. Determine the magnitude of **P** and the tension in each cable. **(20)**

   (b) A 800 N force P is applied at point A of a structural member as shown in the Fig. for Q. No. 5(b). Replace P with an equivalent force-couple system at C. **(15)**

6. (a) A vertical load P is applied at end B of rod BC as shown in the Fig. for Q. No. 6(a). The constant of spring is k and the spring is unstretched when $\theta = 90°$. Neglecting the weight of the rod, express the angle θ corresponding to equilibrium in terms of P, k and l. Also determine the value of θ corresponding to the equilibrium when $P = kl/4$. **(20)**

   (b) A pitched flat roof truss is shown in the Fig. for Q. No. 6(b). Determine the force in members EG, GH and HJ. **(15)**

7. (a) Knowing that each pulley as shown in the Fig. for Q. No. 7(a) has a radius of 250 mm, determine the components of the reactions at D and E. **(20)**

   (b) Block A supports a pipe column and rests on wedge B as shown in the Fig. for Q. No. 7(b). Knowing that, the coefficient of static friction at all surfaces of contact is 0.25 and that $\theta = 45°$, determine the smallest force required to raise the block A. **(15)**

8. (a) Determine the moments of inertia of the shaded area with respect to x and y axis as shown in the Fig. for Q. No. 8(a) when a = 20 mm. **(20)**

   (b) A 15 mm diameter hole is drilled in a piece of 20 mm thick steel plate which afterwards is countersunk as shown in the Fig. for Q. No. 8(b). Determine the volume of the steel removed during the countersinking process. **(15)**

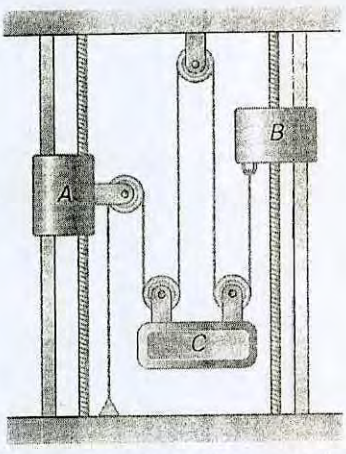


Figure for question no. 1(a)

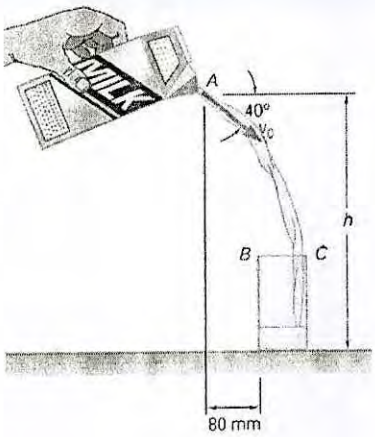


Figure for question no. 1(b)

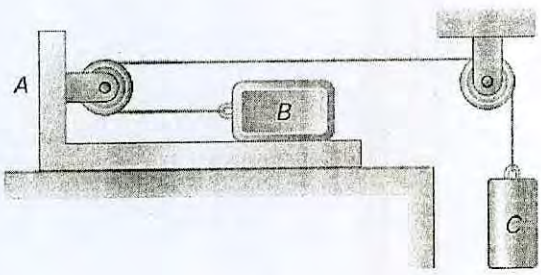


Figure for question no. 2(a)

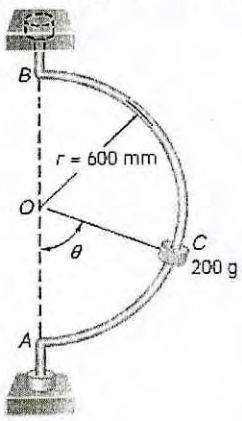


Figure for question no. 2(b)

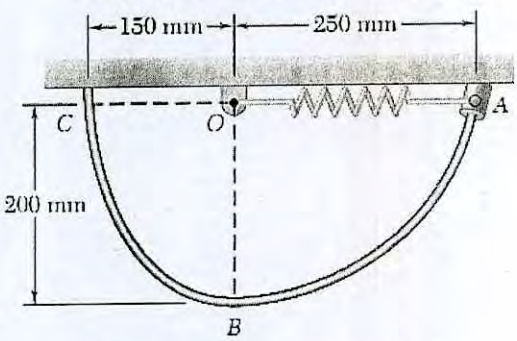


Figure for question no. 3(a)

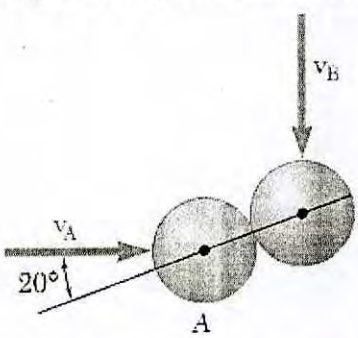


Figure for question no. 3(b)

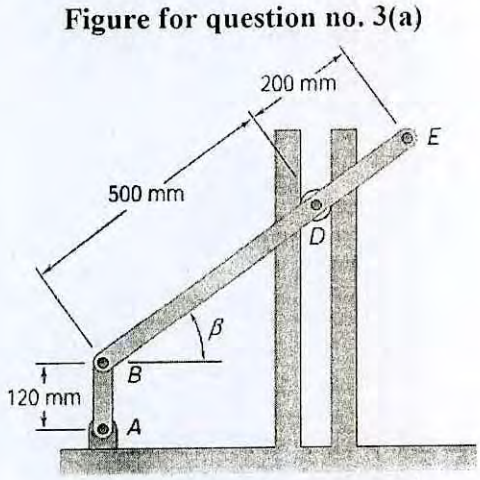


Figure for question no. 4(a)

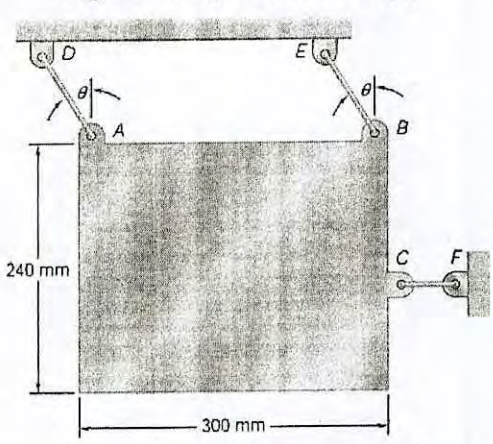


Figure for question no. 4(b)

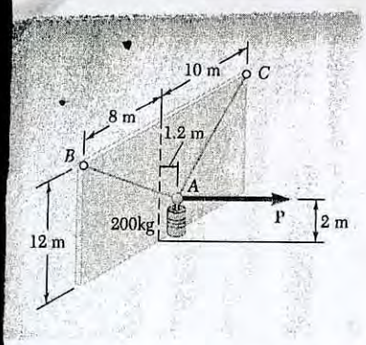


Fig. for Q. 5(a)

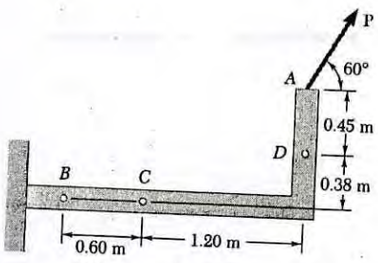


Fig. for Q. 5(b)

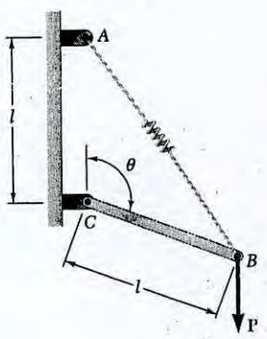


Fig. for Q. 6(a)

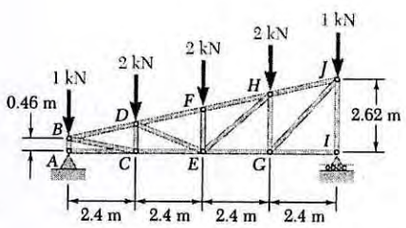


Fig. for Q. 6(b)

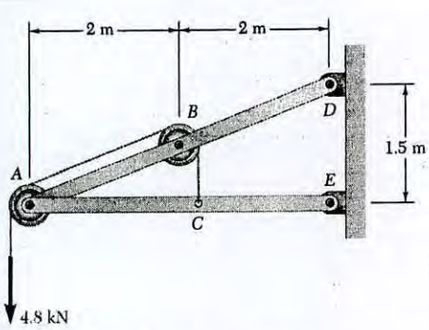


Fig. for Q. 7(a)

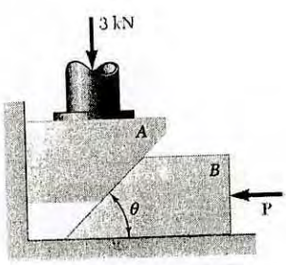


Fig. for Q. 7. (b)

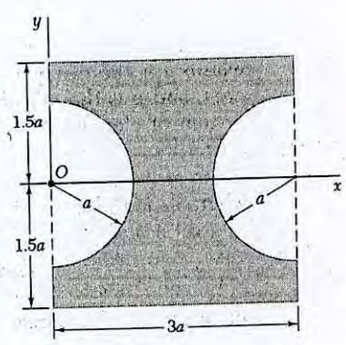


Fig. for Q. 8(a)

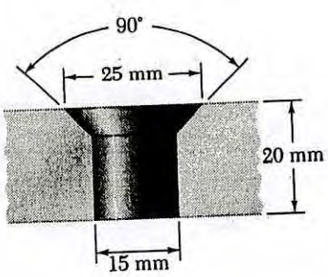


Fig. for Q. 8(b)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **CHEM 111** (Inorganic Chemistry)

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) Explain formation of $[Fe(H_2O)_6]^{3+}$ complex ion according to valence bond theory. Show the geometrical structure of the complex ion and calculate the magnetic moment of the complex. **(12)**

   (b) What is Effective Atomic Number (EAN) rule and why is it considered as a rule? According to EAN rule discuss, with suitable examples, formation of carbonyl complexes of transition metals having both even and odd atomic numbers. **(15)**

   (c) Discuss the different steps for naming complex compounds/ions according to IUPAC. Cite suitable examples for naming. **(8)**

2. (a) Why is it important to know the structure of a molecule? Discuss, with examples, the different methods of determination of molecular structures. **(15)**

   (b) 10 D_q value for a splitting of d-orbitals in an octahedral complex, $[Ti(H_2O)_6]^{3+}$ is 20400 cm^{-1}. Show the possible electronic transition in the complex and calculate the CFSE in kJ/mol. **(10)**

   (c) Discuss the factors on which the splitting of d-orbitals depends. **(10)**

3. (a) What are the informations obtained from Nephelanxetic effect and electron spin resonance (esr) about the bonding characteristics in a complex? Discuss briefly the molecular orbital theory of complex compounds. **(15)**

   (b) Alfred Werner was awarded the Nobel prize in chemistry in 1913. Discuss briefly his contribution. **(10)**

   (c) What are K and β values of complex compounds? Deduce a relationship of β_4 with the K values. **(10)**

4. (a) Draw the geometrical structures of H_3O^+, ClF_3 and ICl_2^- on the basis of VSEPR Theory. **(6)**

   (b) Draw molecular orbital energy level diagram for O_2 molecule and answer the following: **(9)**

   (i) Calculate the bond order in O_2 and O_2^+ ion.

   (ii) What would be the magnetic character of O_2 and O_2^+?

Contd P/2

CHEM 111/CHE

Contd ... Q. No. 4

(c) Explain the term 'screening effect'. How does this term explain the change in the values of ionization energies of elements? **(10)**

(d) What is 'inert pair effect'? Explain why carbon is tetravalent but lead is divalent being in the same group of the periodic table? **(10)**

SECTION – B

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

5. (a) Discuss the properties of Alkaline earth metals (group - IIA elements) in relation to their electronic structure. **(10)**

(b) Compare the chemical properties of Alkali metals (group IA elements) with that of coinage metals (group IB elements). **(10)**

(c) Draw the flow sheet of Solvay process for sodium carbonate preparation. Write down the reactions in the production if this salt in Le Blanch process. Discuss the purification process of common salt. **(5+5+5=15)**

6. (a) What is "The Hard and Soft Acid and Base" principle? Discuss the characteristics of Hard and Soft Acids and Bases. Illustrate your answer with examples. **(8)**

(b) Discuss the application of Hard and Soft Acid and Base principle in the following fields: **(5×4=20)**

(i) Oxidation Reduction reaction.

(ii) Quantitative analysis scheme for metal ions.

(iii) Medicinal chemistry.

(iv) Geochemical classification of the elements and their occurrence in nature as minerals.

(v) Predicting favorable equilibrium.

(c) An acid solution is prepared in 250 ml volumetric flask with H_2SO_4 of specific gravity 1.85 and distilled water in the ratio 1 : 1 (v/v). Calculate the specific gravity of the acid mixture. **(7)**

7. (a) Compare the chemistry of carbon with that of silicon. **(10)**

(b) Discuss the factors affecting the strength of acids and bases. Illustrate your answer with examples. **(10)**

(c) Justify the following statements: **(5×3=15)**

(i) β-Picoline is more basic than α-Picoline.

(ii) Aqueous solutions of $AlCl_3$ and $ZnCl_2$ are acidic in nature but aqueous solutions of NaCl and KCl are neutral.

(iii) K_1^H is greater than K_2^H for oxalic acid.

(iv) $HMnO_4$ is stronger acid than H_3PO_4.

(v) BF_3 is an acid but NH_3 is a base.

Contd P/3

CHEM 111/CHE

8. (a) What do you understand by the dual character of material particle? Derive an expression for the wavelength of material particle waves. **(3+7=10)**

(b) There are so many lines in hydrogen spectrum even though hydrogen atom contains only one electron. How will you explain the existence of various lines in hydrogen spectrum with the help of Bohr's model of atomic structure? **(10)**

(c) What is meant by radial probability distribution curve? Discuss distribution curves for 3s orbital. **(3+7=10)**

(d) The electron energy is hydrogen atom is given by **(5)**

$$E = \frac{-21.7 \times 10^{-12}}{n^2} \text{ erg}$$

Calculate the energy required to remove an electron completely from the n = 2 orbit. What is the Longest Wavelength of light that can be used to cause this transition? ($R = 109686\ cm^{-1}$).

L-1/T-1/CHE **Date : 08/08/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **PHY 111** (Physical Optics, Wave and Oscillation, Heat and Thermodynamics)

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) State thermodynamic laws. **(10)**

   (b) Deduce Clausius-Clapeyron equation. **(15)**

   (c) One gram molecules of a gas expands isothermally to four times its volume. Calculate the change of entropy. Given R = 8.32 J/mole-K and J = 4.2 J/cal. **(10)**

2. (a) State and prove Carnot's theorem. **(15)**

   (b) Derive an expression for the change in entropy of a perfect gas interms of temperature and pressure. **(10)**

   (c) A Carnot engine whose temperature of the source is 600 K takes 200 calories of heat at this temperature and rejects 100 calories of heat in the sink of temperature of 300 K. Calculate the efficiency of the engine. **(10)**

3. (a) What are the thermodynamic functions? **(5)**

   (b) Deduce the Maxwell's thermodynamics relation by using the thermodynamic functions. **(20)**

   (c) Derive the most probable energy of a molecule according to Maxwell's law of distribution of velocities of a gas molecule. **(10)**

4. (a) Distinguish between interference and diffraction of light. **(5)**

   (b) Define resolving power of a telescope. Deduce an expression for it. **(20)**

   (c) Two pinholes 1.0×10^{-3} m apart are placed in front of a source of light of 589 nm wavelength and seen through a telescope with its objective is stopped down to a diameter of 0.4 cm. Find the minimum distance from the telescope at which the pinholes can be resolved. **(10)**

Contd P/2

PHY 111/CHE

SECTION – B

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

5. (a) In a Young's double-slit experiment, three light waves-blue, yellow and red are used successively. For which colour will the fringe width be maximum? **(5)**

   (b) Explain the formation of coherent sources in the case of Fresnel bi-prism. How is the separation between such coherent sources measured in the experiment with a bi-prism? **(20)**

   (c) In a double-slit interference pattern at a point, we observe the 8^{th} bright fringe for 770 nm. What order will be visible here, if the source of light is replaced by light of wavelength 473.8 nm? **(10)**

6. (a) What is plane polarized light? Explain the phenomenon of double refraction in a uniaxial crystal. **(17)**

   (b)Write short notes on (i) Optic axis and (ii) Quarter-waveplate. **(8)**

   (c) A beam of linearly polarized light is changed into circularly polarized light by passing it through a slice of 0.003 cm thick crystal. Assuming this to be minimum thickness that will produce the effect, calculate the difference in the refractive indices of the two rays in the crystal. The wavelength of light used is 600 nm. **(10)**

7. (a) Write down the characteristics of simple harmonic motion. **(5)**

   (b) A body is subjected to an acceleration proportional to its displacement from a fixed point and directed towards the point and oscillates in a medium which offers resistance proportional to its velocity. Establish the differential equation of the motion and hence solve it. **(20)**

   (c) A particle is moving simple harmonically in a straight line. If the distances of the particle from the equilibrium position are x_1 and x_2 corresponding to the velocities u_1 and u_2, show that the period is given by, $T = 2\pi [x_2^2 - x_1^2/u_1^2 - u_2^2]^{1/2}$. **(10)**

8. (a) Prove that in the case of progressive longitudinal waves, [particle velocity at any instant] = [wave velocity] × [slope of the displacement curve at that instant]. **(10)**

   (b) Show that the energy density of a plane progressive wave is given by $E = 2\pi^2 n^2 a^2 \rho$, where the symbols have their usual meaning. **(15)**

   (c) A string vibrates according to the equation $y = 5 \sin(\pi x/3) \cos(40\pi t)$, where x and y are in centimeters and t in seconds. What are the amplitudes and velocities of the component waves whose superposition gives rise to this vibration? **(10)**
