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

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **MATH 257** (Ordinary and Partial Differential Equations)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols have their usual meanings.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Form the differential equation from the equation:

$$y = c_1 e^{2x} \cos 3x + c_2 e^{2x} \sin 3x$$ **(10)**

(b) Solve: $y(2x^2 - xy + y^2)\,dx - x^2(2x - y)dy = 0$ **(12)**

(c) Solve: $y(x^2y^2 + 2)\,dx + x(2 - 2x^2y^2)dy = 0$ by finding an integrating factor. **(13)**

2. (a) Solve: $3x(1 - x^2)y^2 \frac{dy}{dx} + (2x^2 - 1)y^3 = ax^3$ **(11)**

(b) Obtain the orthogonal trajectories of the family of the curves r = 4a $\sec\theta \tan\theta$. **(12)**

(c) At 9.00 AM a thermometer with reading 70°F is taken outdoors where the temperature is 15°F. At 9.05 AM the thermometer reading is 45°F. At 9.10 AM the thermometer is taken back indoors where the temperature is fixed at 70°F. Find the reading at 9.20 AM. **(12)**

3. (a) Solve: $(D^2 - 7D + 12)y = 2^x$ **(11)**

(b) Solve: $x^3 \frac{d^3y}{dx^3} + 6x^2 \frac{d^2y}{dx^2} + 8x\frac{dy}{dx} + 2y = x^2 + 3x - 4$ **(12)**

(c) Solve by variation of parameters method: $(D^2 + 1)y = sec^3 x$ **(12)**

4. (a) Use the method of factorization of operators to solve the equation: **(12)**

$$[(x+2)D^2 - (2x+5)D + 2]y = (x+1)e^x$$

(b) Solve the following equations:

(i) $(1 - x^2)\frac{d^2y}{dx^2} - x\frac{dy}{dx} = 2$ **(11)**

(ii) $y(1 - \ln y)\frac{d^2y}{dx^2} + (1 + \ln y)\left(\frac{dy}{dx}\right)^2 = 0$ **(12)**

Contd P/2

MATH 257(EEE)

SECTION – B

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

5. (a) Find the series solution of the following differential equation by using the method of Frobenius: **(25)**

$$x\frac{d^2y}{dx^2}+(1+x)\frac{dy}{dx}+2y=0$$

(b) Form a partial differential equation by eliminating the arbitrary function ϕ from

$$\phi\left(x^2+y^2+z^2,\ x^2-3y^2+z^2\right)=0.$$ **(10)**

6. (a) Find the integral surface of the partial differential equation

$(2xy-1)p+\left(z-2x^2\right)q=2(x-yz)$ which passes through the line $x = 1, y = 0$. **(11)**

(b) Using Charpit's method find the complete integral of the partial differential equation

$$16p^2z^2+9q^2z^2+4z^2-4=0.$$ **(12)**

(c) Find the complete and singular integrals of the following partial differential equation:

$$\left(p^2+q^2\right)y=qz.$$ **(12)**

7. Solve the following higher order partial differential equations:

(a) $\left(D_x^2+D_xD_y-6D_y^2\right)z=y\sin x$ **(11)**

(b) $\left(D_x^2+D_xD_y-2D_y^2+2D_x+2D_y\right)z=e^{3x+4y}+xy$ **(12)**

(c) $\left(3D_x^2+2D_y^2+D_y+2\right)z=e^{x+2y}\cos(2x+y)$ **(12)**

8. (a) Solve the following higher order partial differential equation: **(15)**

$$\left(x^2D_x^2-xyD_xD_y-2y^2D_y^2+xD_x-2yD_y\right)z=\log\left(\frac{y}{x}\right)-\frac{1}{2}$$

(b) The vibrations of an elastic string is governed by the partial differential equation $\frac{\partial^2u}{\partial t^2}=\frac{\partial^2u}{\partial x^2}$. The length of the string is π and the ends are fixed. The initial velocity is zero and the initial deflection is $u(x,\ 0)=2(\sin x+\sin 3x)$. Find the deflection $u(x,\ t)$ of the vibrating string for $t > 0$. **(20)**

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

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **EEE 105** (Electrical Circuits II)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

All Symbols used have their usual meanings.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

B-H curve is attached.

1. (a) For the magnetic circuit shown in Fig. for Q. No. 1(a), find the value of I required to establish a flux in the gap of $\phi_g = 2.5\times10^{-4}\,Wb$. **(18)**

   (b) Compute power absorbed by the load in the circuit shown in Fig. for Q. No. 1(b). **(17)**

2. (a) A π-section filter has in its series arm z_1 = –j 80 ohms and in shunt arms $2z_2$ = j400 ohms. **(18)**

   (i) Calculate the characteristics impedance.

   (ii) Calculate the attenuation in decibels and the phase shift in degrees.

   (iii) Are the reactances given for a frequency within the pass band or stop band?

   (b) Nine T sections each having series arms of $\frac{z_1}{2}$ = j400 ohms and shunt arms z_2 = -j180 ohms are connected in series or cascade. If the input voltage is 90 volts, find the output voltage of the ninth section and the output current, assuming characteristics termination. **(17)**

3. (a) Draw constant – k high pass T or π filter sections. Derive the design equations of the section i.e. C_{1k} and L_{2k} in terms of R_k and f_c. Also evaluate Z_{OT} and $Z_{O\pi}$ in terms of f_C, f, C_{1k} and L_{2k}. **(18)**

   (b) Derive Campbell's equation and from this, derive the expressions of attenuation constant in stop band and phase shift constant in pass band. **(17)**

4. (a) Derive i(t) in the circuit shown in Fig. for Q. No. 4(a). Explain its transient and steady state parts. **(18)**

   (b) Show analytically that the maximum voltage across the capacitor is obtained at a lower value of capacitance than the capacitance at resonance when resonance is achieved by varying capacitance in a series R-L-C circuit. **(17)**

Contd P/2

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SECTION – B

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

5. (a) With proper reasoning determine whether the following two waves are of the same shape or not: **(9)**

$$e = 10\sin(\omega t + 30°) - 2\sin(3\omega t - 60°) + 0.4\sin(5\omega t + 40°)$$

$$i = 35\sin(\omega t + 30°) + 7\sin(3\omega t - 150°) + 1.4\cos(5\omega t + 310°)$$

(b) Consider the circuit of Figure for Q. No. 5(b) with input source voltage v and frequency f = 50 Hz. **(18)**

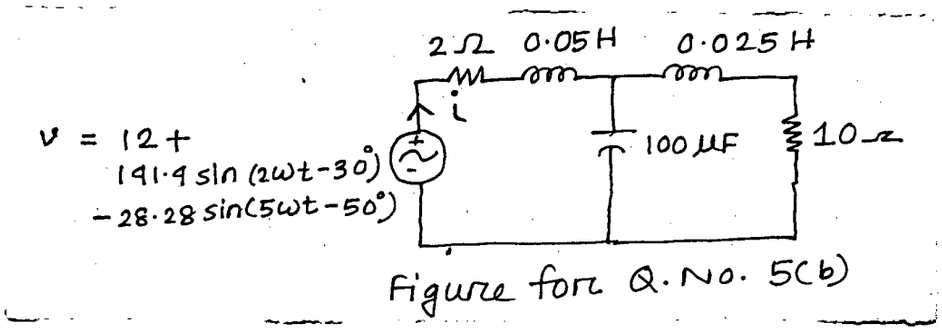

Figure for Q. No. 5(b)

(i) Determine the instantaneous and effective value of the current i.

(ii) Determine the power delivered by the source. Also determine the power factor.

(c) Draw the three origin vector diagram for a balanced three pahse, 0.6 p.f. lagging load. Consider acb sequence of line voltages. **(8)**

6. (a) Two balanced loads are connected to a 220 V, 50 Hz line as shown in the Fig. for Q. No. 6(a)

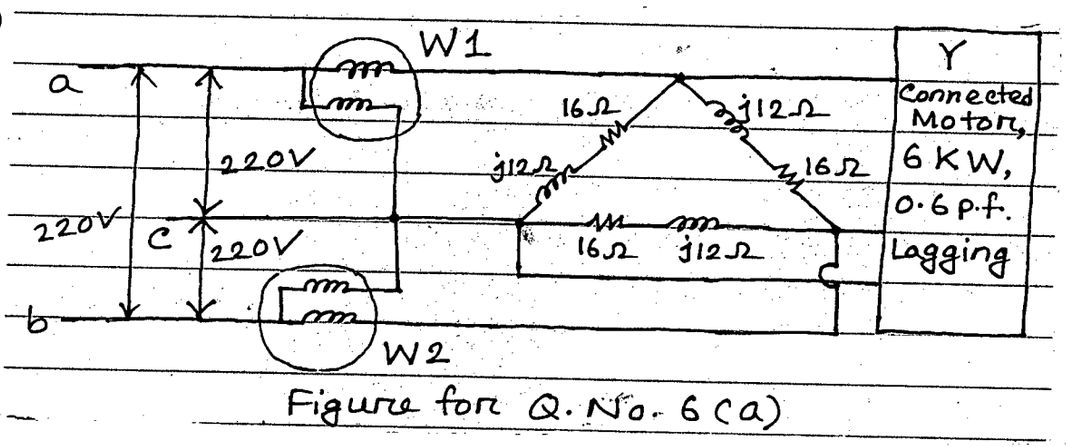

Figure for Q. No. 6(a)

Assuming abc sequence, determine **(23)**

(i) The wattmeter readings, total power and the overall power factor.

(ii) The kVAR rating of the three Δ-capacitors connected in parallel with the existing loads that will raise the power factor to 0.9 lagging.

(b) Show that, copper required to transmit power under fixed conditions is minimum for three phase connection. **(12)**

Contd P/3

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7. (a) Consider that, two signals, one of frequency 10 kHz and other of 20 kHz, are impressed at ab of the Fig. for Q. No. 7(a). **(18)**

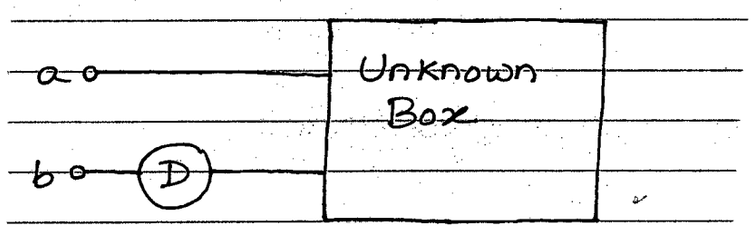

Figure for Q. No. 7(a)

It is desired to suppress the 10 kHz signal at D. Two resistors, each valued 20 Ω, and a fixed capacitor of 0.01 μF are available. Propose a design of the circuit for the "Unknown Box" that will fulfill the above mentioned requirement.

(b) Consider the following circuit of Fig. for Q. No. 7(b). **(17)**

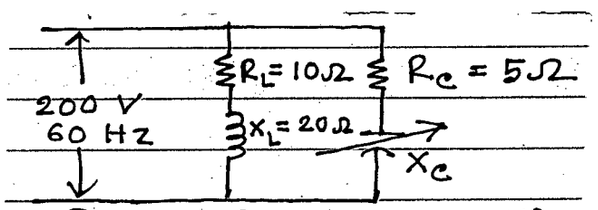

Figure for Q. No. 7(b)

(i) Determine resonant points.

(ii) Find the value of the capacitance which will yield maximum impedance for the whole circuit.

8. (a) Suppose, you have an inductor, a resistor and a voltmeter with you. Propose a method to determine phase sequence with these elements. **(10)**

(b) Determine line currents and line-to-line voltages at load end for the circuit of Fig. for Q. No. 8(b) **(25)**

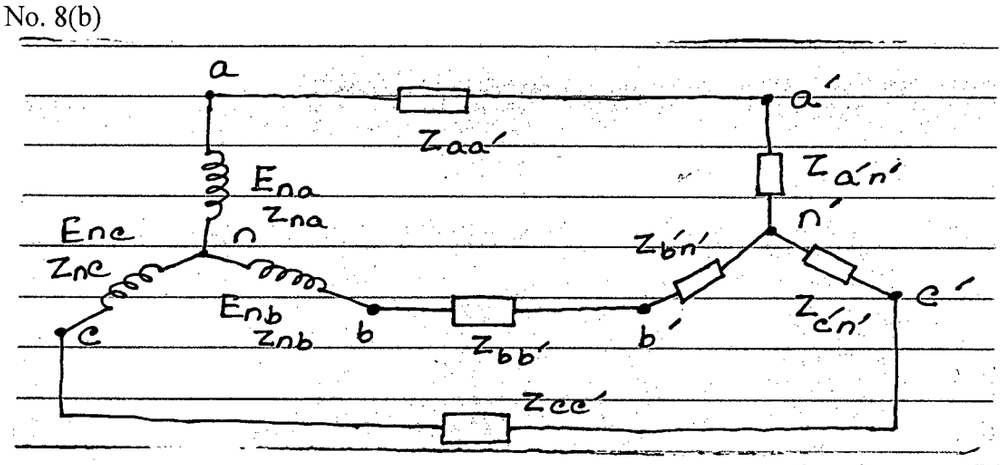

Figure for Q. No. 8(b).

Contd P/4

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Given,

$E_{na} = 1000\angle 0°$, $E_{nb} = 1000\angle -120°$, $E_{nc} = 1000\angle -240°$

$Z_{na} = 2 + j8$, $Z_{aa'} = 1+j1.8$, $Z_{a'n'} = 19 + j18$,

$Z_{nb} = 2 + j8$, $Z_{bb'} = 1+j1.8$, $Z_{b'n'} = 49 - j2$,

$Z_{nc} = 2 + j8$, $Z_{cc'} = 1+j1.8$, $Z_{c'n'} = 29 + j50$.

All the parameters have their usual unit.

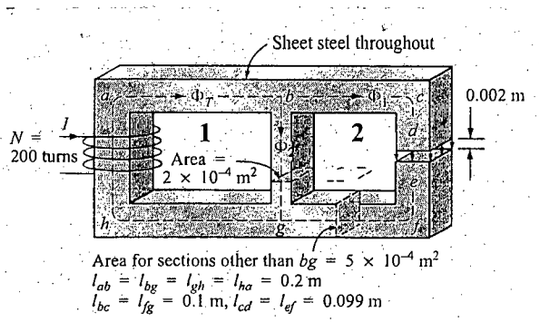

Fig. for Q. No. 1(a)

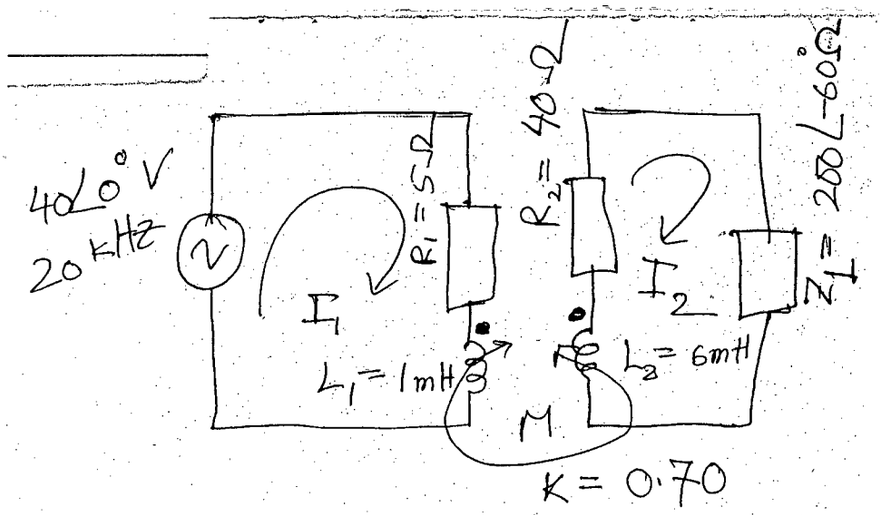

Fig. for Q. No. 1(b)

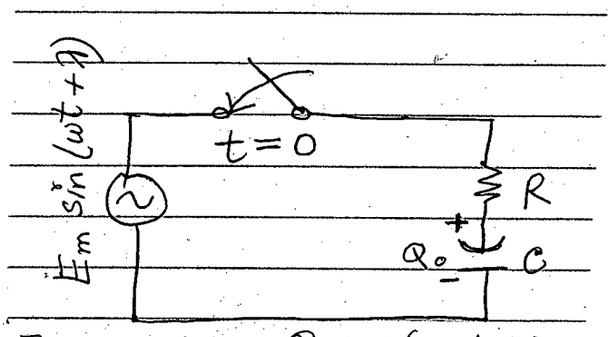

Fig. for Q. No. 4(a)

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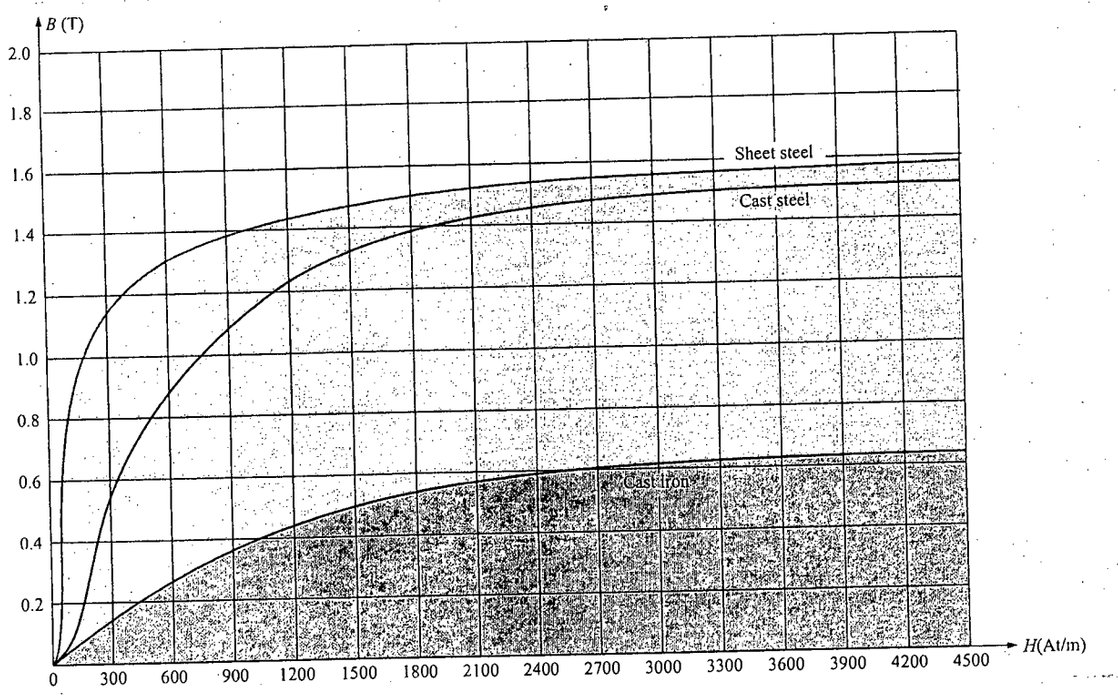
B-H curve



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

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **HUM 277** (Fundamentals of Economics)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols indicate their usual meaning.

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 MRTS? Explain any three characteristics of an isoquant. **(10)**

   (b) Complete the following table and plot the total product (TP), average product (AP) and marginal product (MP) of labour. **(15)**

Number of workers	Total product (TP)	Average Product (AP)	Marginal Product (MP)
1	3		
2	8		
3	12		
4	15		
5	17		
6	17		
7	16		
8	13		

   (c) What is the relation between the AP and MP curves? Use these curves to define three stages of production for labour. **(10)**

2. (a) How would you derive the short run supply curve of a firm under perfect competition? **(10)**

   (b) Explain the closing down point of a firm under perfect competition. **(10)**

   (c) Graphically explain the long run equilibrium of a firm under perfect competition. **(15)**

3. (a) Define fixed cost and variable cost. From the following cost function, find the AC, AVC, AFC and MC function. Calculate the amount of output when MC and AVC will be minimum. **(10)**

$$C = \frac{1}{3}Q^3 - 8Q^2 + 122Q + 50$$

   (b) How would you derive the long run average cost (LAC) curve of a firm from its short run average cost curves? Explain graphically. **(15)**

   (c) What are the relations among various short run average cost curves of a firm? **(10)**

Contd P/2

HUM 277(EEE)

4. (a) "GDP is not a perfect measure of the happiness or quality of life" explain. Consider an economy in which a farmer harvested wheat and sold it to a miller at $100. The Miller made into flour and generated revenue $200. The cost of producing flour is $150 of which $50 is spent for wages of labor. A Baker bought wheat flour and made it into bread and sold to the consumer at $300. The cost of making bread is $240 of which $40 for labor wages. Calculate the GDP of the economy using. **(15)**

   (i) Expenditure Method

   (ii) Value added Method

   (iii) Income Method

   (b) What are the goals of monetary policy? How is the money supply controlled? Explain. **(10)**

   (c) Write down about NPV, IRR, Human Development Index and Natural rate of unemployment. **(10)**

SECTION – B

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

5. (a) State the assumptions of the cardinal theory of utility analysis and illustrate the law of diminishing marginal utility. **(10)**

   (b) How would you derive the demand curve of the consumer based on the axiom of diminishing marginal utility. **(10)**

   (c) What is a demand function? Which factors would you consider to construct a comprehensive demand function for electricity in Bangladesh? Give reasons in favour of your answer. **(15)**

6. (a) Define price elasticity and cross-price elasticity of demand. How would you derive the formulae for measuring these two types of elasticity of demand? **(10)**

   (b) What is Ernst Engel's Law? Evaluate the law with reference to the present state of agriculture in Bangladesh. **(10)**

   (c) Given the demand function of a commodity X

   $$Q_{dx} = 1280 - 15P_x + 0.002\,M + 2.8\,P_y - 5P_z$$

   Where, price of X, P_x = Tk. 25, price of Y, P_y = Tk. 60, price of Z, P_z = Tk. 12 and income, M = Tk. 60000. Find the cross-price elasticities and income elasticity of X. Sate the implications of the results you have obtained. **(15)**

Contd P/3

HUM 277(EEE)

7. (a) Distinguish between GDP deflator and CPL. Consider an economy which is characterized by the following table:

Year (t)	Quantity (Q) Shirts	Quantity (Q) Apples	Price (P) Shirt	Price (P) Apples
2014	6000	4000	$1	$0.9
2015	7000	5000	$1.2	$0.8

Assume that the two goods are produced and consumed within the domestic economy. Calculate the following using 2014 as the base year for both periods. **(10)**

(i) Inflation rate in 2015 as measured by the GDP deflator.

(ii) Inflation rate in 2015 based on a consumer basket which is given by the quantities consumed in 2014.

(b) What do you know about money and its function? How is money measured? State the quantity theory of money. **(10)**

(c) Give reasons why the aggregate supply curve should slope upward and aggregate demand curve slope downward. Graphically explain macro failures. **(15)**

8. Write short notes on any THREE of the following **(35)**

(i) Marginal Rate of substitution (MRS)

(ii) 'Change in supply' and 'change in quantity supplied'

(iii) Market demand curve and market equilibrium

(iv) Optimum consumption point in ordinal approach to utility analysis

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

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **PHY 165** (Electricity and Magnetism, Modern Physics and 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) Discuss an electric dipole and an electric quadrapole. Define electric dipole moment and quadrapole moment. Draw the electric lines of force due to a point charge and an electric dipole. **(10)**

(b) Figure Q. 1(b) below shows an electric quadrapole. Show that the value of electric field $\vec{E}$ on the axis of the quadrapole for points a distance Z from its center (assume Z>>d) is given by $E = \frac{3Q}{4\pi\varepsilon_0 Z^4}$, where quadrapole moment Q is given by $Q = 2qd^2$. **(15)**

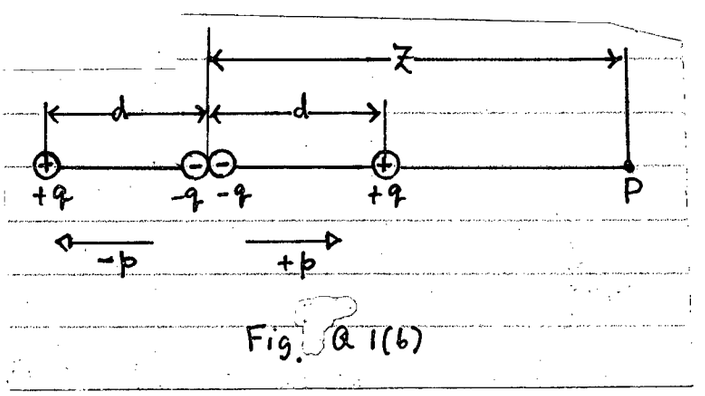

Fig. Q 1(b)

(c) In the Millikan oil-drop experiment an oil drop of radius R = 2.76 μm has an excess charge of three electrons. What are the magnitude and direction of the electric field that is required to balance the drop so it remains stationary in the apparatus? (Density of oil is 920 kg/m^3) **(10)**

2. (a) Discuss Gauss's law in electrostatics. Define electric flux ϕ_E and also compare with its magnetic analog. Write down Gauss's law for gravitation and an incompressible fluid and discuss the terms in these equations. **(10)**

(b) Define electric potential V. Show that the electric potential V in the space around a point charge relative to the infinity potential at r = 0 is given by $V = \frac{1}{4\pi\varepsilon_0}.\frac{q}{r}$, where the symbols have their usual meanings. Plot the electric potential V(r) due to a positive point charge which is located at the origin of an xy-plane. **(15)**

Contd P/2

PHY 165(EEE)

Contd ... Q. No. 2

(c) Fig. Q. 2(c) shows three charges held in fixed positions by forces that are not shown in the diagram. Calculate the electric potential energy of this system of charges. Assume that d = 12 cm and that $q_1 = +q$, $q_2 = -4q$ and $q_3 = +2q$ in which q = 150 nC (1 nC = 10^{-9}C). **(10)**

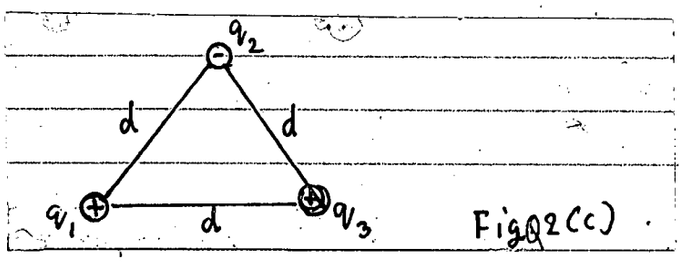

Fig Q2(c)

3. (a) Define capacitance of a capacitor. Discuss what happens when a dielectric material is inserted in between the capacitor plates. Briefly discuss the dielectrics in an atomic view. **(10)**

(b) Discuss resistance and resistivity from the atomic point of view. Show that for a metallic conductor obeying Ohm's law the resistivity ρ is independent of the strength of the applied electric field and is given by $\rho = \frac{m}{e^2 n\tau}$ where the symbols have their usual meaning. **(15)**

(c) Calculate the mean free time τ between collisions for the conduction electrons in copper and hence calculate the mean free path λ for these collisions assuming the effective speed $V_{eff} = 1.6 \times 10^6$ m/s (conduction electron per unit volume for copper is 8.47×10^{28} and $\rho = 1.69 \times 10^{-8}\ \Omega$.m). **(10)**

4. (a) What do you mean by activity of a radioactive substance? Deduce the radioactive decay law. **(14)**

(b) In case of α-decay, show that α-particle kinetic energy T_α is always less than its decay energy Q_α. **(14)**

(c) Calculate the activity of 0.1 mg sample of ^{90}Sr whose half-life is 28 years. **(7)**

SECTION – B

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

5. (a) Write down the postulates of special relativity. **(6)**

(b) Show that the Maxwell's electromagnetic wave equation

$$\frac{\partial^2\varphi}{\partial x^2}+\frac{\partial^2\varphi}{\partial y^2}+\frac{\partial^2\varphi}{\partial z^2}-\frac{1}{c^2}\frac{\partial^2\varphi}{\partial t^2}=0$$

is invariant under a Lorentz transformation. The symbols have their usual meanings. **(23)**

Contd P/3

PHY 165(EEE)

Contd ... Q. No. 5

(c) The half life of a particle as measured in the laboratory comes out to be 4×10^{-8} s when its speed is 0.8c (c is the speed of light) and 3×10^{-8} s when its speed is 0.6c. Find out its actual life time. **(6)**

6. (a) Distinguish between soft and hard x-rays. **(5)**

(b) (i) Describe an experimental outfit for production of x-rays and obtain the expression $\lambda_{min} = \frac{1.24 \times 10^{-6}}{V} volt - m$. The symbols have their usual meaning. **(12)**

(ii) What are the origins of continuous and characteristics x-rays? Discuss how wavelength of x-rays can be determined. **(13)**

(c) The distance between adjacent atomic planes in calcite is 3×10^{-8}cm. What is the smallest angle between these planes and an incident beam of 0.3-Å x-rays at which these x-rays can be detected? **(5)**

7. (a) What do you mean by normalization? How can you normalize a wave function? **(5)**

(b) Show that, if a wave function is normalized at t = 0 then it is normalized for any time. **(12)**

(c) A particle is represented by **(18)**

$$\Psi(x,0) = \begin{cases} A(a^2 - x^2) \; if \; -a \le x \le a \\ 0 \qquad\qquad \text{otherwise} \end{cases}$$

(i) Normalize the wave function.

(ii) What is the expectation value of momentum P at t = 0.

(iii) Find out the expectation value of P^2.

8. (a) State and prove Keplar's first law. **(15)**

(b) What do you mean by stationary state? Write down the physical significance of stationary state. **(8)**

(c) Show that there is no acceptable solution of Schrödinger equation for the infinite square well potential with energy E = 0 and E = < 0. **(12)**

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

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **CHEM 101** (Chemistry 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 information can be achieved when Kinetic study is carried out on a chemical reaction? **(4)**

   (b) Discuss the terms "rate constant" and "order" in kinetics with examples. **(4)**

   (c) Derive an integrated mathematical expression for the reaction $2A \rightarrow P$. What is the half-life ($t_{1/2}$) for such a reaction? **(8+2)**

   (d) Discuss integral method and differential method for the determination of order. **(8)**

   (e) Decomposition of a gas follows second order kinetics. It takes 40 mins. for 40% of the gas to be dissociated when its initial concentration is 4.0×10^{-2} mol.lit^{-1}. Calculate the rate constant and half-life of the above reaction. **(6+3)**

2. (a) Define 'solution' and give the types of solutions with examples. Describe what do you understand by molarity (M) and molality (m) with suitable examples. **(2+3+4)**

   (b) State and discuss Henry's Law. Show the effect of temperature on dissolution of gases in liquid. **(7)**

   (c) What is the importance of Critical Solution Temperature (CST) in the dissolution of liquid in a liquid? Draw and explain CST curve of Tri ethyl amine system. **(9)**

   (d) 40 gm NaCl is dissolved in 200 mL of water. Calculate the molarity (M) and molality (m) of the solution [Density of solution: 1.06 gm/cc] **(10)**

3. (a) What do you understand by Gibb's free energy and chemical potential? **(4)**

   (b) Derive a mathematical equation showing the relationship between equilibrium constant and free energy. Mention the significance of the relationship. **(8+4)**

   (c) State and explain LeChatelier principle. What is the effect of change of pressure and catalyst on equilibrium constant? **(9)**

   (d) For the reaction N_2O_4 (g) $\rightleftharpoons$ $2NO_2$ (g), 50% N_2O_4 (g) is dissociated at 60°C and 1 atm. total pressure. Calculate the value of K_p and K_c for the reaction. **(10)**

Contd P/2

CHEM 101(EEE)

4. (a) Dissolution of solids in liquids are usually endothermic – prove. **(8)**

(b) What are colligative properties? Why are they so called? **(6)**

(c) With the help of diagram, prove that the elevation of boiling point of a solution containing a non-electrolyte and non-volatile substance is proportional to the molality of the solute in the solution. **(11)**

(d) 0.562 gm naphthalene was dissolved in 30 gm CCl_4. If the normal boiling point of CCl_4 is taken as 76.91°C, at what temperature the solution will boil at atmospheric pressure? The value of Kb is 5.02. **(10)**

SECTION – B

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

5. (a) Describe Planck's hypothesis about quantization of energy. How Einstein used Planck's hypothesis in his theory of Photoelectric effect? **(12)**

(b) (i) The H atom Be^{3+} ion each have one electron. Would you expect the Bohr model to predict their spectra accurately? (ii) Why does the Bohr model of H atom violate the uncertainty principle? **(4+4)**

(c) An electron in the n = 5 level of an H atom emits a photon of wavelength 1281 nm, to what energy level does it move? [The value of Rydberg's constant is 2.18×10^{-18} J] **(8)**

(d) What is the Schrödinger equation? What physical meaning is attributed to ψ^2? **(7)**

6. (a) What feature of an orbital is related to each of the following? **(5)**

(i) Principal quantum number (n) (ii) Angular momentum quantum number (l) (iii) Magnetic quantum number (m_e)

(b) For a given value of principal quantum number, n, how do the energies of the s, p, d and f subshells vary for hydrogen and many-electron atom? What does each box in an orbital diagram represent? **(5)**

(c) Sketch the outline of the periodic table and show group and period trends in the atomic size, first ionization energy, metallic property and electronegativity of the elements. **(10)**

(d) For each element, indicate the number of valence electrons, core electrons, and unpaired electrons in the ground state (i) Si (z = 14), (ii) Cr (z = 24), (iii) As (z = 33) [z is atomic number] **(9)**

(e) (i) Group the species that are isoelectronic with N_e[z =10] according to decrease of their atomic/ionic radius **(3+3)**

(ii) Arrange the following oxides in order of increasing acidity:

CO_2, CaO, Al_2O_3, SO_3, SiO_2 and P_2O_5

Contd P/3

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7. (a) Define the term 'lattice energy'. Explain the following trends in lattice energy; **(5)**

(i) NaCl > RbBr > CsBr; (ii) BaO > KF; (iii) SrO > $SrCl_2$

(b) List the individual steps used in constructing a Borh-Haber cycle for the formation of BaI_2 from the elements. Which of the steps would you expect to be exothermic? **(5)**

(c) Write Lewis structure that obey the Octet rule for each of the following, and assign oxidation numbers and formal charges to each atom: (i) OCS, (ii) $SOCl_2$ (S is bonded to the two Cl atoms and to the O), (iii) $HClO_2$ (Cl is the central atom and H is bonded to O), (iv) BrO_3^- **(8)**

(d) In the series SiF_4, PF_3 and SF_2, estimate the F–X–F bond angle in each case and explain your rationale [Atomic no. of S_i = 14, P = 15, S = 16 and F = 9] **(5)**

(e) What is the difference between the electron-region geometry and the molecular geometry of a molecule? Use the shape of water molecule as an example in your discussion. **(4)**

(f) What is the distinction between a bond dipole and a molecular dipole moment? What conditions must be met if a molecule with polar bonds is non polar? Predict whether each of the following molecules is polar or nonpolar: **(8)**

CS_2, IF, SO_3, PCl_3, SF_6 and IF_5

8. (a) Explain the following statements according to molecular orbital theory of Bonding **(2+3)**

(i) The peroxide ion, O_2^{2-}, has a longer bond length than the superoxide ion, O_2^{2-}.

(ii) The magnetic properties of B_2 are consistent with the π_{2p} MOs being lower in energy than σ_{2p} MO.

(b) Assume that you want to construct a voltaic cell that uses the following half-reactions:

$$A^{2+}_{(aq)} + 2e^- \rightarrow A_{(s)} \quad E^0_{red} = -0.10V$$
$$B^{2+}_{(aq)} + 2e^- \rightarrow B_{(s)} \quad E^0_{red} = -1.10V$$

What additions must you make to the cell for it to generate a standard emf? Which direction do electrons move through the external circuit? What voltage will the cell generate under standard conditions? Write down the cell notation for this cell. **(5)**

(c) Using the standard reduction potentials provided here, calculate the equilibrium constant for the following reaction at 298°C **(5)**

$$16H^+ + 10Br^-_{(aq)} + 2MnO_4^-(aq) \rightarrow 2Mn^{2+}_{(aq)} + 8H_2O(l) + 5Br_2(l)$$
$$\left[E^0_{Mn^{7+}/Mn^{2+}} = +1.51V,\ E^0_{Br_2/Br^-} = +1.06V\right]$$

(d) (i) Under what circumstances is the Nernst equation applicable? What is the numerical value of the reaction quotient Q, under standard conditions?

Contd P/4

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Contd ... Q. No. 8(d)

(ii) In cardiac muscle cells the concentration of K^+ in the intracellular fluid (ICF) and the extra cellular fluid (ECF) are 135 millimolar (mM) and 4 mM respectively. The cell membrane is permeable to K^+ ions. Find out the potential for moving K^+ from the ECF to the ICF using $E^\circ = 0$. **(3+6)**

(e) Suggest an explanation for why liquid water is needed in an alkaline battery? What is the difference between a battery and a fuel cell? **(5)**

(f) (i) What is electrolysis? Comment on the spontaneity of the electrolytic cell using molten NaCl as example. **(6)**

(ii) Magnesium metal is used as a sacrificial anode to protect underground pipe from corrosion. Why is the magnesium referred to as a "sacrificial" anode?
