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

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **CE 101** (Analytic 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) The frame shown in Fig. 1 consists of two vertical members AE and BD, a horizontal member CD and an inclined member DE. All the members have been assumed to be weightless. **(13)**

   (i) Identify the two force member(s).

   (ii) Calculate the components of pin reaction at A.

   (iii) Determine axial force in the two force member(s).

   (b) A flexible cable weighing 2 lb/ft is strung between two supports. One support is 100 ft higher than the other support and the sag measured from the lower support is 50 ft. The magnitude of tension force at the upper support is 8000 lb. Calculate the following: **(10)**

   (i) Minimum tension in the cable.

   (ii) Distance between the two supports.

   (iii) Total length of the cable.

   (iv) Slope in degree at the lower support.

   (c) A ladder of length 4 m and weighing 200 N is placed against a vertical wall as shown in Fig. 2. The ladder also supports a man weighing 550 N. The coefficient of static friction between the wall and the ladder is 0.3 and that between the floor and the ladder is 0.2. Calculate the minimum horizontal force P to be applied at the bottom of the ladder to prevent sliping of the ladder. **(12)**

2. (a) A bar of weight 200 lb is hinged to a vertical wall at A and has been supported by a cable as shown in Fig. 3. Determine the tension in the cable and the components of pin reactions at A and C. **(13)**

   (b) A brass rod of weight 16 lb has been welded at the mid-height of a cast-iron cylinder of unit weight 490 lb/ft^3 as shown in Fig. 4. Calculate the radius of gyration of this composite mass with respect to y-axis. **(11)**

   (c) In Fig. 5, the bodies A and B weigh 400 and 800 N respectively. The coefficient of friction for all surfaces is 0.3. The cord is parallel to the inclined plane CD. Calculate the angle θ and tension in the cord when motion of the body B impends down the plane CD. **(11)**

Contd P/2

CE 101

3. (a) For the simply supported truss shown in Fig. 6, find the force in the members ab, pe, fq, dm and lm. **(14)**

(b) With neat figures derive an expression for the total length of a symmetrical catenary in terms of weight per foot (ω), span length (L) and tension at the low point (Q) of the catenary. **(9)**

(c) A table supports a load of 300 N at point D as shown in Fig. 7. The weight of the triangular top is 200 N. Calculate the reactions at the supporting legs A, B and C. Given AC = BC = 1200 mm and AB = 1050 mm. **(12)**

4. (a) Fig. 8 shows a boom made of two timbers AB and AC. The cable AE holds the timber in a horizontal plane and supports a vertical load of 2000 lb. The line BC is the intersection of the horizontal plane of the boom with the vertical plane BCGF. Determine the force in the timbers AB and AC and tension in the cable AE. Given AB = 15′, AC = 20′, AD = 10′ and DE = 12′. **(12)**

(b) The body A in Fig. 9 weighs 100 lb. The coefficient of static friction between the body A and the inclined plane is 0.5. The coefficient of static friction between the rope and the drum 1 is 0.4 while it is 0.3 between the rope and the drum 2. What value of W will cause motion of the body A to impend up the plane? **(13)**

(c) Using direct integration, determine the coordinates of the centroid of the area bounded by the parabola $y^2 = 18\,x$ and the straight line $y = 3x$. **(10)**

SECTION – B

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

5. (a) In Fig. 10 $W_A = 120$ kN and $W_B = 80$ kN. Consider the cord and pulleys weightless and neglect friction. Determine the acceleration of each body and the tension in the chords T_A and T_B. **(10)**

(b) A counterweight B is to hold a load A of 1610 lb as shown in Fig. 11. The radius of gyration of B is $\bar{k} = 2$ ft. The pulley C is frictionless and weightless. Determine the speed of the c.g. of B after the load A has moved down 20 ft from rest. Use the principle of work and kinetic energy. **(13)**

(c) Determine the x and y coordinates of the centroid of the shaded area shown in Fig. 12. **(12)**

6. (a) An automobile starts from rest and moves around a circular path whose radius is 600 ft. Its tangential acceleration is $a_t = (s + 6)^{1/2}$. Determine the normal acceleration of the car after it has gone 100 ft. **(11)**

(b) Using the method of virtual work, determine the force in the member CD of the frame structure shown in Fig. 13. **(13)**

(c) Calculate the moment of inertia of the shaded area shown in Fig. 14 about the line y = 6 inch. **(11)**

Contd P/3

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7. (a) A D = 18″solid cylinder 'A' weighs 1288 (Fig. 15). It rolls without slipping down a $\theta = 30°$ inclined plane. Determine the time required for its c.g. to attain a speed of 30 fps from an initial speed of 10 fps. Also calculate the friction between the cylinder and the plane. Use the principle of work and kinetic energy. **(12)**

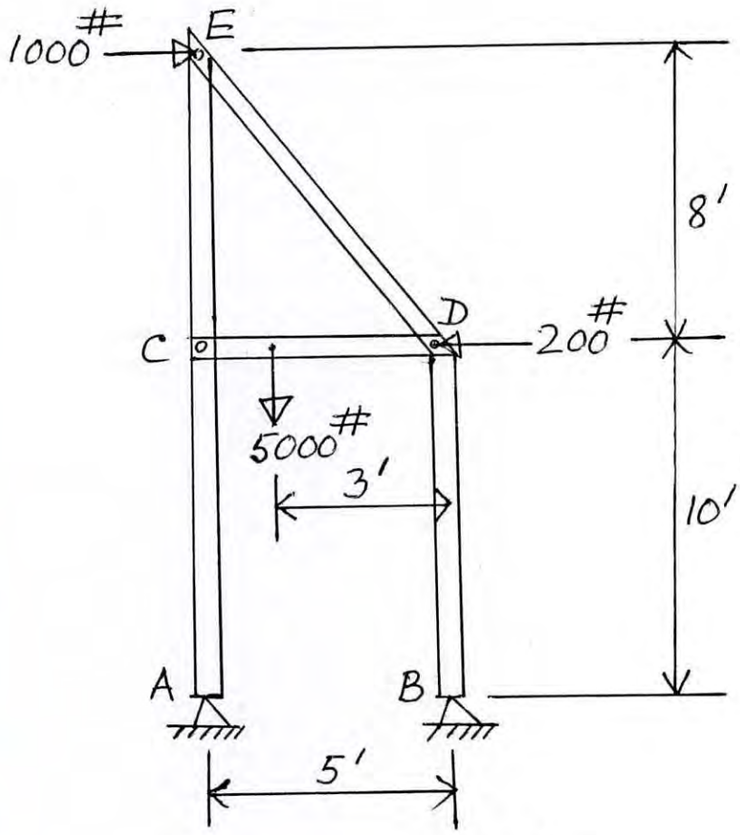
   (b) A disk A (Fig. 16) has a weightless cord wrapped about its midsection. This cord passes over a frictionless and weightless sheave C and then connected to a 50 lb weight B. Let W_A = 80 lb, $\theta = 30°$, $\bar{I}_A$ = 0.3 slug-ft^2 and the displacement of B be 20 ft. If the system starts from rest, determine the final speed of the c.g. of A and the tension in the cord. Use the principle of impulse and momentum. **(13)**

   (c) Using direct integration, derive an expression for the moment of inertial of a homogeneous right circular cone about its geometric axis. **(10)**

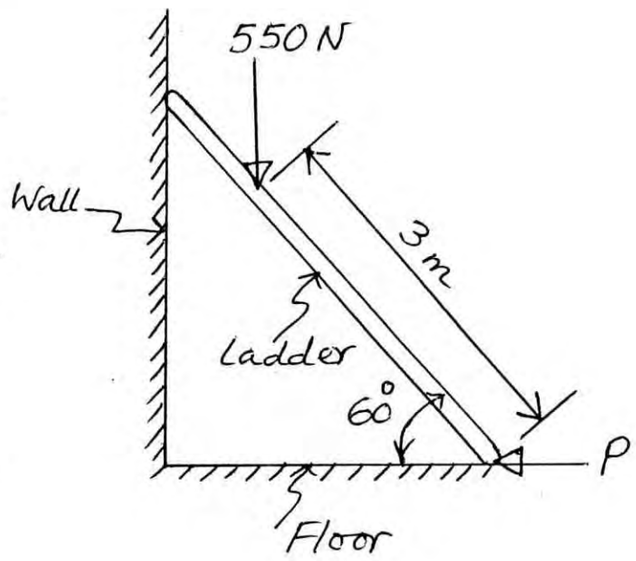
8. (a) In Fig. 17 W_A = 1000 lb, $f = \frac{1}{3}$. Pulleys C and D are considered frictionless and weightless. If A moves 60 ft from rest up the incline in 12 seconds, what is the weight of body B. Use the principle of impulse and momentum. **(13)**

   (b) The block A and the weight W (Fig. 18) are in a state of impending motion. Let W_A = 966 lb and $f_A = 1/3$. Using the method of virtual work, determine the weight W. **(12)**

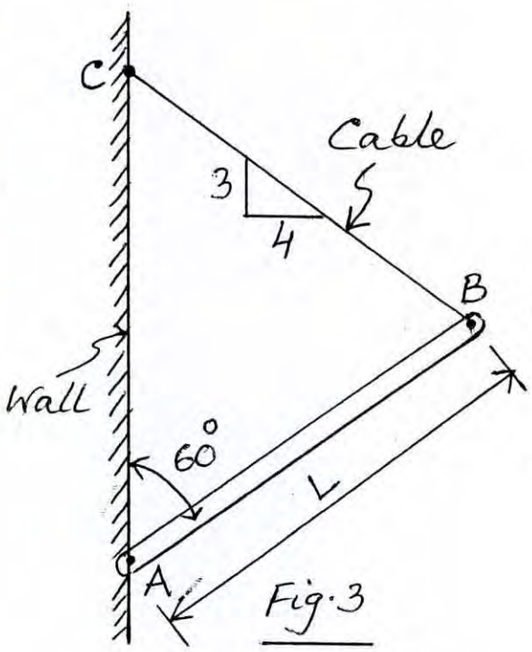
   (c) A simply supported overhanging beam is shown in Fig. 19. Calculate the reactions at the supports A and B. **(10)**



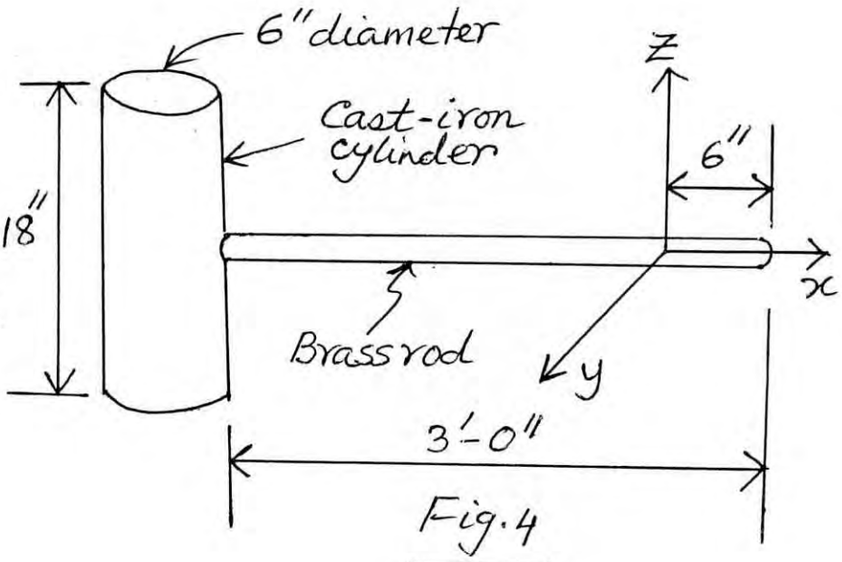
Fig·1



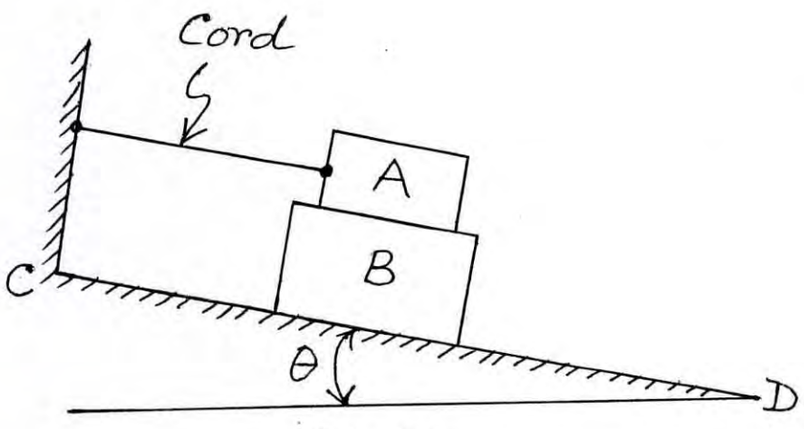
Fig·2



Fig·3

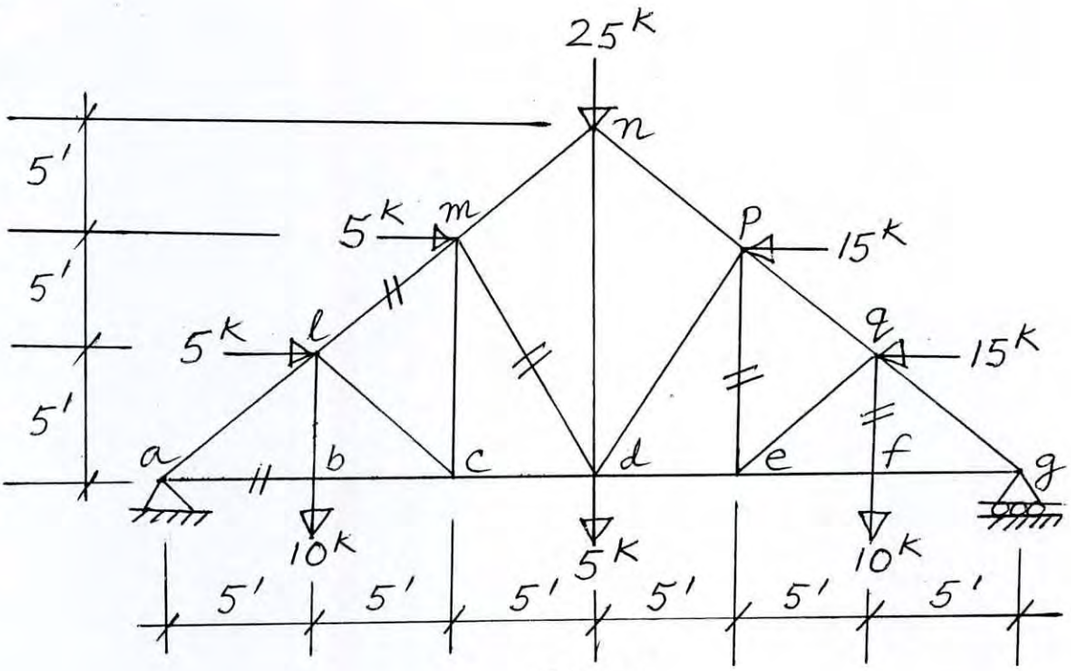


Fig·4

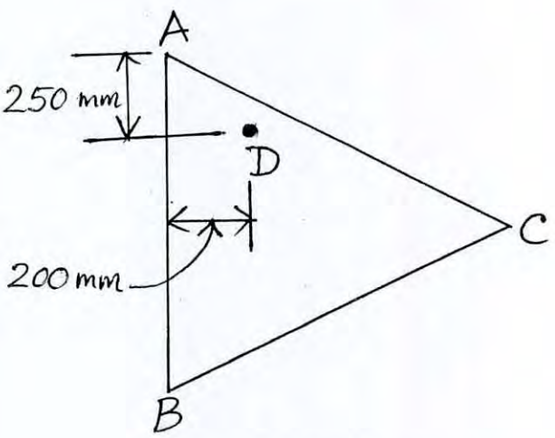


Fig·5

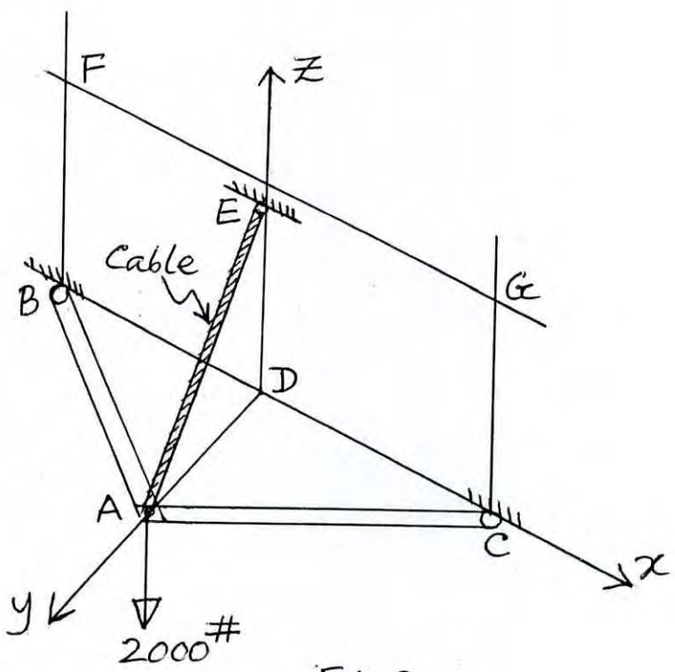
5/11



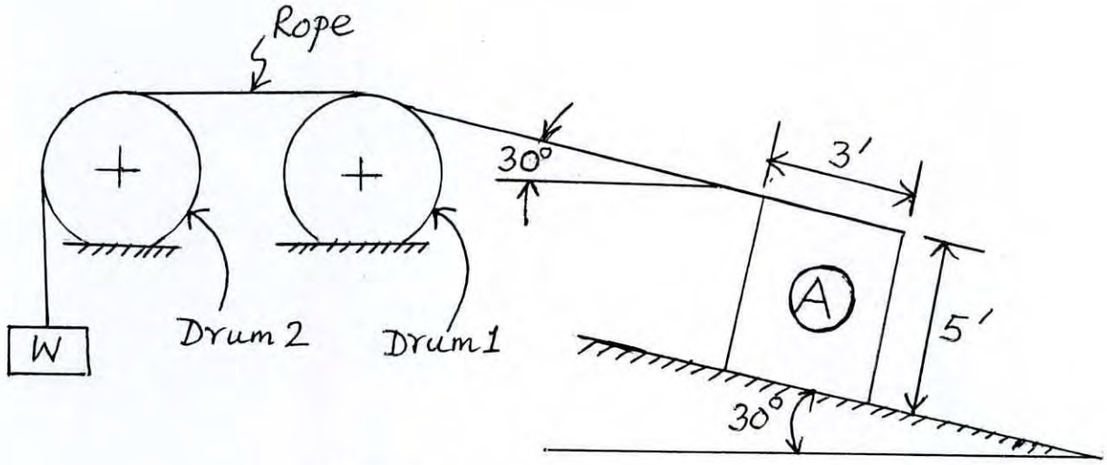
Fig·6



Fig·7



Fig·8



Fig·9

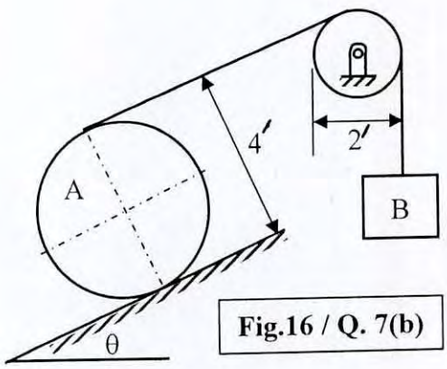


Fig.16 / Q. 7(b)

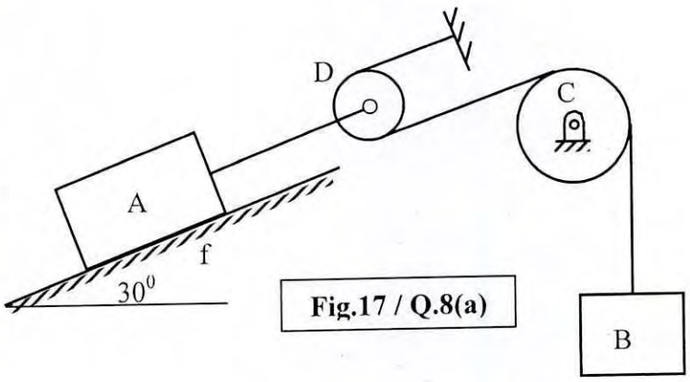


Fig.17 / Q.8(a)

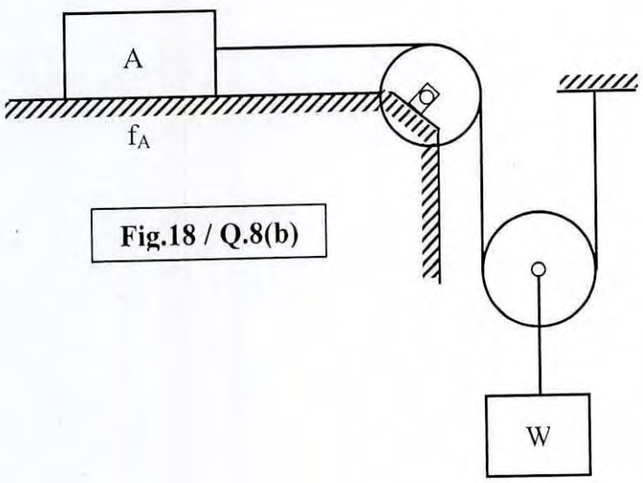


Fig.18 / Q.8(b)

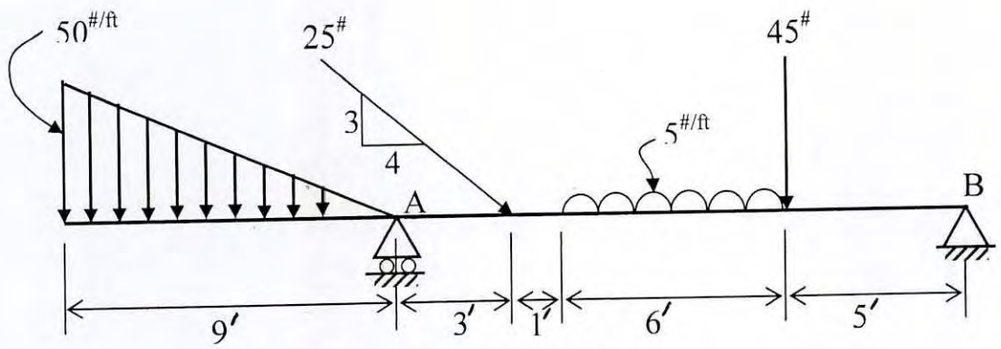


Fig.19 / Q.8(c)

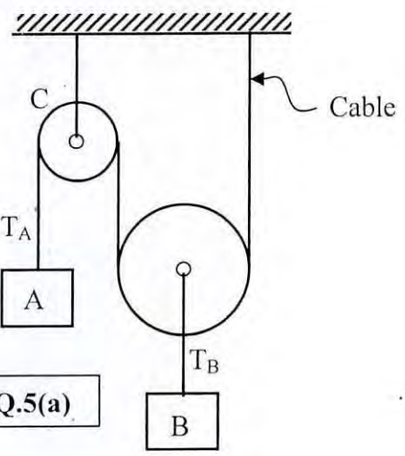


Fig.10 / Q.5(a)

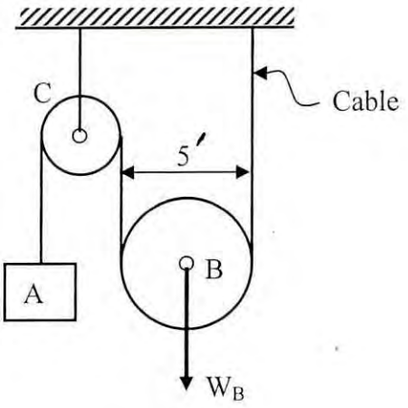


Fig.11 / Q.5(b)

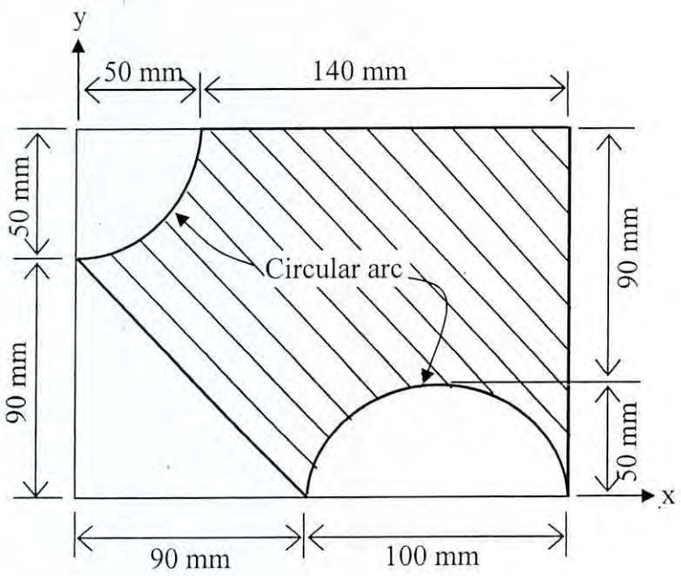


Fig.12 / Q.5(c)

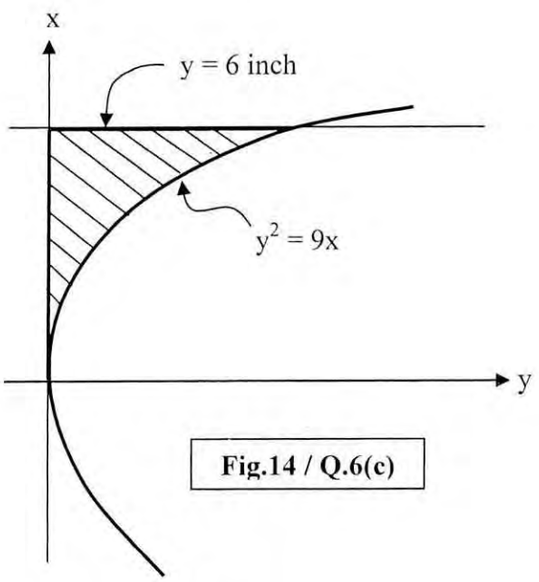


Fig.14 / Q.6(c)

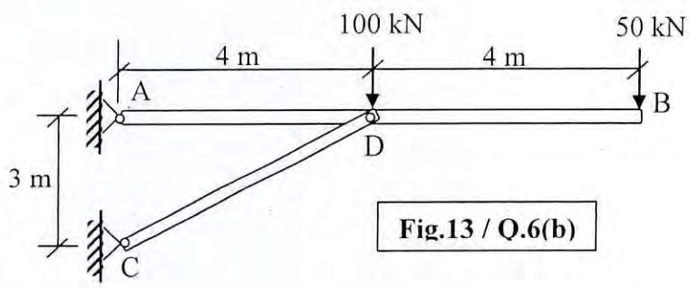


Fig.13 / Q.6(b)

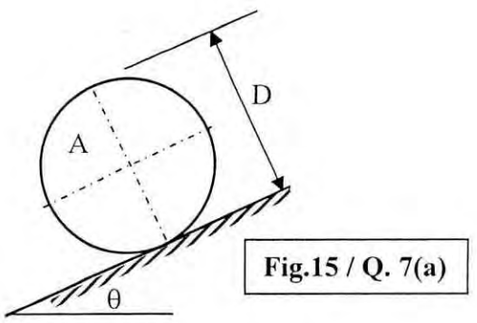


Fig.15 / Q. 7(a)

L-1/T-1/CE **Date : 04/07/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **CHEM 103** (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**.

Use attached tables for Question No. 7 and 8.

1. (a) What are the important process parameters which have to be maintained during the manufacture of a good quality cement? **(7)**

   (b) Show a series of complex chemical reactions that involved during setting and hardening of cement water mass. **(7)**

   (c) Discuss the industrial manufacturing process of Portland cement. **(9)**

   (d) Explain the properties and uses of the following different types of cements. **(12)**

   (i) Unsound cement (ii) Hydrophobic cement

   (iii) Masonry cement (iv) Expansive cement

2. (a) How would you classify the impurities that are usually found in natural water? Discuss the softening technique of hard water by using cation exchange resin. **(9)**

   (b) Show the chemical reactions involved in the determination of dissolved oxygen, total hardness and chlorine content in water. **(9)**

   (c) Distinguish between alkaline hardness and non alkaline hardness. How permanent hardness can be removed by lime-soda process? **(9)**

   (d) The hardness of 100,000 litres of sample water was completely removed by passing it through a zeolite bed. This zeolite bed then required 500 litres of brine containing 100 g/L of NaCl for regeneration. Calculate the hardness of sample water. **(8)**

3. (a) What are the causes of scale formation in the boiler? Discuss the disadvantages of scale formation in the boiler. **(10)**

   (b) How silica, the harmful constituent of the boiler feed water can be removed by chemical treatment? What are the reasons of corrosion that takes place on the boiler tube or plate due to the use of natural water? **(10)**

   (c) What do you mean by carryover? Mention the causes of priming and how it can be minimized. **(9)**

   (d) How boiler corrosion can be prevented by physical and chemical methods? **(6)**

Contd P/2

CHEM 103 (CE)

4. (a) How can you justify the structure of hydrogen atom according to the model of Bohr? **(10)**

   (b) Comment on the correctness of the following statement: **(8)**

   The probability of finding two electrons with the same set of four quantum numbers in an atom is zero.

   (c) How the concept of atomic orbital is introduced? **(7)**

   (d) The He^+ ion contains only one electron and is therefore a hydrogen like ion. Calculate the wavelengths, in increasing order, of the first four transitions in the Balmer series of the He^+ ion. **(10)**

   Compare these wavelengths with the same transitions in an H atom. Comment on the differences.

   (The Rydberg constant for He^+ is 8.72×10^{-18} J and that for H is 2.18×10^{-18} J)

SECTION – B

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

5. (a) How many different kinds of energies are involved in the formation of an ionic crystal? Explain with a suitable example. **(11)**

   (b) What is polar covalent bond? Justify that ionic bond is an extreme case of polar covalent bond. **(10)**

   (c) Predict the geometry and bond angle of the following molecule and ion: **(8)**

   (i) CH_3Cl (ii) PO_4^{3-}

   (d) Sketch the shapes of the following molecular orbitals: σ_{1s}, σ^*_{1s}, π_{2p} and π^*_{2p}. **(6)**

6. (a) Describe the hybridization state of phosphorous in phosphorous pentabromide (PBr_5). **(8)**

   (b) What is the influence of shielding effect on the size of ions? **(8)**

   (c) Explain why enthalpy is a state function and why this is an extensive property. **(6)**

   (d) What is pressure-volume work? How is this work related to enthalpy? **(6)**

   (e) Given the following hypothetical thermo-chemical equations: **(7)**

   $A + B \rightarrow 2C$; $\Delta H = -447$ kJ

   $A + 3D \rightarrow 2E$; $\Delta H = -484$ kJ

   $2D + B \rightarrow 2F$; $\Delta H = -429$ kJ

   Calculate ΔH for the equation

   $4E + 5B \rightarrow 4C + 6F$

Contd P/3

CHEM 103 (CE)

7. (a) What are lattice energy and hydration energy? What role do they play in determining the solubility of ionic solids in water? **(10)**

(b) Equal numbers of moles of two soluble substances, substance A and substance B are placed in two separate 1.0 kg samples of water. Upon cooling sample A freezes at –1.0°C and sample B freezes at – 2.0°C. **(5×5=25)**

(i) Explain why the solutions can have different freezing points.

(ii) Which sample would have higher boiling point? Why?

(iii) Calculate the molalities of the solutions A and B. Assume i = 1 for substance A.

(iv) Assuming molarity and molality are equal for these two aqueous solutions calculate the osmotic pressure for both samples.

(v) What concentration (molality) of substances A and B would result in both solution having freezing point – 0.50°C?

8. (a) Iron reacts spontaneously with copper (11) ion.

$$Fe\ (s) + Cu^{2+}\ (aq) \rightarrow Fe^{2+}\ (aq) + Cu\ (s)$$

(i) Write the half-cell reactions and the cell diagram using the cell notations. **(5)**

(ii) Make a sketch of this cell and label it. **(5)**

(iii) Calculate the standard cell potential considering the cell is running under standard state condition. Calculate the standard free energy change. **(8)**

(b) Calculate the equilibrium K for the following reaction at 25°C from standard electrode potentials. **(8)**

$$2\ Cu^{+}\ (aq) \rightarrow Cu\ (s) + Cu^{2+}\ (aq)$$

(c) The voltaic cell **(9)**

$$Cd\ (s)\ |\ Cd^{2+}\ (aq)\ ||\ Ni^{2+}\ (1.0\ M)\ |\ Ni\ (s)$$

has a cell potential of 0.240 V at 35°C. What is the concentration of Cd^{2+} in the solution?

Tables for Question nos. 7 and 8

Appendixes - Chem 103

Appendix A. Boiling-Point-Elevation Constants (K_b) and Freezing-Point-Depression Constants (K_f)

Solvent	Boiling Point (°C)	Freezing Point (°C)	K_b(°C/*m*)	K_f (°C/*m*)
Acetic Acid (CH_3COOH)	118.5	16.60	3.08	3.59
Benzene (C_6H_6)	80.2	5.455	2.61	5.065
Camphor ($C_{10}H_{16}O$)	---	179.5	---	40
Carbon disulfide (CS_2)	46.3	---	2.40	---
Cyclohexane (C_6H_{12})	80.74	6.55	2.79	20.0
Ethanol (C_2H_5OH)	78.3	---	1.07	---
Water (H_2O)	100.000	0.000	0.512	1.858

Appendix B. Standard Reduction Potentials in Aqueous Solution at 25 °C

Cathode (Reduction) Half-Reaction	Standard Potential, $E°$ (V)
$Li^+(aq) + e^- \rightleftharpoons Li(s)$	−3.04
$K^+(aq) + e^- \rightleftharpoons K(s)$	−2.92
$Ca^{2+}(aq) + 2e^- \rightleftharpoons Ca(s)$	−2.76
$Na^+(aq) + e^- \rightleftharpoons Na(s)$	−2.71
$Mg^{2+}(aq) + 2e^- \rightleftharpoons Mg(s)$	−2.38
$Al^{3+}(aq) + 3e^- \rightleftharpoons Al(s)$	−1.66
$2H_2O(l) + 2e^- \rightleftharpoons H_2(g) + 2OH^-(aq)$	−0.83
$Zn^{2+}(aq) + 2e^- \rightleftharpoons Zn(s)$	−0.76
$Cr^{3+}(aq) + 3e^- \rightleftharpoons Cr(s)$	−0.74
$Fe^{2+}(aq) + 2e^- \rightleftharpoons Fe(s)$	−0.41
$Cd^{2+}(aq) + 2e^- \rightleftharpoons Cd(s)$	−0.40
$Ni^{2+}(aq) + 2e^- \rightleftharpoons Ni(s)$	−0.23
$Sn^{2+}(aq) + 2e^- \rightleftharpoons Sn(s)$	−0.14
$Pb^{2+}(aq) + 2e^- \rightleftharpoons Pb(s)$	−0.13
$Fe^{3+}(aq) + 3e^- \rightleftharpoons Fe(s)$	−0.04
$2H^+(aq) + 2e^- \rightleftharpoons H_2(g)$	0.00
$Sn^{4+}(aq) + 2e^- \rightleftharpoons Sn^{2+}(aq)$	0.15
$Cu^{2+}(aq) + e^- \rightleftharpoons Cu^+(aq)$	0.16
$ClO_4^-(aq) + H_2O(l) + 2e^- \rightleftharpoons ClO_3^-(aq) + 2OH^-(aq)$	0.17
$AgCl(s) + e^- \rightleftharpoons Ag(s) + Cl^-(aq)$	0.22
$Cu^{2+}(aq) + 2e^- \rightleftharpoons Cu(s)$	0.34
$ClO_3^-(aq) + H_2O(l) + 2e^- \rightleftharpoons ClO_2^-(aq) + 2OH^-(aq)$	0.35
$IO^-(aq) + H_2O(l) + 2e^- \rightleftharpoons I^-(aq) + 2OH^-(aq)$	0.49
$Cu^+(aq) + e^- \rightleftharpoons Cu(s)$	0.52
$I_2(s) + 2e^- \rightleftharpoons 2I^-(aq)$	0.54
$ClO_2^-(aq) + H_2O(l) + 2e^- \rightleftharpoons ClO^-(aq) + 2OH^-(aq)$	0.59
$Fe^{3+}(aq) + e^- \rightleftharpoons Fe^{2+}(aq)$	0.77
$Hg_2^{2+}(aq) + 2e^- \rightleftharpoons 2Hg(l)$	0.80
$Ag^+(aq) + e^- \rightleftharpoons Ag(s)$	0.80
$Hg^{2+}(aq) + 2e^- \rightleftharpoons Hg(l)$	0.85
$ClO^-(aq) + H_2O(l) + 2e^- \rightleftharpoons Cl^-(aq) + 2OH^-(aq)$	0.90
$2Hg^{2+}(aq) + 2e^- \rightleftharpoons Hg_2^{2+}(aq)$	0.90
$NO_3^-(aq) + 4H^+(aq) + 3e^- \rightleftharpoons NO(g) + 2H_2O(l)$	0.96
$Br_2(l) + 2e^- \rightleftharpoons 2Br^-(aq)$	1.07
$O_2(g) + 4H^+(aq) + 4e^- \rightleftharpoons 2H_2O(l)$	1.23
$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightleftharpoons 2Cr^{3+}(aq) + 7H_2O(l)$	1.33
$Cl_2(g) + 2e^- \rightleftharpoons 2Cl^-(aq)$	1.36
$Ce^{4+}(aq) + e^- \rightleftharpoons Ce^{3+}(aq)$	1.44
$MnO_4^-(aq) + 8H^+(aq) + 5e^- \rightleftharpoons Mn^{2+}(aq) + 4H_2O(l)$	1.49
$H_2O_2(aq) + 2H^+(aq) + 2e^- \rightleftharpoons 2H_2O(l)$	1.78
$Co^{3+}(aq) + e^- \rightleftharpoons Co^{2+}(aq)$	1.82
$S_2O_8^{2-}(aq) + 2e^- \rightleftharpoons 2SO_4^{2-}(aq)$	2.01
$O_3(g) + 2H^+(aq) + 2e^- \rightleftharpoons O_2(g) + H_2O(l)$	2.07
$F_2(g) + 2e^- \rightleftharpoons 2F^-(aq)$	2.87

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

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **HUM 355** (Sociology)

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) 'Sociological imagination is an unusual type of creative thinking' – Justify this statement with suitable examples. **(10)**

   (b) What is theoretical perspective? Make a comparison between functionalist perspective and conflict perspective. **(13 1/3)**

2. (a) What do you understand by socialization? Evaluate the roles of different agents of socialization. **(10)**

   (b) Discuss G.H Mead's theory of self. **(13 1/3)**

3. (a) What is social mobility? Explain horizontal mobility and vertical mobility with suitable examples. **(10)**

   (b) What do you understand by social stratification? Describe different systems of social stratification. **(13 1/3)**

4. Write short notes on any three of the following: **(23 1/3)**

   (a) Dominant ideology
   (b) Anticipatory socialization and resocialization
   (c) Social norms and social values
   (d) Ethnocentrism and Cultural relativism.

SECTION – B

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

5. (a) How did the Agricultural Revolution help to bring about the Industrial Revolution in Britain? **(13 1/3)**

   (b) Describe the separate spheres of men and women and the responsibilities associated with them during industrial revolution. **(10)**

Contd P/2

HUM 355/CE

6. (a) How can 'role-status conflict' and 'lack of conformity and obedience' produce social disorganization in society? **(13 ⅓)**

   (b) Identify the positive and negative consequences of Weber's 'ideal type' of bureaucracy. **(10)**

7. (a) Critically discuss 'Malthusian theory' and 'Population transition theory'. **(13 ⅓)**

   (b) Elaborate the sustainable ways to reduce environmental pollution in Bangladesh. **(10)**

8. Write short notes on any THREE of the following: **(23 ⅓)**

   (a) Significance of work
   (b) IMR
   (c) Socialism
   (d) Noise pollution.

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

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **HUM 375** (Government)

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) Discuss the increasing factors of internationalism. **(11 1/3)**

   (b) Distinguish between 'De facto' and 'De Jure' sovereignty. **(12)**

2. (a) Classify modern forms of government with relevant examples. **(11 1/3)**

   (b) Analyze the political rights of a citizen in a country. **(12)**

3. (a) Explain the merits of parliamentary form of government. **(11 1/3)**

   (b) Make a comparative discussion between democracy and dictatorship. **(12)**

4. Write short notes on any three (3) of the following: **(23 1/3)**

   (a) Independence of Judiciary

   (b) Bureaucracy

   (c) Local Government

   (d) Bicameral Legislature.

SECTION – B

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

5. (a) Why is the six-point program called the charter of freedom to Bengali Nation? **(12)**

   (b) Discuss the role of Agartala Conspiracy case in the mass upsurge of 1969. **(11 1/3)**

6. (a) Describe the major amendments of Bangladesh constitution. **(12)**

   (b) Define public policy. Describe the Policy Making Process in Bangladesh. **(11 1/3)**

Contd P/2

HUM 375/CE

7. (a) Discuss the Success and Failure of SAARC. **(12)**

   (b) Critically analyze the structure and functions of NGOs. **(11 1/3)**

8. (a) How is a welfare state different from a socialist country? **(12)**

   (b) Write short notes on any two (2) of the following: **(11 1/3)**

   (i) Election Commission.

   (ii) United Nations Organization.

   (iii) E-government.

L-1/T-1/CE **Date : 04/08/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **MATH 137** (Differential and Integral Calculus, Matrices)

Full Marks : 210 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) For what value of 'a' that the function $f(x)=\begin{cases}\dfrac{\sin^2(ax)}{x^2}, & x\neq 0\\ 1, & x=0\end{cases}$ is continuous at x = 0. **(5)**

   (b) Evaluate: (i) $\lim\limits_{x\to 0}\left[\dfrac{e^x+e^{-x}-2\cos x}{x\sin x}\right]$ (ii) $\lim\limits_{x\to 0}(\cos x)^{\cot^2 x}$. **(12)**

   (c) If $y=\dfrac{1}{x^2+a^2}$ then show that $y_n=\dfrac{(-1)^{n+1}\lfloor n(\sin\theta)^{n+1}\sin(n+1)\theta}{a^{n+2}}$, where $\theta=\cot^{-1}(x/a)$ and hence find the nth derivative of $\tan^{-1}x$. **(18)**

2. (a) State Leibnitz's theorem and use this theorem to find $(y_n)_0$, where $y=(\sin^{-1}x)^2$. **(17)**

   (b) If v is a function of x, y and z and F $(v^2-x^2, v^2-y^2, v^2-z^2)$, show that **(18)**

   $$\frac{1}{x}\frac{\partial v}{\partial x}+\frac{1}{y}\frac{\partial v}{\partial y}+\frac{1}{z}\frac{\partial v}{\partial z}=\frac{1}{v}$$

3. (a) Examine the function $(x-a)^{1/3}(2x-a)^{2/3}$ for maximum and minimum values. **(15)**

   (b) Suppose that we require a box of volume 2592 cubic inches with square top and bottom and rectangular sides. Side material costs Tk. 6 per square inch, and top and bottom material costs Tk. 9 per square inch. Find the dimensions for which we can minimize the cost of the materials. **(10)**

   (c) If $lx + my = 1$ touches the curve $(ax)^n + (by)^n = 1$, find the value of **(10)**

   $$\left(l/a\right)^{\frac{n}{n-1}}+\left(m/b\right)^{\frac{n}{n-1}}$$

4. Find the following:

   (a) $\displaystyle\int\frac{x^2+1}{1+x^4}\,dx$ **(11)**

   (b) $\displaystyle\int\frac{dx}{(2x-3)\sqrt{2x^2-3x+4}}$ **(12)**

   (c) $\displaystyle\int\frac{2+3\sin x-\cos x}{1+\cos x+\sin x}\,dx$ **(12)**

Contd P/2

MATH 137/CE

SECTION – B

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

5. (a) Find a reduction formula for $I_n = \int e^{ax} \cos^n x \, dx$ and hence find $\int e^{2x} \cos^4 x \, dx$. **(15)**

(b) Evaluate (i) $\int_0^{\pi/2} \frac{\sin^2 x}{\sin x + \cos x} dx$ **(10)**

(ii) $\int_0^{\infty} \frac{x}{(x^2 + a^2)(x^2 + b^2)} dx$. **(10)**

6. (a) Show that $\beta(m, n) = \frac{\lceil m \, \lceil n}{\lceil m+n}$. **(13)**

(b) Evaluate: $\int_0^a y^4 \sqrt{a^2 - y^2} \, dy$. **(10)**

(c) Evaluate $\iiint_R (x - 2y + z) \, dx \, dy \, dz$ **(12)**

where $R : 0 \le x \le 1, \ 0 \le y \le x^2, \ 0 \le z \le x + y$

7. (a) Use only elementary row transformations, to reduce A to I_4, then find the inverse of A:

where, $A = \begin{bmatrix} 1 & 2 & 3 & 4 \\ 2 & 3 & 4 & 5 \\ 3 & 4 & 5 & 7 \\ 4 & 5 & 5 & 7 \end{bmatrix}$. **(13)**

(b) Reduce $A = \begin{bmatrix} 1 & 2 & -1 & 2 \\ 3 & 1 & -2 & -1 \\ 4 & -3 & 1 & 1 \end{bmatrix}$ to the normal form B and obtain the non-singular matrices P and Q such that PAQ = B. **(12)**

(c) Find for what values of k, the set of equations has (i) no solution (ii) infinite number of solutions: **(10)**

$2x - 3y + 6z - 5t = 3$

$y - 4z + t = 1$

$4x - 5y + 8z - 9t = k$

Contd P/3

MATH 137/CE

8. (a) State and prove Cayley-Hamilton theorem. Verify the above theorem for the matrix, **(20)**

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

(b) Find all eigen values and corresponding eigenvectors of the matrix **(15)**

$$A = \begin{bmatrix} 1 & 2 & -1 \\ 0 & -2 & 0 \\ 0 & -5 & 2 \end{bmatrix}$$

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

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **PHY 101** (Physical Optics, Waves 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) What is a thin film? Distinguish between a parallel film and a wedge-shaped film. **(6)**

   (b) (i) Draw a neat diagram for Newton's rings interference experiment and explain how Newton's rings are formed. **(24)**

   (ii) Deduce the formula for determination of the radius of curvature (R) of a plano-convex lens using Newton's rings method and discuss briefly how the value of R can be measured.

   (c) Newton's rings are formed by reflected light of wavelength 589.3 nm with a liquid placed in between the plane and curved surface. If the diameter of the fifth bright ring is 3×10^{-3} m and the radius of curvature of the curved surface is 1 m, then determine the refractive index of the liquid. **(5)**

2. (a) What is a diffraction grating? Differentiate a transmission grating from a reflection grating. **(7)**

   (b) Discuss the theory of a plane transmission grating and obtain an expression of its intensity distribution at a point on a screen. **(22)**

   (c) A diffraction grating which has 4000 lines per centimeter is used at normal incidence. Calculate the dispersive power of the grating in the third order spectrum in the wavelength region of 5000 Å. **(6)**

3. (a) What do you understand by polarized and unpolarized lights? Discuss why the light emitted from a tube light is unpolarized? **(7)**

   (b) Using the elastic theory of Fresnel's law of reflection, show that in case of perpendicular polarization the amplitude reflection coefficient r_l is given by $r_l = -\dfrac{\sin(\theta_i - \theta_t)}{\sin(\theta_i + \theta_t)}$, where θ_i = angle of incidence and θ_t = angle of refraction of light. **(22)**

   (c) One of the surfaces of two glass slabs 'A' and 'B' of different refractive indices is joined together an oblique light ray is then allowed to partly reflect from the external surface of 'A' and the reflected ray is found to be completely plane polarized. Under this state, the other part of the ray is refracted first through 'A' of refractive index 1.5 and then through 'B'. If the angle of refraction of light in B is 20.28°, find the refractive index of the material of 'B'. **(6)**

Contd P/2

PHY 101/CE

4. (a) What are the thermodynamic substance and thermodynamic property of a platinum resistance thermometer? **(5)**

   (b) Describe the construction and the working principle of a platinum resistance thermometer. **(20)**

   (c) The platinum resistance thermometer temperature is 50.25°C when the temperature on the gas scale is 50°C. What will be the temperature on the platinum scale corresponding to 150°C on the gas scale? **(10)**

SECTION – B

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

5. (a) State the law of equipartition of energy and find an expression for the energy associated with each degree of freedom. **(15)**

   (b) Establish a relationship between the ratio of two specific heat and the degrees of freedom. **(10)**

   (c) Calculate theoretically the ratio of two specific heats for diatomic and triatomic gas molecule. **(10)**

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

   (b) Evaluate the most probable energy of a molecule by using the Maxwell's law of distribution of velocities of a gas molecule. **(10)**

   (c) Calculate the most probable energy of a molecule of hydrogen at 300 K. Given Boltzmann's constant $K_B = 1.38 \times 10^{-16}$ erg/K. **(10)**

7. (a) Define damped harmonic motion. **(5)**

   (b) Establish the differential equation of a damped harmonic motion. Solve this equation and hence discuss the case (i) under-damped motion (ii) over-damped motion and (iii) critically damped motion with appropriate graph. **(20)**

   (c) At a certain harbor, the tides cause the ocean surface to rise and fall in simple harmonic motion, with a period of 12.5 hours. How long does it take for the water to fall from its maximum height to one half its maximum height above its average (equilibrium) level? **(10)**

8. (a) Define reverberation and reverberation time. **(5)**

   (b) Derive Sabine's reverberation formula. **(20)**

   (c) Calculate the reverberation time of a class room 10 m wide, 20 m long and 3 m high. The ceiling of the room is acoustic, the walls are made of plaster, the floor is of concrete and there are 60 students in the room. Given that the speed of sound is 340 m/s, the sound absorption coefficients are: 0.60 for acoustic ceiling, 0.03 for plaster, 0.02 for concrete and absorbing power for each student is 0.5 Sabine. **(10)**
