

**SECTION – A**

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

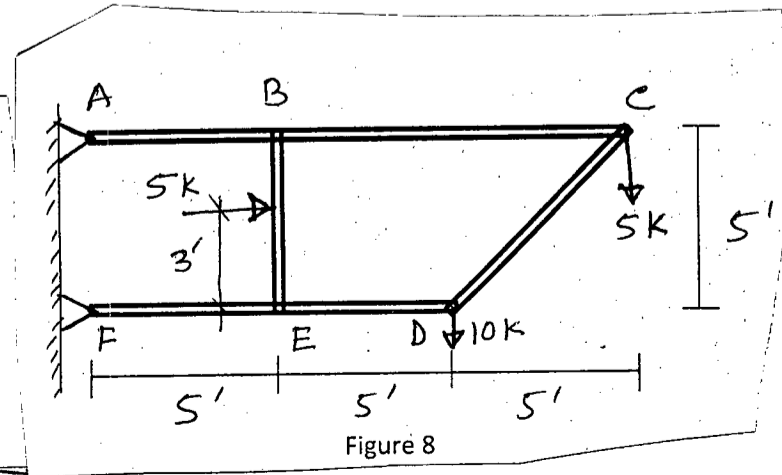
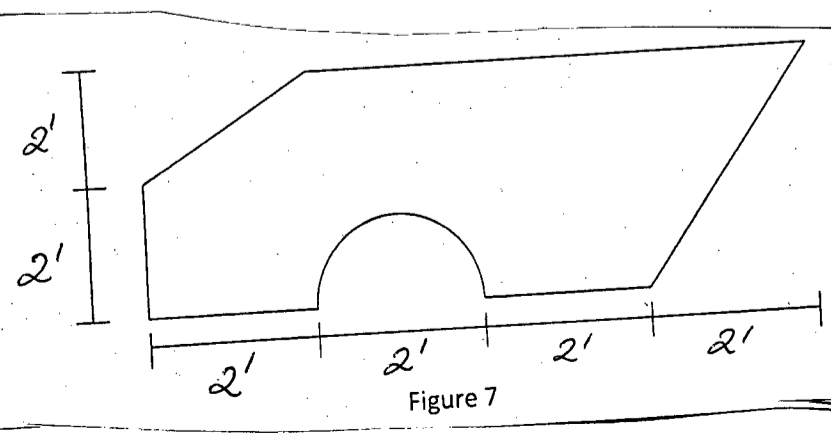
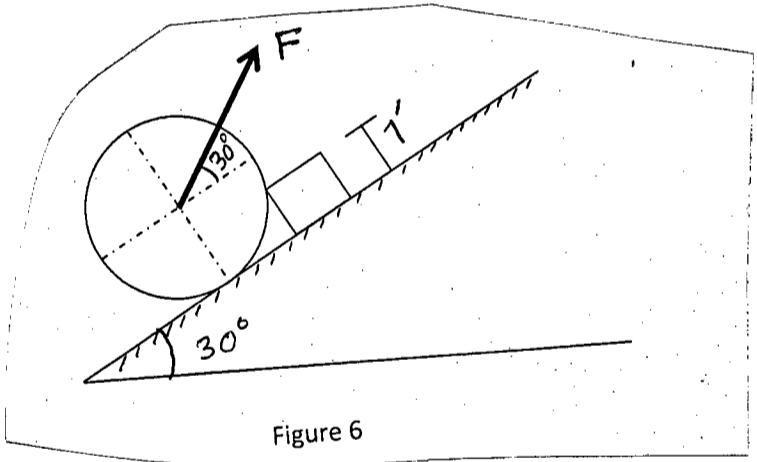
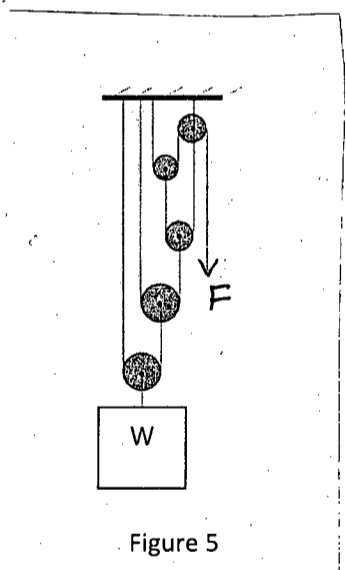
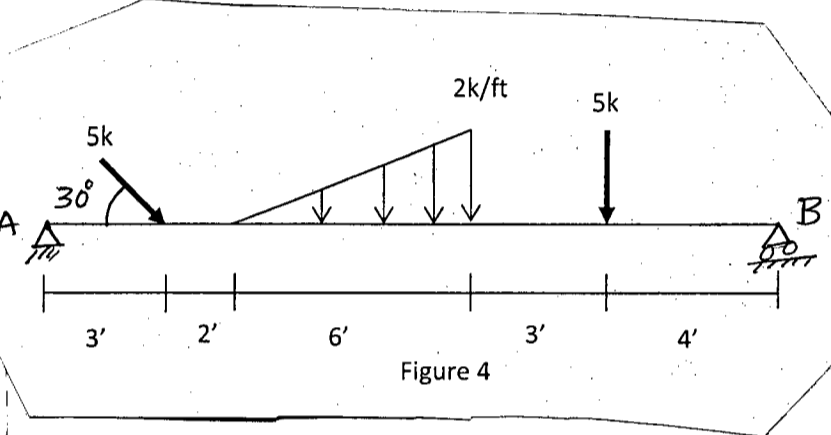
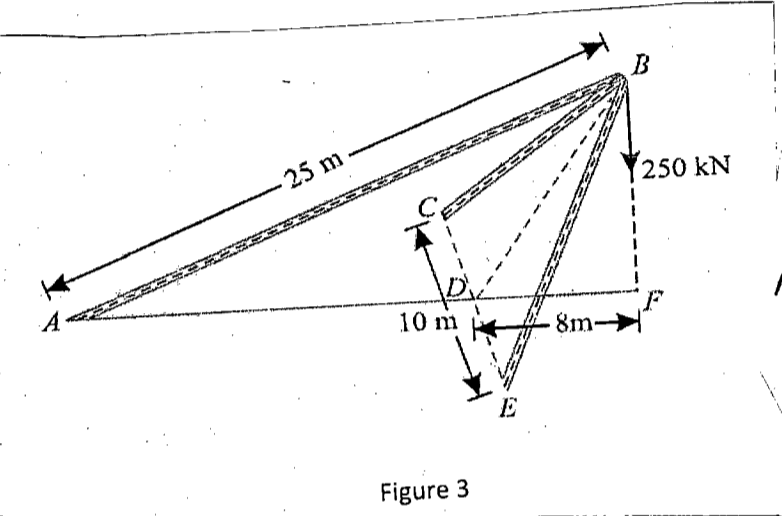
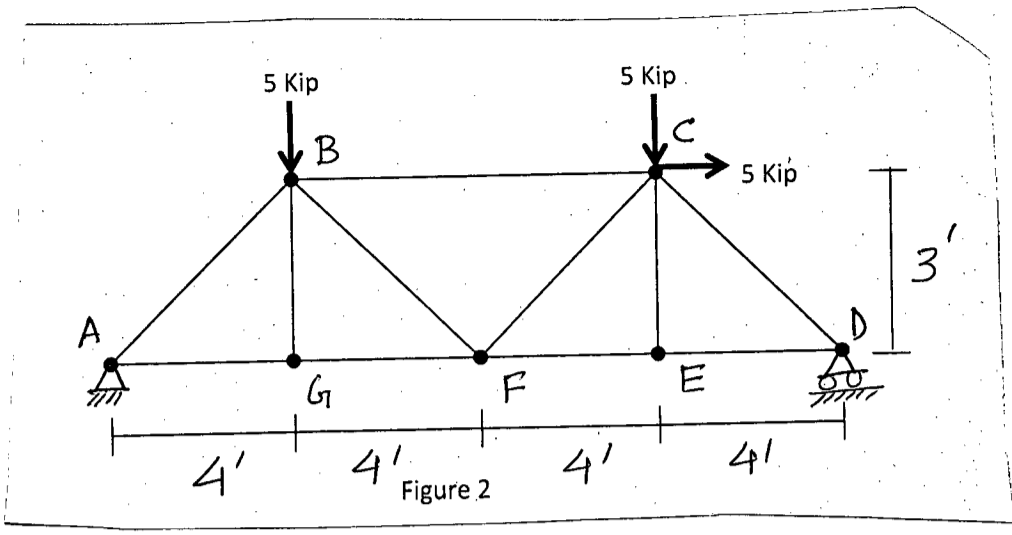
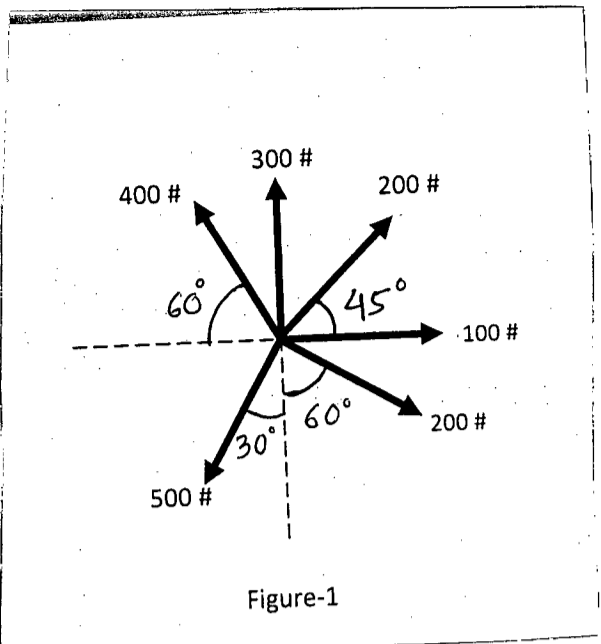
1. (a) Determine the resultants of the coplanar concurrent forces shown in Fig-1. (10)
- (b) Calculate member forces of the members AB, BC, BF, BG and AG of the truss shown in Fig-2. (12)
- (c) Fig-3 shows a shear leg crane lifting a load of 250 KN. The legs BC and BE are 20 m long and 10 m apart at the base. The back stay AB is 25 m long. If all the members are pin-jointed at A, C and E, at the same level, find the forces in all the three members of the crane. (13)
  
2. (a) Calculate the support reactions of the simply supported beam AB as shown in Fig-4. (10)
- (b) What force F is required to lift the weight W using the pulley system shown in Fig-5. (10)
- (c) A 3-ft diameter oil drum is pulled by a force F, as shown in Fig-6, to move over an obstruction on an inclined surface. The drum weights 500 lb and the coefficient of static friction for all surfaces is 0.3. Find F when motion impends. Is this impending motion spinning or rolling? (15)
  
3. (a) Determine the location of the centroid of the area given in Fig-7. (15)
- (b) Calculate the reaction forces of the frame, as shown in Fig-8, at A and B points. Also calculate the member force of the two force member. (20)
  
4. (a) Locate the centroid of a right circular cone by integration. (12)
- (b) Calculate the minimum radius of gyration of the angle section shown in Fig-9. (23)

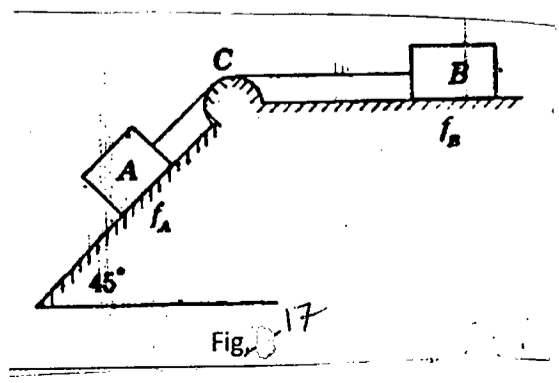
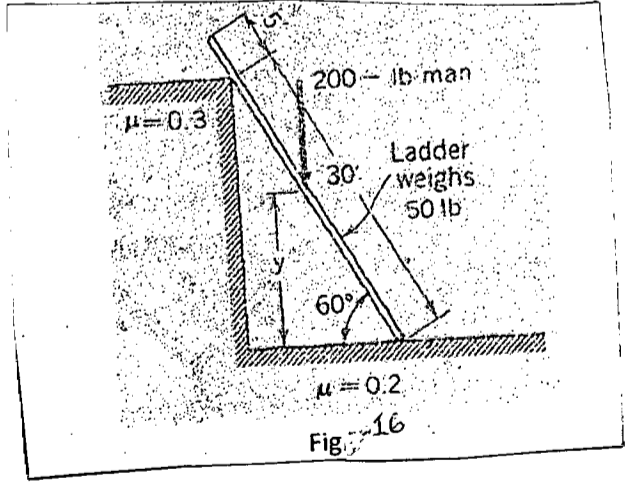
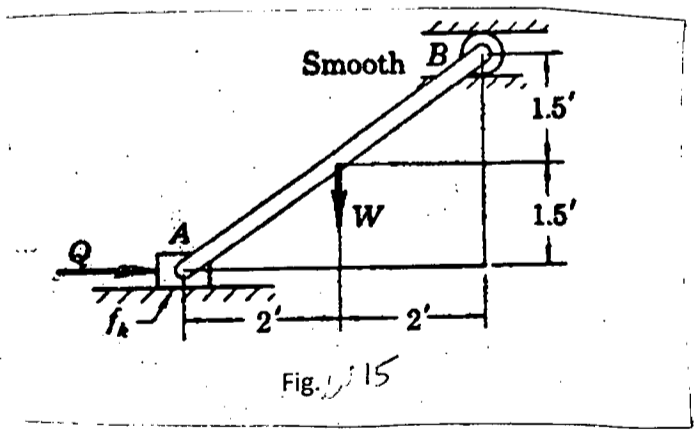
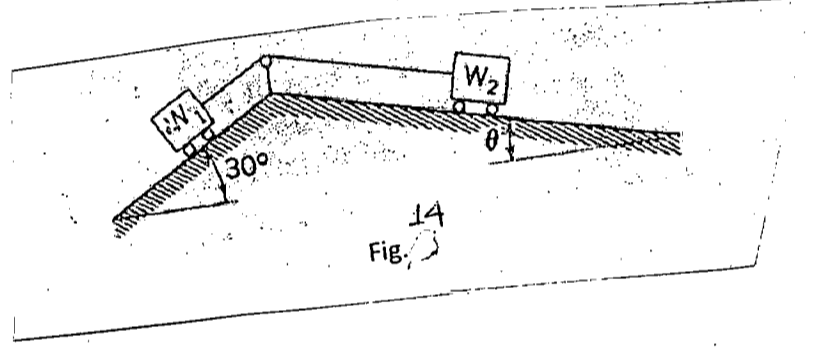
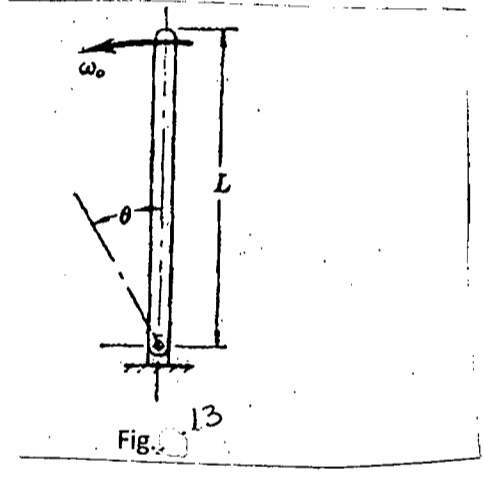
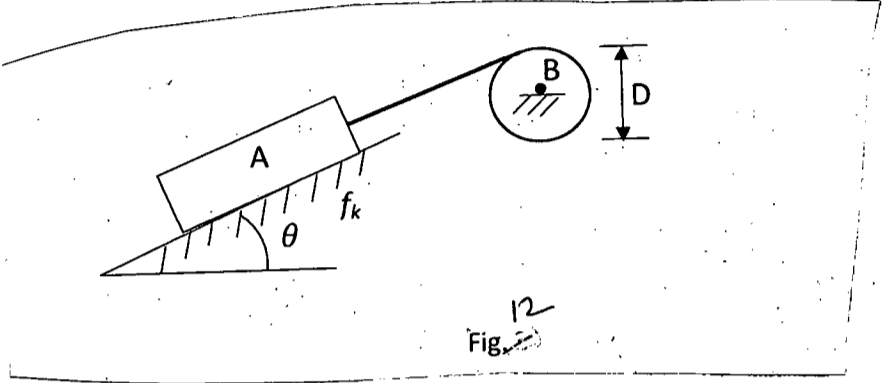
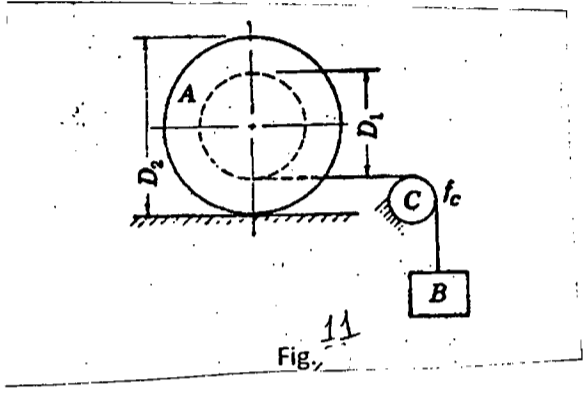
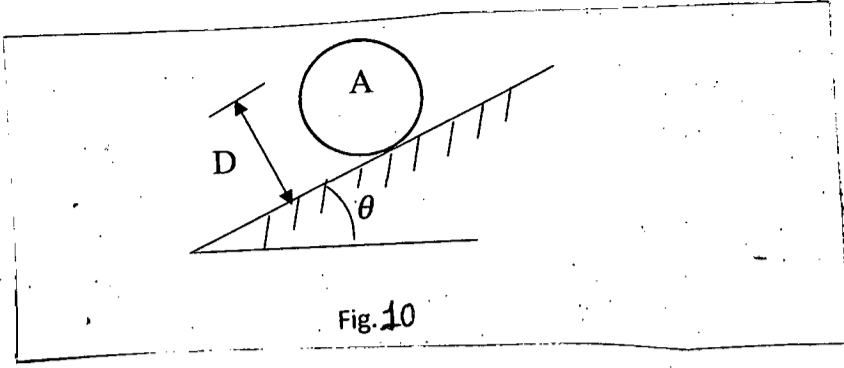
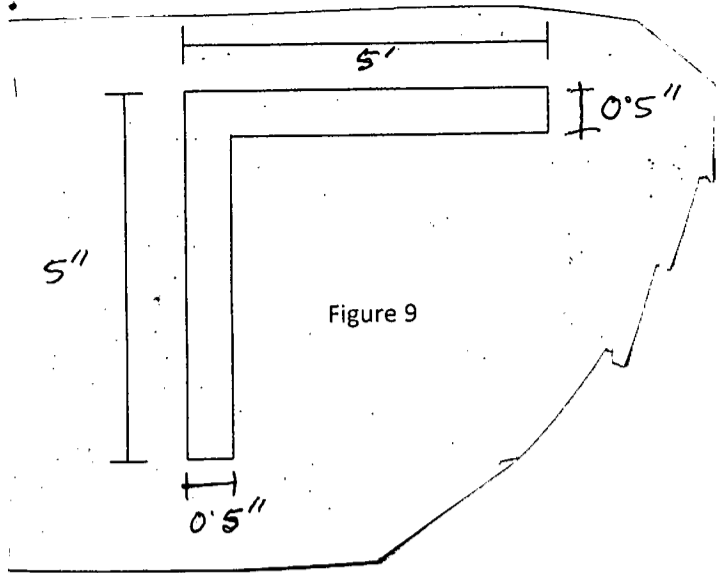
## CE 101

SECTION-B

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

5. (a) A point  $P$  moves in the path of a curve defined by the equation  $y = e^x$ . Its tangential velocity is constant and is equal to 12 fps. At a position defined by  $y = 10$  ft., what are the components  $v_x$  and  $v_y$  of the velocity? (10)
- (b) A homogenous sphere  $D = 12$  in., rolls down a rough  $\theta = 30^\circ$  inclined plane, Fig. 10. If the initial speed of its center of gravity is 10 fps down the plane, find the speed 8 sec later and find the minimum value of the coefficient of friction that will cause pure rolling. (13)
- (c) A wire weighing 0.5 lb. per ft is strung between two supports, 400 ft. apart. One support is 20 ft. higher than the other and the sag, measured from lower support is 5 ft. Compute the tension at each support and the length of wire. Assume the curve to be parabolic. (12)
6. (a) In Fig.11, the grooved cylinder  $A$  weighs 200lb.. and has a moment of inertia  $\bar{I}_A = 6$  Slug-ft<sup>2</sup>. Let  $D_1 = 2$  ft.,  $D_2 = 3$  ft.  $W_B = 32.2$  lb. and  $f_c = 0$ . Determine the speed of the cg of  $A$  and the acceleration of  $B$  after  $B$  has moved downward through 20 ft. (11)
- (b) In Fig. 12  $W_A = 64.4$  lb.  $f_k = 0.2$  for  $A$ ,  $\theta = 30^\circ$ ,  $W_B = 966$  lb. and  $D = 4$  ft. The cord from  $A$  warps about the cylinder  $B$ . Find the velocity of  $A$  5 sec. after it is released from rest. (13)
- (c) Determine the moment of inertia of a homogenous right circular cylinder about a diameter of its base. (11)
7. (a) A slender rod which weighs 16.1 lb. and is  $L = 4$  ft long, is pivoted at one end. It rotates from rest under the action of gravity only, starting from a vertical position, Fig. 13. What is the speed of its center of gravity after it has turned through  $\theta = 120^\circ$ ? (12)
- (b) If  $W_1 = 100$  lb. and  $W_2 = 150$  lb. Find the angle  $\theta$  for equilibrium in Fig.14. (13)
- (c) A cable weighing 5 lb. per ft. hangs as a Catenary from points which are 600 ft. apart and on the same level. The tension at the lowest point is 1500 lb. Find (a) the length of the cable, (b) the sag and (c) the maximum tension. (10)
8. (a) In Fig. 15, the weight of the bar is  $W = 100$  lb. Neglect the size and weight of the wheel and of the block. If the reaction at  $B$  is 10 lb. upward and  $f_k = 0.2$ , find  $\bar{a}$  and  $Q$ . (13)
- (b) In Fig. 16, how high up can a man get before the ladder starts to slip? The coefficient of friction on top is 0.3 and on the bottom support is 0.2. Use the method of virtual work. (12)
- (c) In Fig. 17,  $W_A = 1000$  lb.,  $f_A = 0.15$ ,  $f_B = 0.6$  and guide  $C$  for the weightless cable is smooth. The bodies  $A$  and  $B$  are moving leftward with an initial speed of 20 fps with the cable taut. After these bodies have each moved 160 ft. neither one changing its direction, their speed is 10 fps. What is the weight  $W_B$  of the body  $B$ ? (10)





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

1. (a) A function  $f(x)$  is defined as follows: (15)

$$f(x) = \begin{cases} x^2 + 1 & \text{when } x \leq 0 \\ x^2 + x + 1 & \text{when } 0 < x < 1 \\ 2x + 1 & \text{when } 1 \leq x \leq 2 \end{cases}$$

Discuss the continuity and differentiability of  $f(x)$  at  $x=1$ . Also sketch the graph of  $f(x)$ .

(b) Evaluate:  $\lim_{x \rightarrow 1} (1-x^2)^{1/\log(1-x)}$  (10)

(c) Find the  $n$ -th derivative of the function  $y = \tan^{-1}\left(\frac{x}{a}\right)$ . (10)

2. (a) If  $y = \left[\log(x + \sqrt{1+x^2})\right]^2$ , show that  $y_{n+2}(0) = -n^2 y_n(0)$  hence find  $y_n(0)$ . (13)

(b) In the mean value theorem  $f(h) = f(0) + hf'(0) + \frac{h^2}{2!} f''(\theta h)$ ,  $0 < \theta < 1$ , find  $\theta$

when  $h=7$  and  $f(x) = \frac{1}{1+x}$ . (10)

(c) If  $V = f(r)$  and  $x^2 + y^2 + z^2 = r^2$ , show that  $\frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2} = \frac{d^2 V}{dr^2} + \frac{2}{r} \frac{dV}{dr}$ . (12)

3. (a) Show that the surface area of a right circular cylinder (including the two end faces) with a volume  $128\pi$  cu. m. is minimum when its height is 8 meters. (13)

(b) Show that in the curve  $a^2 y^5 = k(bx + c)^4$ , the cube of the subtangent varies as the fifth power of the subnormal. (12)

(c) Find the pedal equation of the cardioid  $r = a(1 - \cos \theta)$ . (10)

4. Find the following:

(i)  $\int \frac{1}{(x^2 + 1)\sqrt{x^2 + 4}} dx$  (12)

(ii)  $\int \frac{dx}{3 \cos x - 4 \sin x + 1}$  (12)

(iii)  $\int e^{2x} \frac{1 + \sin 2x}{1 + \cos 2x} dx$  (11)

## MATH 137/CE

### SECTION-B

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

5. (a) Obtain a reduction formula for  $\int \sin^m x \cos^n x dx$  and hence evaluate  $\int \sin^4 x \cos^5 x dx$ . (17)

(b) Evaluate  $\int_0^1 \sqrt{x} dx$  by the process of summation. (10)

(c) Evaluate  $\int_0^1 \frac{\log x}{\sqrt{1-x^2}} dx$ . (8)

6. (a) Prove that  $\beta(m, n) = \frac{\Gamma(m) \Gamma(n)}{\Gamma(m+n)}$  and hence find  $\Gamma\left(\frac{1}{2}\right)$ . (13)

(b) Evaluate  $\iiint_R (x+y+z) dx dy dz$ , where  $R: 0 \leq x \leq 1, 1 \leq y \leq 2, 2 \leq z \leq 3$ . (7)

(c) Write down algorithm to solve a system of linear equations using Gaussain elimination method and hence solve the following system of linear equations (15)

$$\begin{aligned} 5x_1 + 10x_2 + x_3 &= 28 \\ x_1 + x_2 + x_3 &= 6 \\ 4x_1 + 8x_2 + 3x_3 &= 29 \end{aligned}$$

7. Consider a matrix

$$A = \begin{bmatrix} 2 & -6 & -2 & -3 \\ 5 & -13 & -4 & -7 \\ -1 & 4 & 1 & 2 \\ 0 & 1 & 0 & 1 \end{bmatrix}$$

(i) Define Band matrix, Triangular matrix, Boolean matrix, singular and non-singular matrix, partition matrix with an illustration. (10)

(ii) Write down algorithm to find inverse of a non-singular matrix using elementary row operations. (5)

(iii) Compute the inverse of the matrix A by using elementary transformations hence verify the result. (15)

(iv) Find trace of the matrix A. (5)

8. Consider a matrix

$$M = \begin{pmatrix} 3 & 1 & 1 \\ -1 & 5 & -1 \\ 1 & 1 & 3 \end{pmatrix}$$

(i) Define eigenvalues and eigenvectors of a square matrix with applications. (4)

(ii) Write down some properties of eigenvalues and eigenvectors. (3)

(iii) Compute the eigenvalues and eigenvectors for the matrix M. (12)

(iv) State Cayley-Hamilton theorem. (2)

(v) Verify Cayley-Hamilton theorem and find  $M^{-1}$  and  $M^4$  for the matrix M. (14)

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**SECTION – A**

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

1. (a) What are the advantages and disadvantages of Platinum resistance thermometer? (5)  
 (b) Describe the working procedure of Platinum resistance thermometer. (20)  
 (c) State the law of equipartition of energy and find an expression for the energy associated with each degree of freedom. (10)
2. (a) State and prove Carnot's theorem. (20)  
 (b) Evaluate the most probable energy of a molecule by using the Maxwell's law of distribution of velocity of a gas molecule. (15)
3. (a) State thermodynamic laws. (8)  
 (b) Derive van der Waal's equation for gases. (17)  
 (c) One gram molecules of a gas expands isothermally to four times its volume. Calculate the change of its entropy. Given  $R = 8.32$  Joule/mole. K and  $J = 4.2$  Joule/cal. (10)
4. (a) What do you mean by optic axis of a crystal and double refraction of light? (6)  
 (b) Discuss the theory of production of linearly and circularly polarized lights. (20)  
 (c) Prove that two plane polarized waves of equal amplitude with their planes of vibration being at right angles to each other, cannot produce interference effects. (9)

**SECTION – B**

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

5. (a) What is a wavefront and how does it propagate? (7)  
 (b) Explain how Newton's rings are formed and describe the theory and method for determination of radius of curvature of a Plano-convex lens, using Newton's rings. (22)  
 (c) In a Fresnel Biprism experiment, the fringe width is observed to be 0.19 cm. If the distance between the slit and biprism is decreased to  $\frac{3}{4}$  times that of the original distance, calculate the new fringe separation. (6)

## PHY 101/CE

6. (a) Explain clearly the difference between interference and diffraction of light. (7)
- (b) Discuss the phenomena of Fraunhofer diffraction due to a single slit and hence obtain the expression of intensity as viewed on a screen. Find the condition of secondary maxima and draw the intensity pattern for diffraction of light by a single slit. (22)
- (c) A parallel beam of light of wavelength 589 nm is incident perpendicularly on a slit of width 0.1 mm. Calculate angular width and linear width of central maximum formed on the screen 100 cm away. (6)
7. (a) What do you mean by Simple Harmonic Oscillation? Briefly explain the characteristics of simple harmonic oscillation. (7)
- (b) Derive an expression for the time period of oscillation of the spring-mass system for a spring having non-zero mass. Hence explain the term effective mass of the system. Show how the effective mass of a spring can be measured experimentally. (18)
- (c) A spider can tell when its web has captured, say, a fly because the fly's thrashing causes the web threads to oscillate. A spider can even determine the size of the fly by the frequency of the oscillations. Assume that a fly oscillates on the capture thread on which it is caught like a block on a spring. What is the ratio of oscillation frequency for a fly with mass 'm' to a fly with mass 3.5m? (10)
8. (a) What do you mean by damped harmonic oscillation? Explain why damped oscillation is more common in nature. (5)
- (b) Show how the energy of an oscillator dissipates during damped vibration. (12)
- (c) Many oscillatory systems, although the loss or dissipation mechanism is not analogous to viscous damping, show an exponential decrease in their stored average energy with time as  $\bar{E} = \bar{E}_0 e^{-\gamma t}$ . A Q-value for such an oscillator may be defined as  $Q = \omega_0 / \gamma$ , where  $\omega_0$  is the natural angular frequency. (18)
- (i) When the note "middle C" on the piano is struck, its energy of oscillation decreases to one half of its initial value in about 1 sec. The frequency of middle C is 256 Hz. What is the Q-value of the system?
- (ii) If the note of 512 Hz takes about the same time for its energy to decay what is its Q-value?
- (iii) A free, damped harmonic oscillator, consisting of a mass  $m = 0.1$  kg moving in a viscous liquid of damping coefficient  $b$  ( $F_{\text{viscous}} = -bv$ ) and attached a spring of spring constant  $k = 0.9$  N/m, is observed as it performs damped oscillatory motion. Its average energy decays to  $1/e$  of its initial value in 4 sec. What is the Q-value of the oscillator? What is the value of  $b$ ?
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**SECTION – A**

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

1. (a) 'Traditional functions of family have been more modified than lost'- discuss this by analyzing the changing structure and functions of family. (10)  
(b) How does functionalist explain the roles of family in a modern society? (13 1/3)
2. (a) What is social inequality? Explain caste system and class system of social stratification with examples. (10)  
(b) Explain different types of social mobility. (13 1/3)
3. (a) Explain the social stigma theory to understand the critical issues of deviant behavior. (10)  
(b) Briefly discuss Merton's theory of Anomie and social structure. (13 1/3)
4. Write short notes on any three of the following: (23 1/3)  
(a) Social norms and social values.  
(b) Sociological imagination.  
(c) Functionalist perspective.  
(d) Dominant ideology and ethnocentrism.

**SECTION-B**

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

5. (a) In your opinion, was the Industrial Revolution a positive thing or a negative thing for the average person in Europe in the Nineteenth Century? (13 1/3)  
(b) Critically discuss the "Transition Theory of Population". (10)

**HUM 355/CE**

6. (a) Identify both individual level and organizational level of disadvantages of Max Weber's 'ideal type of bureaucracy'. Cite examples from your society. **(13 1/3)**
- (b) Define poverty. Discuss the important measures should be taken to reduce poverty from Bangladesh. **(10)**
7. (a) Explain the socio-economic features of pre-industrial, industrial and post- industrial cities. **(13 1/3)**
- (b) Describe some causes and effects of the major environmental pollution in society. **(10)**
8. Write short notes on any THREE of the following: **(23 1/3)**
- (a) Neonatal Mortality Rate (NNMR)
  - (b) Mega city
  - (c) Traditionalism
  - (d) Guild
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**SECTION – A**

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

1. (a) Discuss the meaning and significance of sovereignty as a constituent element of a state. (11 1/3)
- (b) Explain the meaning of the term nationality, nation and nationalism? Analyze the relationship between nationalism and internationalism. (12)
2. (a) Write an analytical note on the different kinds of constitution. (11 1/3)
- (b) What do you understand by rights? Discuss briefly the fundamental political rights which a citizen enjoys in a modern state. (12)
3. (a) Describe the conditions which are necessary for the success of democracy. (11 1/3)
- (b) Distinguish between political executive and non-political executive. (12)
4. Write short notes on any three (3) of the following: (23 1/3)
  - (a) Constraints of good governance
  - (b) Ideal type of bureaucracy
  - (c) Urban local government
  - (d) Cabinet form of government

**SECTION - B**

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

5. (a) What is public policy? Discuss different models to the study of public policy. (11 1/3)
- (b) Discuss the major characteristics of the constitution of Bangladesh. (12)

**HUM 375/CE**

6. (a) Define a development project. Discuss the problems of implementation process of a development project in Bangladesh. **(11 1/3)**
- (b) What is an NGO? Describe the major activities of NGOs in developing countries. **(12)**
7. (a) What is foreign policy? Discuss the determinants of the foreign policy of Bangladesh. **(11 1/3)**
- (b) Describe the significance of the language movement of 1952. **(12)**
8. Write short notes on any three (3) the followings: **(23 1/3)**
- (a) Democracy
  - (b) Socialism
  - (c) UNO
  - (d) E-government
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