

SECTION – A

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

1. (a) The cantilever frame shown in Fig. 1 consists of two horizontal member AC and DF, a vertical member BE and an inclined member CF. All the members have been assumed to be weightless. Calculate the component of pin reaction at A and force in the member CF. (14)
 (b) The body A weighing 400 N rests over the body B weighing 800 N as shown in Fig. 2. The coefficient of static friction between the bodies A and B is 0.3 and between the body B and the floor is 0.25. Determine the value of the force P that will cause the body B to have impending motion towards right. (11)
 (c) A glass rod of weight 10 oz. is placed in a glass beaker of 5 inch diameter in a position of equilibrium as shown in Fig. 3. Consider all the surface to be smooth, determine the length of the glass rod and reactions at contact point A and C. (10)

2. (a) A bar AB of weight 500 N is hinged to a wall at A and supported by a cable as shown in Fig. 4. The length of the bar AB is 10 m. Calculate the tension in the cable and components of pin reactions at A and C. (13)
 (b) A ladder of length 5 m and weighing 250 N is placed against a vertical wall as shown in Fig. 5. 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. The ladder also supports a man weighing 800 N. Determine the minimum horizontal force P to be applied at the bottom of the ladder to prevent slipping of the ladder. (12)
 (c) For the simply supported beam shown in Fig. 6, calculate the reaction at the supports A and B. (10)

3. (a) The body A in Fig. 7 weighs 300 lb. The coefficient of static friction is 0.4 between the body A and the inclined plane, and 0.25 between the rope and the drums. Determine the value of W when the motion of the body A impends up the plane. (13)
 (b) For the truss shown in Fig. 8, find the force in the members ab, dm, ep and fq. (12)
 (c) Find the centroid of the area bounded by the curves $x^2 = 4y$ and $x = y$ as shown in Fig. 9. (10)

4. (a) Determine the centroid of the composite area shown in Figure 10. (18)
 (b) A parabolic cable carries a load of 150 lb per horizontal foot supported at two ends 300 ft apart and one support is 20 ft higher than the other. The sag measured from the lower support is 8 ft. Determine the tension at the supports and length of the cable. (17)

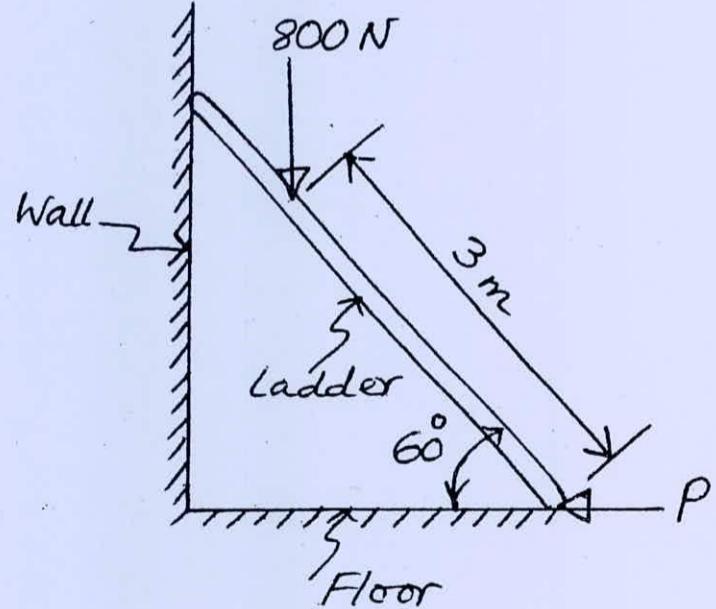
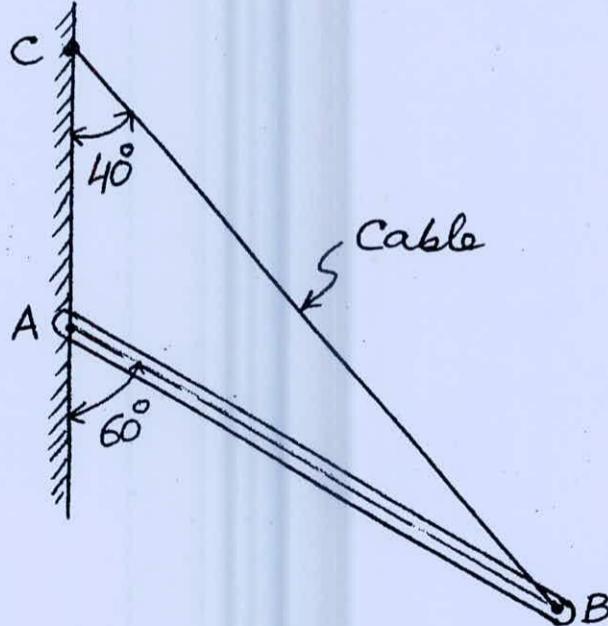
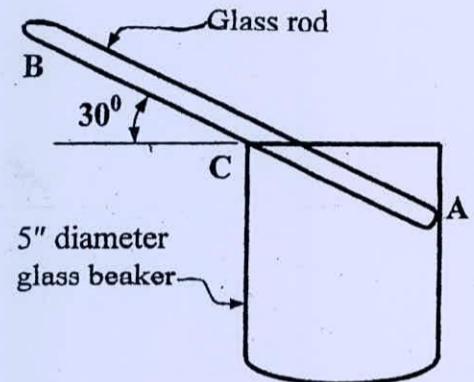
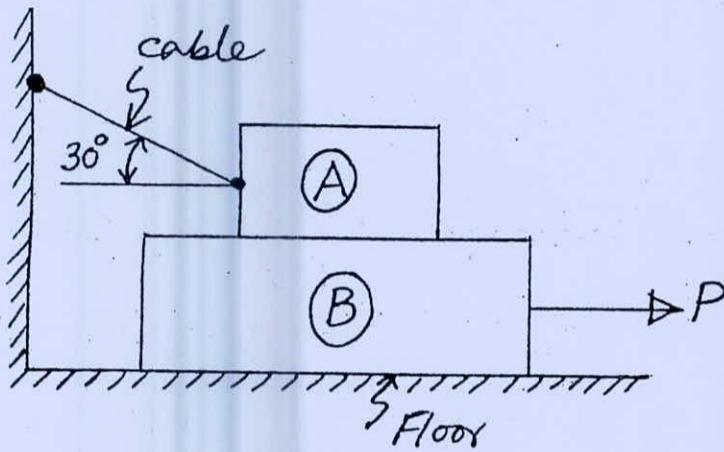
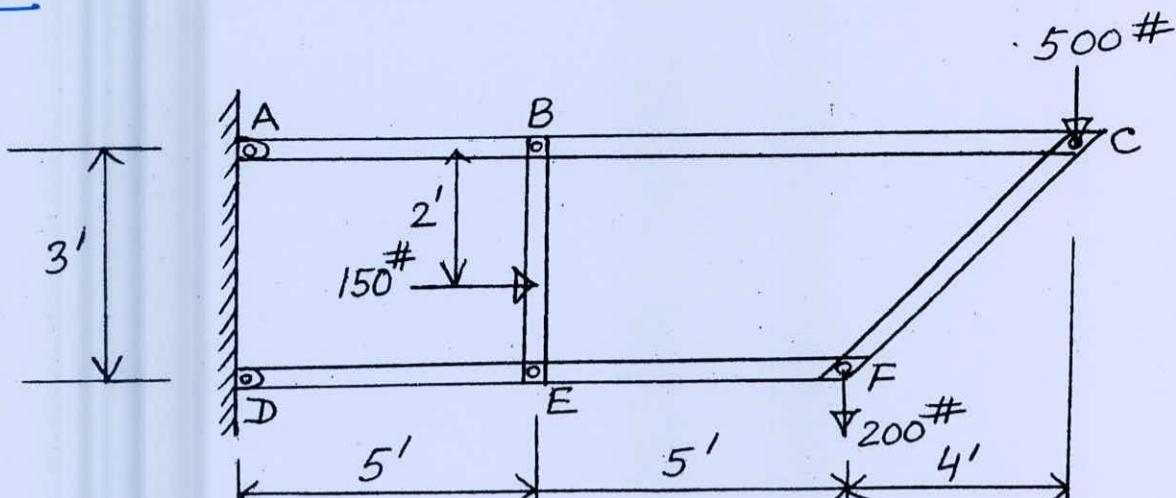
CE 101

SECTION – B

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

Symbols carry their usual meaning.

5. (a) A mast AB, supported by a spherical socket at A and horizontal guy wires BC and BD, carries a vertical load of 100 lb at B (Fig. 11). The wires BC and BD intersect at B at right angle in a horizontal plane. Find the force in the mast AB and tension in the wires BC and BD. Neglect weight of the mast AB. (15)
- (b) Determine the minimum moment of inertia of area of the L-section shown in Fig. 12. (20)
6. (a) Determine the mass moment of inertia of a right circular homogeneous cone about the geometric axis. (15)
- (b) A homogeneous sphere $D = 12$ in., rolls down a rough $\theta = 30^\circ$ inclined plane, Fig. 13. 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. (20)
7. (a) Suppose a motor is driving a shaft with an angular acceleration $a = 3t - 12$ rad/s 2 with an initial angular velocity of 15 rad/s with the same sense as the angular acceleration. Diameter of the shaft is 6 in. (i) What will be the maximum linear velocity of a particle on the shaft after 10 s.? (ii) What will be the linear tangential and normal accelerations of the particle at that time? (10)
- (b) In Fig. 14, the grooved cylinder A weighs 200 lb. and has a moment of inertia $\bar{I}_A = 6$ Slug-ft 2 . 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. (12)
- (c) The masses of A, B and C (Fig. 15) are respectively 1 slug, 2 slugs and 4 slugs. The cords are weightless and flexible. Sheaves D and E are considered free and weightless. After all elements are simultaneously released from rest, when A moves 40 ft. upward, what are the velocities and displacements of B and C? (13)
8. (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. 16. What is the speed of its center of gravity after it has turned through $\theta = 120^\circ$? (12)
- (b) The weight of the drum assembly B (Fig. 17) is 2576 lb. and its radius of gyration with respect to the axis of rotation is 14 in. The weight W is suspended from a cable which wraps about the $D = 32$ in. diameter. While W moves downward, the speed of the drum increased from 20 rpm to 30 rpm in 5 sec. If the frictional effects are negligible, what is the weight W? (11)
- (c) In Fig. 18, 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)



Contd... P/4

=4=

CE101

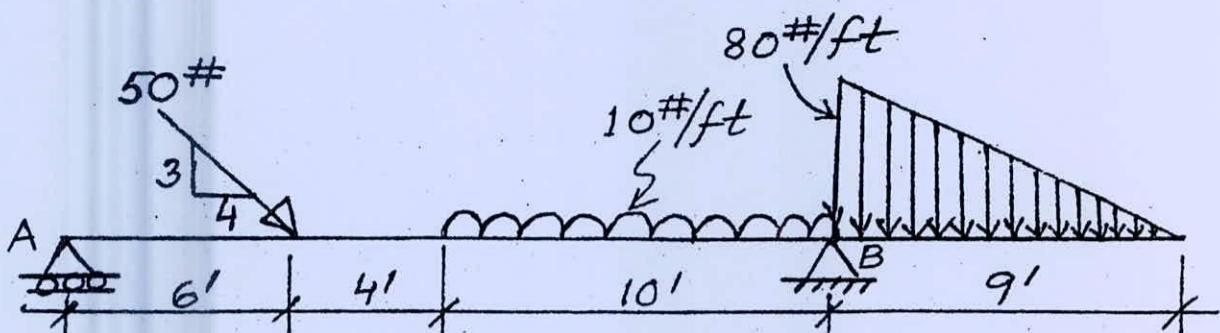


Fig. 6

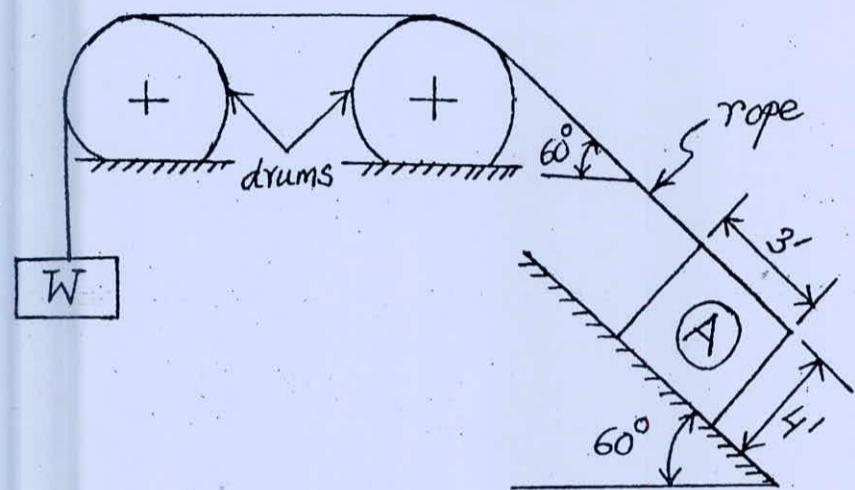


Fig. 7

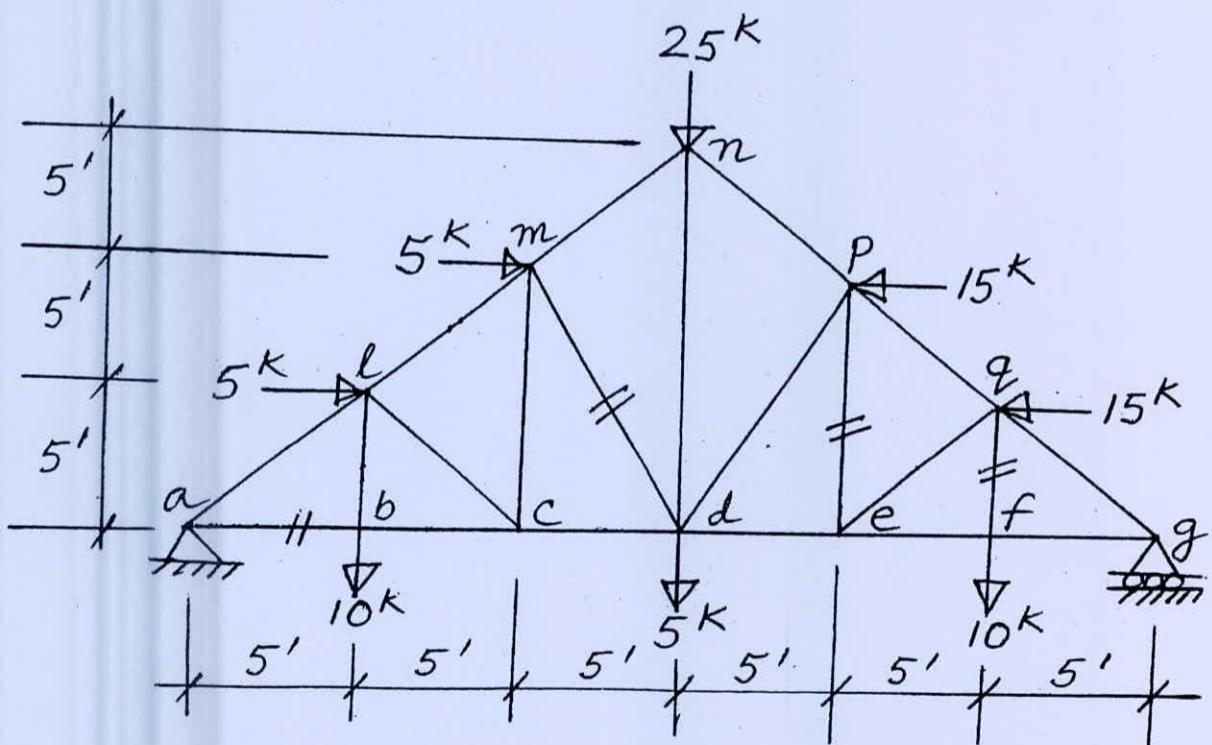


Fig. 8

Ex

Contd - P/5

= S =

CE101

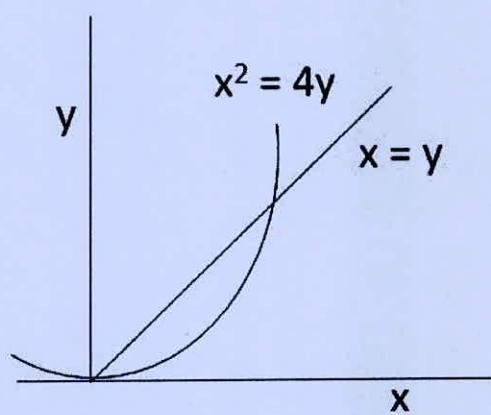


Figure 9

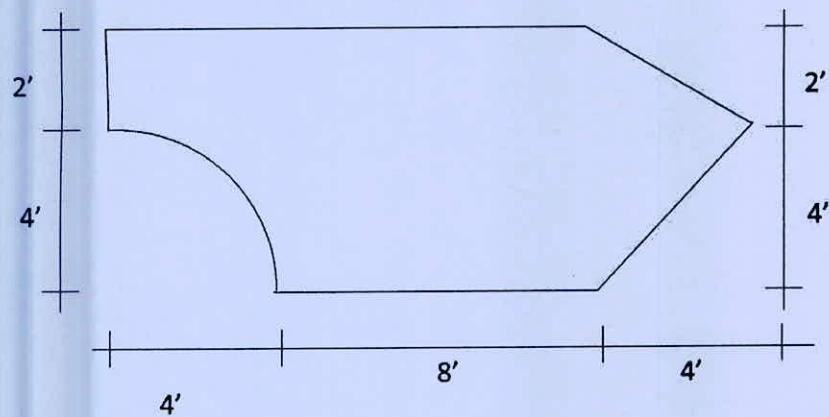


Figure 10

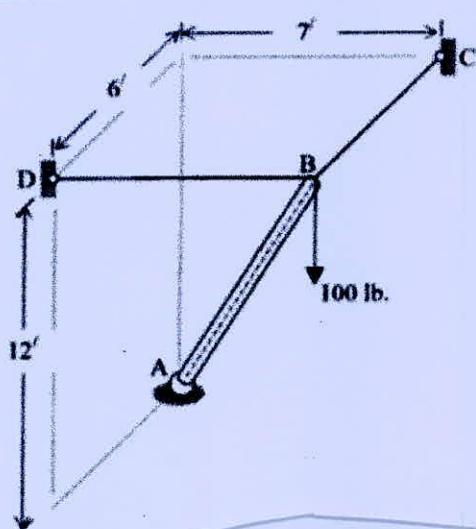


Fig. 11

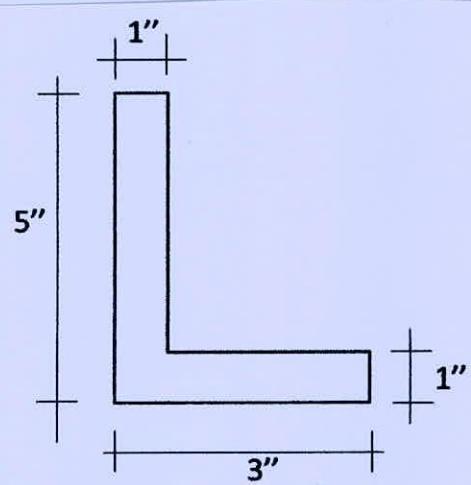


Fig. 12

Contd... P/6

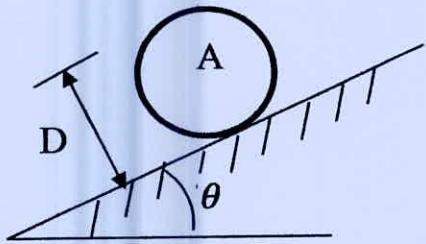


Fig. 13

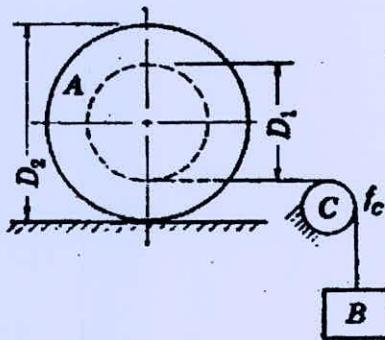


Fig. 14

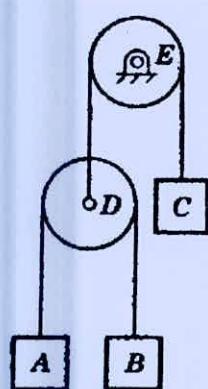


Fig. 15

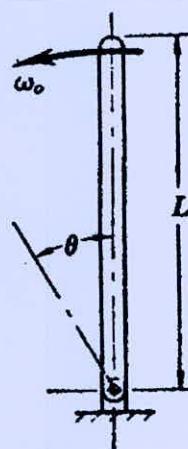


Fig. 16

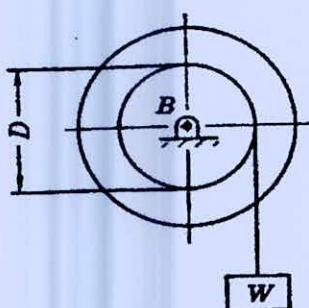


Fig. 17

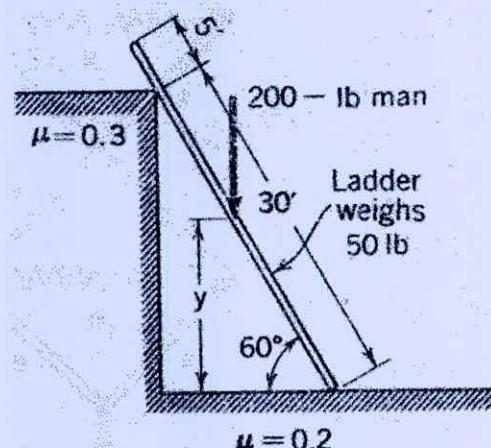


Fig. 18

— X —

Sub: **PHY 101** (Physical Optics, Waves and Oscillations and Heat & Thermodynamics)

Full Marks: 210

Time: 3 Hours

The figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

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

1. (a) Deduce an expression for temperature as measured by a Platinum resistance thermometer. (10)
(b) Two reversible engines A and B working between the same two temperature limits T_1 (higher) and T_2 (lower). Prove that their efficiencies are equal. (15)
(c) A Carnot engine has an efficiency of 50%. On increasing the temperature of the sink reservoir by 100°C , the efficiency drops to 40%. By what amount should the source reservoir temperature be increased to restore the original efficiency? (10)

2. (a) What is degrees of freedom? Establish a relationship between the ratio of two specific heats and the degrees of freedom. (15)
(b) State the law of equipartition of energy and find an expression for energy associated with each degree of freedom for a molecule. (10)
(c) Calculate the total rotational of energy of all the molecules in one mole of air at 27°C . Given $R = 8.314 \text{ J/mole-K}$ and $N = 6.023 \times 10^{23} \text{ mol}^{-1}$. (10)

3. (a) State third law of thermodynamics. (5)
(b) Deduce the Maxwell's thermodynamic relations by using the thermodynamic functions. (20)
(c) Calculate the latent heat of ice given that change of pressure of 1 atmosphere changes the melting point of ice by 0.0074°C and when 1 gm of ice melts volume changes by 0.0907 cc . (10)

4. (a) What do you understand by a quarter-wave plate and half-wave plate? How may a circularly polarized light be verified? (10)
(b) Discuss the theory of production of plane, circularly and elliptically polarized light. (10)
(c) A beam of circularly polarized light falls on a polarizing sheet. Find the expression of intensity of the transmitted beam in terms of the intensity of the circularly polarized light. (15)

PHY 101/CE

SECTION – B

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

5. (a) Discuss the phenomenon of interference of light. (8)
- (b) Light from an extended source falls obliquely on a thin transparent film. Find an expression for the effective path difference between a part of a ray reflected externally at the first surface and the part which suffers reflection internally at the other surface. Also find the conditions of bright and dark fringes. (20)
- (c) In Young's double slit experiment, the central fringe of the interference pattern produced by light having a wavelength 650 nm is shifted to the position of the fifth bright fringe when a thin transparent sheet of refractive index 1.50 is introduced in front of one of the slits. Find the thickness of the sheet. (7)
6. (a) What is meant by diffraction of light? How can diffraction of light be explained on the basis of wave theory? (8)
- (b) Find an expression for intensity distribution arising from Fraunhofer diffraction at a grating. Hence, show that the condition for secondary maxima is $N \tan \gamma = \tan N\gamma$ where the symbols have their usual meaning. (20)
- (c) A grating with 5900 lines/cm is used in diffraction experiment with sodium light (wavelength = 589.3 nm) at normal incidence. Calculate the dispersive power of the grating for 2^{nd} order. (7)
7. (a) A particle of mass m was executing an oscillatory motion under the influence of a small amount of damping force. An external force, $F_0 e^{i\omega t}$, is applied to the particle during oscillation. Establish the differential equation for the oscillating particle after application of the external force and find the general solution of the equation. (15)
- (b) Define resonance. Derive the relation between response, and damping coefficient in a forced oscillation. (10)
- (c) A block of mass 12.5 g is attached to a spring with the spring constant 345 Nm^{-1} . The block is oscillating in a medium with damping force constant $0.36 \text{ N-m}^{-1}\text{s}$. An external periodic force with the maximum value 9.7 N is applied to the block and resonance is achieved. Evaluate the resonant frequency and amplitude of resonance. (10)
8. (a) A string is closed at both end in which a stationary wave is generated by reflection. Deduce the equations of particle displacement, particle velocity, acceleration, and strain for the resultant stationary wave. Explain under which condition stationary instant is achieved. (15)

PHY 101/CE
Contd... Q. No. 8

(b) Consider that the stationary wave described in question no. 8(a) is formed by reflection of a wave propagating along positive x-direction. Amplitude of the incident wave is 0.05 m, velocity is 320 m/s, and frequency is 545 Hz. Find the expression of displacement of the resultant stationary wave and evaluate the position where the first antinode occurs.

(10)

(c) Two travelling waves with the same amplitudes and frequencies ω_1 and ω_2 are superimposed with each other in a medium. The difference between frequencies of the waves ($\Delta\omega$) is very small. The equation of resultant wave after superposition of the two waves is given by $y = 2A \cos \frac{1}{2}(\Delta\omega.t - \Delta k.x) \sin(\omega t - kx)$. Give an interpretation of the amplitude of the resultant wave and hence establish a relation between group velocity and phase velocity. In which medium both the velocities are the same?

(10)

SECTION – A

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

1. (a) Predict the position of an electron in an atom by using electron probability density diagram for many electron system. **(15)**
(b) Illustrate the similarities and dissimilarities of waves and particles. Why does effective nuclear charge (Z_{eff}) for subshell 3p is higher than 4s? **(10)**
(c) An electron in the $n = 6$ energy level of an H atom drops to a lower energy level; the atom emits a photon of wavelength 410 nm. (i) What is ΔE for this transition in 1 mol of H atoms? (ii) what energy level did the electron move? **(10)**

2. (a) Where does hydrogen belong in periodic table? Hydrogen has only one proton, but its first ionization energy is much greater than that of lithium, which has three protons. Why? Explain. **(15)**
(b) What are acidic hydrogens? How many acidic hydrogens are present in phosphoric acid and phosphorus acid, explain with their structures? **(10)**
(c) What correlation, if any, exists for the Period 2 elements between group number and the number of covalent bonds the element typically forms? How is the correlation different for elements in Periods 3 to 6? **(10)**

3. (a) A molecule with weaker bonds is usually more reactive than one with stronger bonds, why? How to differentiate a symmetric and asymmetric stretching vibration of a bond in a molecule by IR spectroscopy? **(15)**
(b) Draw Lewis structures for the following compounds, and predict which member of each pair will form hydrogen bonds (i) NF_3 or NH_3 (ii) CH_3OCH_3 or CH_3CH_2OH **(10)**
(c) Draw the molecular shapes and predict the bond angles (relative to the ideal angles) of (i) BrF_4^- and (ii) PCl_6^- **(10)**

4. (a) Predict the change in energy and bond length, if one electron is released from N_2 and Ne_2 to from N_2^+ and Ne_2^+ respectively ? Explain with energy diagram. **(15)**

CHEM 103
Contd... Q. No. 4

- (b) Draw and explain the energy diagram for molecular orbital of CO and HCl with their electronic configuration. (10)
- (c) Using molecular orbital diagram and the bond order answer the followings with explanation: (10)
- (i) Is O_2^- stable? (ii) Is O_2^- paramagnetic?

SECTION – B

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

5. (a) Describe a process for the measurement of enthalpy of chemical reaction. (12)
- (b) Justify that internal energy is an extensive property and change in internal energy is a state function. (12)
- (c) Use Hess's Law to express enthalpy of formation of a compound. (11)
6. (a) State and rationalize the effects of change in concentrations, electrode area and temperature on the emf of the cell. (12)
- (b) Draw a schematic diagram of a concentration cell and derive the equation to express the emf of the cell. (12)
- (c) Explain the electrochemical reactions of rust formation on iron. (11)
7. (a) In what respects the titration of weak acid with strong base is different from the titration of strong acid with strong base? Provide justification of the differences. (12)
- (b) Relate the nature of cation and anion to determine the relative acidity and basicity of aqueous salt solution. (12)
- (c) Explain, why the concentration of acid and base can not be determined by simple pH measurement. (11)
8. (a) Express the relation of Gibbs free-energy with enthalpy and entropy. Explain entropy driven process and enthalpy driven process. (12)
- (b) What are the colligative properties? Utilize the phenomena of osmotic pressure measurement for the determination of molecular weight of polymers. (12)
- (c) Explain the effects of pressure and temperature on the solubility of gases. (11)

Appendix 1: Periodic Table

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

Symbols used have their usual meaning.

1. (a) Is $f(x)$ defined below continuous at $x = 1$ and $x = 2$? Does $f'(x)$ exist for these values? (15)

$$f(x) = \begin{cases} x, & 0 < x < 1 \\ 2 - x, & 1 \leq x \leq 2 \\ x - \frac{1}{2}x^2, & x > 2 \end{cases}$$

Also sketch the graph of $f(x)$.

- (b) Evaluate the following limits:

$$(i) \lim_{x \rightarrow 2} \left[\frac{4}{x^2 - 4} - \frac{1}{x - 2} \right] \quad (10)$$

$$(ii) \lim_{x \rightarrow 0^+} (e^{2x} - 1)^x \quad (10)$$

2. State Leibnitz's theorem and utilize this theorem to find the value of (10)

$$y_{n+2}(0) + 2n^2 y_n(0) + n(n-1)^2(n-2)y_{n-2}(0), \quad \text{if } y = \frac{1}{2}(\tan^{-1} x)^2$$

- (b) Find the infinite series of $y = \log(1 - \cos 2x)$ and also state the condition under which the expansion is valid. (15)

- (c) A cable of a certain suspension bridge is attached to supporting pillars 300 ft apart. If it hangs in the form of a parabola with the lowest point 50 ft below the point of suspension, find the angle between the cable and the pillar. (10)

3. (a) A box with a square base is taller than it is wide. In order to send the box through the mail, the height of the box and the perimeter of the base can sum to no more than 108 in. What is the maximum volume for such a box? (10)

- (b) State and prove first mean value theorem. Find the value of 'c' (critical value) using Cauchy's Mean Value theorem for the functions $f(x) = e^x$ and $g(x) = e^{-x}$ in the interval $(3, 5)$. (10)

- (c) State Euler's theorem for homogeneous functions and hence verify the theorem for (15)

$$f(x, y) = \sin \frac{x^2 + y^2}{xy}$$

MATH 137/CE

4. Workout the following integrals:

$$(i) \int \frac{dx}{(x+1)\sqrt{1+2x-x^2}} \quad (10)$$

$$(ii) \int \frac{(2x-1)dx}{\sqrt{2+4x+4x^2}} \quad (15)$$

$$(iii) \int \frac{dx}{1+\sin x + \cos x} \quad (10)$$

SECTION - B

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

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

$$(b) \text{Evaluate } \int_0^1 \frac{\log(1+x)}{1+x^2} dx. \quad (10)$$

$$(c) \text{Evaluate } \lim_{n \rightarrow \infty} \left[\left(2 + \frac{1}{n^2} \right)^{\frac{1}{n^2}} \left(2 + \frac{2^2}{n^2} \right)^{\frac{2}{n^2}} \left(2 + \frac{3^2}{n^2} \right)^{\frac{3}{n^2}} \dots \left(2 + \frac{n^2}{n^2} \right)^{\frac{n}{n^2}} \right]. \quad (10)$$

6. (a) Evaluate $\int_0^{\frac{\pi}{2}} \frac{dx}{5+3\cos x}$. (10)

$$(b) \text{Evaluate } \int_0^1 x^5 \sqrt{\frac{1+x^2}{1-x^2}} dx. \quad (13)$$

$$(c) \text{Evaluate } \iiint_R \frac{1}{\sqrt{x+y}} dy dx dz, \text{ where } R : x \leq y \leq z, 0 \leq x \leq z, 1 \leq z \leq 4. \quad (12)$$

7. (a) Define rank of a matrix with applications. Reduce the given matrix $A = \begin{bmatrix} 1 & 2 & 3 \\ 3 & 2 & 1 \\ 1 & 3 & 2 \\ 2 & 1 & 3 \end{bmatrix}$ to the normal form B and compute the matrices P and Q such that $PAQ = B$, where A and B are equivalent matrices. Also find the rank of A. (20)

(b) Determine the values of λ and μ such that the following system of unknowns x_1, x_2 and x_3 have (i) a unique solution, (ii) more than one solution and (iii) no solution: (15)

$$x_1 + 2x_2 + x_3 = 8$$

$$2x_1 + x_2 + 3x_3 = 13$$

$$3x_1 + 4x_2 - \lambda x_3 = \mu$$

= 3 =

MATH 137/CE

8. (a) State Cayley-Hamilton theorem and verify Cayley-Hamilton theorem for the matrix (15)

$$A = \begin{bmatrix} 1 & 0 & 2 \\ 0 & 2 & 1 \\ 2 & 0 & 3 \end{bmatrix}$$

Using this theorem also find the inverse of A.

- (b) Find the eigen values and the corresponding eigen vectors of the matrix (20)

$$A = \begin{bmatrix} 5 & 3 & -1 \\ 3 & 5 & -1 \\ -3 & -3 & 3 \end{bmatrix}.$$

Is the matrix A diagonalizable? If so, write down a nonsingular matrix P that diagonalizes A and hence determine the corresponding diagonal matrix D.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-I/T-I B. Sc. Engineering Examinations 2020-2021

Sub : **HUM 355** (Sociology)

Full Marks : 140

Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) What is sociological imagination? Explain the significant roles of sociological imagination for analyzing social relationships. (10)
(b) Discuss the functionalist theoretical perspective of sociology. (13 1/3)
2. (a) What do you understand by social inequality? Explain the nature of caste system and estate system of social stratification. (10)
(b) Discuss the significant of Daniel Rossides's class model of industrial society. (13 1/3)
3. (a) Briefly explain Charles Horton Cooley's looking glass-self theory of socialization. (10)
(b) How does socialization shape human behavior? Write your answer highlighting the roles of different agents of socialization. (13 1/3)
4. Write short notes on any three of the following: (23 1/3)
(a) Social networks, (b) Primary group and secondary group, (c) sub-culture and counter culture, (d) Culture lag.

SECTION – B

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

5. (a) Define urban area, urbanization, urbanism and over-urbanization. (10)
(b) What are the factors that influence a city's growth? Discuss. (13 1/3)
6. (a) 'Everything is connected to everything else' – explain in terms of human ecology. Briefly discuss the urban ecological process. (13 1/3)
(b) Define hazard and disaster. What are the negative impacts of global warming? (10)
7. (a) Explain what is meant by deviance, crime and white-collar crime. (10)
(b) Define juvenile delinquency. What are the causes of juvenile delinquency? (13 1/3)
8. Write short notes on any THREE of the following – (23 1/3)
(a) Sources of social change, (b) Demographic Transition Theory,
(c) Timeline of evolution of Pollution Prevention Control,
(d) Functions of the family.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-I/T-I B. Sc. Engineering Examinations 2020-2021Sub : **HUM 375** (Government)

Full Marks : 140

Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – AThere are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Define state. Discuss the differences between society and state. **(11 1/3)**
(b) What is constitution? Analyze different types of constitution with examples. **(12)**
2. (a) Explain the political rights and duties of a citizen in a state. **(11 1/3)**
(b) Analyze the functions of Legislature in a state. **(12)**
3. (a) Classify democratic forms of government with relevant examples. **(11 1/3)**
(b) Write an analytical note on the merits of nationalism. **(12)**
4. Write short notes on any three (3) of the following: **(23 1/3)**
(a) Limitations of Democracy
(b) Parliamentary form of Government
(c) Good Governance
(d) Bureaucracy.

SECTION – BThere are **FOUR** questions in this section. Answer any **THREE**.

5. (a) What is foreign policy? Write the principles of Bangladesh foreign policy. **(11 1/3)**
(b) Explain the internal and external determinants of foreign policy of Bangladesh. **(12)**
6. (a) Define public policy? Why do we study public policy? **(11 1/3)**
(b) Discuss the characteristics of Bangladesh constitution of 1972. **(12)**
7. (a) What is NGO? Discuss the development activities of NGOs in Bangladesh. **(11 1/3)**
(b) Describe the limitations of NGO activities in Bangladesh. **(12)**
8. (a) What is United Nations Organization (UNO)? Describe the six major organs of UNO. **(11 1/3)**
(b) Define local government. Explain the functions of local Government in Bangladesh. **(12)**