

# KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

## Department of Mechanical Engineering

B. Sc. Engineering Special Backlog Examination, 2023

ME 1209

(Engineering Mechanics I)

Time: 3 Hours

Total Marks: 210

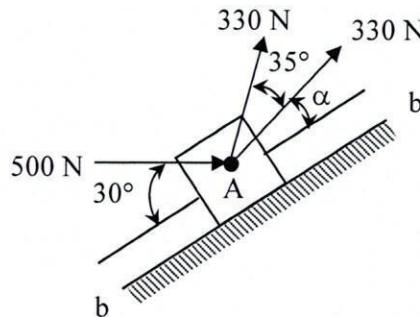
**N.B.:** i) Answer any THREE questions from each section in separate scripts.

ii) Figures in the right margin indicate full marks.

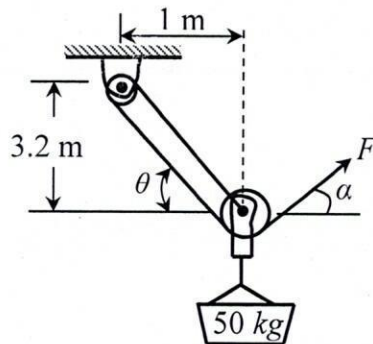
iii) Assume reasonable data if any are missing.

### SECTION-A

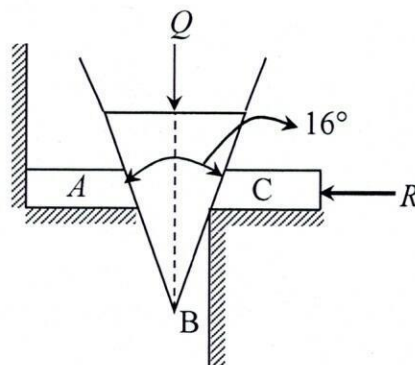
- 1(a) The direction of the 330 N forces may vary, but the angle between the forces is always  $35^\circ$ . Determine the value of  $\alpha$  for which the resultant of the forces acting at A is directed parallel to the plane *b-b*. 10



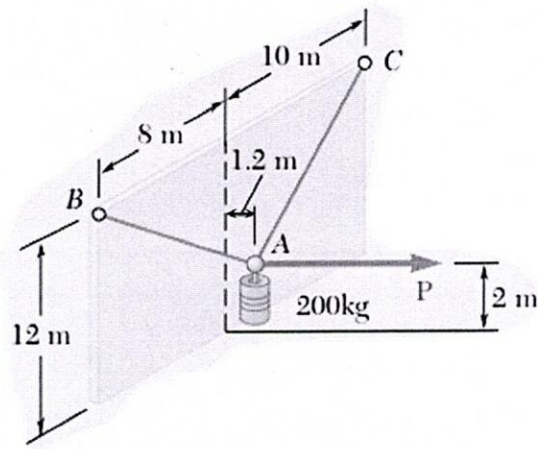
- 1(b) A crate is to be supported by the rope-and-pulley arrangement as shown in the figure. Determine the magnitude and direction of the force *F* which should be exerted on the free end of the rope. 10



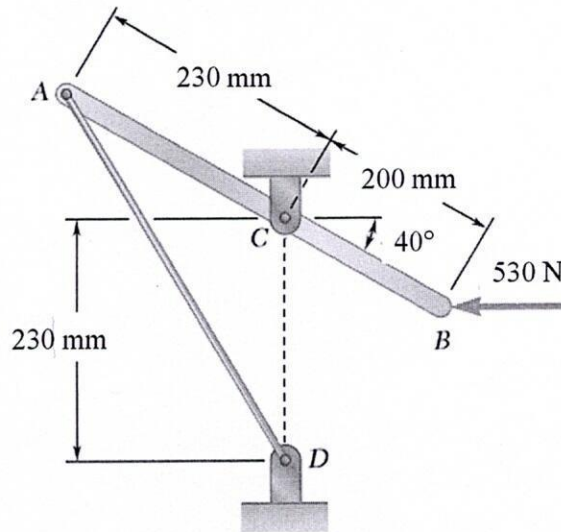
- 1(c) In the figure,  $m_A = 900 \text{ kg}$ ,  $m_B = 100 \text{ kg}$ ,  $m_C = 2500 \text{ kg}$  and force  $R = 35 \text{ kN}$ . Neglecting friction at all surfaces of contact, determine the force *Q* on the top of the wedge, to make the system in equilibrium. 15



- 2(a) A 200-kg cylinder is hung by means of two cables AB and AC, which are attached to the top of a vertical wall. A horizontal force *P* perpendicular to the wall holds the cylinder in the position shown. Determine the magnitude of *P* and the tension in each cable. 17

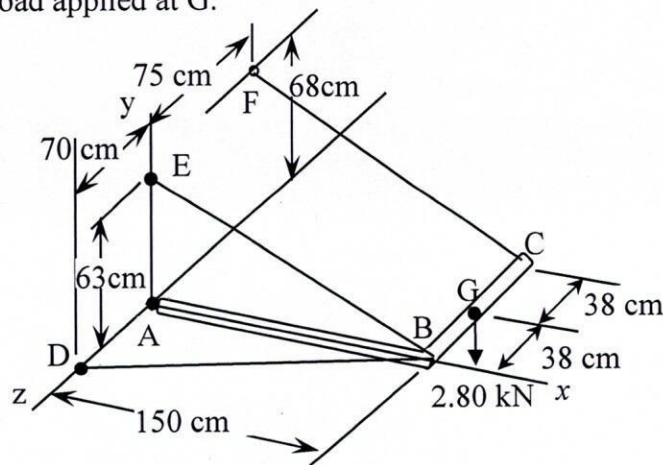


- 2(b) A lever AB is hinged at C and attached to a control cable at A. If the lever is subjected at B to a 530-N force, determine (i) the tension in the cable, (ii) the reaction at C. 18

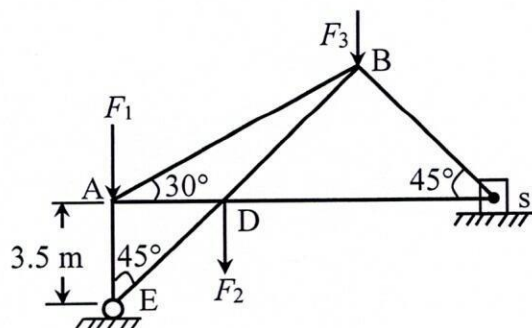


- 3(a) What are the conditions of equilibrium of a rigid body in two and three dimensions? Write the equations in rectangular coordinates. 05

- 3(b) The rigid L-shaped member ABC is supported by a ball and socket at A and by three cables as shown. Determine the tension in each cable and the reaction at A caused by the 2.80 kN load applied at G. 30

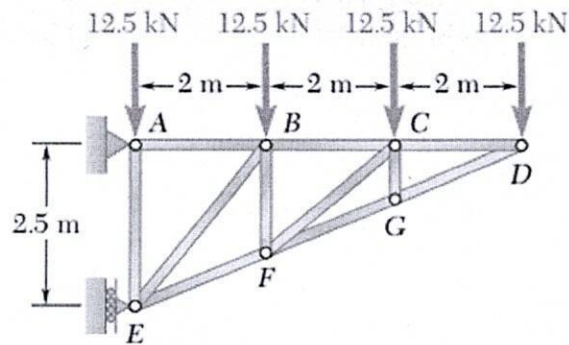


- 4(a) The framework in the figure is loaded with forces  $F_1 = F_2 = F_3 = 3100$  N as shown. Find the loads on each member (AB, AD, and DE). 17



4(b) Determine the force in each member of the truss shown.

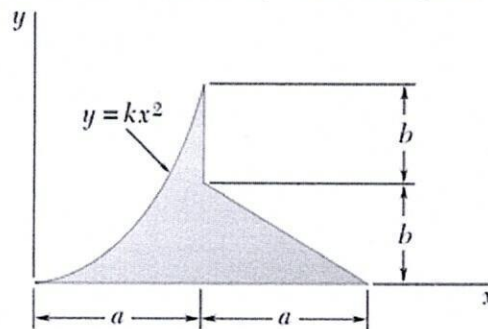
18



### SECTION-B

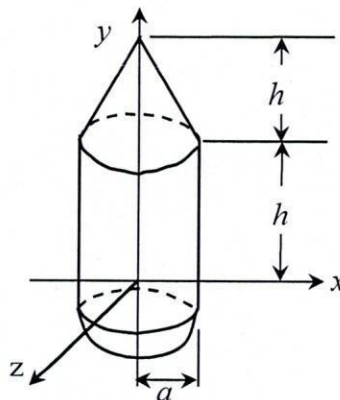
5(a) Determine the centroid of the area shown by direct integration.

17



5(b) A hemisphere, a cylinder, and a cone are placed together as shown in the figure. Determine the location of the centroid of the composite body.

18

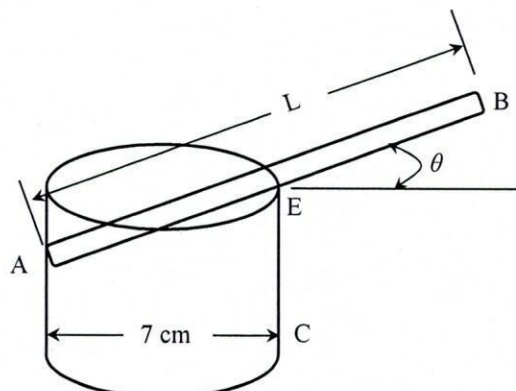


6(a) For a V-belt, derive the expression for the tensions in the two sides of the belt. Assume belt angle  $\alpha$  and the contact angle  $\beta$  and the coefficient of friction as  $\mu$ .

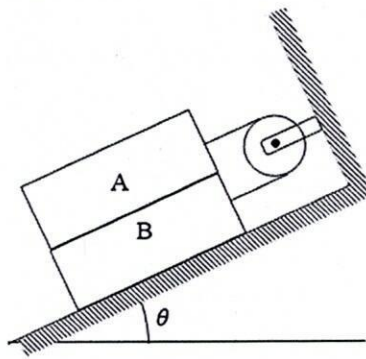
17

6(b) A small glass rod of length 15 cm is placed inside a glass tumbler as shown in the figure. The coefficient of static friction between the rod and the glass tumbler is 0.10. Determine the largest value of  $\theta$  for which the rod will not fall into the tumbler.

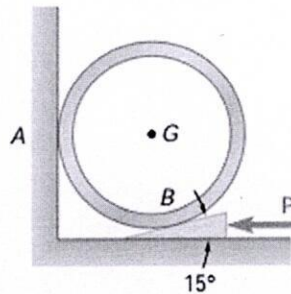
18



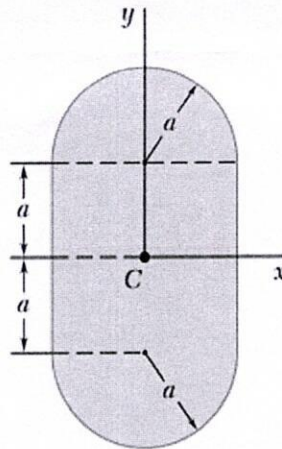
- 7(a) Block A weighs 50 kg and block B weighs 20 kg. Knowing that the coefficient of static friction is 0.15 between all surfaces of contact, determine the value of  $\theta$  for which the motion is impending. 17



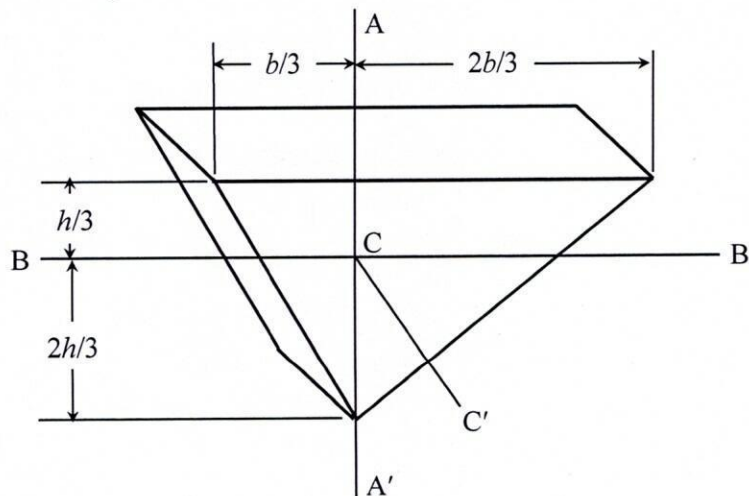
- 7(b) A 15° wedge is forced under a 50-kg pipe as shown. The coefficient of static friction at all surfaces is 0.20. (i) Determine if slipping will occur between the pipe and the vertical wall. (ii) Determine the force P required to move the wedge. 18



- 8(a) Determine the moments of inertia of the shaded area shown with respect to the x and y axes when  $a = 20$  mm. 17



- 8(b) A thin plate of mass  $m$  is cut in the shape of an isosceles triangle of base  $b$  and height  $h$ . Determine the mass moment of inertia of the plate with respect to (i) the centroidal axes  $AA'$  and  $BB'$  in the plane of the plate, (ii) the centroidal axis  $CC'$  perpendicular to the plate. 18



# KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering  
B. Sc. Engineering Special Backlog Examination, 2023

Math 2105  
(Mathematics III)

Time: 3 Hours

Total Marks: 210

- N.B.:** i) Answer any THREE questions from each section in separate scripts.  
ii) Figures in the right margin indicate full marks.  
iii) Assume reasonable data if any are missing.

## SECTION-A

- 1(a) The position vector of a moving particle is  $\vec{r}(t) = (\cos t + \sin t)\hat{i} + (\sin t - \cos t)\hat{j} + t\hat{k}$ . Determine the velocity, speed, and acceleration of the particle in the direction of the motion. 10
- 1(b) By finding the gradient of the function  $f(x, y, z) = x^2 + y^2 + z^2$  at  $(1,1,0)$ , find the equations of the line normal to the sphere  $x^2 + y^2 + z^2 = 2$  at  $(1,1,0)$  and use this result to find the normal. 10
- 1(c) What is meant by a conservative vector field? Find the value of the integral  $\oint[(3x + 4y)dx + (2x + 3y^2)dy]$  around the closed path consisting of a circle of radius 2 and centered at the origin of the  $xy$  plane. 15
- 2(a) Determine whether  $\vec{F} = e^{y+2z}(\hat{i} + x\hat{j} + 2x\hat{k})$  is a solenoid, conservative. If possible, find a potential function for the field  $\vec{F}$ . 15
- 2(b) Find the work done by  $\vec{F} = (x^2 + y)\hat{i} + (y^2 + x)\hat{j} + ze^z\hat{k}$  over the path  $C$  from  $(1,0,0)$  to  $(1,0,1)$  where  $C$  is the line segment  $x = 1, y = 0, 0 \leq z \leq 1$ . 10
- 2(c) Calculate the outward flux of the vector field  $\vec{F}(x, y) = 2e^{xy}\hat{i} + y^3\hat{j}$  across the square bounded by the lines  $x = \pm 1$  and  $y = \pm 1$ . 10
- 3(a) State Stokes' theorem verbally as well as mathematically. Verify this theorem for the vector field  $\vec{F} = 2z\hat{i} + 3x\hat{j} + 5y\hat{k}$  taking  $S$  (surface) to be the portion of the paraboloid  $z = 4 - x^2 - y^2; z \geq 0$  with upward orientation and  $C$ , be the boundary of  $S$ , is positively oriented circle  $x^2 + y^2 = 4$  in the  $xy$  plane. 20
- 3(b) State the divergence theorem and use this to find the outward flux of the vector field  $\vec{V} = x^3\hat{i} + y^3\hat{j} + z^2\hat{k}$  across the surface of the region bounded by  $x^2 + y^2 = 9$  and the planes  $z = 0$  and  $z = 2$ . 15
- 4(a) Find the equations of the tangent plane and normal line at the point  $P_0(1, -1, 3)$  to the surface  $x^2 + 2xy - y^2 + z^2 = 7$ . 10
- 4(b) Find the mass of a wire that lies along the curve  $\vec{r}(t) = (t^2 - 1)\hat{j} + 2t\hat{k}; 0 \leq t \leq 1$  if the density is  $\delta = \frac{3}{2}t$ . 10
- 4(c) Find the scale factors for spherical coordinates and hence find in detail the expression for the gradient in the spherical system. 15

## SECTION-B

- 5(a) Define symmetric and elementary matrix. Construct a symmetric and skew-symmetric matrix from 10

$$\begin{bmatrix} 2 & 5 & 7 \\ 3 & 4 & 8 \\ -1 & 3 & 0 \end{bmatrix}$$

- 5(b) Using row operations only to find the inverse of the matrix 10

$$\begin{bmatrix} 7 & 4 & 3 \\ 5 & 6 & 4 \\ 4 & 1 & 6 \end{bmatrix}$$

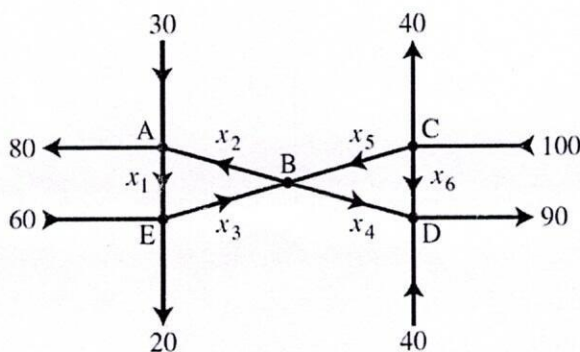
- 5(c) Find the reduced row echelon form of the matrix 15

$$\begin{bmatrix} 1 & 1 & 1 & -1 \\ 1 & 2 & 3 & 4 \\ 3 & 4 & 5 & 2 \end{bmatrix}$$

and hence rank. If the given matrix were an augmented matrix, then how many solutions of the system have?

- 6(a) Check the linear dependency of the set of vectors— 13  
 $\{(1,1,1,0), (3,2,2,1), (1,1,3,-2), (1,2,6,-5)\}$  of  $V_4(R)$  and if they are linearly dependent, find a linear combination of the set of vectors.

- 6(b) Find the general flow pattern in the network shown in the figure. Also, find the minimum flows in the branches denoted by  $x_2, x_3, x_4,$  and  $x_5$ , where the flow must be in directions as indicated in the figures. 17



- 6(c) Prove that the matrix which is both symmetric and skew-symmetric must be a null matrix. 05

- 7(a) What do we understand by the conjugate of a matrix? 10

If  $A = \begin{bmatrix} 2 & 1+2i & -3-4i \\ 1+i & 7 & 2+i \\ 3-2i & 4+i & -3+3i \end{bmatrix}$ , express  $A$  as the sum of a Hermitian matrix and a Skew-Hermitian matrix.

- 7(b) Determine the eigenvalues and corresponding eigenvectors of the matrix. 15

$$A = \begin{bmatrix} -9 & 4 & 4 \\ -8 & 3 & 4 \\ -16 & 8 & 1 \end{bmatrix}$$

- 7(c) Separate  $\ln \sin(x + iy)$  into real and imaginary parts. 07

- 7(d) Find the nature of the singular point of  $f(z) = \frac{\cot z}{z}$  at the point  $z = 0$ . 03

- 8(a) Verify whether the function  $f(z) = u + iv$ , where  $u = \frac{x^3 - y^3}{x^2 + y^2}$ ,  $v = \frac{x^3 + y^3}{x^2 + y^2}$ , when  $z \neq 0$  and  $f(0) = 0$  is continuous at  $z = 0$ ? Does  $f'(0)$  exist? 14

- 8(b) Test whether the function  $u(x, y) = (x - 1)^3 - 3xy^2 + 3y^2$  is harmonic, and if so, find its conjugate harmonic function  $v(x, y)$  and the corresponding analytic function  $f(z) = u + iv$ . 15

- 8(c) Show that the analytic function of constant modulus is constant. 06

# KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering  
B. Sc. Engineering Special Backlog Examination, 2023

HUM 2105

(Industrial Environment and Sociology)

Time: 3 Hours

Total Marks: 210

- N.B.:** i) Answer any THREE questions from each section in separate scripts.  
ii) Figures in the right margin indicate full marks.  
iii) Assume reasonable data if any are missing.

## SECTION-A

- 1(a) What is population growth? 05
- 1(b) How will the population growth rate affect economic growth? 10
- 1(c) Critically describe Malthus's theory on population growth. 10
- 1(d) Explain the relation between industrialization and energy use. 10
- 2(a) What are the characteristics of Industrial waste? 05
- 2(b) Describe how industrial activities contribute to environmental pollution. 10
- 2(c) How can modern technology help reduce environmental pollution? 10
- 2(d) Explain the importance of waste minimization in industries. 10
- 3(a) "Not all industrial waste is hazardous, but all hazardous waste is industrial". Discuss the accuracy of the statement. 10
- 3(b) What is the importance of industrial law in the workplace? 07
- 3(c) Describe the role of certifying surgeons in ensuring workers' health. 10
- 3(d) "Good health and hygiene practices improve industrial productivity". Discuss. 08
- 4(a) What are the main objectives of the Bangladesh Labor Act, 2006? 07
- 4(b) Describe the main features of the Bangladesh Labor Act, 2006. 10
- 4(c) How does the Environmental Conservation Act, 1995, contribute to sustainable development in Bangladesh? 10
- 4(d) What role has the ILO played in improving workplace safety in Bangladesh? 08

## SECTION-B

- 5(a) What is sociology? 05
- 5(b) Discuss why the sociological study is important for the students of Mechanical Engineering. 10
- 5(c) Describe how societies evolved over time? 10
- 5(d) Explain the characteristics of society. 10

|      |  |    |
|------|--|----|
| 6(a) | What is social structure?  | 05 |
| 6(b) | Describe the elements of social structure.                         | 10 |
| 6(c) | Explain the types of social stratification.                        | 10 |
| 6(d) | Discuss the concepts of “Association, Institution, and Community”. | 10 |
|      |  |    |
| 7(a) | What is cultural lag?  | 05 |
| 7(b) | Describe the elements of culture.                                  | 10 |
| 7(c) | Differentiate between subculture and counterculture.               | 10 |
| 7(d) | Where does culture differ from civilization?                       | 10 |
|      |  |    |
| 8(a) | What is urban ecology?   | 05 |
| 8(b) | What are the main reasons for urbanization?                        | 10 |
| 8(c) | Show the relationship between urbanization and industrialization.  | 10 |
| 8(d) | Why do people engage in criminal activities in Bangladesh?         | 10 |

# KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering  
B. Sc. Engineering Special Backlog Examination, 2023

ME 3121

(Numerical Computation for Mechanical Engineers)

Time: 3 Hours

Total Marks: 210

- N.B.:** i) Answer any THREE questions from each section in separate scripts.  
ii) Figures in the right margin indicate full marks.  
iii) Assume reasonable data if any are missing.

## SECTION-A

1(a) What is meant by interpolation? Derive Newton's forward interpolation formula in general form. 17

1(b) The value of  $x$  and  $f(x)$  are given below: 18

|        |    |     |     |     |      |
|--------|----|-----|-----|-----|------|
| $x$    | 4  | 5   | 7   | 10  | 11   |
| $f(x)$ | 55 | 110 | 294 | 900 | 1210 |

With the help of the given data, construct a divided difference table and find the value of  $f(8)$ .

2(a) Why is numerical integration important? Deduce the Trapezoidal rule for numerical integration. 17

2(b) Estimate the value of the integral,  $I = \int_0^4 \frac{2x}{1+x^2} dx$  by the Simpson 1/3 rule with 4 strips. 18

3(a) Derive the formula for the Newton-Raphson method and state the geometric significance of the formula. 18

3(b) Find the real root of the equation  $x^3 - 2x - 5 = 0$  using the bisection method. 17

4(a) What are the methods for solving a system of linear algebraic equations? Describe the Gauss Elimination method for solving these equations. 17

4(b) Solve the following system of linear algebraic equations using the Gauss-Seidel Method. 18

$$2x + y + z = 5$$

$$3x + 5y + 2z = 15$$

$$2x + y + 4z = 8$$

## SECTION-B

5(a) Using Taylor's series of  $y(x)$ , find  $y(0.2)$  correct to four decimal places if  $y(x)$  satisfies  $\frac{dy}{dx} = x + y^2$  and  $y(0) = 1$ . 18

5(b) What is meant by an ordinary differential equation? Using the Euler method, find the value of  $y(0.8)$  with  $h = 0.2$  from the following equation  $\frac{dy}{dx} = x + y$  with  $y(0) = 0$ . 17

- 6(a) Solve the following ordinary differential equation by the fourth-order Runge-Kutta method. 18

$$\frac{dy}{dx} = x^2 + y \quad \text{where } y(0) = 3$$

Find  $y(0.2), y(0.4)$  assuming step size 0.2.

- 6(b) Fit a function of the form  $y = ax^b$  to the following data. 17

|     |    |    |    |    |    |    |    |    |
|-----|----|----|----|----|----|----|----|----|
| $x$ | 2  | 4  | 7  | 10 | 20 | 40 | 60 | 80 |
| $y$ | 43 | 25 | 18 | 13 | 8  | 5  | 3  | 2  |

- 7(a) What is meant by eigenvalue and eigenvector? What is the importance of eigenvalues and eigenvectors? 05

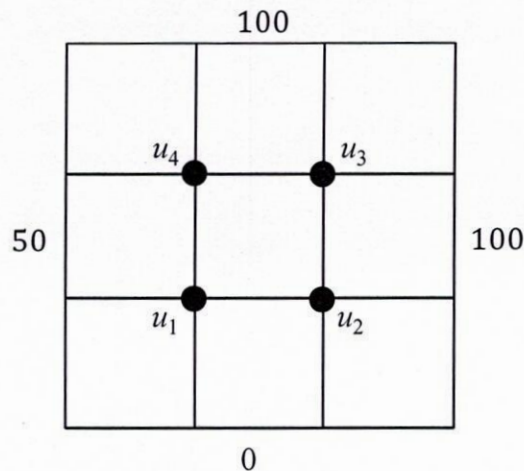
- 7(b) Find the eigenvalues and eigenvectors of the following matrix. 15

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

- 7(c) A 100 m long conducting rod of rectangular cross-section and thermal conductivity  $k = 20 \text{ W/m.K}$ . The temperature of one end is  $150^\circ\text{C}$ , and the other end is  $50^\circ\text{C}$ . All other surfaces are insulated. Assuming steady state heat conduction and using the finite difference method with a grid spacing of 20 mm, determine the temperature distribution in the rod. 15

- 8(a) Derive the Crank-Nicolson method for solving a parabolic-type partial differential equation. 15

- 8(b) Solve the equation  $U_{xx} + U_{yy} = 0$  in the domain of the figure below by the finite difference method for given boundary conditions. Consider  $\Delta x = \Delta y$ . 20



# KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering  
B. Sc. Engineering Special Backlog Examination, 2023

ME 4229

(Industrial Management and Professional Ethics)

Time: 3 Hours

Total Marks: 210

- N.B.:** i) Answer any THREE questions from each section in separate scripts.  
ii) Figures in the right margin indicate full marks.  
iii) Assume reasonable data if any are missing.

## SECTION-A

- 1(a) Explain the behavioral management theory. 12
- 1(b) Briefly explain the differences between the private limited company and the public limited company. 08
- 1(c) Describe two organizational structures, one is suitable for large and multiproduct organizations, and the other is fit for medium-sized organization where multiple lines of authority exist. Also, find the differences between them. 15
- 2(a) Briefly explain the Taylor's principle of Scientific Management theory with its problems and modifications. 12
- 2(b) Discuss the Equity theory of motivation. Also state the different inequity reactions. 12
- 2(c) Explain the methods of employee development. 11
- 3(a) Explain the thought leader and servant leader. 11
- 3(b) Describe bureaucratic and democratic styles of leading. 12
- 3(c) Define leadership style. Enlist leadership styles. Discuss Autocratic leadership. When is a leader termed as autocratic? 12
- 4(a) Compare and contrast job enlargement and job enrichment. 10
- 4(b) Discuss the following wage incentive plans: 15  
(i) Halsey 50-50 premium plan.  
(ii) Rowan premium plan and  
(iii) Taylor's differential piece rate plan.
- 4(c) Define moral and motivation. Explain the impact of high moral of employees in an organization. 10

## SECTION-B

- 5(a) Define budget. Discuss different types of budgets in brief. 12
- 5(b) What are the essential conditions for applying budgetary control? Discuss. 11
- 5(c) Show how budget and budgetary control are used for effective financial control in business management. 12

- 6(a) Define marketing. What are the benefits of market research? Explain its necessity in modern industries. 15
- 6(b) Define purchasing. Enlist purchase parameters and purchasing methods. 10
- 6(c) Describe advertisement techniques and the positive and negative impacts of advertisements. 10
- 
- 7(a) Why is ethics important in engineering? Mention the differences between personal and professional ethics. 15
- 7(b) Mistakes made by the engineers can be costly. Explain. 10
- 7(c) How do engineers view themselves, and what are the public perceptions? 10
- 
- 8(a) Explain the role of engineers in sustainable development. Describe the code of ethics for engineers and sustainable developments. 18
- 8(b) Explain the four branches of ethics. 10
- 8(c) Describe moral reasoning with examples. 07