

Khulna University
 Science, Engineering and Technology School
 Discipline: **Mathematics**, Program: **B.Sc. (Hons.)**
 Year: **Fourth**, Term: **I** Examination-2026; Session: **2024-2025**
 Course Code: **Phy-2251**
 Course Title: **Physics-IV**
 Total Marks: **60**, Time: **03** Hours, Credit: **03**



- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate answer script for each section.

Section-A

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

Marks

- | | | |
|----|--|----|
| 1. | (a) State and briefly explain Huygen's Principle of light. | 03 |
| | (b) Explain basic properties of light briefly | 03 |
| | (c) What is ether? Justify the existence of ether with the help of Michelson and Morley experiment. | 04 |
| 2. | (a) Explain with the necessary theory Newton's rings method of measuring the wavelength of light. | 07 |
| | (b) In a Newton's rings experiment, the diameter of the 5th dark ring is 0.336 cm, and the diameter of the 15th dark ring is 0.590 cm. Find the radius of the curvature of the plano-convex lens if the wavelength of light is 5890 Å. | 03 |
| 3. | (a) Explain the difference between Fresnel and Fraunhofer diffraction with suitable examples. | 04 |
| | (b) Derive the expression for the fringe width in Young's double-slit experiment. | 04 |
| | (c) Light of wavelength 600 nm passes through a single slit of width 0.2 mm. Calculate the angular position of the first minimum. | 02 |
| 4. | (a) What is meant by plane, circular, and elliptical polarisation? | 03 |
| | (b) Derive the expression for the Brewster angle and show that $\tan i_B = \mu$, where i_B is the polarizing angle and μ is the refractive index. | 05 |
| | (c) Find the Brewster angle for light incident on glass of refractive index 1.5. | 02 |

Section-B

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

- | | | |
|----|--|----|
| 5. | (a) Explain the main postulates of Bohr's atomic model and their physical significance. | 03 |
| | (b) Derive the expression for the radius of the nth orbit in Bohr's hydrogen atom model. | 07 |
| 6. | (a) Write short notes on: a) Photoelectric effect; b) Compton effect; c) Isoton and d) Isobar | 04 |
| | (b) Write the concept of wave-particle duality of light. How does de Broglie wavelength provide evidence for this concept? | 04 |
| | (c) Appraise the role of wave function in quantum mechanics. | 02 |
| 7. | (a) Briefly explain uncertainty principle and conclude the importance of this principle in atomic physics. | 05 |
| | (b) What is mass defect? Explain the role of mass defect in a calculation of binding energy of any atomic nucleus. | 05 |
| 8. | (a) What is radioactivity? Mathematically deduce Radioactive decay law with proper explanation. | 05 |
| | (b) State and explain Fusion process. | 03 |
| | (c) Recall basic components of a nuclear reactor. | 02 |

***** THE END *****

Khulna University
 Science, Engineering and Technology School
 Discipline: **Mathematics**, Program: **B.Sc. (Hons.)**
 Year: **Fourth** Term: **I** Examination-2026; Session: **2024-2025**
 Course Code: **Math-4215**



Course Title: **Advanced Mathematical Methods**

Total Marks: **60**, Time: **03** Hours, Credit: **03**

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- Use separate answer script for each section.

Section-A

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

Marks

1. (a) What is associate Laguerre Differential equation? Prove that $\frac{d}{dx}[L_n^\alpha(x)] = -\sum_{r=0}^{n-1} L_r^\alpha(x)$. **05**
 (b) Deduce the relation $\frac{d}{dx}[L_n^{2n}(x)] = L_n^{2n+1}(x)$ for associate Laguerre polynomial. **05**
2. (a) What is orthogonal property? Prove that $\int_{-1}^1 P_{n_1}^m(x) P_{n_2}^m(x) dx = \begin{cases} 0, & n_1 \neq n_2 \\ \frac{2|n+m|}{(2n+1)|n-m|}, & n_1 = n_2 \end{cases}$ where the **05**
 symbols having their usual meanings.
 (b) Deduce Neumann function from the solution of the Bessel function of first kind of order n . **05**
3. (a) State and derive the Bessel function of second kind of order n . **05**
 (b) Derive the Rodrigue's formula for associated Legendre polynomials. **05**
4. What is Green's function? Solve the boundary value problem by using Laplace transform and construct a Green's function of $y'' + \lambda y = f(t)$, $y(0) = y(\pi) = 0$. **10**

Section-B

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

5. (a) Define Laplace transform of $f(t)$, $t > 0$. Prove that $L\left\{\frac{\sin t}{t}\right\} = \tan^{-1}\left(\frac{1}{s}\right)$ and hence find **07**
 $L\left\{\frac{\sin at}{t}\right\}$. Does $L\left\{\frac{\cos at}{t}\right\}$ exist?
- (b) Show that $\int_0^\infty \frac{\sin t}{t} dt = \frac{\pi}{2}$. Evaluate the improper integral $\int_0^\infty \frac{\cos \alpha x}{\alpha^2 + 1} d\alpha = \frac{\pi}{2} e^{-x}$, $x > 0$. **03**
6. (a) Find the Hankel transform of, $f(x) = \begin{cases} a^2 - x^2, & 0 < x < a, n = 0 \\ 0, & x > a, n = 0 \end{cases}$ **05**
 (b) Heat is supplied at a constant rate a per unit area per unit time over. Circular area of radius a in the plane $z = 0$ to an infinite solid of conductivity k . Show that the steady temperature at a point distend r from the axis of the circular area and distance z from the plane $z = 0$ is given by, **05**
 $\frac{Q_a}{2k} \int_0^\infty e^{-pz} J_0(pr) J_1(pa) p^{-1} dp$.
7. (a) Define Z-transform. Find Z-transform of $\{\cos(\frac{k\pi}{8} + \alpha)\}$. **05**
 (b) Solve the difference equation $y_{k+3} - 2y_{k+2} + 3y_{k+1} = U_k$, $y(0) = y(1) = y(2) = 0$ by using Z-transform. **05**
8. (a) State and prove Mellin inversion formula. **05**
 (b) Evaluate $Z[\{f(k)\}]$ where $f(k) = \begin{cases} 5^k, & k < 0 \\ 3^k, & k \geq 0 \end{cases}$ **05**

***** THE END *****

Khulna University
 Science, Engineering and Technology School
 Discipline: **Mathematics**, Program: **B.Sc. (Hons.)**
 Year: **Fourth**, Term: **I** Examination-2026; Session: **2024-2025**
 Course Code: **Math-1103**
 Course Title: **Calculus-I**
 Total Marks: **60**, Time: **03** Hours, Credit: **03**



- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate answer script for each section.

Section-A

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

- | | Marks |
|---|-------|
| 1. (a) If $y = \sin \alpha x + \cos \alpha x$, then show that $y_n = \alpha^n \sqrt{1 + (-1)^n \sin 2\alpha x}$. | 05 |
| (b) If $y = \tan^{-1} x$, then show that $(1 + x^2)y_{n+2} + 2(n+1)xy_{n+1} + n(n+1)y_n = 0$. | 05 |
| 2. (a) Write the geometrical interpretation of derivative. | 03 |
| (b) Differentiate $x^{\cos^{-1} x}$ with respect to $\cos^{-1} x$. | 03 |
| (c) Find $\frac{dy}{dx}$ of the given equation $x^y + y^x = 2^7$. | 04 |
| 3. (a) State and derive Euler's theorem. | 05 |
| (b) If $u = \ln\left(\frac{x^2 + y^2}{x + y}\right)$ prove that $x \frac{\partial u}{\partial x} + y \frac{\partial u}{\partial y} = 1$. | 05 |
| 4. (a) Find maximum and minimum values of the function $f(x) = x^3 - 3x + 5$. | 05 |
| (b) Determine the intervals on which the function $f(x) = x + \frac{1}{x}$ is increasing or decreasing. | 05 |

Section-B

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

- | | |
|---|----|
| 5. Find the integrals of the followings: | 10 |
| $(i) \int \frac{\ln(\tan^{-1} x)}{1+x^2} dx; (ii) \int \ln(x^2 + 2x + 1) dx; (iii) \int \frac{dx}{\sqrt{x} - 4}.$ | |
| 6. (a) Evaluate the integral $\int_0^{\frac{\pi}{2}} \ln \tan x dx$. | 05 |
| (b) Evaluate the integral $\int_0^{\pi} \frac{x}{1 + \sin x} dx$. | 05 |
| 7. Evaluate the integrals: (i) $\int_0^{\infty} e^{-x^2} dx$; (ii) $\int_0^{\infty} \frac{x^5}{(1+x^2)^2} dx$. | 10 |
| 8. (a) Prove that $\int \frac{dx}{a^2 + x^2} = \frac{1}{a} \tan^{-1} \frac{x}{a} + c$. | 03 |
| (b) Find a function f such that $f''(x) = x + \cos x$ and $f(0) = 1, f'(0) = 2$. | 03 |
| (c) If f is integrable on $[a, b]$ and $f(x) \geq 0$ for all x in $[a, b]$, prove that $\int_a^b f(x) dx \geq 0$. | 04 |

***** THE END *****

Khulna University
 Science, Engineering and Technology School
 Discipline: **Mathematics**, Program: **B.Sc. (Hons.)**
 Year: **Fourth** Term: **I** Examination-2026; Session: **2024-2025**
 Course Code: **Math-4103**



Course Title: **Mathematical Modeling**
 Total Marks: **60**, Time: **03** Hours, Credit: **03**

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- Use separate answer script for each section.

Section-A

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

- | | | Marks |
|----|---|--------------|
| 1. | (a) Discuss the different processes of mathematical modeling with appropriate flow chart. | 03 |
| | (b) How is balance principle preserved in mathematical modeling? Explain with your argument. | 03 |
| | (c) Discuss the possible limitations of unbounded growth model. Derive a logistic growth model for single species population. Solve the model with stability analysis. | 04 |
| 2. | (a) State the Malthusian growth law for a single species population. Construct an exponential growth model for a single species population. Discuss its solution and limitations, if any. | 04 |
| | (b) Explain migration and harvesting in ecology. Suppose migration is considered and let e be the migration rate. Then for harvesting a renewable resource, an ecological model can be formulated as
$\frac{dx}{dt} = rx \left(1 - \frac{x}{K}\right) - ex.$ Find an analytical solution of the model and discuss the stability at equilibrium points. | 06 |
| 3. | (a) Construct a fishery management model for single species population with harvesting effort.
Solve the model and discuss the stability of the solution. | 05 |
| | (b) Identify and solve the linear population model
$x' = x + y$ $y' = -x + y$ where $x(0) = y(0) = 1000$.
Determine all future populations; when will the prey population be eliminated? | 05 |
| 4. | A predator-prey model in a two species ecosystem with <i>Holling type- II</i> can be formulated as
$x'(t) = rx \left(1 - \frac{x}{K}\right) - \frac{sxy}{1 + sHx}$ $y'(t) = \frac{esxy}{1 + sHx} - my$ where, x is the density of prey and y is the predator density. Verify the model for well posedness and discuss the stability at equilibrium points and sketch the phase portraits. Describe the trajectories in xy plane. | 10 |

Section-B

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

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| 5. | (a) Discuss the importance of discrete model. Construct a SIR type continuous model of disease dynamics. Convert this continuous model in the form of difference equation and solve with stability analysis. | 05 |
| | (b) Let x and y denote the two conflicting nations, and let $x(t)$ and $y(t)$ be the war potentials of nation x and y respectively. So, the rate of change of war potential can be given by | 05 |

$$\frac{dx}{dt} = ky - \alpha x + g$$

$$\frac{dy}{dt} = lx - \beta y + h$$

where $\alpha, \beta, k, l, g, h$ are positive constant. Here α, β depends on the resource constraints of the respective nations; k, l depends on the war readiness of opponent nations and, g, h are depend on the dissatisfaction of one nation against of the order. Discuss the solution of the model.

6. (a) Discuss the importance of delay in epidemic model. Incorporating delay in the systems, formulate a basic epidemic SIR model and solve the model with stability analysis. 04
- (b) A nonlinear prey-predator model with Holling type II response function takes the form 06

$$\dot{x}(t) = rx \left(1 - \frac{x}{K}\right) - \frac{sxy}{1 + sHx}$$

$$\dot{y}(t) = \frac{esxy}{1 + sHx} - my$$

Let s be the search rate, P be the predation rate per predator, f be the fraction of time spent for searching and H be the time needed to handle one prey, then show that $P = \frac{sx}{1+sHx}$. Also test the stability of the model at the equilibrium points.

7. Discuss different *force of infections* in case of disease transmission. An SIRS epidemic model with nonlinear saturated incident rate can be constructed as $\frac{dS}{dt} = (1-p)A - \frac{\beta SI}{1+\alpha I} - dS + \gamma R, \frac{dI}{dt} = pA + \frac{\beta SI}{1+\alpha I} - (d+m)I, \frac{dR}{dt} = mI - (d+\gamma)R$, where $(1-p)A$ and pA are the constant recruitments of S and I individuals. Describe the model with a schematic diagram. Find the equilibrium points and test the stability at disease free equilibrium point. Explain basic reproduction number. 10
8. Consider two different types of foodstuffs, say, F_1 and F_2 . Assume that these foodstuffs contain vitamins V_1, V_2 and V_3 respectively. Minimum daily requirements of these vitamins are 1mg of V_1 , 50mg of V_2 and 10mg of V_3 . Suppose that the foodstuffs F_1 contains 1mg of V_1 , 100mg of V_2 and 10mg of V_3 , whereas foodstuffs F_2 contains 1mg of V_1 , 10mg of V_2 and 100mg of V_3 . Cost of one unit of foodstuffs F_1 is \$1 and that of F_2 is \$1.5. Formulate a linear programming model to find the minimum cost diet that would supply the body at least minimum requirements of each vitamin. 10

***** THE END *****

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 Discipline: **Mathematics**, Program: **B.Sc. (Hons.)**
 Year: **Fourth**, Term: **I** Examination-2026; Session: **2024-2025**
 Course Code: **0541 12 Math 4103**
 Course Title: **Mathematical Modeling**
 Total Marks: **60**, Time: **03** Hours, Credit: **03**



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- Use separate answer script for each section.

Section-A

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

Marks

1. (a) Explain modeling and mathematical modeling in terms of dynamical systems. Discuss the different processes of mathematical modeling with appropriate flow chart. [L1; CLO1] **03**
 (b) How balance principle is preserved in mathematical modeling? Explain with your argument. [L2; CLO1] **04**
 (c) Incorporating all possible limitations of unbounded growth model, derive a logistic growth model for single species population. Solve the model with stability analysis. [L3; CLO2] **03**

2. (a) Suppose the population $p(t)$ is given by the exponential growth law. Growth rate r is positive. Let T be the amount of time required for the starting population p_0 to double. Then show that $T = \frac{\log_e 2}{r}$ which is independent of p_0 . [L2; CLO2] **06**
 (b) How mathematical model can be applied to kidney dialysis process? Describe and formulate an artificial kidney dialysis model and discuss the solution of the model. [L3; CLO2] **04**

3. (a) Explain pharmacokinetics. Describe and formulate a pharmacokinetic model using the following diagram. Solve the model with all possible equilibrium points and stability analysis. [L2; CLO3] **06**

- (b) A symbiotic linear model can be formulated by the following governing equations. **04**

$$\frac{dx}{dt} = -x + 2y, \frac{dy}{dt} = 2x - y$$

where $x(0) = 100$ and $y(0) = 300$. Check the nature of stability at $(0,0)$. Determine the populations $(x(t), y(t))$ at all future times t . What will be the populations after six months? When will the species y be eliminated? [L3; CLO3]

4. (a) State and explain two species Lotka-Volterra competition model. [L1; CLO4] **05**
 (b) What is traffic flow? What are the objectives of traffic flow modeling. Numerically solve the LWR (Lighthill, Whitham and Richards) traffic flow model $\frac{\partial \rho}{\partial t} + \frac{\partial(\rho v)}{\partial x} = 0$, $v = v(\rho)$. Given, Initial conditions: $\rho(x, 0) = \rho_0(x)$ and Boundary conditions: $\rho(0, t) = \alpha$, $\rho(L, t) = \beta$. [L4; CLO4] **05**

Section-B

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

Marks

- | | | | |
|----|-----|---|----|
| 5. | (a) | Discuss the importance of discrete model. Construct an SIR type continuous model of disease dynamics. Convert this continuous model in the form of difference equation and solve with stability analysis. [L2; CLO5] | 06 |
| | (b) | Suppose “bugbox” is a simple computer simulation for structured population and it functions as a biology lab for a virtual world . For this “bugbox” model, let L_t be the number of larvae at time t , J_t be the number of juveniles at time t and A_t be the number of adults at time t . Formulate a structured population model and discuss the solution of the model with stability analysis. [L4; CLO5] | 04 |
| 6. | | Consider the pre-predator model with functional response $\frac{dx}{dt} = rx \left(1 - \frac{x}{k}\right) - bxy$, $\frac{dy}{dt} = cxy - dy$, where x is pray and y is predator. Examine the positivity and analyze its stability. [L3; CLO6] | 10 |
| 7. | | Discuss different <i>force of infections</i> in case of disease transmission. An SIRS epidemic model with nonlinear saturated incident rate can be constructed as $\frac{dS}{dt} = (1-p)A - \frac{\beta SI}{1+\alpha I} - dS + \gamma R$, $\frac{dI}{dt} = pA + \frac{\beta SI}{1+\alpha I} - (d+m)I$, $\frac{dR}{dt} = mI - (d+\gamma)R$, where $(1-p)A$ and pA are the constant recruitments of S and I individuals. Describe the model with a schematic diagram. Find the equilibrium points and test the stability at disease free equilibrium point. Explain basic reproduction number. [L5; CLO5] | 10 |
| 8. | | Consider two different types of foodstuffs, say, F_1 and F_2 . Assume that these foodstuffs contain vitamins V_1 , V_2 and V_3 respectively. Minimum daily requirements of these vitamins are 1mg of V_1 , 50mg of V_2 and 10mg of V_3 . Suppose that the foodstuffs F_1 contains 1mg of V_1 , 100mg of V_2 and 10mg of V_3 , whereas foodstuffs F_2 contains 1mg of V_1 , 10mg of V_2 and 100mg of V_3 . Cost of one unit of foodstuffs F_1 is \$1 and that of F_2 is \$1.5. Formulate a linear programming model to find the minimum cost diet that would supply the body at least minimum requirements of each vitamin. [L3; CLO6] | 10 |

***** THE END *****

Khulna University
 Science, Engineering and Technology School
 Discipline: **Mathematics**, Program: **B.Sc. (Hons.)**
 Year: **Fourth**, Term: **I** Examination-2026; Session: **2024-2025**
 Course Code: **Math-3207**
 Course Title: **Mechanics**
 Total Marks: **60**, Time: **03** Hours, Credit: **03**



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- Use separate answer script for each section.

Section-A

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

Marks

- | | | | |
|----|-----|---|-----------|
| 1. | (a) | Derive the equation of line of action of the resultant of a system of forces in one plane. Also write the condition equilibrium of that system of coplanar forces. | 05 |
| | (b) | State and prove the principle of virtual work for any system of forces in one plane. | 05 |
| 2. | (a) | Find the centre of gravity of a lamina in the shape of a quadrant of the curve $(x/a)^{2/3} + (y/a)^{2/3} = 1$, the density being given by $\rho = kxy$. | 05 |
| | (b) | Two equal uniform rods are firmly joined at one end so that the angle between them is α and they rest on a vertical plane on a smooth sphere of radius r . Show that they are in stable or unstable equilibrium according as the length of either rod is $\leq$ or $\geq 4r \cos \alpha$. | 05 |
| 3. | (a) | State the conditions of equilibrium of a system of coplanar forces and derive the equation of the line of action of the resultant. | 05 |
| | (b) | A string of length a form the shorter diagonal of a rhombus of four uniform rods, each of length b and weight w which are hinged together. If one of the rods be supported in a horizontal position, prove that the torsion in the string is $2w(2b^2 - a^2)/b\sqrt{4b^2 - a^2}$. | 05 |
| 4. | (a) | Find the center of gravity of the area of the astroid $x^{2/3} + y^{2/3} = a^{2/3}$ lying in the first quadrant. | 05 |
| | (b) | Find the centroid of the arc of the cycloid $x = a(\theta - \sin \theta)$ and $y = a(1 - \cos \theta)$ which lies in the positive quadrant. | 05 |

Section-B

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

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|----|-----|---|-----------|
| 5. | (a) | A particle moves in a straight line OA with an acceleration, which is always directed towards O and varies inversely as the square of its distance from O . If initially the particle were at rest at A , then find the motion. | 05 |
| | (b) | Find the velocity and acceleration of a particle along and perpendicular to the radius vector from a fixed origin. | 05 |
| 6. | (a) | A particle is projected under gravity and a resistance equal to mk (velocity) with a velocity u at an angle α to the horizon. Find the motion. | 05 |
| | (b) | Find the law of force for a moving particle towards the pole through the curve that can be described as the equation $r = a \cos \theta$. | 05 |
| 7. | (a) | A particle rests in equilibrium under the attraction of two centres of force which attract directly as the distance, their attraction per unit of mass at unit distance being μ and μ' , is slightly displaced towards one of them, show that the time of a small oscillation is $2\pi/\sqrt{\mu + \mu'}$. | 05 |
| | (b) | A particle moves with a central acceleration $\mu(r + a^4/r^3)$ being projected from an apse at a distance a with a velocity $2\sqrt{k/a}$. Show that it describes the curve $r^2(z + \cos \sqrt{3} v) = 3a^2$. | 05 |
| 8. | (a) | Show that the momental ellipsoid at the centre of a solid ellipsoid is $(b^2 + c^2)x^2 + (c^2 + a^2)y^2 + (a^2 + b^2)z^2 = \text{constant}$. | 05 |
| | (b) | Show that the equation of the momental ellipsoid at the corner of a cube of side $2a$ referred to its principal axis is $2x^2 + 11(y^2 + z^2) = c$, where c is a constant. | 05 |

***** THE END *****

Khulna University
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 Discipline: **Mathematics**, Program: **B.Sc. (Hons.)**
 Year: **Fourth**, Term: **I** Examination-2026; Session: **2024-2025**
 Course Code: **Math-4207**
 Course Title: **Graph Theory**
 Total Marks: **60**, Time: **03** Hours, Credit: **03**



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- Use separate answer script for each section.

Section-A

There are FOUR questions in this section. Answer any THREE questions		Marks
1. (a)	Define simple graph. Draw a simple graph and a non-simple graph without a loop with six vertices and nine edges.	03
(b)	Describe the ko'nigsberg bridge problem and utilities problem.	04
(c)	Show that the number of vertices of odd degree in a graph is always even.	03
2. (a)	Explain graph isomorphism. How can you check if two graphs are isomorphic?	03
(b)	Prove that a simple graph with n vertices and k components have at most $\frac{(n-k)(n-k+1)}{2}$ edges.	04
(c)	Explain Hamiltonian path and Hamiltonian circuit.	03
3. (a)	Define rooted tree and binary tree. Show that a tree in which its diameter is not equal to twofold the radius? Under what condition does this inequality hold? Elaborate.	05
(b)	Define spanning tree. Prove that every connected graph has at least one spanning tree.	05
4. (a)	What is planar graph? Explain it with figures.	02
(b)	State and prove Euler theorem for planar graph.	04
(c)	Show that, with respect to a spanning tree T , a chord c that defines a fundamental circuit C appears in every fundamental cut-set associated with the branches of T that belong to C , and in no other fundamental cut-set.	04

Section-B

There are FOUR questions in this section. Answer any THREE questions		
5. (a)	Define vector space associated with a graph.	02
(b)	Prove that the ring sum of any two circuits in a graph is either a circuit or an edge-disjoint union of circuits.	04
(c)	Show that the set consisting of all the cut-sets and the edge-disjoint unions of cut-sets (including the null set $\emptyset$) in a graph G forms an abelian group under the ring sum operation.	04
6. (a)	Define incidence matrix and circuit matrix. Write their properties.	06
(b)	Find the rank of the circuit matrix of a connected graph G with n vertices and e edges.	04
7. (a)	Prove that a graph with at least one edge is 2- chromatic if and only if it has no circuits of odd length.	05
(b)	Prove that a graph of n vertices is a complete graph if and only if its chromatic polynomial is $P_n(\lambda) = \lambda(\lambda-1)(\lambda-2)\dots(\lambda-n+1)$.	05
8. (a)	What is digraph? Discuss it with figures.	03
(b)	Explain different types of digraphs and show their relation with binary relation.	04
(c)	Compare the directed and undirected versions of the fundamental circuit matrix in terms of structure and physical meaning.	03

***** THE END *****

Khulna University
 Science, Engineering and Technology School
 Discipline: **Mathematics**, Program: **B.Sc. (Hons.)**
 Year: **Fourth** Term: **I** Examination-2026; Session: **2024-2025**
 Course Code: **Math-4105**



Course Title: **Hydrodynamics**

Total Marks: **60**, Time: **03** Hours, Credit: **03**

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Section-A

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

		Marks
1.	(a) Define streamline and path line. State and prove Bernoulli's theorem for compressible fluid.	05
	(b) Derive the continuity equation for incompressible and compressible fluids in vector form	05
2.	(a) Define complex potential. Find the complex potential for the streaming motion flow past an elliptic cylinder, the stream U making an angle α with the real axis.	05
	(b) Show that the velocity potential $\phi = \frac{1}{2}a(x^2 + y^2 - 2z^2)$ satisfies Laplace's equation. Also determine the streamlines.	05
3.	(a) Established the equation of motion for inviscid fluid in the form; $\frac{dq}{dt} - q \wedge (\nabla \wedge q) = F - \frac{1}{\rho} \nabla p - \frac{1}{2} \nabla q^2.$	05
	(b) Show that $u = \frac{-2xyz}{(x^2 + y^2)^2}$, $v = \frac{(x^2 - y^2)z}{(x^2 + y^2)^2}$, $w = \frac{y}{x^2 + y^2}$ are the velocity components of the possible fluid motion. Is this motion irrotational?	05
4.	(a) Derive the acceleration of a fluid particle in a Cartesian coordinate system.	05
	(b) Prove that the velocity function $\psi = U(r + \frac{a^2}{r}) \cos \theta$ represents a streaming motion past a fixed circular cylinder.	05

Section-B

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

5.	(a) Define source and sink with geometrical configuration. Find the complex potential for equal source and sink in a stream.	05
	(b) Two sources of strength m are placed at the points $(a,0)$ and $(-a,0)$ and the sink of strength $2m$ is placed at the origin, show that $(x^2 + y^2)^2 = a^2(x^2 - y^2 + 2\lambda xy)$ where λ is the variable parameter.	05
6.	(a) Define vortex line. Find the necessary and sufficient condition that vortex lines may be at right angles to streamlines.	05
	(b) A vortex pair is situated within a cylinder. Show that it will remain at rest if the distance of either from the center is given by $(\sqrt{5} - 2)^{1/2}a$, where a is the radius of the cylinder.	05
7.	(a) State and prove circle theorem.	05
	(b) Find the center of pressure of a triangular area, the depth of whose vertices are α, β, γ from the free surface.	05
8.	(a) Find the center of pressure of a triangular area whose one vertex is on the free surface.	05
	(b) Define stagnation point. Prove that a streamline is divided into two branches at the point of stagnation and perpendicular to each other when the motion is irrotational.	05

***** THE END *****

Khulna University
Science, Engineering and Technology School
Discipline: Mathematics, Program: B.Sc. (Hons.)
Year: Fourth, Term: I Examination-2026; Session: 2024-2025
Course Code: 0541 12 Math 4113
Course Title: Special Functions
Total Marks: 60, Time: 03 Hours, Credit: 03



- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate answer script for each section.

Section-A

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

1. (a) If $P_m(x)$ and $P_n(x)$ are Legendre polynomials, then prove that **05**

$$\int_{-1}^1 P_m(x) P_n(x) dx = \begin{cases} 0 & \text{if } m \neq n \\ \frac{2}{2n+1} & \text{if } m = n \end{cases} \text{ [L1; CLO1]}$$

 (b) Show that $P_n(x) = \frac{1}{\pi} \int_0^\pi [x \pm \sqrt{x^2 - 1} \cos \phi]^n d\phi$, where $P_n(x)$ is the Legendre polynomial. **05**
 [L3; CLO1]
2. (a) What is the generating function of Bessel function and establish it? **05**
 [L2; CLO2]
 (b) If $J_n(x)$ is the Bessel function then show that **05**
 $(i) \frac{d}{dx} [x^n J_n(x)] = x^n J_{n-1}(x), (ii) \frac{d}{dx} [x^{-n} J_n(x)] = -x^{-n} J_{n+1}(x).$ **05**
 [L5; CLO2]
3. (a) Write the Legendre, Bessel, Chebyshev, Hermite, Legendre and Hypergeometric differential equations. **04**
 [L2; CLO1]
 (b) Expand $x^4 - 3x^2 + x$ in a series of the form $f(x) = \sum C_r P_r(x)$. **03**
 [L3; CLO2]
 (c) Use the generating function to show that $J_n(-x) = (-1)^n J_n(x)$. **03**
 [L4; CLO3]
4. (a) If $J_n(x)$ is the Bessel function of order n , then prove that **05**
 $(i) J'_n(x) = \frac{1}{2} \{J_{n-1}(x) - J_{n+1}(x)\}, (ii) J_n(x) = \frac{x}{2n} \{J_{n-1}(x) + J_{n+1}(x)\}.$ **05**
 [L5; CLO1]
 (b) State and prove Laplace's first definite integral for Legendre Polynomials. **05**
 [L5; CLO1]

Section-B

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

5. (a) Define Laguerre polynomial of order n . Prove that $L_n(x) = \frac{e^x}{n!} \frac{d^n}{dx^n} (x^n e^{-x})$. Hence **05**
 find $L_0(x), L_1(x), L_2(x)$ and $L_3(x)$. **05**
 [L5; CLO4]
 (b) Prove that $(n+1)L_{n+1}(x) = (2n+1-x)L_n(x) - nL_{n-1}(x)$. **05**
 [L5; CLO4]
6. (a) State and prove Rodrigues formula for the Hermite polynomials $H_n(x)$. **05**
 [L3; CLO5]
 (b) Prove that $P_n(x) = \frac{2}{\sqrt{\pi} n!} \int_0^\infty t^n e^{-t^2} H_n(xt) dt$ where $P_n(x)$ is the Legendre polynomials and $H_n(x)$ is the Hermite polynomials. **05**
 [L5; CLO5]
7. (a) Derive integral representation of hypergeometric function. **05**
 [L3; CLO4]
 (b) What is confluent hypergeometric function? Show that for Legendre polynomial, **05**
 $P_n(x) = {}_2F_1(-n, n+1; 1; \frac{1-x}{2}).$ **05**
 [L2; CLO4]
8. (a) Express $H(x) = x^4 + 2x^3 + 2x^2 - x - 3$ in terms of Hermite's polynomials. **05**
 [L4; CLO6]
 (b) For the hypergeometric function prove the Gauss's theorem $F(\alpha, \beta, \gamma, 1) = \frac{\Gamma(\gamma)\Gamma(\gamma-\beta-\alpha)}{\Gamma(\gamma-\alpha)\Gamma(\gamma-\beta)}$. **05**
 [L3; CLO5]

***** THE END *****

*Levels of Bloom's cognitive domain:

[L1=Remember; L2=Understand; L3=Apply; L4=Analyze; L5=Evaluate; L6=Create]

Khulna University
 Science, Engineering and Technology School
 Discipline: **Mathematics**, Program: **B.Sc. (Hons.)**
 Year: **Fourth**, Term: **I** Examination-2026; Session: **2024-2025**
 Course Code: **BA-2161**
 Course Title: **Accounting**
 Total Marks: **60**, Time: **03** Hours, Credit: **03**



- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate answer script for each section.

Section-A

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

1. (a) Define Accounting. What are the features of a transaction? Explain. **05**
 (b) Discuss the importance of financial accounting. **05**
2. (a) The terms debit and credit mean increase and decrease, respectively. Is this true? Explain why or why not. **03**
 (b) Transaction data for Royale Real Estate Agency are presented as follows. **07**
 Oct. 1- James Royale begins business as a real estate agent with a cash investment of \$17,000.
 Oct. 2- Hires an administrative assistant.
 Oct. 3- Purchases office furniture for \$1,900, on account.
 Oct. 6- Sells a house and lot for C. Rouse; bills C. Rouse \$3,800 for realty services performed.
 Oct. 27- Pays \$1,300 on the balance related to the transaction of October 3.
 Oct. 30- Pays the administrative assistant \$2,500 in salary for October.

Journalize the transactions.

3. From the following ending ledger balance of Shopmart Pty Ltd. for the month of April 2023, prepare a trial balance. **10**

Account Title	Balance in Taka	Account Title	Balance in Taka
Cash	2,00,000	Rent Expense	60,000
Prepaid Salary	1,00,000	Books and Stationaries	50,000
Unearned revenue	2,00,000	Accumulated Depreciation	50,000
Service Revenue	3,00,000	Depreciation Expense	20,000
Owner's Equity	11,30,000	Accounts Payable	1,04,000
Accounts Receivable	5,00,000	Interest Payable	40,000
Bank Loan	4,00,000	Land	8,00,000
Furniture	3,00,000	Prepaid Insurance	60,000
Salary Expense	1,50,000	Interest Income	20,000
Interest Expense	4,000		

4. Write short note on the following topics: **10**
 (a) Income statement, (b) Prepaid expense, (c) Accumulated depreciation, and
 (d) Accounts Receivable.

Section-B

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

5. (a) What is depreciation? Why do companies use Declining Balance method of depreciation? **04**
- (b) A Company purchased a new machine on January 1, 2022, at a cost of Tk. 11,00,000. The company estimated that the machine would have a salvage value of Tk. 1,00,000 at the end of its 5-year life. Compute the depreciation expense under the following methods for the five years. **06**
- i). Straight-line.
- ii). Declining-balance using double the straight-line rate.
6. The following data relate to the manufacture of a standard product during a four-week period ending June 30, 2013: **10**
- Raw materials consumed \$ 8000
- Wages \$ 12000
- Machine hours worked 2000
- Machine hour rate \$ 0.50
- Office overhead @ 20% on works cost
- Selling overhead per unit \$ 0.06
- Units produced 40000
- Units sold (at \$ 1 per unit) 36000
- Prepare a cost sheet showing the cost per unit and profit for the period.
7. (a) "The total fixed cost doesn't change with activity change, but total variable cost changes with activity change. Per unit fixed cost changes with activity change, but per unit variable cost is fixed". –Explain this statement. **05**
- (b) Mauro Products distributes a single product, a woven basket whose selling price is \$15 per unit and whose variable expense is \$12 per unit. The company's monthly fixed expense is \$4,200. Calculate the company's break-even point in unit sales and in dollar sales. **05**
8. Write short notes on: **10**
- (a) Fair Value Principle, (b) Manufacturing Overhead Cost, (c) Economic Entity Assumption, and (d) Indirect Materials.

***** THE END *****

Khulna University
 Science, Engineering and Technology School
 Discipline: **Mathematics**, Program: **B.Sc. (Hons.)**
 Year: **Fourth**, Term: **I** Examination-2026; Session: **2024-2025**
 Course Code: **Math-3205**
 Course Title: **Complex Analysis**
 Total Marks: **60**, Time: **03** Hours, Credit: **03**



- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate answer script for each section.

Section-A

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

- | | | |
|----|---|----|
| 1. | (a) Define analytic function. State and prove Cauchy-Riemann equation. | 05 |
| | (b) Define harmonic function. Show that $u = xe^x \cos y - ye^x \sin y$ is harmonic. Find its conjugate harmonic function v and express $w = u + iv$ as an analytic function of z . | 05 |
| 2. | (a) Find the name of the singularities of the following function $f(z) = (z^2 + 1)^{\frac{1}{2}} \ln z \frac{z^2-1}{z+1} e^{z-3}$. | 04 |
| | (b) State and prove Laurent's theorem on the expansion of a function $f(z)$. How is Laurent's series converted to a Taylor's series? | 06 |
| 3. | (a) Define line integration. Evaluate $\int_{(0,3)}^{(2,4)} (2y + x^2)dx + (3x - y)dy$ along (i) the parabola $x = 2t, y = t^2 + 3$ (ii) a straight line from $(0, 3)$ to $(2, 4)$. | 05 |
| | (b) State and prove Cauchy's integral formula for 1 st derivative. | 05 |
| 4. | (a) State and prove Taylor's theorem on the expansion of a function $f(z)$ in a series. Expand $f(z) = \log(1 + z)$ in a Taylor's series about $z = 0$. | 05 |
| | (b) Expand $f(z) = \frac{z}{(z-1)(2-z)}$ in a Laurent's series valid for (i) $ z < 1$ and (ii) $ z - 1 > 1$. | 05 |

Section-B

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

- | | | |
|----|---|----|
| 5. | (a) Test the convergency of the series $\sum_1^{\infty} \frac{(z+2)^{n-1}}{(n+1)^3 4^n}$ and find also the region of convergency. | 05 |
| | (b) Define residue of a complex function and how to find it? State residue theorem. | 05 |
| 6. | (a) Evaluate the contour integration $\int_0^{2\pi} \frac{\cos 3\theta}{5 - 4 \cos \theta} d\theta$ | 05 |
| | (b) Show that a bilinear transformation is the combination of translation, rotation, stretching and inversion. | 05 |
| 7. | (a) If a is a pole of $f(z)$ of order m , then show that, $Res(t=a) = a_{-1} = \frac{1}{(m-1)!} \lim_{z \rightarrow a} \frac{d^{m-1}}{dz^{m-1}} [(z-a)^m f(z)]$ | 05 |
| | (b) Using residue theorem evaluate $\oint_C \frac{(4-3z)}{z(z-1)(z-2)} dz$ where C is the circle $ z = \frac{3}{2}$ | 05 |
| 8. | (a) Write the name of the general transformations with examples. Define bilinear transformation. Write the properties of bilinear transformation. | 05 |
| | (b) Define cross ratio of 4 points. Find a bilinear transformation which maps $1, i, -1$ into w plane $i, 0, -i$ | 05 |

***** THE END *****

Khulna University
 Science, Engineering and Technology School
 Discipline: **Mathematics**, Program: **B.Sc. (Hons.)**
 Year: **Fourth** Term: **I** Examination-2026; Session: **2024-2025**
 Course Code: **Math-4107**



Course Title: **Differential Geometry**

Total Marks: **60**, Time: **03** Hours, Credit: **03**

- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate answer script for each section.

Section-A

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

		Marks
1.	(a) Define the contact of n -th order between a curve and a surface in parametric form.	03
	(b) Show that a curve and a surface have contact of order 2 <i>iff</i> the curve lies in the tangent plane of the surface at the point.	03
	(c) Find the length of the curve given as the intersection of the surfaces $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$, $x = \cosh\left(\frac{z}{a}\right)$ from the point $(a, 0, 0)$ to (x, y, z) .	04
2.	(a) Show that if a curve is given in terms of a general parameter u , then equation of the osculating plane is $[R - r, \dot{r}, \ddot{r}] = 0$	03
	(b) Define contact of n^{th} order of a curve and a surface and find the conditions for this type of contact.	03
	(c) Find the lines that have four point contact at $(0,0,1)$ with the surface $x^4 + 3xyz + x^2 - y^2 - z^2 + 2yz - 3xy - 2y + 2z = 1$	04
3.	(a) Describe the unit vectors $\mathbf{t}$, $\mathbf{n}$, $\mathbf{b}$ and fundamental planes.	03
	(b) Determine the direction of the principal normal and the bi-normal.	02
	(c) State and explain the Serret-Frennet's formula.	05
4.	(a) Find Curvature and Torsion of a curve for both $r = f(u)$ and $r = f(s)$	05
	(b) If C is a curve for which b varies differentially with arc length. Then to show that a necessary and sufficient condition that C is a plane curve is that $\tau = 0$ at all points.	05

Section-B

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

5.	(a) Estimate the equations of a circular helix. A curve is drawn on a parabolic cylinder to cut all the generators at the same angle. Find an expression for the curvature and torsion.	05
	(b) Show that the curvature of the helix $x = a \cos \theta$, $y = a \sin \theta$, $z = a\theta \tan \alpha$ is $\frac{\cos^2 \alpha}{a}$, also estimate the torsion.	05
6.	(a) What is intrinsic equation?	02
	(b) State and prove the fundamental theorem of space curves.	04
	(c) Write the properties of Bertrand curves.	04
7.	(a) Derive the equation of evolute. Also evaluate the curvature and torsion of evolute.	05
	(b) Find the center and radius of circle of curvature.	05
8.	(a) Define the spherical indicatrix (Spherical image) of the tangent.	02
	(b) Deduce the curvature and torsion of the spherical indicatrix of Tangent.	04
	(c) Describe the two important properties of the first fundamental form of metric.	04

***** THE END *****

Khulna University
 Science, Engineering and Technology School
 Discipline: **Mathematics**, Program: **B.Sc. (Hons.)**
 Year: **Fourth**, Term: **I** Examination-2026; Session: **2024-2025**
 Course Code: **0541 12 Math 4101**
 Course Title: **Hydrodynamics and Hydrostatics**
 Total Marks: **60**, Time: **03** Hours, Credit: **03**



- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate answer script for each section.

Section-A

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

- | | | | |
|----|-----|--|-----------|
| 1. | (a) | Define stream tube, stream filament, rotational and irrotational flow. Distinguish between stream lines and path lines. [L4; CLO1] | 05 |
| | (b) | Derive a relation between local and individual rates of changes. Also briefly discuss about velocity potential or velocity function. [L5; CLO1] | 05 |
| 2. | (a) | Given the velocity components: $u = \frac{ax - by}{x^2 + y^2}, v = \frac{ay + bx}{x^2 + y^2}, w = 0$. Explain these components for a possible fluid flow. Also test its rotationality. [L4; CLO2] | 04 |
| | (b) | Deduce the equation of conservation of mass of fluid. If $q = -i(3y^2) - j(6x)$, determine the stream lines at (1, 1). [L5; CLO1] | 06 |
| 3. | (a) | State and prove Bernoulli's theorem for steady motion of an inviscid fluid. [L5; CLO2] | 05 |
| | (b) | Derive Euler's equation of motion in the form $\frac{\partial q}{\partial t} + \frac{1}{2} \nabla q^2 - q \times \text{curl} q = F - \frac{1}{\rho} \nabla p$. [L5; CLO2] | 05 |
| 4. | (a) | Find the expression to the complex potential for the streaming motion past an ellipse in terms of the elliptic co-ordinates and hence find the stream function. [L6; CLO3] | 05 |
| | (b) | Prove that the velocity function $\psi = U(r + \frac{a^2}{r}) \cos \theta$ represents a streaming motion past a fixed circular cylinder. [L6; CLO3] | 05 |

Section-B

- There are **FOUR** questions in this section. Answer any **THREE** questions
- | | Marks |
|--|-------|
| 5. (a) Define source and sink. What are the values of velocity, stream function and velocity potential at the sink and source. Find the stream function if a source is in a uniform stream. [L1; CLO3] | 05 |
| (b) What is doublet? Derive the complex potential due to a doublet. [L5; CLO2,3] | 05 |
| 6. (a) State and prove Blasius theorem. [L5; CLO3] | 05 |
| (b) Discuss the motion represented by $W = \frac{1}{2}U \frac{a^3}{z^2}$, and show that the stream lines are lemniscates. [L5; CLO3] | 05 |
| 7. (a) Find the strength of a circular vortex. Show that the circulation can be considered as the measure of velocity potential around a closed circuit. [L2; CLO4] | 05 |
| (b) Calculate the circulation of the velocity field $\vec{q} = \frac{-yi + xj}{x^2 + y^2}$ round a square with corners (1, 0), (2, 0), (2, 1) and (1, 1). [L4; CLO4] | 05 |
| 8. (a) Find the center of pressure of a triangular area, the depth of whose vertices are α, β, γ from the free surface. [L5; CLO4] | 05 |
| (b) A regular hexagon is immersed in a liquid with one side in the surface. Show that the depth of its centre of pressure is to that of its centre of gravity as 23:18. [L6; CLO4] | 05 |

***** THE END *****

Khulna University
 Science, Engineering and Technology School
 Discipline: **Mathematics**, Program: **B.Sc. (Hons.)**
 Year: **Fourth**, Term: **I** Examination-2026; Session: **2024-2025**
 Course Code: **Math-3111**
 Course Title: **Axiomatic Geometry**
 Total Marks: **60**, Time: **03** Hours, Credit: **03**



- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate answer script for each section.

Section-A

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

Marks

- | | | | |
|----|-----|--|----|
| 1. | (a) | Define abstract geometry and unit sphere and great circle. Prove that the set of great circles on S^2 is an abstract geometry. | 05 |
| | (b) | Define incidence geometry. Prove that the Cartesian plane is an incidence geometry. | 05 |
| 2. | (a) | Show by example that there are (at least) three non-collinear points in the Cartesian Plane. | 05 |
| | (b) | Show that the taxicab distance is a distance function on $\mathbb{R}^2$. | 05 |
| 3. | (a) | Consider $d_{\mathbb{H}}$ is a distance function for the Poincare Plane, prove that $\{\mathbb{H}, \mathcal{L}_{\mathbb{H}}, d_{\mathbb{H}}\}$ is a metric geometry. | 07 |
| | (b) | If $A = (4,7)$, $B = (1,1)$ and $C = (2,3)$, prove that $A - C - B$ in the Taxicab plane. | 03 |
| 4. | (a) | In a metric geometry, show that B is the only extreme point of $\angle ABC$. | 06 |
| | (b) | If A and B are distinct points in a metric geometry then there exists a point C with $A - C - B$ or $A - B - C$. | 04 |

Section-B

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

- | | | | |
|----|-----|--|----|
| 5. | (a) | Define betweenness. Let $A = \left(-\frac{1}{2}, \frac{\sqrt{3}}{2}\right)$, $B = (0,1)$ and $C = \left(\frac{1}{2}, \frac{\sqrt{3}}{2}\right)$ be points in the Poincare plane. Prove that $A - B - C$. | 05 |
| | (b) | Define congruent. In the Poincare plane let $A = (0,2)$, $B = (0,1)$, $P = (0,4)$, $Q = (7,3)$. Find $C \in \overline{AB}$ so that $\overline{AC} \simeq \overline{PQ}$. | 05 |
| 6. | (a) | Consider, L_{AB} is a Cartesian line then show that $f: L_{AB} \rightarrow \mathbb{R}$ defined by $f(A + t(B - A)) = t B - A $ is a ruler for $\mathbb{R}^2, \mathcal{L}_E, d_E$. | 04 |
| | (b) | Consider, l be a line in metric geometry with plane separation axiom and H_1 is a half plane determined by the line l . If H_1 is also a half plane determined by the line $\hat{l}$, then prove that $l = \hat{l}$. | 06 |
| 7. | (a) | Verify that the Euclidean Plane satisfies plane separation axiom. | 07 |
| | (b) | If a metric geometry satisfies plane separation axiom, then show that it also satisfies Pash's Postulate. | 03 |
| 8. | (a) | Show that $m_E(\angle ABC) = \cos^{-1} \left(\frac{\langle A-B, C-B \rangle}{ A-B \cdot C-B } \right)$ is an angle measure on $\{\mathbb{R}^2, \mathcal{L}_E, d_E\}$. | 05 |
| | (b) | Prove that neutral geometry satisfies the Side-Side-Side axiom. | 05 |

***** THE END *****

Khulna University
Science, Engineering and Technology School
Discipline: Mathematics, Program: B.Sc. (Hons.)
Year: Fourth, Term: I Examination-2026; Session: 2024-2025
Course Code: Math-1101
Course Title: Algebra and Trigonometry
Total Marks: 60, Time: 03 Hours, Credit: 03



- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate answer script for each section.

Section-A

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

Marks

1. (a) Explain the tautology and Fallacy of two statements. 02
 (b) For any three statements p, q and r , prove that $p \vee (q \wedge r) = (p \vee q) \wedge (p \vee r)$ 04
 (c) If p and q are any two statements, prove that $[(p \Rightarrow q) \wedge (\sim q)] \Rightarrow \sim p$ is a tautology. 04
2. (a) Show that (i) $(1 - a_1)(1 - a_2) \dots (1 - a_n) > 1 - s_n$ and (ii) $(1 + a_1)(1 + a_2) \dots (1 + a_n) > \frac{1}{1 - s_n}$; where $a_1, a_2, a_3, \dots, a_n$ are all positive numbers, less than 1 and $s_n = a_1 + a_2 + a_3 + \dots + a_n$. 06
 (b) Evaluate $(1 - x)(1 - y)(1 - z) > 8xyz$, where x, y, z are positive and $x + y + z = 1$. 04
3. (a) Evaluate the sum of the n terms of the series: $\frac{1}{2.5.8} + \frac{1}{5.8.11} + \frac{1}{8.11.14} + \dots$ 05
 (b) Find the sum of the n terms of the series: $2.4.6^2 + 4.6.8^2 + 6.8.10^2 + \dots$ 05
4. (a) Show that every equation of degree n can't have more than n roots. 03
 (b) State Descartes Rule. Find the nature of the roots of $x^{10} - 4x^6 + x^4 - 2x - 3 = 0$ using Descartes Rule. 03
 (c) The roots of the equation $x^3 - 7x^2 + 14x - 8 = 0$ are in geometric progression. Solve the equation. 04

Section-B

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

5. (a) State and prove De Moivre's theorem. 05
 (b) Derive $\tan^{-1}x = x - \frac{1}{3}x^3 + \frac{1}{5}x^5 - \dots + (-1)^{n-1} \frac{x^{2n-1}}{2n-1} + \dots$ where $-1 \leq x \leq 1$ 05
6. (a) Show that $y = -i \log \tan \left(\frac{ix}{2} + \frac{\pi}{4} \right)$, where $x = \log \tan \left(\frac{\pi}{4} + \frac{y}{2} \right)$. 05
 (b) If $\tan(\alpha + i\beta) = (x + iy)$, where α, β, x, y are all real, then prove that $x^2 + y^2 \cot 2\alpha = 1$. 05
7. (a) Find the sum of the series $1 + n \cos A + \frac{n(n+1)}{2!} \cos 2A + \frac{n(n+1)(n+2)}{3!} \cos 3A + \dots$ 05
 (b) In any spherical triangle, prove that $\sin(B + C) = \frac{\cos b \cos c}{1 + \cos b \cos c}$, when $A = 90^\circ$. 05
8. (a) Write down the Girard's theorem. If in a right spherical triangle $C = \frac{\pi}{2}$, then prove that $\sin a \tan \frac{A}{2} - \sin b \tan \frac{B}{2} = \sin(a - b)$. 05
 (b) What are dual triangles? State and prove the Lhuillier's Formula for spherical plane triangle area. 05

***** THE END *****

Khulna University
 Science, Engineering and Technology School
 Discipline: **Mathematics**, Program: **B.Sc. (Hons.)**
 Year: **Fourth** Term: **I** Examination-2026; Session: **2024-2025**
 Course Code: **Stat-2153**
 Course Title: **Statistics-III**



Total Marks: **60**, Time: **03** Hours, Credit: **03**

- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate answer script for each section.

Section-A

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

		Marks
1.	(a) Define "Experimental Design" and explain the three basic principles: Replication, Randomization, and Local Control.	05
	(b) Distinguish between experimental and non-experimental models in the context of research. Why is randomization considered the "shield" against bias?	05
2.	(a) Define Analysis of Variance (ANOVA). Describe its objectives and underlying assumptions.	05
	(b) Differentiate between between-group variance and within-group variance in ANOVA. Given that the means of 10 individuals in each of 5 groups are 30, 32, 34, 36, and 38 and the estimated variance of a group mean is 3. Construct the analysis of variance.	05
3.	(a) Describe the layout and statistical analysis of a Randomized Block Design (RBD). How does it improve upon the Completely Randomized Design (CRD)?	05
	(b) A researcher wants to compare the yields of 4 varieties of wheat using 5 blocks. Construct a dummy ANOVA table showing the sources of variation and their respective degrees of freedom.	05
4.	(a) Explain the structure of a Latin Square Design (LSD). Under what specific conditions is this design more efficient than an RBD?	05
	(b) What is "Missing Value Analysis"? Describe the procedure (Yates' Method) for estimating one missing observation in an RBD and explain how it affects the degrees of freedom in the ANOVA table.	05

Section-B

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

5.	(a) Define a stochastic process. Classify stochastic processes based on the nature of the state space and parameter space, giving suitable examples for each case.	05
	(b) Define set of random variables. How does it differ from family of random variables?	02
	(c) Consider the following observed sequence of states from a stochastic process:	03

SSRSRSRRRSSRSRSSRS

Assume the process has two states: S and R. (i) Identify all one-step transitions; (ii) Estimate the transition probabilities; (iii) Construct the transition probability matrix.

6.	(a) Define a Markov Chain and the Markov Property. What is a Transition Probability Matrix (TPM), and what are the two necessary properties that every TPM must satisfy?	05
	(b) Distinguish between Transient, Recurrent, and Absorbing states in a Markov Chain. Provide a transition diagram for a simple 3-state chain that contains at least one absorbing state.	05
7.	(a) Define queuing process. Explain its core components and properties.	03
	(b) Define M M 1 model. State the properties of M/M/1 Model	03
	(c) Suppose customers arrive at a service counter at an average rate of $\lambda = 5$ per hour, and the service rate is $\mu = 8$ per hour. The system can be modeled as M M 1. Compute performance measures: (i) Traffic Intensity; (ii) Average number of customers in the system; (iii) Average waiting time in system; (iv) Average number waiting in queue.	04
8.	(a) Define Poisson process. What are the assumptions of Poisson process?	03
	(b) What do you mean by Birth process. How does it differ from death process and Poisson process.	03
	(c) For M/M/1 queuing model, show that average number of customers waiting in the queue is $L_Q = \frac{\lambda^2}{\mu(\mu-\lambda)}$	04

***** THE END *****

Khulna University

Science, Engineering and Technology School

Discipline: **Mathematics**, Program: **B.Sc. (Hons.)**

Year: **Fourth** Term: **I** Examination-2026; Session: **2024-2025**

Course Code: **Math-4113**

Course Title: **Special Functions**

Total Marks: **60**, Time: **03** Hours, Credit: **03**

- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate answer script for each section.



Section-A

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

Marks

1. (a) If $P_m(x)$ and $P_n(x)$ are Legendre polynomials then prove that **05**
- $$\int_{-1}^1 P_m(x) P_n(x) dx = \begin{cases} 0 & \text{if } m \neq n \\ \frac{2}{2n+1} & \text{if } m = n \end{cases}$$
- (b) Show that $(1-2xh+h^2)^{-1/2}$ is a solution of the equation $h \frac{\partial^2}{\partial h^2} (hv) + \frac{\partial}{\partial x} \left\{ (1-x^2) \frac{\partial v}{\partial x} \right\} = 0$ **05**
2. (a) Expand $\sin x$ in a series of Bessel function. **05**
- (b) Show that **05**
- (i) $\frac{d}{dx} [x^n J_n(x)] = x^n J_{n-1}(x)$
- (ii) $\frac{d}{dx} [x^{-n} J_n(x)] = -x^{-n} J_{n+1}(x)$
3. (a) State and prove Rodrigues formula for Legendre polynomials. **05**
- (b) Prove the recurrence formula for Legendre polynomials **05**
- $$(2n+1)xP_n(x) = (n+1)P_{n+1}(x) + nP_{n-1}(x)$$
4. (a) Prove the following generating function of Chebyshev polynomials **05**
- (i) $\frac{1-xt}{1-2xt+t^2} = \sum_{n=0}^{\infty} T_n(x)$ (ii) $\frac{\sqrt{1-x^2}}{1-2xt+t^2} = \sum_{n=0}^{\infty} U_{n+1}(x)$
- (b) Show that $\sum_{r=0}^n T_{2r}(x) = \frac{1}{2} \left[1 + \frac{U_{2n+1}(x)}{\sqrt{1-x^2}} \right]$ **05**

Section-B

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

5. (a) Define Hermite polynomial of order n . Prove that $e^{2xt-t^2} = \sum_{n=0}^{\infty} \frac{H_n(x)t^n}{n!}$, where $H_n(x)$ is Hermite **05**
- polynomials.
- (b) Expand $f(x) = e^{ax}$ in a series of Hermite polynomials. **05**
6. (a) State and prove Rodrigue's formula for the Laguerre polynomials $L_n(x)$. **05**
- (b) Prove that $(n+1)L_{n+1}(x) = (2n+1-x)L_n(x) - nL_{n-1}(x)$ **05**
7. (a) Define Hypergeometric function. If $|x| \leq 1$ and $\gamma > \beta > 0$ then prove that **05**
- $${}_2F_1(\alpha, \beta; \gamma; x) = \frac{\Gamma(\gamma)}{\Gamma(\beta)\Gamma(\gamma-\beta)} = \int_0^1 t^{\beta-1} (1-t)^{\gamma-\beta-1} (1-xt)^{-\alpha} dt$$
- (b) Prove that $P_n(\cos \theta) = \cos^n \theta {}_2F_1\left(-\frac{n}{2}, -\frac{n-1}{2}, 1, -\tan^2 \theta\right)$ **05**
8. (a) Prove that ${}_2F_1(\alpha, \beta; \beta-\alpha+1; -1) = \frac{\Gamma(\beta-\alpha+1)\Gamma(\beta/2+1)}{\Gamma(\beta+1)\Gamma(\beta/2-\alpha+1)}$ **05**
- (b) Expand $f(x) = e^{ax}$ in a series of Hermite polynomials. **05**

***** THE END *****

Khulna University
 Science, Engineering and Technology School
 Discipline: **Mathematics**, Program: **B.Sc. (Hons.)**
 Year: **Fourth**, Term: **I** Examination-2026; Session: **2024-2025**
 Course Code: **0541 12 Math 4111**
 Course Title: **Differential Geometry**
 Total Marks: **60**, Time: **03** Hours, Credit: **03**



- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate answer script for each section.

Section-A

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

- | | | |
|----|---|----|
| 1. | (a) Define functions of class-r and equivalent paths. [L1; CLO1] | 02 |
| | (b) Deduce the formula for the arc length of a curve between two points in vector form. [L4; CLO1] | 04 |
| | (c) Find the arc length of the curve given as the intersection of the surfaces $x^2 + y^2 = a^2$, $z = \tan^{-1}\left(\frac{y}{x}\right)$, from the point $(a, 0, 0)$ to (x, y, z) . [L1; CLO1] | 04 |
| 2. | (a) Define tangent line. [L1; CLO2] | 01 |
| | (b) Show that $\frac{d\vec{r}}{ds}$ is unit tangent vector to a space curve at the point $p(\vec{r})$. [L4; CLO2] | 04 |
| | (c) Obtain the direction cosines of the tangent to the curve of intersection of the surfaces $F_1(x, y, z) = 0$, $F_2(x, y, z) = 0$. [L5; CLO2] | 05 |
| 3. | (a) Define principle normal and bi-normal of space curve. [L1; CLO3] | 02 |
| | (b) Find the equation and the direction of the principle normal and bi-normal of space curve. [L1; CLO3] | 04 |
| | (c) Find the inflexional tangents at (x_1, y_1, z_1) on the surface $y^2z = 4ax$. [L1; CLO3] | 04 |
| 4. | (a) Define the osculating plane of a curve at a point. Find its equation in terms of $\vec{r}'(t)$ and $\vec{r}''(t)$. When does the osculating plane not exist? [L1; CLO2] | 03 |
| | (b) Show that if a curve lies in a plane, its binormal vector $\vec{B}(t)$ is constant. Conversely, if $\vec{B}(t)$ is constant, prove the curve is planar. [L2; CLO2] | 03 |
| | (c) Derive the Frenet-Serret formulas. [L6; CLO2] | 04 |

Section-B

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

- | | | | |
|----|-----|--|----|
| 5. | (a) | Define circular helix. [L1; CLO5] | 01 |
| | (b) | Find the equation of a circular helix. [L1; CLO5] | 04 |
| | (c) | Show that the curvature and torsion of the helix $x = a \cos \theta, y = a \sin \theta, z = a\theta \tan \alpha$ are $\frac{\cos^2 \alpha}{a}$ and $\pm \frac{\sin \alpha \cos \alpha}{a}$, respectively. [L4; CLO5] | 05 |
| | | | |
| 6. | (a) | Define intrinsic equation. [L1; CLO6] | 02 |
| | (b) | State and prove the Uniqueness theorem for space curves. [L5; CLO6] | 04 |
| | (c) | Obtain the curvature κ_1 and torsion τ_1 of the involute. [L5; CLO6] | 04 |
| | | | |
| 7. | (a) | Define the circle of curvature for a space curve at a point where curvature $\kappa > 0$. Explain why the circle of curvature lies in the osculating plane and has radius $\frac{1}{\kappa}$. Why is it unique? [L1; CLO1] | 03 |
| | (b) | Define the spherical indicatrix of the binormal $\mathbf{B}(s)$. Also, deduce the curvature and torsion of the spherical indicatrix of binormal. [L1; CLO2] | 03 |
| | (c) | Find a unit normal vector to the surface $2xz^2 - 3xy - 4x = 7$ at the point $(1, -1, 2)$. [L1; CLO7] | 04 |
| | | | |
| 8. | (a) | Explain that the first fundamental form is a quadratic form that measures arc length on the surface. Why is it called a “metric”? [L3; CLO4] | 03 |
| | (b) | Compute the first fundamental form for the surface $\mathbf{r}(u, v) = (u \cos v, u \sin v, u^2)$ at a general point (u, v) . [L3; CLO4] | 04 |
| | (c) | Show that the curve bisecting the angles between the parametric curves are given by $Edu^2 - Gdv^2 = 0$. [L4; CLO8] | 03 |

***** THE END *****

Khulna University
 Science, Engineering and Technology School
 Discipline: **Mathematics**, Program: **B.Sc. (Hons.)**
 Year: **Fourth**, Term: **I** Examination-2026; Session: **2024-2025**
 Course Code: **Math-2101**
 Course Title: **Vector Analysis**
 Total Marks: **60**, Time: **03** Hours, Credit: **03**



- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate answer script for each section.

Section-A

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

1. (a) Determine the angles α, β, γ that the vector $\mathbf{r} = x\mathbf{i} + y\mathbf{j} + z\mathbf{k}$ makes with the positive directions of the coordinate axes and show that, $\sin^2\alpha + \sin^2\beta + \sin^2\gamma = 2$ **05**
 (b) Prove that the diagonals of a parallelogram bisect each other. **03**
 (c) If $\vec{a} = (2, 1, -1)$, $\vec{b} = (1, -1, 0)$, $\vec{c} = (5, -1, 1)$, find the unit vector parallel to $\vec{a} + \vec{b} - \vec{c}$, but in the opposite direction. **02**

2. (a) Determine a unit vector perpendicular to the plane of $\mathbf{A} = 2\mathbf{i} - 6\mathbf{j} - 3\mathbf{k}$; $\mathbf{B} = 4\mathbf{i} + 3\mathbf{j} - \mathbf{k}$. **02**
 (b) Show that the vectors $\mathbf{A} = -\mathbf{i} + \mathbf{j}$, $\mathbf{B} = -\mathbf{i} - \mathbf{j} - 2\mathbf{k}$, $\mathbf{C} = 2\mathbf{j} + 2\mathbf{k}$ form a right triangle. **03**
 (c) Find the directional derivative of $P = 4e^{2x-y+z}$ at the point $(1, 1, -1)$ in a direction of $\mathbf{A} = -3\mathbf{i} + 5\mathbf{j} + 6\mathbf{k}$. In what direction the directional derivative is maximum? What is the magnitude of the maximum? **05**

3. (a) Explain gradient, divergence, and curl. **05**
 (b) Suppose $\phi(x, y, z) = xy^2z$ and $\mathbf{A} = xz\mathbf{i} - xy^2\mathbf{j} + yz^2\mathbf{k}$. Find $\frac{\partial^3}{\partial x^2 \partial z} (\phi \mathbf{A})$ at the point $(2, -1, 1)$. **05**

4. (a) Prove that, $\nabla r^n = nr^{n-2} \mathbf{r}$. **05**
 (b) Prove that $\vec{\nabla} \times (\vec{\nabla} \times \vec{A}) = -\nabla^2 \vec{A} + \vec{\nabla} (\vec{\nabla} \cdot \vec{A})$. **05**

Section-B

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

5. (a) State Divergence theorem. Justify the Divergence theorem for $\vec{F} = (x + y^2)\hat{i} - 2x\hat{j} + 2yz\hat{k}$ and the volume of a tetrahedron bounded by the coordinate planes and the plane $2x + y + 2z = 6$. 05
- (b) State Stoke's theorem. Verify Stoke's theorem for $\vec{A} = (2x - y)\hat{i} - yz^2\hat{j} - y^2z\hat{k}$, where S is the upper half surface of the sphere $x^2 + y^2 + z^2 = 1$ and C is its boundary. 05
6. (a) Find the volume of the region common to the intersecting cylinders $x^2 + y^2 = a^2$ and $x^2 + z^2 = a^2$. 05
- (b) Prove that in any orthogonal curvilinear co-ordinate system $\text{div}(\text{curl } \vec{F}) = 0$ and $\text{curl}(\text{grad } f) = 0$. 05
7. (a) Verify the divergence theorem for $\vec{A} = 4x\hat{i} - 2y^2\hat{j} + z^2\hat{k}$ taken over the region bounded by $x^2 + y^2 = 4$, $z = 0$, and $z = 3$. 05
- (b) Prove Green's theorem in the plane where C is a closed curve which has the property that any straight line parallel to the coordinate axes cuts C in at most two points. 05
8. (a) Verify Green's theorem in the plane for $\oint_C (3x^2 - 8y^2)dx + (4y - 6xy)dy$, where C is the boundary of the region defined by: $y = \sqrt{x}$, $y = x^2$. 05
- (b) Derive an expression for $\nabla\phi$ in orthogonal curvilinear coordinates. Express the velocity $\vec{v}$ and acceleration $\vec{a}$ of a particle in cylindrical coordinates. 05

***** THE END *****

Khulna University
 Science, Engineering and Technology School
 Discipline: **Mathematics**, Program: **B.Sc. (Hons.)**
 Year: **Fourth**, Term: **I** Examination-2026; Session: **2024-2025**
 Course Code: **Math-3107**
 Course Title: **Partial Differential Equations**
 Total Marks: **60**, Time: **03** Hours, Credit: **03**



- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate answer script for each section.

Section-A

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

- | | Marks |
|---|--------------|
| 1. (a) What is Pfaffian differential equation? Distinguish between ordinary and partial differential equations. | 03 |
| (b) Find a partial differential equation from the relation $\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1$ by eliminating a , b and c . | 03 |
| (c) State and prove the necessary condition for the integrability of the total differential equation $A dx + B dy + C dz = 0$; where A, B , and C are function of x, y , and z . | 04 |
| 2. (a) Describe Lagrange's method for solving the linear partial differential equation. | 03 |
| (b) Use Lagrange's method to find the general solution of $\frac{y^2 z}{x} \frac{\partial z}{\partial x} + xz \frac{\partial z}{\partial y} = y^2$. | 03 |
| (c) Find the general solution of $x \frac{\partial z}{\partial x} + y \frac{\partial z}{\partial y} + t \frac{\partial z}{\partial t} = az + \frac{xz}{t}$. | 04 |
| 3. (a) Obtain Charpit's auxiliary equation to solve a partial differential equation. | 05 |
| (b) Find the complete integral of $p_1 x_1 + p_2 x_2 = p_3^2$ where p_1, p_2 and p_3 have their usual meanings. | 05 |
| 4. (a) Derive Jacobii's auxiliary equations for solving non-linear partial differential equations of order one with three independent variables. | 05 |
| (b) Find the complete, singular, and general integral of $p^3 + q^3 = 27z$. | 05 |

Section-B

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

- | | |
|--|-----------|
| 5. Solve the following differential equations:
(i) $(D^3 - 6D^2 D' + 11DD'^2 - 6D'^3)z = 0$, (ii) $(D^3 - 3D^2 D' + 3DD'^2 - D'^3)z = 0$,
(iii) $(D^2 - 2DD' + D'^2)z = e^{x+4y}$. | 10 |
| 6. (a) Solve each of the following partial differential equations:
(i) $ys - p = xy^2 \cos(xy)$, (ii) $xyr + x^2 s - yp = x^3 e^y$. | 06 |
| (b) Show that a surface satisfying $r = 6x + 2$ and touching $z = x^3 + y^3$ along its section by the plane $x + y + 1 = 0$ is $z = x^3 + y^3 + (x + y + 1)^2$. | 04 |
| 7. (a) Explain Monge's method and using this method, find the solution of $r = a^2 t$. | 05 |
| (b) Apply the separation of variables method to find the solution of the wave equation. | 05 |
| 8. (a) Reduce the equation $A \frac{\partial^2 u}{\partial x^2} + B \frac{\partial^2 u}{\partial x \partial y} + C \frac{\partial^2 u}{\partial y^2} + D \frac{\partial u}{\partial x} + E \frac{\partial u}{\partial y} + Fu = 0$ into canonical form where A, B, C, D, E , and F are real constant. | 05 |
| (b) Consider the PDE: $\frac{\partial^2 u}{\partial x^2} - 6 \frac{\partial^2 u}{\partial x \partial y} + 9 \frac{\partial^2 u}{\partial y^2} + 2 \frac{\partial u}{\partial x} + 3 \frac{\partial u}{\partial y} - u = 0$. (i) Determine the type of the PDE, (ii) Reduce it to canonical form using a suitable change of variables, (iii) Explain why the discriminant determines the type. | 05 |

***** THE END *****

Khulna University
 Science, Engineering and Technology School
 Discipline: **Mathematics**, Program: **B.Sc. (Hons.)**
 Year: **Fourth Term: I** Examination-2026; Session: **2024-2025**
 Course Code: **Math-1105**



Course Title: **Geometry in Two Dimensions**

Total Marks: **60**, Time: **03** Hours, Credit: **03**

- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate answer script for each section.

Section-A

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

- | | | Marks |
|----|--|--------------|
| 1. | (a) Find the angle between the pair of lines $ax^2 + 2hxy + by^2 = 0$ the axes being inclined at an angle ω . | 05 |
| | (b) Prove that the straight lines represented by the equation $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$ will be equidistant from the origin if $f^4 - g^4 = (bf^2ag^2)c$. | 05 |
| 2. | (a) Prove that the product of the perpendicular from (x_1, y_1) on the lines given by $ax^2 + 2hxy + by^2 = 0$ is $\frac{ax_1^2 + 2hx_1y_1 + by_1^2}{\sqrt{(a-b)^2 + 4h^2}}$. | 05 |
| | (b) Show that homogeneous equation of second degree $ax^2 + 2hxy + by^2 = 0$ always represents a pair of straight line. | 05 |
| 3. | (a) Find the angle through which the axes be rotated so that the expression $ax^2 + 2hxy + by^2$ may become of the form $a'x'^2 + b'y'^2$. | 05 |
| | (b) Prove that every equation of the first degree in x and y represents a line and reduce the general equation in normal form. | 05 |
| 4. | (a) Find the equation of bisectors of the angles between the lines $ax^2 + 2hxy + by^2 = 0$ | 05 |
| | (b) Test the nature of the conic $16x^2 - 24xy + 9y^2 - 104x - 172y + 44 = 0$ and reduce it in the standard form. Also find vertex, focus and equation of the directrix | 05 |

Section-B

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

- | | | |
|----|--|----|
| 5. | (a) Prove that the circles $x^2 + y^2 + 2ax + c = 0$ and $x^2 + y^2 + 2by + c = 0$ if $\frac{1}{a^2} + \frac{1}{b^2} = \frac{1}{c}$. | 05 |
| | (b) Prove that the locus of points such that two of the three normals to the parabola $y^2 = 4ax$ from them coincide is $27ay^2 = 4(x - 2a)^3$. | 05 |
| 6. | (a) If the normals at four points on the rectangular hyperbola $xy = c^2$ meet in the point (α, β) , prove that α and β is equal to the summation of abscissas and ordinates respectively. | 05 |
| | (b) Prove that the line $lx + my + n = 0$ is a tangent to the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ if $a^2l^2 + b^2m^2 = n^2$. | 05 |
| 7. | (a) Find the equation of the circle which cuts the circle $x^2 + y^2 - 6x + 8 = 0$ and $x^2 + y^2 - 2x - 2y - 7 = 0$ orthogonally. | 05 |
| | (b) Prove that the two circles $x^2 + y^2 + 2ax + c^2 = 0$ and $x^2 + y^2 + 2bx + c^2 = 0$ touch if $\frac{1}{a^2} + \frac{1}{b^2} = \frac{1}{c^2}$ | 05 |
| 8. | (a) If l and l' are the lengths of the segments of any focal chord of the parabola $y^2 = 4ax$, then prove that $\frac{1}{l} + \frac{1}{l'} = \frac{1}{a}$ | 05 |
| | (b) Find the equation of the polar of the point (x_1, y_1) with respect to the parabola $y^2 = 4ax$. | 05 |

***** THE END *****

Khulna University
Science, Engineering and Technology School
Discipline: **Mathematics**, Program: **B.Sc. (Hons.)**
Year: **Fourth**, Term: **I** Examination-2026; Session: **2024-2025**
Course Code: **CSE-1255**
Course Title: **Computer Programming-I**
Total Marks: **60**, Time: **03** Hours, Credit: **03**



- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate answer script for each section.

Section-A

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

Marks

3

1. (a) What will be the output of the following program?

```
#include <stdio.h>
int main()
{
    int m;
    for(m=0;m<10;++m)
        printf("%d\n", (m%2)?m:m+2);
    return 0;
}
```

- (b) Given an integer number. Write a program that displays the factors that are greater than 5 and less than 20. Remember that one and the given number will not be included as factors. For example, the number 16 has the following factors:

2 4 8

Then the output will be only 8, as it falls within the prescribed range.

- (c) What would be the value of x after execution of the following statements?

```
int x,y=10;
char z='A';
x=y+z;
```

2. (a) Khulna University cafeteria has announced the following seasonal discounts on the purchase of items:

Purchased Amount	Discount
0-100	--
101-200	5%
201-300	7.5%
301-500	11%
Above 500	12.5%

Write a program to take the purchased amount as input, compute the net amount to be paid by the customer, and print it.

- (b) Given an integer number, write a program that displays the number as follows. For example, the number 5678 will be displayed as

5 6 7 8
6 7 8
7 8
8

3. (a) What is the output of the following program?

```
#include<stdio.h>
int main() {
    int m=10;
    do{
        m+=3;
        printf("%d\n", m);
        if (m<11)
            break;
    }while (m<=25);
    return 0;
}
```


- (b) What is the difference between a while loop and a do-while loop? Rewrite the following code using a for loop without changing the logic of the code. 3
- ```
#include<stdio.h>
int main(){
 int x=10;
 while(1){
 if(x>20)
 break;
 x++;
 }
 return 0;
}
```

- (c) Shown below is a binary triangle, 4
- ```
1
0 1
1 0 1
0 1 0 1
.....
.....
```

Write a program to print the triangle for n given row number ROW. For example, if ROW=3 then the following triangle will be printed.

```
1
0 1
1 0 1
```

4. (a) Write a program using **if-else** statements to check whether a number is a **prime number** or not. 03
- (b) Design a menu-driven calculator using a 'switch-case' and 'do-while' loop that performs Addition, Substruction, Multiplication and Division until the user chooses to exit. 07

Section-B

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

5. (a) You will be given 3 sides as input from the user. Write a C program to check whether it's a Pythagorean triplet or not. [Hints: A Pythagorean triple consists of three positive integers a, b, and c such that $a^2 + b^2 = c^2$.] 3

Sample Input	Sample Output
3 4 5	Pythagorean Triplet
5 12 13	Pythagorean Triplet
4 5 6	Not A Pythagorean Triplet

- (b) In mathematics, the Fibonacci numbers are the numbers that are characterized by the fact that every number after the first two is the sum of the two preceding ones: 4
- 1 1 2 3 5 8 13 21 34 55 89 144... ..

Write a program that will take a number n as input and print the Fibonacci series up to the n^{th} term.

- (c) Input a positive integer N. Write a program to compute the sum of the digits of N. For example, the number 321 has three digits 3,2, and 1, and their summation is $3+2+1 = 6$. 3

6. (a) Write a C program to perform matrix multiplication of two 3×3 matrices. 06
- (b) What is recursion? Write a recursive function to calculate the factorial of a number. 04
7. (a) Write a program to explain the use of break and continue statements. 2
- (b) Write a C program that takes a string as input from the user and counts the number of words in it using a function. Assume that words are separated by single spaces and there are no leading or trailing spaces. The function should return the word count, and the main function should print the result. 5

Sample Input	Sample Output
I love programming	Number of words: 3

- (c) How do we define one-dimensional, two-dimensional, and multi-dimensional arrays? 3
8. (a) A palindrome is a word, phrase, number, or other sequence of characters that reads the same backward as forward, such as madam or racecar. Write a program to check if a given string is a palindrome or not. 5
- (b) Write a user-defined function named "**Prime**" which can take an integer number as an argument and return 1 if the number is prime, otherwise return 0. 5

***** THE END *****

Khulna University
 Science, Engineering and Technology School
 Discipline: **Mathematics**, Program: **B.Sc. (Hons.)**
 Year: **Fourth**, Term: **I** Examination-2026; Session: **2024-2025**
 Course Code: **Math-2105**
 Course Title: **Advanced Calculus**
 Total Marks: **60**, Time: **03** Hours, Credit: **03**



- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate answer script for each section.

Section-A

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

1. (a) Define functions of several variables. Sketch the domain of $f(x, y) = \sqrt{y - x^2}$ and determine the range of the given function. Again, let $f(x, y, z) = \frac{1}{x^2 + y^2 + z^2 + 1}$. For what value of k will the graph of the level surface $f(x, y, z) = k$ be nonempty? **05**
 (b) Evaluate the limit of $\lim_{(x,y) \rightarrow (0,0)} \frac{4x-y}{\sin y - 1}$. Also discuss the continuity. **05**
2. (a) Given the function $f(x, y) = \sqrt{x^2 + y^2}$; (i) Show that $f(x, y)$ is continuous at $(0, 0)$ and (ii) Check if $f(x, y)$ is differentiable at $(0, 0)$. **07**
 (b) Suppose that, $x^2 + 4xz + z^2 - 3yz + 5 = 0$. Find $\frac{\partial z}{\partial x}$ and $\frac{\partial z}{\partial y}$ by implicit differentiation. **03**
3. (a) Define directional derivative. Find the directional derivative of $f(x, y) = x^2 - 3xy + 4y^3$ at $p(-2, 0)$ in the direction $\vec{a} = \hat{i} + 2\hat{j}$. And, find in which direction function decreases most rapidly at $p(-2, 0)$. **05**
 (b) Find an equation for the tangent plane and parametric equations for the normal line to the surface $z = 4x^3y^2 + 2y$ at the point $P(1, -2, 12)$. **05**
4. (a) Explain relative extrema at a point. Also Locate all relative extrema and saddle points of $f(x, y) = 4xy - x^4 - y^4$. **05**
 (b) Use lagrange multipliers to determine at what point on the circle at $x^2 + y^2 = 1$, does the function at $f(x, y) = xy$ has maximum? **05**

Section-B

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

5. (a) Evaluate the double integral $\iint_R \sin\theta dA$, where R is the region in the first quadrant that lies outside the circle $r = 3$ and inside the cardioid $r = 3(1 + \cos\theta)$. 05
 (b) Construct and evaluate a double integral to find the volume of the tetrahedron bounded by the coordinate planes and the plane $z = 4 - 2x - y$. 05
6. (a) Use polar co-ordinates to evaluate $\int_{-1}^1 \int_0^{\sqrt{1-x^2}} (x^2 + y^2)^{\frac{3}{2}} dy dx$. 05
 (b) Use spherical coordinates to find the volume and the centroid of the solid G bounded above by the sphere $x^2 + y^2 + z^2 = 16$ and below by the cone $z = \sqrt{x^2 + y^2}$. 05
7. (a) Find the volume of the solid enclosed by the paraboloids $z = 5x^2 + 5y^2$ and $z = 6 - 7x^2 - y^2$. 05
 (b) Evaluate the iterated integral $\int_{-1}^1 \int_0^2 \int_0^1 (x^2 + y^2 + z^2) dx dy dz$. 05
8. (a) Evaluate $\iiint \log(x + y + z) dx dy dz$, the integral extending over all positive values of x, y, z subject to the condition $x + y + z < 1$. 05
 (b) Evaluate $\int_0^{\frac{\pi}{2}} \log(\alpha \cos^2 \theta + \beta \sin^2 \theta) d\theta$. 05

***** THE END *****

Khulna University
 Science, Engineering and Technology School
 Discipline: **Mathematics**, Program: **B.Sc. (Hons.)**
 Year: **Fourth**, Term: **I** Examination-2026; Session: **2024-2025**
 Course Code: **0541 12 Math 4105**
 Course Title: **Topology**
 Total Marks: **60**, Time: **03** Hours, Credit: **03**



- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate answer script for each section.

Section-A

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

- | | | | |
|----|-----|---|----|
| 1. | (a) | Define topological space. Also give example of usual topology, discrete and indiscrete topology. [L1; CLO1] | 03 |
| | (b) | Let $X = \{a, b, c, d, e\}$, write three subclasses of X which will form topology. Check whether it is a topology or not? Find the derived set of $A = \{a, b, c\}$ with respect to the topology T . [L1; CLO2] | 03 |
| | (c) | Define interior, exterior and boundary point. Let $T = \{X, \phi, \{a\}, \{c, d\}, \{a, c, d\}, \{b, c, d, e\}\}$ be a topology on $X = \{a, b, c, d, e\}$. Find the interior, exterior and boundary point of $A = \{a, b, c\}$. [L2; CLO3] | 04 |
| 2. | (a) | Define limit point. Find the limit point of set of rational numbers. [L2; CLO3] | 02 |
| | (b) | State and prove Minkowski's inequality. [L3; CLO4] | 04 |
| | (c) | Define normed space. Let $I = [0, 1]$, $\ f\ = \sup\{ f(x) \}$. Prove that it is a norm on $C[0, 1]$. [L3; CLO4] | 04 |
| 3. | (a) | Define continuous function with respect to some topology with example. [L2; CLO3] | 03 |
| | (b) | Draw the diagram and prove that the function $f(x) = x $ is continuous. [L5; CLO4] | 04 |
| | (c) | Define homeomorphic spaces and give examples. Also define topological property and give two examples which are not topological property. [L3; CLO4] | 03 |
| 4. | (a) | Define metric space, usual metric and trivial metric. Give an example which is not metric space. [L3; CLO4] | 03 |
| | (b) | Let $C[0, 1]$ denote the collection of continuous functions on $[0, 1]$ and let $d(f, g) = \int_0^1 f(x) - g(x) dx$ and $d^*(f, g) = \sup\{ f(x) - g(x) : x \in [0, 1]\}$. Draw their graphs. Are they metric? [L1; CLO4] | 04 |
| | (c) | Define open sphere. Graphically explain three unusual spheres. [L3; CLO3] | 03 |

Section-B

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

- | | | | |
|----|-----|--|----|
| 5. | (a) | Define product space. Consider the topology $T = \{X, \phi, \{a\}, \{b, c\}\}$ on $X = \{a, b, c\}$ and the topology $T^* = \{Y, \phi, \{u\}\}$ on $Y = \{u, v\}$. Determine the subbase and base of the product topology $X \times Y$. [L3; CLO5] | 04 |
| | (b) | Prove that the usual topology on $R^2 = R \times R$ is the product topology. [L2; CLO5] | 03 |
| | (c) | Topologically draw the graph of unit square, annulus, torus and solid torus. [L4; CLO5] | 03 |
| 6. | (a) | Let $B = \{D_p : p \in Z \times Z\}$ where D_p has centre p and radius 1 and $1/2$ respectively. Will B cover R^2 ? Justify your answer. [L2; CLO6] | 03 |
| | (b) | Prove that continuous image of a compact set is compact. [L1; CLO6] | 03 |
| | (c) | State Heine-Borel theorem. Let A be any subset of a topological space X . Then prove that A is compact. [L5; CLO6] | 04 |
| 7. | (a) | State and Prove the Cantor's intersection theorem. [L5; CLO4] | 05 |
| | (b) | Show that a closed subspace of a normal space is a normal space. [L2; CLO4] | 05 |
| 8. | (a) | Define connected set and separated sets with figure. [L3; CLO7] | 03 |
| | (b) | Define path and homotopic path with figure. [L3; CLO8] | 03 |
| | (c) | Prove that $(0,1)$ interval is not compact. [L2; CLO8] | 04 |

***** THE END *****

Khulna University
 Science, Engineering and Technology School
 Discipline: **Mathematics**, Program: **B.Sc. (Hons.)**
 Year: **Fourth**, Term: **I** Examination-2026; Session: **2024-2025**
 Course Code: **Stat-1153**
 Course Title: **Basic Statistics**
 Total Marks: **60**, Time: **03** Hours, Credit: **03**



- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate answer script for each section.

Section-A

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

Marks

1. (a) Define statistics. Discuss the applications and role of statistics in mathematics. **03**
 (b) Distinguish between the following terms: **04**
 - i) Estimate and Estimator
 - ii) Primary data and Secondary data
- (c) Why is statistical analysis often described as a science of estimates? Justify your answer. **03**
2. (a) Define the following terms with suitable examples: **03**
 - i) Classification, ii) Frequency distribution, iii) Class mark
- (b) Compare and contrast various levels of measurement scales. **04**
- (c) What are the advantages of diagrammatic presentation of statistical data over tabular presentation? **03**
3. (a) 'Extreme values influence the mean, not the median'- explain with an example. **03**
 (b) Explain the terms standard deviation and coefficient of variation. **03**
 (c) The median of the following distribution is 17. Find f_1 and f_2 . **04**

Class interval	10-12	12-14	14-16	16-18	18-20	20-22
Frequency	17	f_1	32	50	f_2	12

4. (a) Why is the standard deviation considered the most popular measure of dispersion? Justify your answer. **03**
 (b) Compute the standard deviation of the following dataset and interpret the results in terms of variability: **04**

x_i	7	8	9	12	14	10
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- (c) What is skewness? How does it differ from kurtosis? **03**

Section-B

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

5. (a) Distinguish between Karl Pearson's correlation and the Rank correlation. 03
(b) Differentiate between simple linear regression and multiple regression. 03
(c) Show that the coefficient of correlation is invariant to the changes in origin and scale of measurement. 04
6. (a) Differentiate between partial correlation and multiple correlation. 03
(b) How do you distinguish correlation analysis from regression analysis? 03
(c) The ranks of 6 employees in performance and punctuality are given below. Find the Spearman's rank correlation coefficient and interpret your result 04
- | | | | | | | |
|-------------|---|---|---|---|---|---|
| Performance | 1 | 2 | 3 | 4 | 5 | 6 |
| Punctuality | 2 | 1 | 4 | 3 | 6 | 5 |
7. (a) Discuss the limitations of sample surveys in demographic studies. 03
(b) Explain the role of vital registration systems in demographic analysis. 03
(c) The population of a city is 250,000, growing at an annual rate of 2.5%. Estimate the population of the city after 8 years. 04
8. (a) Briefly describe the construction process of a life table. 03
(b) Differentiate between a complete life table and an abridged life table. Discuss their applications. 04
(c) In a life table, $l_{40} = 75,000$ and $l_{41} = 74,250$. Calculate the mortality rate for age 40. 03

***** THE END *****

Khulna University
Science, Engineering and Technology School
Discipline: **Mathematics**, Program: **B.Sc. (Hons.)**
Year: **Fourth**, Term: **I** Examination-2026; Session: **2024-2025**
Course Code: **Stat-1253**
Course Title: **Statistics-II**
Total Marks: **60**, Time: **03** Hours, Credit: **03**



- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate answer script for each section.

Section-A

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

Marks

- | | | |
|----|---|----|
| 1. | (a) Write down the application of probability in mathematics. | 02 |
| | (b) Define conditional probability. State and prove Bayes theorem. | 05 |
| | (c) At a certain university, 4% of men are over 6 feet tall and 1% of women are over 6 feet tall. The total student population is divided in the ratio 3:2 in favour of women. If a student is selected at random from among all those over six feet tall. What is the probability that the student is a woman? | 03 |
| 2. | (a) Distinguish between discrete and continuous random variables. Provide one real-life example for each. | 03 |
| | (b) Define Probability Mass Function (PMF) and Probability Density Function (PDF). What are the two necessary conditions for a function to be a valid PDF? | 03 |
| | (c) A continuous random variable X has the following probability density function:
$f(x) = k(4 - x)$ for $0 \leq x \leq 4$ and 0 otherwise. | 04 |
| | i) Find the value of the constant k such that $f(x)$ is a valid PDF. | |
| | ii) Determine the Cumulative Distribution Function (CDF), $F(x)$, for all x . | |
| 3. | (a) Explain the concept of Mathematical Expectation. Show that $E(aX + b) = aE(X) + b$, where a and b are constants. | 04 |
| | (b) Define marginal and conditional probability distributions in the context of bivariate (joint) random variables. | 03 |
| | (c) If two random variables X and Y are independent, prove that $E(XY) = E(X)E(Y)$. | 03 |
| 4. | (a) Describe the properties of a Bernoulli trial. Establish the relationship between Bernoulli distribution and Binomial distribution. | 03 |
| | (b) The Normal distribution is often called the "ideal" distribution in statistics. Explain the characteristics of a normal curve and define the Standard Normal variable (Z). | 03 |
| | (c) Show that, for a Poisson distribution with parameter λ , the mean and variance are equal (i.e., $E(X) = Var(X) = \lambda$). | 04 |

Section-B

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

5. (a) Distinguish between a census and a sample survey. Under what specific conditions is a sample survey preferred over a census? 03
- (b) Explain the difference between sampling errors and non-sampling errors. Which of these can be reduced by increasing the sample size? 03
- (c) Define the following terms with example: i) Sampling Frame, ii) Unit of Inquiry, iii) Sampling Unit, iv) Parameter. 04
6. (a) Define simple random sampling (SRS) an example. How does it differ from systematic random sampling. 04
- (b) Write down the steps in planning and executive a sample survey 03
- (c) Suppose we have a population of four measurements 2, 4, 6, and 8. Draw a random sample of size 2 without replacement show that $E(\bar{y}) = \bar{Y}$ and (ii) $V(\bar{y}) = \frac{N-n}{Nn} S^2$ 03
7. (a) Explain the concept of a "Ratio Estimator". In what scenario would you choose a Ratio method over a simple mean estimator? 03
- (b) Compare and contrast the Ratio and Regression methods of estimation. Which one is generally considered more precise if the relationship between variables is linear but does not pass through the origin? 04
- (c) Show (mathematically or conceptually) how the auxiliary information is used in the estimation of population mean using the Ratio method. 03
8. (a) Define the following terms with an example: (i) Statistical Hypothesis; (ii) Null Hypothesis; (iii) Alternative Hypothesis; (iv) Type-I Error & (v) Type-II Error. 05
- (b) Briefly explain the procedure of testing a hypothesis. 02
- (c) Find the power of the test for testing null hypothesis (H_0): $\mu = 138$ against the alternative hypothesis (H_1): $\mu = 142$ at 5% level of significance (α). The standard deviation of the sample mean is known to be 2. 03

***** THE END *****

Khulna University
 Science, Engineering and Technology School
 Discipline: **Mathematics**, Program: **B.Sc. (Hons.)**
 Year: **Fourth** Term: **I** Examination-2026; Session: **2024-2025**
 Course Code: **Math-3105**



Course Title: **Theory of Numbers**

Total Marks: **60**, Time: **03** Hours, Credit: **03**

- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate answer script for each section.

Section-A

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

- | | | Marks |
|----|---|-------|
| 1. | (a) State first principle of finite induction. Establish the formula, by using mathematical induction, $1 + 3 + 5 + \dots + (2n-1) = n^2$ for all $n \geq 1$ by mathematical induction. | 06 |
| | (b) For all $n \geq 1$, prove that $\frac{n(n+1)(2n+1)}{6}$ is an integer. | 04 |
| 2. | (a) If p is prime and $p ab$, then prove that $p a$ or $p b$. | 03 |
| | (b) State and prove the division algorithm. | 04 |
| | (c) Prove that the integer $111^{333} + 333^{111}$ is divisible by 7. | 03 |
| 3. | (a) The neighborhood theater charges \$1.80 for adult admissions and \$0.75 for children. On a particular evening total receipts were \$90. Assuming that more adults than children were present, how many people attended? | 05 |
| | (b) Solve the linear Diophantine equation $172x + 20y = 1000$ where solution space will be non-negative. | 05 |
| 4. | (a) State and prove fundamental theorem of arithmetic. | 05 |
| | (b) Find all prime numbers that divides $50!$. | 02 |
| | (c) Prove that there is an infinite number of prime. | 03 |

Section-B

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

- | | | |
|----|---|----|
| 5. | (a) Show that the integers $m = 3^k \cdot 568$ and $n = 3^k \cdot 638$, where $k \geq 0$, satisfy simultaneously $\tau(m) = \tau(n)$ and $\varphi(m) = \varphi(n)$, where τ and φ are number-theoretic functions. | 05 |
| | (b) State and prove Mobius inversion formula. | 05 |
| 6. | (a) For square free integer, prove that $\sum_{d n} \sigma(d^{k-1}) \varphi(d) = n^k$, for all integers $k \geq 2$. | 03 |
| | (b) If $n \geq 1$ and $\gcd(a, n) = 1$, then prove that $a^{\varphi(n)} \equiv 1 \pmod{n}$. | 04 |
| | (c) Show that φ is a multiplicative function. | 03 |
| 7. | (a) By means of continued fractions determine the general solution of the equation $18x + 5y = 24$. And give assertion if this equation is Diophantine or not. | 06 |
| | (b) For $n > 1$, then prove that the sum of positive integers less than n and relatively prime to n is $\frac{1}{2}n\varphi(n)$. | 04 |
| 8. | (a) Factor the number $2^{11} - 1$ by Fermat's factorization method. | 05 |
| | (b) Show that the functions τ and σ are both multiplicative functions. | 05 |

***** THE END *****

Khulna University
 Science, Engineering and Technology School
 Discipline: **Mathematics**, Program: **B.Sc. (Hons.)**
 Year: **Fourth**, Term: **I** Examination-2026; Session: **2024-2025**
 Course Code: **Math-2103**
 Course Title: **Linear Algebra-I**
 Total Marks: **60**, Time: **03** Hours, Credit: **03**



- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate answer script for each section.

Section-A

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

Marks

- Write a general system of linear equations. Discuss when it has trivial and non-trivial solution. Also discuss about its consistency and inconsistency. 05
 - Show that the matrix $A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$ satisfies the equation $A^2 - (a+d)A + (ad-bc)I = 0$. 05
- Show that every square matrix can be expressed as sum of a symmetric and a skew symmetric matrix. 05
 - Solve the following linear system by Gauss-Jordan elimination process:
 $x_1 + x_2 + 2x_3 = 8$; $-x_1 - 2x_2 + 3x_3 = 1$; $3x_1 - 7x_2 + 4x_3 = 10$ 05
- Define inverse matrix A. Show that the following matrix is not invertible without using determinant
 form: $A = \begin{bmatrix} 1 & 6 & 4 \\ 2 & 4 & -1 \\ -1 & 2 & 5 \end{bmatrix}$ 05
 - Do you think the sum of upper triangular and lower triangular matrix is diagonal matrix? If so, then prove it with example. 05
- Find the conditions based on ' α ' and ' β ', when the solutions of the given system of linear equation will be (i) unique, (ii) no solutions, and (iii) many solutions. 05

$$\begin{aligned} 2x_1 - 2x_2 + 3x_3 &= 1 \\ 2x_1 + 5x_2 - 3x_3 &= 3 \\ x_1 - x_2 - \alpha x_3 &= \beta \end{aligned}$$
 - Apply row echelon method to balance the following chemical reaction by finding the values of x_1, x_2, x_3 , and x_4 . 05

$$(x_1)C_4H_{10} + (x_2)O_2 \rightarrow (x_3)CO_2 + (x_4)H_2O$$

Section-B

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

- Let $S = \{v_1, v_2, \dots, v_r\}$ be the set of vectors in $\mathbb{R}^n$. If $r > n$, then prove that S is linearly independent. 05
 - Let W be a subspace generated by the polynomials $P_1(t) = t^3 + 2t^2 - 2t + 1$, $P_2(t) = t^3 + 3t^2 - t + 4$, and $P_3(t) = 2t^3 + t^2 - 7t - 7$. Find a basis and dimension of W . 05
- If W is a subspace of a finite dimensional vector space V , then prove that W is finite dimensional and $\dim(W) \leq \dim(V)$. 05
 - Determine whether the vectors $v_1 = (1, 2, 2, -1)$, $v_2 = (4, 9, 9, -4)$, $v_3 = (5, 8, 9, -5)$ are linearly independent or dependent in $\mathbb{R}^4$. 05
- Show that the matrices,

$$M_1 = \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}, M_2 = \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}, M_3 = \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix}, M_4 = \begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix}$$
 form a basis for the vector space M_{22} of 2×2 matrices. 05
 - If $T: \mathbb{R}^5 \rightarrow \mathbb{R}^3$ be the linear transformation defined by the formula,

$$T(x_1, x_2, x_3, x_4, x_5) = (x_1 + x_2, x_2 + x_3 + x_4, x_4 + x_5)$$
 Find the rank and nullity of the standard matrix for T . 05
- Determine whether the vectors $u = (2, 1, 4)$, $v = (1, -1, 3)$ and $w = (3, 2, 5)$ span the vector space $\mathbb{R}^3$. 05
 - Use the Wronskian to show that $f_1 = 1, f_2 = e^x, f_3 = e^{2x}$ are linearly independent vectors in $C^\infty(-\infty, \infty)$. 05

***** THE END *****