+3 Sem-III(NEP)
MAT-C-1(P-5) Major(R)
Arts/Sc

December, 2025
Probability
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Full Marks: 100 **Time: 3 hours**

Answer as per instructions.
Symbols have their as usual meanings

NO.1 Answer all the Question. **10x1=10**

a) In a college,30% students failed in Physics, 25% failed in math and 10% failed in both. One student is chosen at random, the probability that she failed in Physics if she has failed in math is ______
a) $\frac{1}{10}$ b)$\frac{2}{5}$ c)$\frac{9}{20}$ d)$\frac{1}{3}$

b) If A and B are two events such that
$P(A) = \frac{1}{2}$ and $P(B) = \frac{1}{3}, P(A|B) = \frac{1}{4}$ $then$ $P(A^c \cap B^c) =$_______
a) $\frac{1}{12}$ b)$\frac{3}{4}$ c)$\frac{1}{4}$ d)$\frac{3}{16}$

c) In a Binomial Distribution the Probability of getting a success is $\frac{1}{4}$ and standard deviation is 3 then its mean is ___________

d) If X has a Poisson variable such that $P(X = 1) = 2\ P(X = 2)$ then $P(X = 0) is$ ____

e) If $E(X) = 5$ $then$ $E(3x - 1) =$________

f) Define Moment about origin.

g) The Mean of Standard Normal Distribution is ___________

h) Define Covariance of two Random variable X and Y.

i) Define Correlation Coefficient.

j) Give an Example of Markov's Chain.

No. 2 Answer All the Question. **9x2 =18**

a) If $P(E) = 0.9$ and $P(F) = 0.8$ then show that $P(E \cap F) \geq 0.7$

b) If two fair dice are rolled, what is the probability that the sum is 10.

c) If X is Uniformly Distributed over the interval $(0,10)$ then calculated the Probability that $1 < X < 6$.

d) Define Independent Random Variable, Write the condition for X and Y to be independent.

e) State strong law of Large Number.

f) Define Negative Binomial Distribution.

g) Define Conditional Density of X given Y=y that is $f(x|y)$.

h) Define Moment Generating Function.

i) Define Markov's Inequality.

No.3 Answer **Any Eight** Question. **8x5 = 40**

a) There are 3 coins in a box. One is a two headed coin, another is fair coin and the 3rd is a biased coin that comes up head 75 % of the time. When one of the three coins is selected at random and flipped, it Shows head. What is the probability that it was two headed coins?

b) State and Proof Baye's Theorem.

c) For any Two events A and B if $P(A) = 0.4$, $P(B|A) = 0.3$ and $P(B^c|A^c) = 0.2$ then find $P(B|A^c)$.

d) A Discrete Random Variable X has the following Probability Distribution

X	0	1	2	3	4	5
P(X)	$4C^2$	$3C^2$	$2C^2$	C^2	C	$2C$

1) Find the Value of C 2) Find the mean of the distribution 3) if $\sum p_i x_i^2 = 14$ then find Variance.

e) In a Poisson Distribution $P(X = 2) = 9\ P(X = 4) + 90\ P(X = 6)$ then find $E(X)$ and $Var(X)$

f) Let the Probability density of X be given by f(x)= $\begin{cases} c(4x-2x^2) & if\ 0<x<2 \\ 0 & otherwise \end{cases}$

i. What is the value of c   ii. find $P(\frac{1}{2} < X < \frac{3}{2})$

g) If X and Y are independent random variable, then show that $E(XY) = E(X)E(Y)$.

h) Show that the moment generating function of the Poisson Distribution is $M_x(t) = e^{\lambda(e^t-1)}$.

i) If the regression of Y on X is Linear then show that its equation is $\mu_{Y|x} = \mu_2 + \rho\frac{\sigma_2}{\sigma_1}(x-\mu_1)$.

j) Suppose that $P(x,y)$ is the joint probability mass function of X and Y , given by $P(1,1) = 0.5, P(1,2) = 0.1, P(2,1) = 0.1, P(2,2) = 0.3$ then calculate the Conditional Probability mass function of X given that Y=1.

No. 4 Answer **any Four** Question. **4 X 8 =32**

a) Find The mean and variance of Binomial Distribution.

b) Given the Values of the Joint Probability Distribution of X and Y is shown in the table

		X	
Y	-1 0 1	-1	1
		1/8	½
		0	¼
		1/8	0

i. Find the Marginal Distribution of X
ii. Find the Marginal Distribution of Y
iii. Find the Conditional Distribution of X given Y=-1.

c) State and Proof Chebyshev's Inequality.

d) Given the joint Density $f(x,y) = \begin{cases} \frac{2}{5}(2x+3y) & if\ 0 < X < 1,\quad 0 < Y < 1 \\ 0 & Elsewhere \end{cases}$ find the Regression equation of Y on X.

e) The Weight of Students of a class follows normal distribution with mean 50 kg and Standard deviation 2 Kg, find the Probability that a student selected at random will have weight

i. Less than 45 Kg
ii. More than 54 Kg
iii. Between 45 and 54 Kg Given F (2.5) =0.9938 and F (2) =0.9772

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+3 Sem-III(NEP)
MAT-C-1(P-6) Major(R)

December, 2025
DIFFERENTIAL EQUATION-1

Full Marks: 100 **Time: 3 hours**

Answer as per instructions.
Symbols have their as usual meanings.

1. Answer all the questions **(10x1=10)**

(i) What is the degree of the differential equation $\frac{d^2y}{dx^2} + \sqrt{1 + \frac{dy}{dx}} = 0.$

(a) zero (b) 1

(c) 2 (d) 4

(ii) The differential equation $\frac{d^2y}{dx^2} + sinx\frac{dy}{dx} + ye^x = cosx$ is

(a) First order and linear (b) First order but non linear

(c) Second order and linear (d) Second order but non linear

(iii) The differential equation $M(x,y)dx + N(x,y)dx = 0$ is exact iff______.

(iv) The number of integrating factors for the equation $M(x,y)dx + N(x,y)dx = 0$ is_______.

(v) If the wronskian of two solutions of a second order homogeneous equation is zero, then the solutions are

(a) Linearly dependent (b) Linearly independent

(c) Trivial solutions (d) orthogonal

(vi) The integrating factor of $xlogx\frac{dy}{dx} + y = 2logx$ is

(a) e^x (b) $logx$

(c) $\frac{1}{e^x}$ (d) $\frac{1}{logx}$

(vii) If the reproduction rate is 2,then the time taken for population to double its size is

(a) $\frac{2}{log2}$ (b) $\frac{log2}{2}$

(c) $log2$ (d) $\frac{1}{2}$

(viii) $\frac{1}{D-a}\varphi(x)$ is equal to

(a) $e^{ax}\int \varphi(x)e^x dx$ (b) $\int e^{-ax}\varphi(x)dx$

(c) $e^{ax}\int e^{-ax}\varphi(x)dx$ (d) $e^{ax}\int \varphi(x)dx$

(ix) The differential equation formed from the function $z = f(x^2 + y^2)$ is

(x) The equation $Pp + Qq = R$ is known as___ equation.

2. Answer all the questions. **(9x2=18)**

(i) Show that the differential equations $p = 4x + 3y + 1,\ q = 3x + 2y + 1$ are compatible and find their solution.

(ii) Show that $y = \sqrt{1+x^2}$ is a solution of the differential equation $\frac{dy}{dx} = \frac{xy}{1+x^2}$.

(iii) Form the partial differential equation by eliminating the arbitrary constants $z = ax + by + a^2 + b^2$.

(iv) Solve: $yzp + zxq = xy$

(v) Solve the differential equation: $\frac{dy}{dx} + \frac{cosx\, siny}{cosy} = 0$

(vi) Solve: $(1 + y^2)dx = (\tan^{-1} y - x)dy$

(vii) Find the UC sets of $(i) sin2x \quad (ii) cos2x$

(viii) Solve the Euler's equation $x^2\frac{d^2y}{dx^2} + x\frac{dy}{dx} - 4y = 0$

(ix) Find the particular integral of $((D-2)^2y = e^{2x}$

3. Answer any **Eight** questions **(8x5=40)**

(i) Solve: $sinx\, cosy\, dx + cosx\, sinydy = 0; y(0) = \frac{\pi}{4}$

(ii) Solve: $(2x + y + 1)dx + (4x + 2y - 1)dy = 0$

(iii) Solve : $x\frac{dy}{dx} + y\, logy = xy$

(iv) If $y_1\ and\ y_2$ are two solution of $L[y] = 0$ on an interval I such that their wronskian $W(y_1, y_2; x) \neq 0$ for all $x \in I$, then show that $y_1\ and\ y_2$ are linearly independent on I.

(v) Solve: $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + 2y = e^x tanx$

(vi) Using the method of UC solve the IVP
$(D^2 + 4D + 8)y = 4cosx + 7sinx,\ \ y(0) = 1, Dy(0) = -1$

(vii) Find the general solution of the ODE by the method of variation of parameter
$(D^2 - 2D + 1)y = xe^x\, logx,\ x \geq 0.$

(viii) Solve: $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} + z\frac{\partial y}{\partial z} = au + \frac{xy}{z}$

(ix) Solve the equation ${U_x}^2 + {U_y}^2 = 1$ using a separable solution $U(x,y) = f(x) + g(y)$

(x) Solve the Cauchy problem: $au_x + bu_y = cu, u(x,0) = f(x), where\ a, b, c$ are constants.

4. Answer any **Four** questions. **(4x8=32)**

(i) Solve the IVP: $\frac{dy}{dx} + y = f(x), y(0) = 0 \ where\ f(x) = \begin{cases} 2, & 0 \leq x < 1 \\ 0, & x \geq 1 \end{cases}$

(ii) The half life period of a radioactive material is 10years. How long does it take for 90% of the original amount of material to disintegrate?

(iii) Solve the IVP : $y^{III} - 6y^{II} + 11y^{I} - 6y = 0, y(0) = 0 = y^{I}(0), y^{II}(0) = 2$

(iv) Solve: $(x^3D^3 + 2x^2D^2 - xD + 1)y = x^2 logx$

(v) Find the integral surface of the equation $(x - y)y^2p + (y - x)x^2q = (x^2 + y^2)z$ through the curve $xz = a^3, y = 0$.

+3 Sem-III(NEP)
MAT-C-1(P-7) Major(R) Arts/Sc

December, 2025
LINEAR ALGEBRA

Time: 3 hours **Full marks:** 100

Answer as per instructions.
Symbols have their as usual meanings

1. Answer **ALL** the followings. **[10x1 = 10]**
   i) In any vector space, $ax = ay$ implies that $x = y$. (True/False).
   ii) The set$\{v_1, v_2\}$ is linearly dependent iff v_1 and v_2 are_________.
   iii) If T is linear operator in R^2 and $T(1,2) = (3,4)$ then $T(2,4) =$ _______.
   iv) $P_5(R) \cong M_{2\times3}$.(True /False).
   v) A square matrix A is said to be idempotent if_________.
   vi) Let A be a square matrix of order 2×2 and has eigen values -1 and 4 then write the trace of A^2.
   vii) The inverse of a non-singular upper triangular matrix is_______.
   viii) Write the minimal polynomial of the matrix $A = \begin{pmatrix} 1 & -2 \\ 0 & -1 \end{pmatrix}$.
   ix) Define norm of v for $v \in V(F)$.
   x) A matrix A is said to be normal if ___________.
2. Answer **ALL** the followings. **[9x2 = 18]**
   i) Write $(4,6)$ as a linear combination of $(1,1)$ and $(1,-1)$ in R^2.
   ii) State why $T: R^2 \to R^2$ given by $T(x,y) = (1,y)$ is not linear.
   iii) Define a basis for a vector space.
   iv) Find the inverse of $A = \begin{pmatrix} 3 & -1 \\ 2 & 0 \end{pmatrix}$.
   v) Let $T \& S: R^2 \to R^2$ be two linear map defined by $T(x,y) = (x-y, x+y)$ and $S(x,y) = (2x, y)$ then compute the composition map SoT.
   vi) Without expanding, prove that $\begin{vmatrix} 1 & 1 & 3 \\ 2 & 9 & 1 \\ 4 & 11 & 7 \end{vmatrix} = 0$.
   vii) Define invariant subspace.
   viii) Let $T: R^3 \to R^2$ given by $T(x_1, x_2, x_3) = (x_2 + 3x_3, 2x_1)$, then compute the adjoint T^*.
   ix) Write the quadratic form corresponding to the matrix $\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$.
3. Answer **EIGHT** of the following. [5 × 8 = 40]
   i) If U and W are subspace of a vector space $V(F)$, then prove that $U \cap W$ is a subspace of $V(F)$.
   ii) Let $S = \{(1,1,1,1), (1,2,1,2)\}$ be a linearly independent subset of the vector space R^4. Extend S to a basis of R^4.
   iii) Define Null space$N(T)$ and Range space $R(T)$. Determine $R(T)$ and $N(T)$ for the transformation $T: R^3 \to R^2$ defined by $T(x,y,z) = (x-y, x+z)$.
   iv) Let $D: P_3(R): \to P_2(R)$ be the differential operator given by $D(p(x)) = p'(x)$. Calculate matrix of D relative to the standard basis of $P_3(R)$ and $P_2(R)$. Also find the Rank and nullity of D.
   v) Let$T: U \to V$ and $S: V \to W$ be two linear maps then prove that if S and T are nonsingular then ST is nonsingular and $(ST)^{-1} = T^{-1}S^{-1}$.
   vi) Invert the matrix $A = \begin{pmatrix} 1 & 1 & 0 \\ 1 & -1 & 1 \\ 1 & -1 & 2 \end{pmatrix}$ by matrix inversion method.

vii) Show the $A = \begin{pmatrix} 0 & -2 \\ 1 & 3 \end{pmatrix}$ is diagonalizable and find a 2×2 matrix Q such that $Q^{-1}AQ$ is a diagonal matrix.

viii) Determine whether the following system of linear equations is consistent or not. $x_1 - x_2 + 2x_3 + 3x_4 = 1, 2x_1 + 2x_2 + 2x_4 = 1, 4x_1 + x_2 - x_3 - x_4 = 1, x_1 + 2x_2 + 3x_3 = 1$.

ix) State and verify the Cayley-Hamilton theorem for the matrix $A = \begin{pmatrix} 1 & 2 \\ -1 & 1 \end{pmatrix}$.

x) State and prove Cauchy Schwarz inequality.

4. Answer **FOUR** of the followings **[4x8 = 32]**

i) If U and W are two subspaces of a finite dimensional vector space $V(F)$, then show that $\dim(U + W) = \dim(U) + \dim(W) - \dim(U \cap W)$.

ii) State and prove Rank-Nullity theorem.

iii) Prove that the linear map $T: R^3 \to R^3$ defined by $T(e_1) = e_1 + e_2, T(e_2) = e_2 + e_3$ and $T(e_3) = e_1 + e_2 + e_3$ is nonsingular and find its inverse.

iv) Determine the eigenvalues and corresponding eigenspaces for the matrix

$$A = \begin{pmatrix} 1 & 1 & 1 \\ 0 & 1 & 0 \\ 0 & 1 & 2 \end{pmatrix}.$$

v) Using Gram-Schmidt procedure find an orthonormal basis of $P_2(R)$ using the inner product given by $< p(x), q(x) > = \int_{-1}^{1} p(x)q(x)dx$.

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+3 Sem-III(NEP)
MAT-C-2(P-2) Minor(R)

December, 2025

Introduction to Algebra and Number Theory

Answer as per instructions.
Symbols have their as usual meanings.

Full Marks: 100 **Time: 3 hours**

NO.1 Answer all the Question. **10x1 =10**

a) Write the Elements of D_4.
b) Write the Elements of $U(10)$.
c) $(\mathbb{Q}, -)$ is a Group. (True/False)
d) Give an example of Abelian Group which is not Cyclic.
e) Every Subgroup of abelian Group is Normal Subgroup. (True/False)
f) Find all the unit elements of $\mathbb{Z}_{10}$.
g) If p is Prime element then $p^2 + 1$ is also Prime. (True/False)
h) Find the reminder when 2^{31} is divided by 7.
i) Find a solution of the system of congruence equation $x \equiv 1(mod\ 3), x \equiv\ 2\ (mod\ 5)$.
j) The LCM and GCD of 2 numbers are 168 and 6 respectively. If one of the numbers is 24, then find the other number?

No. 2 Answer All the Question. **9x2 =18**

a) Show that in a Group, Identity element is unique.
b) Define Field, Give an Example.
c) Is $U(10)$ under Multiplication Modulo 10, a cyclic Group? (Justify it)
d) Find the zero divisor of $\mathbb{Z}_6$.
e) If $a, b \in \mathbb{Z}^+\ such\ that\ a|b\ and\ b|a$ then show that $a = b$.
f) What is Fibonacci Numbers? Write first five Fibonacci Number.
g) Find the GCD (1024,1000).
h) State Fundamental Theorem of Algebra.
i) State Wilson's Theorem.

No.3 Answer Any Eight Question. **8x5= 40**

a) Define Centre of a Group $Z(G)$, Show that $Z(G)$ is a Subgroup of G.
b) Show that the congruence relation on set of Integer is an Equivalence Relation.
c) Show that Every finite integral domain is a field.
d) Show that the intersection of Two subgroup is again a Subgroup.
e) Show that Every cyclic Group is abelian group but the converse is not true (Give an example).
f) Show that there are infinitely many primes.
g) If $g = \gcd(a, b)$ and $'d'$ is any common divisor of $a\ and\ b$ then show that $d|\ g$.
h) If $a, b\ \in \mathbb{Z}\ and\ \gcd(d, a) = 1\ and\ d|ab$ then show that $d|b$.
i) If $a \equiv b\ (mod\ n), c \equiv d\ (mod\ n)$ then show that $a + c \equiv b + d\ (mod\ n) and\ ac \equiv bd\ (mod\ n)$.
j) Find the general solution of linear Diophantine Equation $12\ x + 20\ y = 28$.

No. 4 Answer any Four Question. **4 x 8 =32**

a) Show that union of Two subgroup is again a subgroup if and only if one of them is contained in other.
b) Prove that a group G is abelian if and only if $(ab)^2 = a^2b^2$ for all $a, b\ \epsilon\ G$.
c) Using Euclidean algorithm, obtain $m, n\ \in \mathbb{Z}$ such that $\gcd(4076,1024) = 4076\ m + 1024\ n$.
d) If P is a Prime number and $a\ \in \mathbb{Z}\ such\ that\ \gcd(a, p) = 1$ then show that $a^{p-1} \equiv 1\ (mod\ P)$.
e) Find all the solution of the Linear congruence equation $12x \equiv 18\ (mod\ 15)$.

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+3 Sem III (NEP)
MAT/CSC-MDC-III

DECEMBER,2025
PROGRAMMING ON C++

Full Mark - 100 Time -3 Hours

Answer as per instructions.
Figures in the right-hand margin indicates marks

Part-I

1. All are Compulsory **10x1=10**
   - A. Which data type is used to store decimal values?
   - B. What is the size modifier used with floating data types?
   - C. What object is used with the extraction operator?
   - D. Which header file is required for cin and cout?
   - E. What is a loop inside another loop called?
   - F. Which keyword is used to terminate a switch case?
   - G. Which variables are accessible only within a function?
   - H. What does a pointer store?
   - I. What data structure stores elements in contiguous memory?
   - J. Which data type is used to store a sequence of characters?

Part-II

2. All are Compulsory (answer within 50 words) **9x2=18**
   - A. What is a floating data type? Give one example.
   - B. Differentiate between char and string.
   - C. Differentiate between cin and cout.
   - D. Explain increment and decrement operators with examples.
   - E. Define logical operators. Name any two.
   - F. What is the purpose of the if–else statement?
   - G. Differentiate between while and do–while loops.
   - H. What is call by reference?
   - I. Differentiate between value return and void functions.

Part-III

3. Answer any 8 out of 10 questions in 250 word **8x5=40**
   - A. Describe different types of data types in C++ with suitable examples.
   - B. Explain arithmetic operators in C++ and discuss operator precedence with an example.
   - C. Explain character and string data types with examples.
   - D. Explain variables and constants in C++. Write the syntax for their declaration with examples.
   - E. Explain increment and decrement operators in C++ with examples.
   - F. Discuss different looping statements in C++ (for, while, do–while) with examples.
   - G. Explain nested control statements and the use of the continue statement with examples.
   - H. Explain functions in C++. Describe value returning functions with examples.
   - I. Describe one-dimensional and two-dimensional arrays with examples.
   - J. Describe expressions in C++ and explain their evaluation.

Part-IV

4. Answer any 4 out of 5 Questions in 800 words **4x8=32**

A. Explain the concept of structured programming in detail. Discuss its principles, advantages, and significance in C++ program development.

B. Describe input and output operations in C++ using cin and cout. Explain the role of extraction (>>) and insertion (<<) operators with examples.

C. Explain expressions in C++. Discuss increment and decrement operators and their types with examples.

D. Explain the switch statement in C++. Discuss the use of break and continue statements with examples.

E. Explain pointers in C++. Describe pointer variables and their applications with suitable examples.

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