DAY — 09 SEAT NUMBER | | | | | | | |

2026	II	21	1100	J-169	(E)

MATHEMATICS & STATISTICS (88)
(COMMERCE)

Time : 3 Hrs. (15 Pages) Max. Marks : 80

General Instructions :

(i) *All questions are compulsory.*

(ii) *There are six questions divided into two sections.*

(iii) *Write answers of Section-I and Section-II in the same answer book.*

(iv) *Use of logarithmic tables is allowed. Use of calculator is not allowed.*

(v) *For L.P.P. and Time Series graph paper is not necessary. Only rough sketch of graph is expected.*

(vi) *Start answer to each question on a new page.*

(vii) *For each objective type of question (i.e. Q.1 and Q.4) only the first attempt will be considered for evaluation.*

SECTION - I

Q. 1. **(A)** Select and write the correct answer of the following multiple choice type of questions (1 mark each) : [12] (6)

(i) If $y=\sqrt[3]{a^2+x^2}$ then $\frac{dy}{dx}=$ _____.

(a) $\frac{2}{3}x(a^2+x^2)^{\frac{-2}{3}}$

(b) $\frac{2}{3}x(a^2+x^2)^{\frac{2}{3}}$

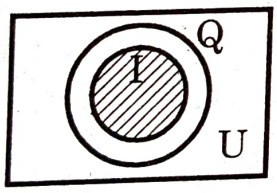
(c) $\frac{2}{3}(a^2+x^2)^{\frac{-2}{3}}$

(d) $\frac{2}{3}(a^2+x^2)^{\frac{2}{3}}$

(ii) If $y=\log\left(\frac{e^x}{x^2}\right)$ then $\frac{dy}{dx}=$ _____.

(a) $\frac{2-x}{x}$ (b) $\frac{x-2}{x}$

(c) $\frac{e-x}{e^x}$ (d) $\frac{x-e}{ex}$

(iii) 

U : the set of all real numbers
Q : the set of all rational numbers
I : the set of all integers.

The above Venn diagram represents the truth value of which of the following statements?

(a) Some integers are rational numbers.

(b) All integers are rational numbers.

(c) No integers are rational numbers.

(d) All rational numbers are integers.

SEAT NUMBER | | | | | | | |

(iv) The equation of normal to the curve $y=3x^2-x+1$ at $(1, 3)$ is _____.

(a) $x-5y-16=0$ (b) $x+5y-16=0$

(c) $x-5y+16=0$ (d) $-5y-x-16=0$

(v) The solution of $\frac{dy}{dx}=1$ is :

(a) $x+y=c$ (b) $xy=c$

(c) $x^2+y^2=c$ (d) $y-x=c$

(vi) If $\int_0^a 3x^2dx=8$ then $a=$ _____.

(a) 2 (b) 0

(c) $\frac{8}{3}$ (d) 1

(B) State whether the following statements are true or false (1 mark each) : (3)

(i) If $y=20+15x+x^2$ then $\frac{dx}{dy}=\frac{1}{15+2x}$.

(ii) If $\int\frac{x}{(1+x)(2+x)}dx=\int\left(\frac{A}{1+x}+\frac{B}{2+x}\right)dx$

then $A=1$, $B=2$.

(iii) Order and degree of a differential equation are always positive integers.

(C) Fill in the following blanks (1 mark each) : (3)

(i) Statement $p\leftrightarrow q$ is true, when p and q have _____ truth values.

(ii) If $y=e^{ax}$ then $x\frac{dy}{dx}=$ _____.

(iii) If $f(x) = x \cdot \log x$ then its minimum value is _____.

Q. 2. **(A)** Attempt any TWO of the following questions (3 marks each) : [14] (6)

(i) Using truth table, examine whether the following statement pattern is a tautology, a contradiction or a contingency.

$(p \wedge \sim q) \rightarrow (\sim p \wedge \sim q)$

(ii) If $e^x + e^y = e^{(x+y)}$ then show that $\frac{dy}{dx} = -e^{y-x}$.

(iii) Evaluate : $\int \frac{1+x}{x+e^{-x}} dx$

(B) Attempt any TWO of the following questions (4 marks each) : (8)

(i) Find the inverse of $\begin{bmatrix} 1 & -1 & 1 \\ 2 & 1 & -3 \\ 1 & 1 & 1 \end{bmatrix}$ by adjoint method.

(ii) The consumption expenditure E_c of a person with income x is given by $E_c = 0.0006x^2 + 0.003x$.

Find average propensity to consume, marginal propensity to consume when his income is ₹ 200. Also find his marginal propensity to save and average propensity to save.

(iii) Evaluate : $\int_2^7 \frac{\sqrt{x}}{\sqrt{x} + \sqrt{9-x}} dx$

SEAT NUMBER | | | | | | | |

Q. 3. (A) Attempt any TWO of the following questions (3 marks each) : [14]

(6)

(i) If the demand function is $D = 50 - 3p - p^2$, find the elasticity of demand at $p = 5$. Comment on the result.

(ii) If p : He swims

q : Water is warm

Give the verbal statements for the following symbolic statements :

(a) $p \leftrightarrow \sim q$

(b) $\sim (p \vee q)$

(c) $q \rightarrow p$

(iii) Evaluate : $\int \frac{1}{4x^2 - 20x + 17}\, dx$

(B) Attempt any ONE of the following questions (4 marks each):

(4)

(i) Solve the following differential equation

$(x^2 - y^2)dx + 2xy\, dy = 0$

(ii) Find the area of the region bounded by the curve $x^2 = 16y$ and the line $y = 4$.

(C) Attempt any ONE of the following questions (Activity) (4 marks each):

(4)

(i) Express the following equations in matrix form and solve them by method of reduction.

$x - y + z = 1,\ 2x - y = 1,\ 3x + 3y - 4z = 2$

Solution :

The given equations can be written in matrix form as

$$\begin{bmatrix} 1 & -1 & 1 \\ 2 & -1 & 0 \\ 3 & 3 & -4 \end{bmatrix}\begin{bmatrix} x \\ y \\ z \end{bmatrix}=\begin{bmatrix} 1 \\ 1 \\ 2 \end{bmatrix}$$

By $R_2 \to R_2 - 2R_1$

$$\begin{bmatrix} 1 & -1 & 1 \\ \square & \square & \square \\ 3 & 3 & -4 \end{bmatrix}\begin{bmatrix} x \\ y \\ z \end{bmatrix}=\begin{bmatrix} 1 \\ -1 \\ 2 \end{bmatrix}$$

By $R_3 \to R_3 - 3R_1$

$$\begin{bmatrix} 1 & -1 & 1 \\ 0 & 1 & -2 \\ \square & \square & \square \end{bmatrix}\begin{bmatrix} x \\ y \\ z \end{bmatrix}=\begin{bmatrix} 1 \\ -1 \\ -1 \end{bmatrix}$$

By $R_3 \to R_3 - 6R_2$

$$\begin{bmatrix} 1 & -1 & 1 \\ 0 & 1 & -2 \\ 0 & 0 & 5 \end{bmatrix}\begin{bmatrix} x \\ y \\ z \end{bmatrix}=\begin{bmatrix} 1 \\ -1 \\ \square \end{bmatrix}$$

We write equations as

$x - y + z = 1$ .....(I)

$y - 2z = -1$ .....(II)

$5z = 5$ .....(III)

Solving equations (I), (II) and (III)

We get $x = \square$, $y = \square$, $z = \square$

(ii) Obtain the differential equation from the relation $Ax^2 + By^2 = 1$, where A and B are constants.

Solution :

The given equation is $Ax^2 + By^2 = 1$ .....(I)

Differentiating equation (I) w.r.t. x,

we get,

$$\square\, x + 2By\frac{dy}{dx} = 0$$

$$Ax + By\frac{dy}{dx} = 0 \qquad \text{.....(II)}$$

Differentiating equation (II) w.r.t. x,
we get

$$A + B\square = 0 \qquad \text{.....(III)}$$

Since equations (I), (II) and (III) are consistent in A and B

$$\therefore \quad \begin{vmatrix} x^2 & y^2 & 1 \\ x & y\frac{dy}{dx} & 0 \\ 1 & \square & 0 \end{vmatrix} = 0$$

$$\therefore \quad \left\{ x\left[y\frac{d^2y}{dx^2} + \left(\frac{dy}{dx}\right)^2 \right] - y\frac{dy}{dx} \right\} = 0$$

$$\therefore \quad \square + x\left(\frac{dy}{dx}\right)^2 - y\frac{dy}{dx} = 0$$

P.T.O

SECTION - II

Q. 4. **(A)** Select and write the correct answer of the following multiple choice type of questions (1 mark each) : [12]

(6)

(i) The difference between face value and present worth is called _____.

(a) Banker's discount

(b) True discount

(c) Banker's gain

(d) Cash value

(ii) Insurance companies collect a fixed amount from their customers at a fixed interval of time. This amount is called _____.

(a) EMI

(b) Installment

(c) Contribution

(d) Premium

(iii) If $b_{YX} > 1$ then b_{XY} is _____.

(a) > 1

(b) < 0

(c) $= 0$

(d) < 1

(iv) Which of the following can't be a component of a time series?

(a) Seasonality

(b) Cyclical

(c) Trend

(d) Mean

SEAT NUMBER | | | | | | | |

(v) Price Index Number by Simple Aggregate Method is given by :

(a) $\Sigma \frac{p_1}{p_0} \times 100$

(b) $\Sigma \frac{p_0}{p_1} \times 100$

(c) $\frac{\Sigma p_1}{\Sigma p_0} \times 100$

(d) $\frac{\Sigma p_0}{\Sigma p_1} \times 100$

(vi) If the corner points of the feasible region are (0, 10), (2, 2) and (4, 0) then the point of minimum $z = 3x + 2y$ is _____.

(a) (2, 2)

(b) (0, 10)

(c) (4, 0)

(d) (2, 4)

(B) State whether the following statements are true or false (1 mark each) : (3)

(i) The banker's discount is always lower than the true discount.

(ii) The cost of living Index Number using weighted relative method is given by $\frac{\Sigma IW}{\Sigma W}$.

(iii) To convert an assignment problem into a minimization problem, the smallest element in the matrix is deducted from all other elements.

P.T.O

(C) Fill in the following blanks (1 mark each) : (3)

(i) The difference between the banker's discount and the true discount is called _____.

(ii) If $P_{01}(L) = 225$, $P_{01}(P) = 144$ then $P_{01}(F) =$ _____.

(iii) A dish washing machine holds up to 40 pieces of large crockery (x). This constraint is given by _____.

Q. 5. (A) Attempt any TWO of the following questions (3 marks each) : [14] (6)

(i) A shop is valued at ₹ 3,60,000 and is insured for 75% of its value. If the rate of premium is 0.9%, find the premium paid by the owner of the shop. Also find the agent's commission if the agent gets commission at 15% of the premium.

(ii) Given the following information about the production (X) and demand (Y) of a commodity, obtain the regression line of X on Y.

	Production (X)	Demand (Y)
Mean	85	90
S.D.	5	6

Coefficient of correlation between X and Y is 0.6.

Also estimate the production when demand is 100.

(iii) The following table shows the production of pig-iron and ferro-alloys ('000 metric tons)

Years	1974	1975	1976	1977	1978	1979	1980	1981	1982
Production	0	4	9	9	8	5	4	8	10

Find trend values for the above data by using 5 yearly moving averages.

(B) Attempt any TWO of the following questions (4 marks each) : (8)

(i) Solve the following L.P.P. by graphical method.

Minimize : $z = 8x + 10y$

Subject to : $2x + y \geq 7,\ 2x + 3y \geq 15,$

$y \geq 2, x \geq 0, y \geq 0$

(ii) Solve the following assignment problem for minimization :

Men	Tasks (in hours)			
	I	II	III	IV
A	7	25	26	10
B	12	27	3	25
C	37	18	17	14
D	18	25	23	9

(iii) The probability distribution of a discrete r.v. X is as follows :

x	1	2	3	4	5	6
$P(X = x)$	k	$2k$	$3k$	$4k$	$5k$	$6k$

(a) Determine the value of k.

(b) Find $P(X \leq 4), P(2 < X < 4), P(X \geq 3)$

Q. 6. (A) Attempt any TWO of the following questions (3 marks each) : [14]

(6)

(i) The true discount on a sum is $\frac{3}{8}$ of the sum due at 12% p.a. Find the period of the bill.

(ii) Following data shows the number of bags of cereals sold in years 1977 to 1984.

Years	1977	1978	1979	1980	1981	1982	1983	1984
No. of bags (in ten thousands)	1	0	3	8	10	4	5	8

Fit a trend line to the above data by graphical method.

(iii) The following is the p.d.f. of a r.v. X:

$$f(x)=\begin{cases}\frac{x}{8} & \text{for } 0<x<4\\ 0, & \text{otherwise}\end{cases}$$

Find (a) $P(x<1.5)$

(b) $P(1<x<2)$

(c) $P(x>2)$

(B) Attempt any ONE of the following questions (4 marks each) : (4)

(i) For the following bivariate data obtain the equation of regression line of Y on X.

X	1	2	3	4	5
Y	5	7	9	11	13

(ii) Calculate (a) Laspeyre's and (b) Paasche's Price Index Numbers for the following data :

Commodity	Base Year		Current Year	
	Price	Quantity	Price	Quantity
P	12	20	18	24
Q	14	12	21	16
R	8	10	12	18
S	16	15	20	25

(C) Attempt any ONE of the following questions (Activity) (4 marks each) : (4)

(i) Determine the optimal sequence of jobs that minimizes the total elapsed time for the data given below (processing time on machines is given in hours). Also find the total elapsed time and the idle time for three machines.

Jobs	I	II	III	IV	V	VI	VII
Machine A	3	8	7	4	9	8	7
Machine B	4	3	2	5	1	4	3
Machine C	6	7	5	11	5	6	12

Solution :

Here min A = 3, min C = 5, Max B = 5. Since Min $C \geq \max B$ is satisfied, the problem can be converted into a two machine problem.

Let G and H be two fictitious machines

$\therefore\ G = A + B,\ H = B + C$

The above problem can be written as :

Jobs	I	II	III	IV	V	VI	VII
Machine G	7	11	9	9	10	12	10
Machine H	10	10	7	16	6	10	15

Using optimal sequence algorithm, the following sequence can be obtained.

			VI	II		

Work table :

Jobs	Machine A		Machine B		Machine C	
	In	Out	In	Out	In	Out
I	0	3	3	7	7	13
IV	3	7	7	12	13	24
□	7	14	14	17	24	36
VI	14	22	22	26	36	42
II	22	30	30	33	□	49
□	30	37	37	39	49	54
V	37	46	46	47	54	59

$\therefore$ Total elapsed time is = 59 hrs.

Idle time for machine A = □ hrs.

Idle time for machine B = □ hrs.

Idle time for machine C = 7 hrs.

SEAT NUMBER | | | | | | | |

(ii) In a town 10 accidents take place in the span of 50 days. Assuming that the number of accidents follows Poisson distribution, find the probability that there will be 3 or more accidents on a day.

[Given that $e^{-0.2} = 0.8187$]

Solution :

Here $m =$ [ ] and $X \sim P(m)$ with parameter m.

The p.m.f. of X is :

$$P(X = x) = \frac{e^{-m} \cdot m^x}{x!}, \quad x = 0, 1, 2, \ldots$$

$$P(X \geq 3) = 1 - P(X < 3)$$

$$= 1 - [\,[\quad] + [\quad] + [\quad]\,]$$

$$= 1 - \left[\frac{e^{-0.2}(0.2)^0}{0!} + \frac{e^{-0.2}(0.2)^1}{1!} + \frac{e^{-0.2}(0.2)^2}{2!}\right]$$

$$= 1 - [0.8187(1 + 0.2 + 0.02)]$$

$$= 1 - [\quad]$$

$$= [\quad]$$

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