Series JPR_PB/25-26/12/241/SET No.1

ROLL NO_____

कक्षा/**CLASS:XII** **Subject: Applied Mathematics (241)**

अवधि/**Time :3 hours** अधिकतम अंक/**MaximumMarks:80**

NOTE:-

- Please check that this question paper pcontains 8 printed pages.
- Please check that this question paper contains 38 questions.
- Please write down the serial number of the question in the answer-book before attempting it.
- 15 minutes time has been allotted to read the question paper. The students will read the question paper only and will not write any answer on the answer-book during this period.

General Instructions:

दिशा निर्देश/**General Instructions:**

1. This question paper contains 38 questions. All questions are compulsory.
2. Question paper is divided into FIVE sections-Section A, B, C,D and E.
3. In Section A, Question number 1 to 18 are Multiple Choice Questions (MCQs) and Question number 19 and 20 are Assertion-Reason based questions carrying 1 mark each.
4. In Section B, Question number 21 to 25 are Very Short Answer (VSA) type questions carrying 2 marks each.
5. In Section C, Question number 26 to 31 are Short Answer (SA) type questions carrying 3 marks each.
6. In Section D, Question number 32 to 35 are Long Answer (LA) type questions carrying 5 marks each.
7. In Section E, Question number 36 to 38 are Case Study Based question carrying 4 marks each.
8. There is no overall choice. However, an internal choice has been provided in 2 questions in Section B, 2 questions in Section C, 2 questions in Section D and 2 questions in Section E.
9. Use of calculator is NOT allowed.

SECTION – A

This section comprises of 18 multiple choice questions and two assertion and reason type questions of 1 mark each.

Q.No.	Question	Marks
1.	[(3×7)+5]$mod 4$ is (A)3 (B)2 (C)4 (D)5	1
2.	The ratio in which a grocer mixes two varieties of pulses costing Rs 85 per kg and Rs 100 per kg respectively so as to get a mixture worth Rs 92 per kg, is (A) 7:8 (B) 8:7 (C) 5:7 (D) 7:5	1
3.	If $x^y = e^{x-y}$ $then \frac{dy}{dx}$ is (A)$\frac{1+x}{1+logx}$ (B)$\frac{1-logx}{1+logx}$ (C)$\frac{logx}{(1+logx)^2}$ (D) None of these	1

4. Match the following columns to complete the sentence and choose the correct option — 1

Trend Component	Pattern of variation	Time period of variation
I. Secular trend	a. is a regular periodic variability	i. over a period more than a year
II. cyclical trend	b. has smooth, regular variations	ii. within a period of one year
III. seasonal trend	c. has oscillatory variation	iii. over a long-term period

(A) I – a – ii; II – b – iii; III – c – i (B) I – b – iii; II – c – i; III – a – ii (C) I – b – ii; II – c – i; III – a – iii (D) I – b – ii; II – a – iii; III – c – i

5. If the cash equivalent of a perpetuity of Rs 300 payable at the end of each quarter is Rs 24000 then rate of interest compounded quarterly is — 1

(A) 2% (B) 4% (C) 3% (D) 5%

6. For two distinct positive numbers $x \; and \; y$ — 1

(A) $x+y>2\sqrt{xy}$ (B) $\frac{x+y}{2}>xy$ (C) $\sqrt{xy}>\frac{x+y}{2}$ (D) $\frac{2xy}{x+y}>\sqrt{xy}$

7. If A is a skew symmetric matrix then B^TAB will be — 1

(A) Symmetric Matrix (B)Skew symmetric matrix (C)Unit matrix (D)Zero matrix

8. $\int e^{xloga}e^x\,dx$ is equal to — 1

(A) $\frac{a^x}{logae}+C$ (B) $\frac{e^x}{1+loga}+C$ (C) $(ae)^x+C$ (D) $\frac{(ae)^x}{logae}+C$

9. A Specific characteristic of a population is known as a — 1

(A) a sample (B) parameter (C) statistic (D) mean

10. In one sample t- test, the estimation for population mean is — 1

(A) $\frac{\bar{x}-\mu}{\frac{S}{\sqrt{n}}}$ (B) $\frac{\bar{x}-\mu}{\frac{S}{n}}$ (C) $\frac{\bar{x}-\mu}{\frac{S^2}{n}}$ (D) $\frac{\bar{x}_1-\bar{x}_2}{\frac{S}{\sqrt{n}}}$

11. If solving a system of linear equations in 3 variables by Cramer's rule, we get Δ=0 and at least one of $\Delta x,\Delta y,\Delta z$ is non-zero then the system of linear equations has — 1

(A) no solution (B) unique solution
(C) infinitely many solutions (D) trivial solution

12. The degree of the differential equation $\left(1+\left(\frac{dy}{dx}\right)^2\right)^{\frac{3}{2}}=\frac{d^2y}{dx^2}$ — 1

(A) 2 (B) $\frac{3}{2}$ (C) 4 (D) not defined

13.	EMI stands for (A)Easy monthly installments (B) Emerging monthly installments (C) Equated monthly installments (D)None of these	1
14.	If A is a non singular matrix of order 3 and $\|A\| = -4$, find $\|A.\ adjA\|$ (A)16 (B)32 (C)64 (D)-64	1
15.	Corner points of the feasible region for an LPP are (0, 2), (3, 0), (6, 0), (6, 8) and (0, 5). Let F = 4x+ 6y be the objective function. The Minimum value of F occurs at (A) only (0, 2) (B) only (3, 0) (C) the mid-point of the line segment joining the points (0, 2) and (3, 0) only (D) any point on the line segment joining the points (0, 2) and (3, 0).	1
16.	A discrete random variable X has the probability distribution given as below X | 0.5 | 1 | 1.5 | 2 P(X) | K | K^2 | $2K^2$ | K Find the value of k? (A) 1 (B) $\frac{1}{3}$ (C)$\frac{1}{4}$ (D) $\frac{2}{3}$	1
17.	If A is a square matrix such that A^2=A, then $(I + A)^2$ -3A is (A) I (B) 2A (C) 3I (D) A	1
18.	Mr. X takes a loan of Rs 2,00,000 with 10% annual interest rate for 5 years. Calculate EMI under Flat Rate system. (A) Rs 4,000 (B) Rs 5,000 (C) Rs 6,000 (D) Rs 7,000	1

	Questions 19 and 20 are Assertion and Reason based questions carrying 1 mark each. Two statements are given, one labelled Assertion (A) and the other labelled Reason (R). **Select the correct answer from the options (A), (B), (C) and (D) as given below:** (A) Both Assertion (A) and Reason (R) are true and (R) is the correct explanation of Assertion (A). (B) Both Assertion (A) and Reason ((R) are true but (R) is not the correct explanation of Assertion (A). (C) Assertion (A) is true but Reason (R) is false. (D) Assertion (A) is false but Reason (R) is true.	
19.	**Assertion (A):** For two matrices A and B of order 3,$\|A\|$=3,$\|B\|$=−4 then $\|2AB\|$=−96 **Reason (R):** For a matrix A of order n and a scalar k then $det\ (kA)$=k raised to the power n. (det A)	1
20.	**Assertion (A):** The mean and variance of a binomial variate are 2.4 and 1.44 respectively, then q= $\frac{2}{5}$	1

	Reason (R): If X~ (n,p) then mean and variance of X are np and npq respectively.	
SECTION – B **This section comprises of 5 very short answer (VSA) type questions of 2 marks each**.		
21(A)	'A' can run 40 meters while 'B' runs 50 meters in the same time. In a 1000 m race, find by how much distance 'B' beats 'A'. **OR**	2
21(B)	Two pipes can fill the tank in 20 minutes and 24 minutes respectively and a waste pipe can empty 3 gallons of water per minute. If all the three pipes working together can fill the tank in 15 minutes, find the capacity of the tank.	
22	If X follows binomial distribution with parameters n = 5, p and P(X =2) = 9 P(X=3), Then find the value of p.	2
23	The value V(t) of a machine at time t, in years, follows a linear depreciation model, where the initial value of the machine is ₹ 25,000 and it depreciates by ₹ 2,500 each year. At what time will the value of the machine be half of its initial value? Find the value of the machine after 6 years.	2
24(A)	For the Poison Distribution , Find P(2), given λ=0.7 **OR**	2
24(B)	A Radar unit is installed to measure the speed of cars in highway. The speeds are normally distributed with mean 80 km/hr and standard deviation 10 km/hr. Find the probability of a car running at less than 60 km/hr? [Use F(2) = 0.9772]	
25.	A person invested ₹15000 in a mutual fund and the value of investment at the time of redemption was ₹25000. If CAGR for this investment is 8.88%, Calculate the time period for which the amount was invested? [$Given$ log(1.667) = 0.2219 & log(1.089) = 0.037]	2
SECTION – C **This section comprises of 6 short answer (SA) type questions of 3 marks each**.		
26.	There are 3 points P, Q and R in a straight line such that Q is equidistant from P and R. A can swim from P to R downstream in 24 hours and from Q to P upstream in 16 hours. Find the ratio of speed of man in still water to speed of stream?	3
27(A).	The supply function for a commodity is p = x^2 + 4x + 5 where x denotes supply. Find the producers' surplus when the price is 10. **OR**	3
27(B).	Find $\int \frac{x^2}{(x^2+1)(x^2+4)}\,dx$	
28(A).	Mr Sharma wants to send his daughter abroad for higher studies after 10 years. He sets up a sinking fund in order to have Rs 5,00,000 after 10 years. How much should he set aside semi annually into an account paying 5% per annum compounded annually. [Use $(1.025)^{20}$= 1.6386] **OR**	3

28(B).	A company establishes sinking fund to provide for the payment of Rs. 1,00,000 debt. maturing in 4 years. Contributions to the fund are to be made at the end of every year. Find the amount of each annual deposit if interest is 18% per annum.	
29.	Find the remainder when 5^{61} is divided by 7.	3

30.	Hole punching machine is set to punch a hole 1.84 cm in diameter in a strip of sheet metal in a manufacturing process. The strip of metal is then creased and sent on to the next phase of production, where a metal rod is slipped through the hole. It's important that the hole be punched to the specified diameter of 1.84 cm. To test punching accuracy, technicians randomly sampled 16 punched holes and measured the diameters. The sample data (in centimeters) has a mean of 1.85 and variance 0.0064. Set up null and alternate hypothesis to test if the machine is working properly (whether the holes are being punched an average of 1.84 centimeters), at an alpha level of 0.05. Assume the punched holes are normally distributed in the population. Given: [t(0.05,15) = 2.131]	3
31.	Solve the following problem graphically: Maximize Z = 3x + 9y subject to the constraints: x + 3y ≤ 60 x + y ≥ 10 , x ≤ y , x ≥ 0, y ≥ 0	3
	SECTION – D **This section comprises of 4 long answer (LA) type questions of 5 marks each**.	
32(A).	FindA^{-1} if A = $\begin{bmatrix} -1 & 2 & 5 \\ 2 & -3 & 1 \\ -1 & 1 & 1 \end{bmatrix}$ .Hence solve the system of linear equations 2x – 3y+z = 15 ; -x + y + z = -3; -x +2y + 5z = 2. **OR**	5
32(B).	The equilibrium conditions for three competitive markets are described as given below, where p_1, p_2 and p_3 are the equilibrium price for each market respectively. p_1+2p_2+3p_3=85, 3p_1+2p_2+2p_3=105 and 2p_1+3p_2+2p_3=110 Using matrix method, find the values of respective equilibrium prices.	
33.	Find the intervals in which the function f given by $f(x) = 4x^3 - 6x^2 - 72x + 30$ is (a) increasing (b)decreasing.	5

34(A). 5

The following table relates to the tourist arrivals (in millions) during 2004 to 2010 in India:

Year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Tourist Arrivals	**18**	**20**	**23**	**25**	**24**	**28**	**30**

(I) Fit a straight-line trend by the method of least squares.
(II)Estimate the number of tourists that would arrive in the year 2014.

OR

34(B).

The following data shows the number of vehicles passing through a busy traffic intersection on a specific road in National Capital of India during the months of March to December in 2023:

Month	**Number of vehicles (in thousands)**
March	30
April	35
May	38
June	36
July	40
August	42
September	39
October	45
November	48
December	47

Calculate the 3-month moving average for the given data and determine the trend. Plot the graph to represent the trend values.

35. 5

Rajesh purchased a house from a company for ₹2500000 and made a down payment of ₹500000. He repays the balance in 25 years by monthly instalments at the rate of 9% per annum compounded monthly. (Given $(1.0075)^{-300}$= 0.1062) Then

(i)Find the number of payments and find the rate of interest per month.

(ii) What are the monthly payments of instalments using *reducing balance method*?

SECTION – E

This section comprises of 3 case study/passage-based questions of 4 marks each with sub parts. The first two case study questions have three sub parts (i), (ii), (iii) of marks 1, 1, 2 respectively. The third case study question has two sub parts of 2 marks each

36. A factory produces bulbs, of which 6% are defective bulbs in a large bulk of bulbs.

Based on the above information, answer the following questions

(i)Find the probability that in a sample of 100 bulbs selected at random none of the bulbs are defective (Use e^{-6}=0.0024) 1

(ii) Find the probability that the sample of 100 bulbs has exactly two defective bulbs. 1

(iii) Find the probability that the sample of 100 bulbs will include not more than one defective bulb. 2

OR

Find the Mean and Variance of the distribution of number of defective bulbs in a sample of 100 bulbs

37. The relation between the height of the plant ($\boldsymbol{y}$ $\boldsymbol{cm}$) with respect to exposure to sunlight is governed by the equation $\boldsymbol{y} = \boldsymbol{4x} - \frac{1}{2}\,x^2$, where $\boldsymbol{x}$ is the number of days exposed to light.

Based on the above information, answer the following questions.

(i) Find the rate of growth of the plant with respect to number of days exposed to sunlight. 1

(ii) What will be the height of the plant after 2 days? 1

(iii) What is the maximum number of days it will take for the plant to grow to the maximum height? What is the maximum height of the plant? 2

OR

If the height of the plant is 3.5 cm, find the number of days it has been exposed to the sunlight.

38.	A dietician has to develop a special diet using two foods P and Q. Each packet (containing 30 g) of food P contains 12 units of calcium, 4 units of iron, 6 units of cholesterol and 6 units of vitamin A. Each packet of the same quantity of food Q contains 3 units of calcium, 20 units of iron, 4 units of cholesterol and 3 units of vitamin A. The diet requires at least 240 units of calcium, at least 460 units of iron and at most 300 units of cholesterol. (i)Formulate the objective function and the constraints of the above Linear programming problem. (ii)How many packets of each food should be used to minimise the amount of vitamin A in the diet?	2 2