MID-TERM EXAMINATION (SESSION: 2025-26)
CLASS: XII
SUBJECT: APPLIED MATHEMATICS (Code-241)
TIME ALLOTTED: 3 HOURS **MAXIMUM MARKS: 80**

NAME OF THE STUDENT: _____ **ROLL NO. _____**

General Instructions:

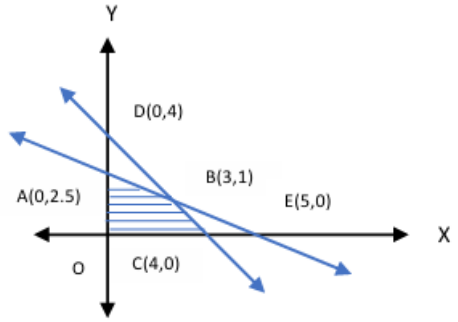
1. This Question paper contains - **five sections** A, B, C, D and E. Each section is compulsory. However, there is some internal choice in some questions.
2. **Section A** has 18 **MCQ's and 02** Assertion Reason based questions of 1 mark each.
3. **Section B** has 5 **Very Short Answer (VSA)** questions of 2 marks each.
4. **Section C** has 6 **Short Answer (SA)** questions of 3 marks each.
5. **Section D** has **4 Long Answer (LA)** questions of 5 marks each.
6. **Section E** has 3 **source based/case based/passage based/integrated units of assessment** (04 marks each) with sub parts.
7. Internal Choice is provided in **2 questions in Section-B, 2 questions in Section-C, 2 Questions in Section-D.** You have to attempt only one alternatives in all such questions.
8. Use of calculators is not allowed.

SECTION – A

(All questions are compulsory. No internal choice is provided in this section)

<table>
<tr><th>Q.No.</th><th>Question</th><th>Marks</th></tr>
<tr><td>1</td><td>Milk and water in two vessels A and B are in the ratio 5 : 3 and 5 : 4 respectively. In what ratio the liquid of both the vessels be mixed to obtain a new mixture in which ratio of milk and water is 7 : 5 respectively.
(A) 3 : 2 (B) 3 : 5 (C) 2 : 3 (D) 2 : 5</td><td>1</td></tr>
<tr><td>2</td><td>In a 700 m race, Khushi reaches the finish point in 20 seconds and Neha reaches in 25 seconds. Khushi beats Neha by a distance of
(A) 120 m (B) 150 m (C) 140 m (D) 100 m</td><td>1</td></tr>
<tr><td>3</td><td>If $x + y = 8$, then the maximum value of (xy) is :
(A) 12 (B) 16 (C) 20 (D) 24</td><td>1</td></tr>
<tr><td>4</td><td>Match the following columns to complete the sentence and choose the correct option
<table>
<tr><th>Trend Component</th><th>Pattern of variation</th><th>Time period of variation</th></tr>
<tr><td>I. Secular trend</td><td>a. is a regular periodic variability</td><td>i. over a period more than a year</td></tr>
<tr><td>II. seasonal trend</td><td>b. has oscillatory variation</td><td>ii. over a long-term period</td></tr>
<tr><td>III. cyclical trend</td><td>c. has smooth, regular variations</td><td>iii. within a period of one year</td></tr>
</table>
(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 – c – ii; II – a – iii; III – b – i</td><td>1</td></tr>
</table>

5	The present value of a sequence of payments of ₹ 300 made at the beginning of every 6 month and continuing forever. If money is worth 6% per annum compounded semi-annually, then the present value of the sequence is: (A) ₹ 5300 (B) ₹ 5000 (C) ₹ 10300 (D) ₹ 10000	**1**
6	If x > y and z < 0, then : (A) xz > yz (B) xz ≥ yz (C) $\frac{x}{z} > \frac{y}{z}$ (D) $\frac{x}{z} < \frac{y}{z}$	**1**
7	If A = $\begin{bmatrix} 2x & 0 \\ x & x \end{bmatrix}$ and $A^{-1} = \begin{bmatrix} 1 & 0 \\ -1 & 2 \end{bmatrix}$, then the value of x is: (A) 1 (B) $\frac{1}{2}$ (C) $-\frac{1}{2}$ (D) 2	**1**
8	What time will it be after 1275 hours, if the present time is 9:00 p.m.? (A) 12 p.m. (B) 10 p.m. (C) 12 a.m. (D) 10 a.m.	**1**
9	The central limit theorem states that if the sample size_____ (A) decreases then the sample distribution must approach normal distribution (B) increases then sampling distribution must approach normal distribution (C) decreases then the sampling distribution much approach an exponential distribution (D) increases then the sampling distribution much approach an exponential distribution	**1**
10	If a man rows 32 km downstream and 14 km upstream in 6 hours each, then the speed of the stream is (A) 2 km/h (B) 1.5 km/h (C) 2.5 km/h (D) 2.25 km/h	**1**
11	For a 3×3 matrix if adj A = $2A^{-1}$, find $\lvert 3AA^T \rvert$ (A) 108 (B) 12 (C) 54 (D) 8	**1**
12	In a 300 m race, A beats B by 22.5 m or 6 seconds. B's time over the race course is. (A) 80 sec (B) 82 sec (C) 76 sec (D) 90 sec	**1**
13	At what rate of interest will the present value of a perpetuity of ₹ 700 payable at the end of each month be ₹ 1,20,000? (A) 7 % p.a (B) 8 % p.a. (C) 5 % p.a. (D) 6 % p.a	**1**
14	If A and B are two square matrices such that $B = -A^{-1}BA$, then $(A + B)^2$ is equal to (A) $A^2 + B^2$ (B) $A^2 + B^2 + 2AB$ (C) $A^2 + B^2 - 2AB$ (D) $A^2 - B^2$	**1**
15	A and B are square matrices of order 3. The determinants of A and B are 5 and 4 respectively, then the determinant of the matrix $4AB$ is (A) 80 (B) 480 (C) 1280 (D) 6400	**1**
16	The mean number of heads in two tosses of a coin is (A) 2 (B) $\frac{1}{2}$ (C) 1 (D) $\frac{3}{2}$	**1**

17	Besides non negativity constraint the figure given below is subject to which of the following constraints  (A) $x + 2y \leq 5; x + y \leq 4$ (B) $x + 2y \geq 5$; $x + y \leq 4$ (C) $x + 2y \geq 5; x + y \geq 4$ (D) $x + 2y \leq 5$; $x + y \geq 4$	**1**
18	An investment becomes of ₹ 10,000 becomes ₹ 14,000 in 6 years, then CAGR is given by: (use $(1.4)^{1/6} = 1.058$ (A)10.58% (B) 9.58% (C) 5.8% (D) 6.58%	**1**
	For questions 19 and 20, two statements are given – one labelled Assertion(A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (i), (ii), (iii) and (iv) as given below: (i) Both A and R are true and R is the correct explanation of the assertion (ii) Both A and R are true but R is not the correct explanation of the assertion (iii) A is true, but R is false (iv) A is false, but R is true	
19	Assertion (A) : Minor of element a_{13} in the matrix $\begin{bmatrix} 0 & 2 & 6 \\ 1 & 2 & -1 \\ 2 & 1 & 3 \end{bmatrix}$ *is* $\begin{vmatrix} 1 & 2 \\ 2 & 1 \end{vmatrix}$. Reason (R) : Minor of an element a_{ij} of a matrix is the determinant obtained by deleting its j_{th} row and i_{th} column in which the element lies. (A) i (B) ii (C) iii (D) iv	**1**
20	Assertion (A): If a random variable X follows a binomial distribution with parameters n and p, then the mean of X is always less than or equal to its variance. Reason (R): Probability of an event lies between 0 and 1 (0 and 1 included).	**1**
	SECTION – B (All questions are compulsory. In case of internal choice, attempt any one question only)	
21(A)	Find the unit's digit of 12^{12}. OR	**2**
21(B)	Without finding the values of the square roots, prove that the inequality $\sqrt{7} + \sqrt{5} > \sqrt{10} + \sqrt{2}$ holds true.	

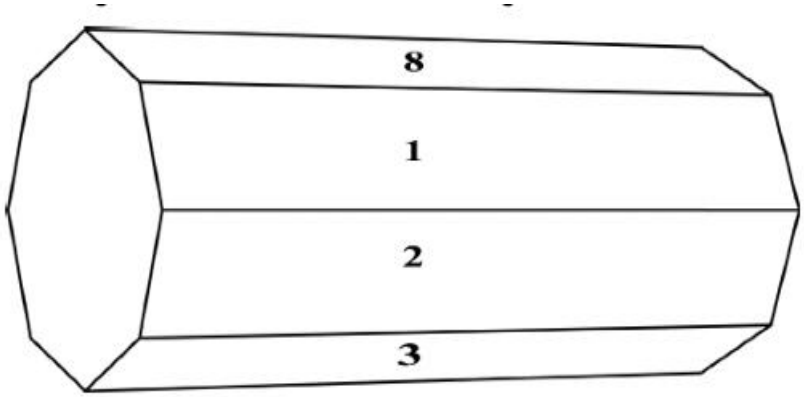
22(A)	A small town experiences an average of 2 power outages per month. Assuming the number of power outages follows a Poisson distribution, find the probability that in a given month, there will be exactly 3 power outages, given that there will be at least one power outage (Use $e^{-2} = 0.14$). OR	**2**
22(B)	It is known that 3% of phones manufactured in a factory are defective. Using the Poisson distribution on a sample of 100 phones, find the probability of: (i) Zero defective phones (ii) At most one phones is defective. [Use $e^{-3} = 0.049$]	
23	If $A = \begin{bmatrix} 1 & 0 \\ -1 & 7 \end{bmatrix}$, find the value of k such that $A^2 - 8A + kI = 0$.	**2**
24	The population of a town increases from 75,000 to 1,25,000 over a period of time. If the compound annual growth rate is 5%, calculate the number of complete years it will take for the population to grow from 75,000 to 1,25,000. [Use log(1.67) = 0.223 and log(1.05) = 0.021]	**2**
25	A book publisher sells a hard cover edition of a book for ₹ 72 and a paperback edition for ₹ 40. In addition to a fixed weekly cost of ₹ 9,600, the cost of printing hardcover and paperback editions are ₹ 56 and ₹ 28 per book respectively. Each edition requires 5 minutes on the printing machine whereas hardcover binding takes 10 minutes and paperback takes 2 minutes on the binding machine. The printing machine and the binding machine are available for 80 hours each week. Formulate the linear programming problem to maximise the publisher's profit.	**2**
	SECTION- C (All questions are compulsory. In case of internal choice, attempt any one question only)	
26	The duration of flight travel from Chennai to London through Indian Airlines is approximately 11 hours. The airplane begins its journey on Sunday at 23:30 hours. If the time at Chennai is four and half hours ahead to that of London's time, then find the time at London, when will the flight lands at London Airport. Find using modulo arithmetic	**3**
27(A)	A sports bike ₹ 2,00,000 has effective life of 7 years and its scrap value is ₹ 30,000. What amount should Proveer put into a sinking fund earning 5% p.a. so that it can replace the bike after its useful life ? Assume that a new bike will cost ₹ 3,00,000 after 7 years. [Given : $(1.05)^7 = 1.407$] OR	**3**
27(B)	A bond having a face or maturity value of ₹ 56,000, redeemable at par in 6 years carries a coupon rate of 7% p.a., to be paid quarterly. Find the purchase price of the bond if effective yield rate is to be 9% p.a., compounded quarterly. [Use $(1.0225)^{-24} = 0.58$]	

28 Two pipes can fill a tank individually in 1 hour and 75 minutes respectively. There is also an outlet pipe which empty the tank. If all the three pipes are opened together, the tank is full in 50 minutes. How much time will be taken by C to empty the full tank? **3**

29(A) The incidence of injury in a sport is such that the players have a 25% chance of getting injured from it. What is the probability that out of five players 4 or more will get injured? **3**

OR

29(B) An octagonal prism is a three-dimensional polyhedron bounded by two octagonal bases and eight rectangular side faces. It has 24 edges and 16vertices. The prism is rolled along the rectangular faces and number on the bottom face (touching the ground) is noted.



Let X denotes the number obtained on the bottom face and the following table gives the probability distribution of X.

X	1	2	3	4	5	6	7	8
P(X)	m	2m	2m	m	2m	m^2	$2m^2$	$7m^2 + m$

On the above context, answer the following questions.

i) Find the value of m.

ii) Find the mean E(X)

30 On a multiple choice examination with three possible answers (out of which only one is correct) for each of the five questions, what is probability that a candidate would get four or more correct answers just by guessing. **3**

31 If a young woman rides her motorcycle at 30 km/hr, she had to spend ₹ 3 per km on petrol. If she rides at a faster speed of 50 km/hr, the petrol cost increases to ₹ 6 per km. She has ₹ 500 to spend on petrol and wishes to find the maximum distance she can travel within one hour. Formulate the objective function and the constraints of the above Linear programming problem. **3**

SECTION – D

(All questions are compulsory. In case of internal choice, attempt any one question only)

32(A) A peacock was sitting in the vidyalaya at (0, k); $k > 0$. Then it starts flying along the path whose equation is given by $y = ax^2 + bx + c$, where $a \in R - \{0\}$, $b\ c, \in R$. It passes through the points (1,2), (2,1) and (4,5). Using Cramer's Rule, find the values of a, b, c and hence k **5**

OR

32(B) A shopkeeper has 3 varieties of pens A, B and C. Harshit purchased 1 pen of each variety for a total of ₹ 21. Kanika purchased 4 pens of A variety, 3 pens of B variety and 2 pens of C variety for ₹ 60. While Shweta purchased 6 pens of A variety, 2 pens of B variety and 3 pens of C variety for ₹ 70. Using matrix method, find cost of each variety of pen.

33 A company has approximated the marginal cost and marginal revenue functions for one of its products by $MC = x^2 - 16x + 81$ and $MR = 20x - 2x^2$ respectively. Determine the profit maximizing output and the total profit at the optimum output, assuming fixed cost as zero. **5**

34 In the year 2010, Mr. Antim Chopra took a home loan of ₹ 30,00,000 from State Bank of India at 7·5% p.a. compounded monthly for 20 years. Find the monthly payments of instalments (EMI) using reducing balance method and the total interest paid over the loan period. [Use $(1{\cdot}00625)^{240} = 4{\cdot}4608$] **5**

35(A) Fit a straight-line trend by using the method of least squares for the following data and calculate the trend values. Also predict the production for the year 1995. **5**

Year	1986	1987	1988	1989	1990
Sales (₹in crores)	4	9	10	7	8

OR

35(B) The quarterly production of a small-scale industry (in tonnes) are as follows. Calculate 4-quarterly moving averages. Plot the graph to represent the trend values.

Year	Quarter 1	Quarter 2	Quarter 3	Quarter 4
2020	20	39	47	56
2021	66	68	72	59
2022	60	67	60	88

SECTION – E

(This section comprises of 3 source based questions (Case Studies) of 4 mark each)

36 CASE STUDY I. The Applied Mathematics scores of a group of 600 students follow a normal distribution with a mean of 75 and a standard deviation of 8.
Based on this data, answer the following questions:

(i) What percentage of students scored below 75 marks? **1**

	(ii) Find the number of students who scored more than 82 marks.	1
	(iii) (A) Calculate the number of students scoring between 67 and 83 marks. OR (B) The top 10% of students are awarded a scholarship. The Z-score for the 90th percentile is 1.28. Determine the minimum score required to qualify for the scholarship. Use $P(Z< 0.875) = 0.8092$, $P(Z < 1) = 0.8413$, $P(Z < -1) = 0.1587$	2
37	CASE STUDY II. P(x): $-5x^2 + 125x + 37500$ is the total profit function of a company, where x is the production of the company.  Based on the above information, answer the following questions:	
	(i) (A) What will be the production when the profit is maximum? Also what will be the maximum profit? OR (B) Find the interval in which the profit is strictly increasing.	2
	(ii) What will be the profit of the company when the production is 2 units?	1
	(iii) What will be the production of the company when the profit is ₹ 38250?	1
38	CASE STUDY III: A manufacturer has three machines I, II and III installed in his factory. Machines I and II are capable of being operated for at most 12 hours whereas machine III must be operated for at least 5 hours a day. He produces only two items M and N, each requiring the use of all the three machines. The number of hours required for producing 1 unit of M and N on three machines are given in the following table:	

Items	**Number of hours required on machines**		
	I	II	III
M	1	2	1
N	2	1	1.25

He makes a profit of ₹ 600 and ₹ 400 on one unit of items M and N respectively.
Based on the above information, answer the following questions:

(i)	Formulate the above problem as LPP	2
(ii)	Solve it graphically to find how many units of each item be produced to maximize profit. Also find the maximum profit.	2