COMMON PRE-BOARD EXAMINATION

APPLIED MATHEMATICS-Code No. 241

Class-XII-(2025-26)

SET: 3

Time allowed: 3 Hrs. **Maximum Marks: 80**

General Instructions:

Read the following instructions very carefully and follow them:

1. This question paper contains 38 questions. All questions are compulsory.
2. This Question paper is divided into five Sections - A, B, C, D and E.
3. In Section A, Questions no. 1 to 18 are multiple choice questions (MCQs) and Questions no. 19 and 20 are Assertion-Reason based questions of 1 mark each.
4. In Section B, Questions no. 21 to 25 are Very Short Answer (VSA)-type questions, carrying 2 marks each.
5. In Section C, Questions no. 26 to 31 are Short Answer (SA)-type questions, carrying 3 marks each.
6. In Section D, Questions no. 32 to 35 are Long Answer (LA)-type questions, carrying 5 marks each.
7. In Section E, Questions no. 36 to 38 are case study-based questions 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 one sub-part each in 2 questions of Section E.
9. Use of calculators is not allowed.

Q. No.	Questions	Marks

SECTION- A

1. If A and B are matrices of the same order, then $(AB^T - B^TA)$ is a [1]

A) skew symmetric matrix B) null matrix

C) unit matrix D) symmetric matrix

2. If for some probability distribution with random variable X, E(X) = $\frac{k}{3}$ and E(X^2) = k^2 then V(X) = [1]

A) $\frac{8k^2}{9}$ B) $\frac{2k^2}{3}$ C) $\frac{3k^2-k}{9}$ D) k^2

3. The value of $\int_0^1 xe^{x^2}\,dx$ [1]

A) $\frac{2}{3}(e-1)$ B) $\frac{1}{4}(2e-1)$ C) $(e-1)$ D) $\frac{1}{2}(e-1)$

4. If A is a singular matrix, then adj A is [1]

A) symmetric B) singular C) not defined D) non-singular

5. The amount of money required to endure a series of lectures costing ₹2500 at the beginning of each year, forever, if money is worth 5% compounded annually is [1]

A) ₹ 25050 B) ₹ 52000 C) ₹ 50500 D) ₹ 52500

6. In a 800 metre race, A beats B by 74 metre and in a 600 metre race, B beats C by 50 metre. By how many metres will A beat C in a race of 500 metre? [1]

A) 90m B) 84.06m C) 86.04m D) 80.46m

7. If A = $\begin{bmatrix}1 & 1\\ 1 & 1\end{bmatrix}$ satisfies $A^4 = \lambda A$ then $\lambda =$ [1]

A) 4 B) 8 C) 3 D) 16

8. $-114(mod\ 11) =$ [1]

A) 4 B) 10 C) 7 D) 2

9. Which of the following is a probability sampling method? [1]

A) Convenience sampling B) Quota sampling

C) Purposive sampling D) Stratified random sampling

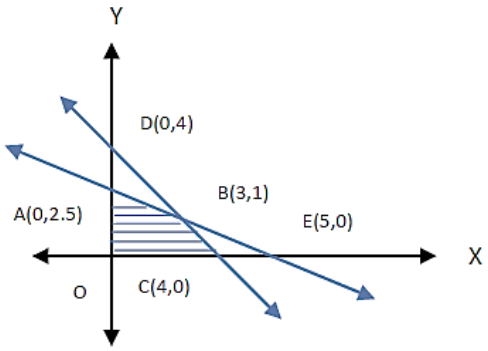
10. If average revenue is (6 + x), then marginal revenue function is [1]

A) $6x + x^2$ B) 6 C) 2x + 3 D) 2(x + 3)

11. If a 3-year moving average is used, how many values are lost at both ends of the original series? [1]

A) 1 at each end B) 2 at each end C) 1 in total D) 3 in total

12. The adjoining graph encloses a shaded region(**feasible region**) as shown. Other than x ≥ 0 and y ≥ 0, which of the following constraints satisfies the solution region: [1]



A) $x + 2y \leq 5; x + y \leq 4$

B) $x + 2y \geq 5; x + y \leq 4$

C) $x + 2y \leq 5; x + y \geq 4$

D) $x + 2y \geq 5; x + y \geq 4$

13. In what ratio must a grocer mix 2 varieties of tea worth ₹60 a kg and ₹65 a kg so that by selling the mixture at ₹68.20 a kg, he may gain 10%? [1]

A) 2 : 3 B) 3 : 2 C) 1 : 4 D) 4 : 1

14. A matrix P has (a + b) rows and (a + 2) columns while the matrix Q has (b + 1) rows and (a + 3) columns. Both PQ and QP exist. Then value of a and b is [1]

A) 2 and 3 B) 1 and 4 C) 2 and 4 D) 4 and 3

15. The sum of order and degree of the differential equation

$x^2\left(\frac{d^2y}{dx^2}\right)^3 + y\left(\frac{dy}{dx}\right)^4 + y^4 = 0$ is [1]

A) 7 B) 5 C) 6 D) 11

16. If the cash equivalent of a perpetuity of ₹1200 payable at the end of each quarter is ₹ 96,000, then the rate of interest convertible quarterly is [1]

A) 4% B) 5% C) 5.5% D) 6.5%

17. Which of the following is not a requirement of binomial distribution? [1]

A) There are 2 outcomes for each trial

B) There is a fixed number of trials

C) The outcomes must be dependent on each other

D) The probability of success must be same for all the trials

18. If A = $\begin{bmatrix}loge & e^2\\ log1 & 2loge\end{bmatrix}$ and A(adj A) = $\begin{bmatrix}k & 0\\ 0 & k\end{bmatrix}$, then k = [1]

A) 2 B) 0 C) -1 D) 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 A), B), C) and D) as given below:

A) Both A and R are true and R is the correct explanation of the assertion
B) Both A and R are true but R is not the correct explanation of the assertion
C) A is true, but R is false
D) A is false, but R is true

19 **Assertion (A):** In the reducing rate system, the EMI decreases over time as the principal reduces. [1]

Reason (R): Interest is recalculated each month on the reduced outstanding balance.

20. **Assertion (A):** The t-distribution is used when the population standard deviation is unknown and the sample size is small. [1]

Reason (R): For large samples, the t-distribution approximates the normal distribution.

SECTION – B

21. M/s KJ Earthmovers was founded on April 1, 2018 by a RK Sharma. The yearly revenue numbers for firm are shown in the adjacent table. Find the compound annual growth rate of the company. [2]

2018-2019	2019-2020	2020-2021
₹300000	₹ 250000	₹ 550000

Given: $(1.833)^{\frac{1}{3}} = 1.2239$

22. If a, b are two positive real numbers such that ab = 1, then prove that (1 + a) (1 + b) ≥ 4

OR [2]

Show that $10^{515} \equiv 5(mod 7)$

23. Suppose the key punching of 80 column IBM cards, the mean number of mistakes per card is 0.3. What percentage of the cards will have
i) no mistakes [2]
ii) only one mistake

Given : $e^{-0.3} = 0.7408$

24. Prove that mean of a binomial distribution is always greater than its variance.

OR

In a hurdle race, a player must cross 10 hurdles. The probability that he will clear each hurdle is $\frac{5}{6}$. What is the probability that he will knock down fewer than 2 hurdles. [2]

25. A vehicle costs ₹8,00,000 and has an expected residual value of ₹80,000 after 8 years. Find: (a) annual depreciation (b) value after 5 years. [2]

SECTION – C

26. A factory makes products A and B. Product A needs 1 hour on Machine M_1 and 2 hours on Machine M_2. Product B needs 2 hours on M_1 and 1 hour on M_2. Each day M_1 is available 100 hours and M_2 is available 80 hours. Profit is ₹300 per unit of A and ₹400 per unit of B. A contract requires that at least 20% of the total production (by units) must be A. Also, because of market demand, production of B cannot exceed twice the production of A. If x and y are the number of units of A and B produced, then formulate the LPP for maximizing the profit. [3]

27. A boat travels from point A to B along the stream and back. The ratio of speed of the boat in still water to the speed of stream is 36 : 5. The boat takes 5 hours 10 minutes to go with the stream from A and reach at B, how much time will it take during the return journey to A. [3]

28. A tank can be filled in 5 hours by 3 pipes A, B and C. The pipe C is twice as fast as B and pipe B is twice as fast as A. How much time each pipe alone takes to fill the tank? [3]

29. A senior meteorologist claims that the annual rainfall at a certain place is normally distributed with mean 45 cm. A sample of the rainfall during the last 5 years is collected to verify the claim The amount of rainfall during last five years is found out to be 47 cm, 41 cm, 40 cm, 44 cm and 43 cm. Using alpha value at 5% can we conclude that the claim of the senior meteorologist is correct. [Given: $t_{(4,\ 0.05)} = 2.132$] [3]

30. A firm anticipates a capital expenditure of ₹50,000 for a new equipment in 5 years. How much money should be deposited quarterly in a sinking fund at 12% per annum compounded quarterly to accumulate the required amount. [Given: $(1.03)^{20} = 1.8061$]

OR

Rohit buys a car for which he makes down payment of ₹1,50,000 and the balance is to be paid in 2 years by monthly installment of ₹25,448 each. If the financer charges interest at the rate of 20% per annum, find the actual price of the car. [Given $\left(\frac{61}{60}\right)^{-24} = 0.6725$] [3]

31. Evaluate $\int \frac{2x-1}{(x-1)(x+2)(x-3)}\,dx$

OR

Solve the differential equation $x(1+y^2)dx - y(1+x^2)dy = 0$, given y = 0 , when x = 1. [3]

SECTION – D

32. For the matrix A = $\begin{bmatrix} 3 & 1 \\ 7 & 5 \end{bmatrix}$, find x and y so that A^2 + xI = yA. Hence find A^{-1}.

OR

The sum of the digits of a three-digit number is 11. If the digits are reversed, the new number is 46 more than five times the original number. If the hundred digit plus twice the tens digit is equal to the unit's digit, then find the original three-digit number? [5]

33. Find the purchase price of a ₹50,000, 6% bond, dividends payable semi-annually, redeemable at par in 10 years and the yield to maturity is 5% compounded semi-annually. [Given: $(1.025)^{-20} = 0.61027$] [5]

34. For a particular commodity the demand and supply functions are

p = D(x) = $16 - \frac{x^2}{100}$ and p = S(x) = $\frac{x^2}{400} + 6$ respectively.

Determine to the nearest rupee the consumer surplus and producer surplus if market equilibrium prevails. [5]

35. Fit a straight-line trend by method of least squares to find the trend values using the following data. [5]

Year:	2010	2012	2013	2014	2015	2016	2019
Sales (in lakhs)	65	68	70	72	75	67	73

OR

Find the trend values by taking four yearly moving averages for the following data:

Year:	2015	2016	2017	2018	2019	2020	2021	2022
Sales (in lakhs)	108	112	110	120	140	120	100	135

SECTION – E

36. For a product, the demand function is p = $\frac{50}{\sqrt{x}}$ and cost function is 0.5x + 100.

i) Find the Profit function P(x) for the product.

ii) Show that P'(x) = $\frac{1}{2}(p-1)$

iii) If 800 < x < 5000 then find the interval in which [4]

a) P(x) strictly increases

OR

b) P(x) strictly decreases

37. The mathematics scores of a group of 500 students follow a normal distribution with a mean of 75 and a standard deviation of 8. Based on this data, answer the following questions using the provided values:

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

(ii) Find the number of students who scored more than 82 marks.

(iii) (a) Calculate the number of students scoring between 67 and 83 marks. [4]

OR

(iii) (b) The top 10% of students is awarded a scholarship. The Z-score for the 90th percentile is 1.28. Determine the minimum score required to qualify for the scholarship.

Use $P(Z < 0.875) = 0.8092,\ P(Z < 1) = 0.8413,\ P(Z < -1) = 0.1587$

38. A company manufactures three kinds of calculators: A, B and C in its two factories, I and II. The company has got an order for at least 6400 calculators of kind A, 4000 of kind B and 4800 of kind C. The daily output of factory I is 50 calculators of kind A, 50 calculators of kind B and 30 calculators of kind C. The daily output of factory II is 40 calculators of kind A, 20 of kind B and 40 of kind C. The cost per day to run factory I is Rs. 12000 and factory II is Rs. 15000. The manufacturer is interested to find that for how many days the two factories must be in operation to produce the order at the minimum cost. [4]

(i) Formulate this problem as an LPP.

(ii) Using graph, find the number of days the two factories must be in operation to produce the order at the minimum cost. Also find the minimum cost.