



**K R MANGALAM WORLD SCHOOL, GK II**  
**PREBOARD EXAMINATION I (2023-24)**  
**APPLIED MATHEMATICS (241)**  
**CLASS XII**

**MM 80**

**Time 3 hours**

**General Instructions:**

*Read the following instructions carefully and strictly follow them:*

1. *This question paper contains 38 questions and 6 printed pages. All questions are compulsory.*
2. *Answer the questions carrying 1 mark by writing the correct option and answer in the answer sheet.*
3. *This question paper is divided into five sections A, B, C, D and E.*
4. *In Section A, Questions no. 1 to 18 are multiple choice questions (MCQ's) and questions no. 19 and 20 are Assertion-Reason based questions of 1 mark each.*
5. *In Section B, Questions no. 21 to 25 are very short answer (VSA) type questions, carrying 2 marks each.*
6. *In Section C, Questions no. 26 to 31 are short answer (SA) type questions, carrying 3 marks each.*
7. *In Section D, Questions no. 32 to 35 are long answer (LA) type questions carrying 5 marks each.*
8. *In Section E, Questions no. are 36 to 38 are case-study based questions carrying 4 marks each.*
9. *Use of calculators is not allowed.*

**Section – A**

*This section comprises multiple choice questions (MCQs) of 1 mark each.*

1. What is the least value of 'x' that satisfy  $x \equiv 27 \pmod{4}$ , when  $27 < x \leq 36$ ?
  - a) 27
  - b) 30
  - c) 31
  - d) 35
2. The length of rectangle is double the breadth. If the minimum perimeter of the rectangle is 120 cm, then
  - a) breadth  $> 20$  cm
  - b) breadth  $< 20$  cm
  - c) breadth  $\geq 20$  cm
  - d) breadth  $\leq 20$  cm
3. If A = diagonal [1, -2, 5], B = diagonal [3,0,-4] and C = diagonal [-2, 7, 0], then find A + 2B – 3C.
  - a) diagonal [13, -23,3]
  - b) diagonal [13, -23,-3]
  - c) diagonal [13, 23,-3]
  - d) diagonal [13, 23,3]
4. For the purpose of t-test of significance, a random sample of size (n) 34 is drawn from a normal population, then the degree of freedom (v) is -
  - a)  $\frac{1}{34}$
  - b) 33
  - c) 34

- d) 35
5. A machine costing Rs C would reduce to Rs 10000 in 7 years. If annual depreciation charge is Rs 10,000, then the value of C is
- 80000
  - 70000
  - 60000
  - none of these

6. If the matrix  $\begin{bmatrix} 0 & -1 & 3x \\ 1 & y & -5 \\ -6 & 5 & 0 \end{bmatrix}$  is skew-symmetric, then

- $x = -2, y = 0$
- $x = 2, y = 0$
- $x = -2, y = 1$
- $x = 2, y = -1$

7. In the given figure (I), what is the LPP shaded region known as?

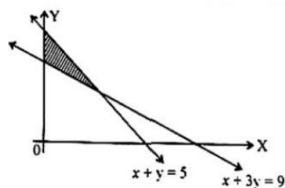


Figure (I)

- Feasible region
  - Feasible solution
  - Optimal region
  - Objective region
8. Calculate the EMI under 'Flat rate system' for a loan of Rs 5,00,000 with 10% annual interest rate for 5 years.
- Rs 12,500
  - Rs 10,000
  - Rs 15,000
  - Rs 20,000
9. If  $\begin{bmatrix} 1 & 3 & 9 \\ 1 & x & x^2 \\ 4 & 6 & 9 \end{bmatrix}$  is singular matrix, then  $x =$
- 3
  - 3 or 6
  - 3 or  $3/2$
  - 3,  $3/2$
10. In a school, a random sample of 145 students is taken to check whether a student's average calory intake is 1500 or not. The collected data of average calories intake of sample students is presented in a frequency distribution, which is called a:
- Statistics
  - Sampling distribution
  - Parameter
  - population sampling
11. Two water supplying trucks – A and B supply water to remote areas. Truck A is carrying 100 litres of water to a village 1.5 km away and truck B is delivering 80 litres of water to another village, 1 km away. Due to bad road conditions, each truck loses 20 ml water while travelling each metre distance. Which truck is able to deliver more water and by how much more?

- a) Truck A, 20 litres  
 b) Truck B, 20 litres  
 c) Truck B, 10 litres  
 d) Truck A, 10 litres
12. If  $X$  is a Poisson variable such that  $P(X = k) = P(X = k + 1)$ , then variance of  $X$  is  
 a)  $k - 1$   
 b)  $k$   
 c)  $k + 1$   
 d)  $k + 2$
13. Standard deviation of a sample from a population is called a -  
 a) Standard error  
 b) Parameter  
 c) Statistic  
 d) Central limit
14. The demand function of a monopolist is given by  $x = 100 - 4p$ . The quantity at which  $MR(\text{marginal revenue}) = 0$  will be  
 a) 25  
 b) 10  
 c) 50  
 d) 40
15. The present value of a sequence of payments of Rs 1000 made at the end of every 6 months and continuing forever, if money is worth 8% per annum compounded semi-annually.  
 a) Rs 25000  
 b) Rs 20000  
 c) Rs 30000  
 d) Rs 28000
16. For predicting the straight-line trend in the sales of scooters (in thousands) on the basis of 6 consecutive years data, the company makes use of 4-year moving averages method. If the sales of scooters for respective years are  $a, b, c, d, e$  and  $f$  respectively, then which of the following average will not be computed?  
 a)  $\frac{a+b+c+d}{4}$   
 b)  $\frac{b+c+d+e}{4}$   
 c)  $\frac{a+c+d+e}{4}$   
 d)  $\frac{c+d+e+f}{4}$
17. If the marginal revenue function of a product is given by  $MR = 2x - 9x^2$  then the revenue function is  
 a)  $2x^2 - 9x^3$   
 b)  $2 - 18x$   
 c)  $x^2 - 3x^3$   
 d)  $18 + x^2 - 3x^3$
18. An investment of ₹ 10,000 becomes ₹ 60,000 in 4 years, then the CAGR (compound annual growth rate) is given by -  
 a)  $\frac{\sqrt[4]{6}-1}{100}$   
 b)  $\frac{\sqrt[4]{6}+1}{100}$   
 c)  $(\sqrt[4]{6} + 1)100$

d)  $(\sqrt[4]{6} - 1)100$

(19-20) Statement I is called Assertion (A) and Statement II is called Reason (R). Read the given statements carefully and choose the correct answer from the options given below.

- (a) Both the statements are true and statement II is the correct explanation of statement I.
- (b) Both the statements are true and statement II is not the correct explanation of statement I.
- (c) Statement I is true, Statement II is false.
- (d) Statement I is false, statement II is true.

19. Let  $y = f(x)$  be an odd function.

Statement I:  $\int_{-a}^a f(x)dx = 0$ .

Statement II:  $\int_{-a}^a f(x)dx$  represents the area bounded by the curve  $y = f(x)$ , the  $x$ -axis and the ordinates  $x = -a$  and  $x = a$ .

20. Statement I: The area under the standard normal curve which lies right of  $Z = -0.48$  is  $F(0.48)$ .

Statement II: If  $Z$  is a standard normal variable, then  $F(z)$  represents the entire area which is left of the line  $Z = z$ .

### Section B

*This section comprises very short answer (VSA) type questions of 2 marks each.*

- 21. Mr Rajesh has two investment options either 10% per annum compounded semiannually or 9.8% per annum compounded quarterly. Which option is better for Mr Rajesh? Given:  $(1.0245)^4 = 1.1017$
- 22. Maximize  $Z = 3x + 4y$  (if possible) subject to constraints  $x - y \leq -1$ ,  $-x + y \leq 0$ ,  $x, y \geq 0$
- 23. If  $A = \begin{bmatrix} 3 & -2 & 3 \\ 2 & 1 & -1 \\ 4 & -3 & 2 \end{bmatrix}$ , find  $A(\text{adj } A)$  without computing  $\text{adj } A$ .
- 24. Explain feasible region and feasible solution in Linear Programming Problem.
- 25. If  $A = \begin{bmatrix} -1 & 2 \\ 3 & 1 \end{bmatrix}$ , find  $f(A)$ , where  $f(x) = x^2 - 2x + 3$ .

### Section C

*This section comprises short answer (SA) type questions of 3 marks each.*

- 26. Let  $A = \begin{bmatrix} 1 & 2 & 1 \\ 2 & 3 & 1 \\ 1 & 1 & 5 \end{bmatrix}$ . Verify that  $[\text{adj } A]^{-1} = \text{adj}(A^{-1})$ .
- 27. In a certain culture of bacteria, the rate of increase is proportional to the number present. It is found that there are 10,000 bacteria at the end of 3 hours and 40,000 bacteria at the end of 5 hours. How many bacteria were present in the beginning?
- 28. Rahul is at the whole sale market to purchase folding tables and chairs, to later sell them at his furniture shop. He has only ₹ 5,760 to spend and his van has space to carry at the most 20 items. A table costs him ₹ 360 and a chair costs ₹ 240. Back at his shop, he plans to sell a table at a profit of ₹ 22 and a chair at a profit of ₹ 18. Given that he can sell all the items that he purchases, how many tables and chairs shall he purchase in order to maximise his profit?

29. In a math aptitude test, student scores are found to be normally distributed having mean as 45 and standard deviation 5. What percentage of students have scores –
- more than the mean score?
  - between 30 and 50?
30. Consider the following hypothesis test:  
 $H_0: p = 0.20$   
 $H_a: p \neq 0.20$   
 A sample of 400 provided a sample proportion  $\bar{p} = 0.175$
- Compute the value of the test statistic.
  - What is the p-value?
  - At  $\alpha = 0.05$ , what is your conclusion?
  - What is rejection rule using critical rule? What is your conclusion?
31. A swimmer whose speed in swimming pool is 4 km/h, swims between two points in a river and returns back to the starting point. He took 10 minutes more to cover the distance upstream than downstream. If the speed of the stream is 2 km/h, find the distance between two points.

### Section D

*This section comprises long answer type questions (LA) of 5 marks each.*

32. (a) A tank is filled by three pipes with uniform flow. The first two pipes operating simultaneously fill the tank in the same time during which the tank is filled by third pipe alone. The second pipe fills the tank 5 hours faster than the first pipe and 4 hours slower than the third pipe. Find the time required by first pipe to fill the tank alone.  
 (b) How many litres of water will have to be added to 1125 litres of the 45% solution of acid so that the resulting mixture will contain more than 25% but less than 30% acid content?
33. Evaluate the following integral:
- $\int \frac{2x}{(x^2+1)(x^2+2)^2} dx$
  - $\int_0^1 \log\left(\frac{1}{x} - 1\right) dx$
34. A loan of Rs 250000 at the interest rate of 6% p.a. compounded monthly is to be amortized by equal payments at the end of each month for 5 years, find
- the size of each monthly payment.
  - the principal outstanding at beginning of 40<sup>th</sup> month.
  - interest paid in 40<sup>th</sup> payment.
  - principal contained in 40<sup>th</sup> payment
  - total interest paid. (Given  $(1.005)^{60} = 1.3489$ ,  $(1.005)^{21} = 1.1104$ )
35. The production of a soft drink company in thousands of litres during each month of a year is as follows:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.2	0.8	1.4	1.6	1.8	2.4	2.6	3.0	3.6	2.8	1.9	3.4

Calculate the five monthly moving averages and show these moving averages on a graph paper.

### Section E

*This section comprises of 3 case-study based questions of 4 marks each.*

36. According to an educational board survey, it was observed that class XII students apply at least one to four weeks ahead of colleges application deadline. Let  $X$  represent the week when an average student applies ahead of a college's application deadline and the probability of student to get admission in the college  $P(X = x)$  is given as follows:

$$P(X = x) = \begin{cases} \frac{kx}{6}, & \text{when } x = 0, 1 \text{ or } 2 \\ \frac{(1-k)x}{6}, & \text{when } x = 3 \\ \frac{kx}{2}, & \text{when } x = 4 \end{cases}$$

Where  $k$  is a real number. Based on the above information, answer the following questions. Show steps to support your answers.

- Find the value of  $k$ . (1)
- What is the probability that Sonali will get admission in the college, given that she applied at least 2 weeks ahead of application deadline? (1)
- Calculate the mathematical expectation of number of weeks taken by a student to apply ahead of a college's application deadline. (2)

OR (2)

To promote early admissions, the college is offering scholarships to the students for applying ahead of deadline as follows:

- ₹ 50000 for applying 4 weeks early,
- ₹ 20000 for applying 3 weeks early,
- ₹ 12000 for applying 2 weeks early,
- and ₹ 9600 for applying 1 week early

What is the expected scholarship offered by the college?

37. A retirement home- sometimes called an old people's home or old age home, although old people's home can also refer to a nursing home- is a multi-residence housing facility intended for the elderly. Typically, each person or couple in the home has an apartment – style room or suite of rooms.  
Sanjay buys a old age home in Haridwar. He agrees to pay the seller a lump sum of Rs 9,50,000 in five years. Until then, he will make monthly simple interest payments to the seller at 15% interest.

- Find the amount of each interest payment. (2)
- Sanjay sets up a sinking fund to save the Rs 9,50,000. Find the size of his semiannually payments if his payments are due at the end of every six-month period and his money earns interest per annum compounded half yearly. Given  $(1.06)^{10} = 1.7908$  (2)

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

Based on the above information, answer the following questions:

- Find the rate of growth of the plant with respect to number of days exposed to sunlight. (1)
- What will be the height of the plant after 2 days? (1)
- What is the 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 (2)

If the height of the plant is  $\frac{7}{2}$  cm, find the number of days it has been exposed to the sunlight.

