

**Pre Board Examination**  
**Class: XII**  
**Applied Mathematics**  
**Subject Code - 241**

**Time Allowed: 3 hr**

**Maximum Marks: 80**

**General Instructions:**

1. This question paper contains five sections A, B, C, D and E. Each section is compulsory.
2. Section - A carries 20 marks weightage, Section - B carries 10 marks weightage, Section - C carries 18 marks weightage, Section - D carries 20 marks weightage and Section - E carries 3 case-based with total weightage of 12 marks.

**Section – A:**

3. It comprises of **20 MCQs of 1 mark** each.

**Section – B:**

4. It comprises of **5 VSA type questions of 2 marks** each.

**Section – C:**

5. It comprises of **6 SA type of questions of 3 marks** each.

**Section – D:**

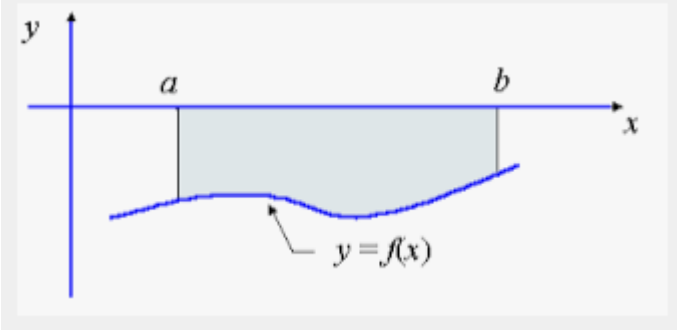
6. It comprises of **4 LA type of questions of 5 marks** each.

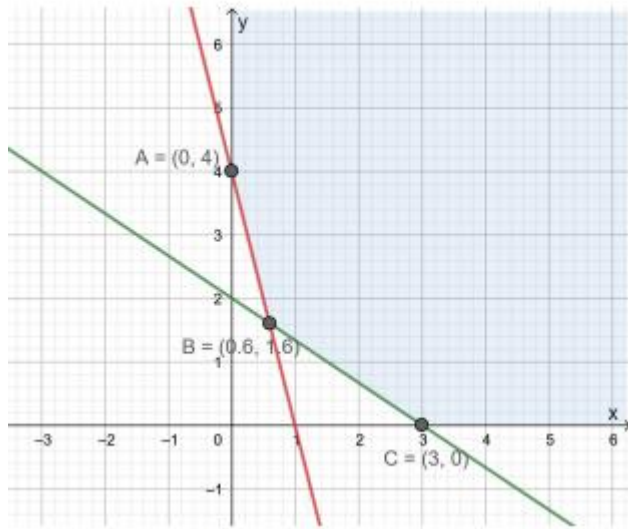
**Section – E:**

7. It has **3 case studies**. Each case study comprises of 3 case-based questions, where **2 VSA type questions are of 1 mark** each and **1 SA type question is of 2 marks**. Internal choice is provided in **2 marks** question in each case-study.

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 of the alternatives in all such questions.

<b><u>SECTION – A</u></b> (All questions are compulsory. No internal choice is provided in this section)	
1.	If $a \equiv b \pmod{n}$ and $q$ is some integer, then (a) $b = a + nq$ (b) $b = a - nq$ (c) $b = nq$ (d) $b = a \cdot nq$
2.	If $0 < x < 1$ , which of the following is greatest (a) $x$ (b) $x^2$ (c) $\frac{1}{x}$ (d) $\frac{1}{x^2}$
3.	A simple random sample consists of four observations 1,3,5,7. What is the point estimate of population standard deviation? (a) 2.3      (b) 2.52      (c) 0.36      (d) 0.4
4.	For the purpose of t-test of significance, a random sample of size $(n)$ 45 is drawn from a normal population, then the degree of freedom $(v)$ is - (a) 44      (b) 45      (c) $\frac{1}{45}$ (d) 46
5.	Speed of river is 6km/hr. Speed of boat in still water is 30km/hr. Distance travelled by the boat in 24

	minutes downstream is (a) 9.8 km                      (b) 12 km                      (c) 12.8 km                      (d) 14.4 km
6.	If we reject the null hypothesis, we might be making (a) Type-I error                      (b) Type-II error                      (c) A correct decision                      (d) A wrong decision
7.	Two water supplying trucks – A and B supply water to remote areas. Truck A is carrying 120 litres of water to a village 2 km away and truck B is delivering 85 litres of water to another village, 1 km away. Due to bad road conditions, each truck loses 15 ml water while travelling each metre distance. Which truck is able to deliver more water and by how much more? (a) Truck A, 10 litres                      (b) Truck B, 10 litres                      (c) Truck A, 20 litres                      (d) Truck B, 20 litres
8.	The face value of a sinking fund that yields a dividend of ₹1000 at 5% quarterly is (a) 80000                      (b) 20000                      (c) 40000                      (d) 8000
9.	In the given figure, the area bounded by the curve $y = f(x)$ , x-axis and $x = a$ and $x = b$ is equal to –  (a) $\int_a^b f(x)dx$ (b) $\int_a^b f(y)dy$ (c) $\int_a^b  f(x) dx$ (d) $\int_a^b f(y)dy$
10.	A factory production is delayed for 20 days due to fire. Under which trend oscillation does this situation fall ? (a) Seasonal                      (b) Irregular                      (c) Secular                      (d) Cyclical
11.	A paper bag making machine costs ₹ 3,00,000 and estimated scrap value of ₹ 20,000 at the end of its useful life of 4 years. What is its annual depreciation as per linear method? (a) 70000                      (b) 7000                      (c) 80000                      (d) 8000
12.	The corner points of the shaded unbounded feasible region of an LPP are (0, 4), (0.6, 1.6) and (3, 0) as shown in the figure. The minimum value of the objective function $Z = 4x + 6y$ occurs at



- (a) (0.6, 1.6) only  
 (b) (3, 0) only  
 (c) (0.6, 1.6) and (3, 0) only  
 (d) at every point of the line-segment joining the points (0.6, 1.6) and (3, 0)

13. The sum of order and degree of the differential equation  $\frac{d^2y}{dx^2} - \left(\frac{dy}{dx}\right)^3 + 7y = 0$  is  
 (a) 2 (b) 3 (c) 4 (d) 5

14. Assume that the year - end revenues of a business over a three period, are mentioned in the following table:

Year End	31-12-2018	31-12-2021
Year End Revenue	9000	13000

Calculate the CAGR of revenues over three years period spanning the “end” of 2018 to the “end” of 2021. Given that  $\left(\frac{13}{9}\right)^{\frac{1}{3}} = 1.13$

- (a) 11.3% (b) 14% (c) 13% (d) 15%
15. A dishonest milkman professes to sell his milk at cost price but he mixes it with water and thereby gains 25%. The percentage of water in the mixture is:  
 (a) 4% (b) 6% (c) 20% (d) 25%
16. An Observed set of the population that has been selected for analysis is called a  
 (a) process (b) sample (c) forecast (d) parameter

17.	<p>For predicting the straight-line trend in the sales of cars (in thousands) on the basis of 5 consecutive years data, the company makes use of 3-year moving averages method. If the sales of cars for respective years are p, q, r, s and t respectively, then which of the following average will not be computed?</p> <p>(a) <math>\frac{p+q+r}{3}</math>                      (b) <math>\frac{q+r+s}{3}</math>                      (c) <math>\frac{q+s+t}{3}</math>                      (d) <math>\frac{r+s+t}{3}</math></p>																
18.	<p>A sample of 50 pens is taken at random, out of which 15 pens are of Reynolds, 17 are of Parker and 18 are of cello. What is the point estimate of population portion of Parker?</p> <p>(a) 0.3                      (b) 0.34                      (c) 0.36                      (d) 0.4</p>																
	<p><b>For questions 19 and 20, two statements are given – one labeled Assertion(A) and the other labeled Reason (R). Select the correct answer to these questions from the codes (i), (ii), (iii) and (iv) as given below:</b></p> <p><b>(i) Both A and R are true and R is the correct explanation of the assertion</b>  <b>(ii) Both A and R are true but R is not the correct explanation of the assertion</b>  <b>(iii) A is true, but R is false</b>  <b>(iv) A is false, but R is true</b></p>																
19.	<p>A random variable X has the following distribution</p> <table border="1" style="width: 100%; text-align: center;"> <tbody> <tr> <td>X</td> <td>0</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> <td>6</td> </tr> <tr> <td>P(X)</td> <td>C</td> <td>2C</td> <td>2C</td> <td>3C</td> <td>C<sup>2</sup></td> <td>2C<sup>2</sup></td> <td>7C<sup>2</sup> + C</td> </tr> </tbody> </table> <p>Assertion (A): Value of C is <math>\frac{1}{10}</math>.</p> <p>Reasoning (R): Using formula <math>\sum P_i = 1</math>, we get the value of C.</p> <p>(a) (i)                      (b) (ii)                      (c) (iii)                      (d) (iv)</p>	X	0	1	2	3	4	5	6	P(X)	C	2C	2C	3C	C <sup>2</sup>	2C <sup>2</sup>	7C <sup>2</sup> + C
X	0	1	2	3	4	5	6										
P(X)	C	2C	2C	3C	C <sup>2</sup>	2C <sup>2</sup>	7C <sup>2</sup> + C										
20.	<p>Assertion (A): A loan is said to be amortized if each installment is used to pay interest and part of principal.</p> <p>Reasoning (R): If the market value of a share is less than its nominal value, then share is called at premium.</p> <p>(a) (i)                      (b) (ii)                      (c) (iii)                      (d) (iv)</p>																
	<p><b>SECTION – B</b></p> <p>(All questions are compulsory. In case of internal choice, attempt any one question only)</p>																
21.	<p>The present value of a perpetual income of ₹ R at the end of each 6 months is ₹ 14400. Find the value of R if money is worthy 8% compounded quarterly.</p>																

22.	<p>If A is a square matrix such that <math>A^2 = A</math>, then find the value of <math>(I + A)^3 - 7A</math>.</p> <p style="text-align: center;">OR</p> <p>If <math>A = \begin{bmatrix} 2 &amp; 3 \\ 5 &amp; -2 \end{bmatrix}</math>, show that <math>A^{-1} = \frac{1}{19} A</math>.</p>
23.	<p>A dealer deals in only two items— wrist watch and wall clock. He has ₹ 60,000 to invest and has storage space of at most 50 pieces. A wrist watch costs ₹ 3000 and a wall clock ₹ 750. He estimates that from the sale of one wrist watch, he can make a profit of ₹ 300 and that from the sale of one wall clock a profit of ₹ 90. Formulate the linear programming problem to maximise dealer's profit. (Assuming that he can sell all the items which he buys.)</p>
24.	<p>A motorboat takes half time to cover a certain distance downstream than upstream. Find the ratio between its speed in still water and the speed of current.</p> <p style="text-align: center;">OR</p> <p>A runs 4 times as fast as B. If A gives B a start of 60 meters, how fast must the goal on the race course be so that A and B reach at the same time.</p>
25.	<p>Mr Rathi invested ₹ 2,00,000 in a fund. At the end of the year the value of the fund is ₹ 2,50,000. What is the nominal rate of interest, if the market price is same at the end of the year?.</p>
<p>SECTION – C</p> <p>(All questions are compulsory. In case of internal choice, attempt any one question only)</p>	
26.	<p>Show that the function <math>f(x) = 4x^3 - 18x^2 + 27x - 7</math> is always increasing on <b>R</b>.</p>
27.	<p>Two booksellers A and B sell the textbook of Mathematics and Applied Mathematics. In the month of March, bookseller A sold 250 books of Mathematics and 400 books of Applied Mathematics whereas bookseller B sold 230 books of Mathematics and 425 books of Applied Mathematics. In the month of April, bookseller A sold 550 books of Mathematics and 300 books of Applied Mathematics and bookseller B sold 270 books of Mathematics and 450 books of Applied Mathematics.</p> <p>Represent the given information into matrix form and find the total sale for both the booksellers in the month of March and April, using matrix algebra.</p>
28.	<p>Evaluate <math>\int \frac{e^x(1+x)}{(1+xe^x)^2} dx</math>      OR      <math>\int \frac{1}{(x-1)(x+3)} dx</math></p>
29.	<p>The supply function for a commodity is <math>p = x^2 + 4x + 5</math> where x denotes supply. Find the producers' surplus when the price is 10.</p> <p style="text-align: center;">OR</p> <p>Find the consumers' surplus for the demand function <math>p = 25 - x - x^2</math> when <math>p_0 = 19</math>.</p>
30.	<p>Mr. X takes a loan of ₹2,00,000 with 10% annual interest rate for 5 years. Calculate EMI under Flat</p>

	Rate system.
31.	10 years ago, Sandeep set up a sinking fund to save for his son's higher studies. At the end of 10 years, he has received an amount of ₹ 10,21,760. What amount did he put in the sinking fund at the end of every 6 months for the tenure, which paid him 5% p.a. compounded semi-annually? [Use $(1.025)^{20} = 1.6386$ ]
	<b>SECTION – D</b> (All questions are compulsory. In case of internal choice, attempt any one question only)
32.	The probability that Rohit will hit a shooting target is $\frac{2}{3}$ . While preparing for an international shooting competition, Rohit aims to achieve the probability of hitting the target at least once to be 0.99. What is the minimum number of chances must he shoot to attain this probability? <b>OR</b> Suppose 2% of the items made by a factory are defective. Using Poisson distribution on a sample of 100 items, find the probability that there are at most 2 defective items
33.	A wire 40 m length is to be cut into two pieces. One of the pieces is to be made into a square and the other into a circle. What should be the lengths of the two pieces so that the combined area of the square and the circle is minimum? <b>OR</b> A radio manufacturer finds that he can sell $x$ radios per week at ₹ $p$ each, where $p = 2(100 - x/4)$ . His cost of production of $x$ radios per week is ₹ $(120x + x^2/2)$ . Show that his profit is maximum when the production is 40 radios per week. Also find his maximum profit per week.
34.	Determine the product $\begin{bmatrix} -4 & 4 & 4 \\ -7 & 1 & 3 \\ 5 & -3 & -1 \end{bmatrix} \begin{bmatrix} 1 & -1 & 1 \\ 1 & -2 & -2 \\ 2 & 1 & 3 \end{bmatrix}$ and use it to solve the system of equations: $x - y + z = 4$ , $x - 2y - 2z = 9$ , $2x + y + 3z = 1$ .
35.	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 atleast 240 units of calcium, atleast 460 units of iron and at most 300 units of cholesterol. How many packets of each food should be used to

minimise the amount of vitamin A in the diet? What is the minimum amount of vitamin A?

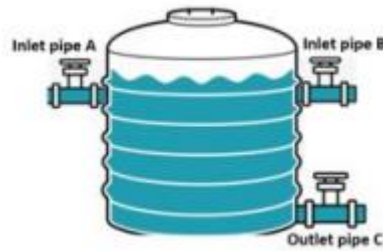
SECTION – E

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

36.

CASE STUDY – I

An overhead water tank has three pipes A, B and C attached to it (as shown in figure (II)). The inlet pipes A and B can fill the empty tank independently in 20 hours and 30 hours respectively. The outlet pipe C alone can empty a full tank in 60 hours.



Based on the above information, answer the following questions. Show steps to support your answers.

- For a routine cleaning of the tank, the tank needs to be emptied. If pipes A and B are closed at the time when the tank is filled to one- third of its total capacity, how long will pipe C take to empty the tank completely?
- How long will it take for the empty tank to fill completely, if all the three pipes are opened simultaneously?
- On a given day, pipes A, B and C are opened (in order) at 5 am, 8 am and 9 am respectively, to fill the empty tank. At what time the tank is full?

OR

Given that the tank is half-full, only pipe C is opened at 6 AM, to empty the tank. After closing the pipe C and an hour's cleaning time, tank is filled completely by pipe A and B together. In how many hours will the tank be filled completely? (1+1+2)

37.

When observed over a long period of time, a time series data can predict trend that can forecast increase or decrease or stagnation of a variable under consideration. Such analytical studies can benefit a business for forecasting or prediction of future estimated sales or production. Mathematically, for finding a line of best-fit to represent a trend, many methods are available. Methods like moving-averages and least-squares squares are



some of the techniques to predict such trends.

Mr. Rajat runs a steel industry and the record of his sales of items for the period of 2001 - 2005 is as follows:

Year	2001	2002	2003	2004	2005
Sales (in lakh)	160	185	220	300	510

	<p>Based on the above information answer the following questions:</p> <p>a) By taking year 2003 as origin, use method of least-squares to find the best-fit trend line equation for Mr. Rajat business. Show the steps of your working.</p> <p style="text-align: center;">OR</p> <p>Demonstrate the technique to fit the best-suited straight-line trend by the method of 3-years moving averages.</p> <p>b) What are the estimated sales for Mr. Rajat business for year 2010?</p> <p>c) Mr. Rajat wishes to grow his business to yearly sale of ₹ 1090 lakhs. In which year will he be able to reach his target? <span style="float: right;">(2+1+1)</span></p>
38.	<p>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 <math>P(X = x)</math> is given as follows:</p> $P(X = x) = \begin{cases} \frac{kx}{6} & \text{when } x = 0, 1 \text{ or } 2 \\ \frac{(1-k)x}{6} & \text{when } x = 3 \\ \frac{kx}{2} & \text{when } x = 4 \\ 0 & \text{when } x > 4 \end{cases}$ <p>Where k is a real number.</p> <p>Based on the above information answer the following questions:</p> <p>a) Find the value of k.</p> <p>b) What is the probability that Sarita will get admission in the college, given that she applied at least 2 weeks ahead of application deadline?</p> <p>c) Calculate the mathematical expectation of number of weeks taken by a student to apply ahead of a college's application deadline.</p> <p style="text-align: center;">OR</p> <p>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?</p>