SAMPLE QUESTION PAPER (2024 - 25)

CLASS- XII

SUBJECT: Applied Mathematics (241)

Time: 3 Hours. **Maximum Marks: 80**

General Instructions:

Read the following instructions very carefully and strictly follow them:

(i) This Question paper contains **38** questions. **All** questions are **compulsory.**

(ii) This Question paper is divided into **five** Sections - **A, B, C, D** and **E.**

(iii) 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**.

(iv) In **Section B,** Questions no. **21** to **25** are **Very Short Answer (VSA)-type** questions, carrying **2 marks each**.

(v) In **Section C,** Questions no. **26** to **31** are **Short Answer (SA)-type** questions, carrying **3 marks each**.

(vi) In **Section D,** Questions no. **32** to **35** are **Long Answer (LA)-type** questions, carrying **5 marks each**.

(vii) In **Section E,** Questions no. **36** to **38** are **case study-based questions** carrying **4 marks each.**

(viii) 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.

(ix) Use of calculators is **not** allowed.

SECTION-A $\left[1\times 20=20\right]$

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

Select the correct option (Question 1 - Question 18):

Q.1. The area (in sq units) bounded by the curve $y=\sqrt{x}$, the $x-$axis, $x=1$ and $x=4$ is

(A) $\frac{11}{3}$ (B) $\frac{1}{4}$ (C) $\frac{14}{3}$ (D) $\frac{13}{3}$

Q.2. Sampling which provides for a known non-zero equal chance of selection is

(A) Systematic sampling (B) Convenience sampling

(C) Quota sampling (D) Purposive sampling

Q.3. Let the cost function for a manufacturer is given by $C\left(x\right)=\frac{x^3}{3}-x^2+2x$ (In rupees)

Which of the following statement is correct based on the above information?

(A) The marginal cost decreases from 0 to 1 and then increases onwards.

(B) The marginal cost increases from 0 to 1 and then decreases onwards.

(C) Marginal cost decreases as production level increases from zero.

(D) Marginal cost increases as production level increases from zero.

Q.4. The absolute minimum value of the function $f(x) = 4x - \frac{1}{2}x^2$ in the interval $\left[-2, \frac{9}{2}\right]$ is:

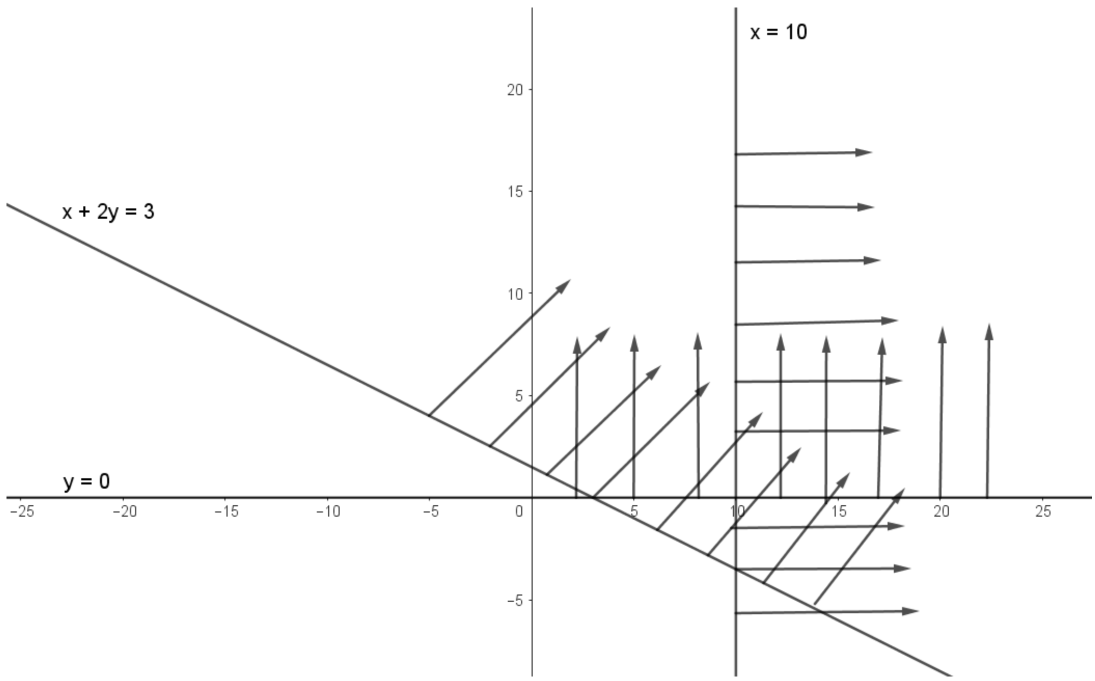
(A) -8 (B) -9 (C) -10 (D) -16

Q.5. For the purpose of $t-$ test of significance, a random sample of size $(n)\,2025$ is drawn from a normal population, then the degree of freedom (υ) is

(A) 2025^{2025} (B) 2024^{2025} (C) 2025 (D) 2024

Q.6. The constraints of a linear programming problem along with their graphs is shown below:

$x + 2y \geq 3, \; x \geq 10, \; y \geq 0$



Which of the following inequality may be removed so that the feasible region remains the same in above graph?

(A) $x + 2y \geq 3$

(B) $x \geq 10$

(C) $y \geq 0$

(D) $x \geq 0$

Q.7. A player rolls one fair die. If the die shows an odd number, the player wins the value that appears on the die, else loses half the value that appears on it. The expected gain of the player is

(A) $-\frac{1}{2}$ (B) 0 (C) $\frac{1}{2}$ (D) 1

Q.8. The original cost of a machine is ₹1200000 and the scarp value of the machine after a useful life of **3 years is** ₹300000, then the book value of the machine at the end **2 years** is

(A) ₹100000 (B) ₹250000 (C) ₹ 600000 (D) ₹800000

Q.9. A fish jumps out of the water surface and follows the parabolic path $y = 6x - x^2 - 8;\ 2 \le x \le 4$.

The fish reaches the highest height in its path at $(3,1)$. The slope of the path of the fish at $(3,1)$ is

(A) **0** (B) **1** (C) **2** (D) **3**

Q.10. In a large consignment of electric bulbs 5% of a batch of batteries are defective. A random sample of **80** is taken for inspection with replacement. Then the Variance of the number of defectives in the sample, is

(A) $\frac{18}{5}$ (B) $\frac{19}{5}$ (C) 4.555 (D) **8**

Q.11. If it is currently $6:00$ pm in 12 hours clock then what will be the time after 375 hours?

(A) 6 am (B) 6 pm (C) 9 am (D) 9 pm

Q.12. The values of $\frac{1}{x}$ for the given values of $x \in (-1,3) - \{0\}$ is

(A) $\left(-1,\frac{1}{3}\right) \cup (3,\infty)$ (B) $(-\infty,-1) \cup \left(\frac{1}{3},\infty\right)$ (C) $\left(-\frac{1}{3},1\right)$ (D) $\left(-\frac{1}{3},-1\right)$

Q.13. The component of a time series attached to long term variations is termed as

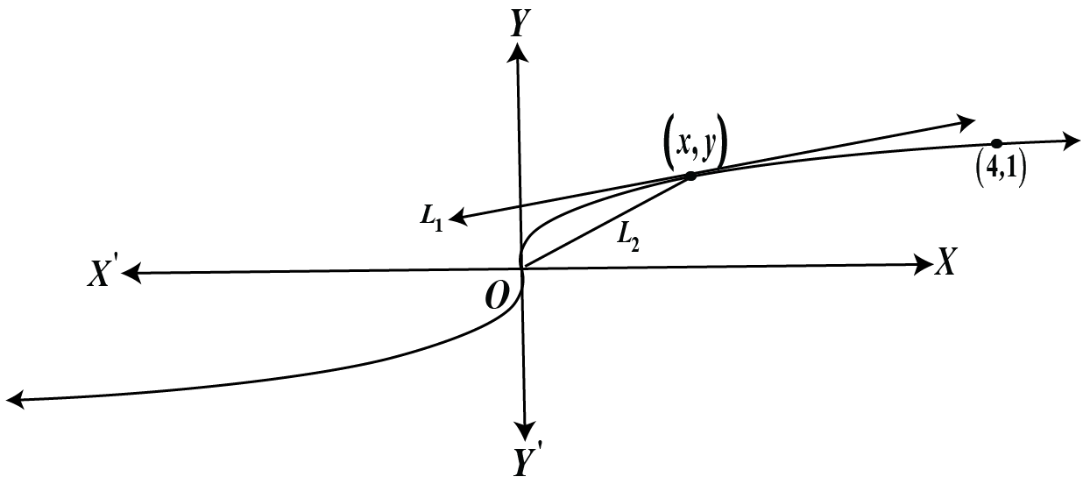
(A) Seasonal variations (B) Irregular variations

(C) Secular trend variations (D) Cyclic variations

Q.14. The present value of a sequence of payments of **₹ 800** made at the end of every **6 month** and continuing forever. If money is worth **4%** per annum compounded semi-annually, then the present value of the sequence is:

(A) ₹ 20000 (B) ₹ 40000 (C) ₹ 60000 (D) ₹ 80000

Q.15. Shown below is a curve.



L_1 is the tangent to any point (x, y) on the curve.

L_2 is the line that connects the point (x, y) to the origin.

The slope of L_1 is one third of the slope of L_2.

Then the differential equation, using the given conditions is:

(A) $\frac{dy}{dx} = \frac{y}{3x}$ (B) $\frac{dy}{dx} = \frac{y}{x}$ (C) $\frac{dy}{dx} = \frac{x}{3y}$ (D) $\frac{dy}{dx} = \frac{3y}{x}$

Q.16. For a 3×3 matrix if $\text{adj } A = 2A^{-1}$, find $|3AA^T|$

(A) 108 (B) 12 (C) 54 (D) 8

Q.17. For two matrices $P = \begin{bmatrix} 3 & 4 \\ -1 & 2 \\ 0 & 1 \end{bmatrix}$ & $Q^T = \begin{bmatrix} -1 & 2 & 1 \\ 1 & 2 & 3 \end{bmatrix}$; (where Q^T is the transpose of the matrix Q)

, $P - Q$ is:

(A) $\begin{bmatrix} 2 & 3 \\ -3 & 0 \\ 0 & -3 \end{bmatrix}$ (B) $\begin{bmatrix} 4 & 3 \\ -3 & 0 \\ -1 & -2 \end{bmatrix}$ (C) $\begin{bmatrix} 4 & 3 \\ 0 & -3 \\ -1 & -2 \end{bmatrix}$ (D) $\begin{bmatrix} 2 & 3 \\ 0 & -3 \\ 0 & -3 \end{bmatrix}$

Q.18. The order and degree of a differential equation $\frac{d^2y}{dx^2} + \left(\frac{dy}{dx}\right)^4 + x^{\frac{1}{5}} = 0$; respectively, are

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

ASSERTION-REASON BASED QUESTIONS

(Questions number 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 codes (A), (B), (C) and (D) as given below.)

$[1 \times 2 = 2]$

(A) Both (A) and (R) are true and (R) is the correct explanation of (A).

(B) Both (A) and (R) are true but (R) is not the correct explanation of (A).

(C) (A) is true but (R) is false.

(D) (A) is false but (R) is true.

Q.19. Assertion (A): The effective rate of interest equivalent to a nominal rate of 6% when compounded continuously is equal to $e^{0.06} - 1 = 6.18\%$.

Reason (R): The relation between effective rate (r_{eff}) of interest and nominal rate (r) of interest: $r_{eff} = e^r - 1;$ where $'e'$ - Euler's number (approximate value is 2.71828), when compounded continuously.

Q.20. Assertion(A): $A = [a_{ij}] = \begin{cases} m; i = j \\ 0; i \neq j \end{cases}$

where m is a scalar, is an identity matrix if $m = 1$

Reason (R): Every identity matrix is not a scalar matrix

SECTION B $[2\times 5 = 10]$

(This section comprises of 5 very short answer (VSA) type questions of 2 marks each.)

Q.21. (a) In what ratio water must be added in milk costing ₹ 60 per litre, so that the resulting mixture would be of worth ₹ 50 per litre?

OR

Q.21. (b) A pump can fill a tank with water in 2 hours. Because of leakage, it took $\frac{7}{3}$ hrs to fill the tank. How much time will it take for the leakage to drain all the water in the full tank?

Q.22. In a 200 m race, A can give a start of 18 m to B and a start of 31 m to C. In a race of 350 m, how much start can B give to C?

Q.23. A boat takes thrice as long to go upstream to a point as to return downstream to the starting point. If the speed of the stream is $5km/h$, find the speed of the boat in still water.

Q.24. (a) The incidence of occupational disease in an industry is such that the workers have a **20%** chance of suffering from it. What is the probability that out of six workers **4 or more** will catch the disease?

OR

Q.24. (b) The lifetime of an item produced by a machine has a normal distribution with **mean 12 months** and **standard deviation** of 2 months. Find the probability of an item produced by this machine will last

(i) less than **7** months

(ii) between **7** and **14** months.

(Given $P\left(Z < \frac{5}{2}\right) = 0.9938$ **and** $P(Z < 1) = 0.8413$**)**

Q.25. If $A = \begin{bmatrix} \alpha & 0 \\ 1 & 1 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 0 \\ 5 & 1 \end{bmatrix}$, then find the value of α (if exists) for which $A^2 = B$.

SECTION C

$\left[3 \times 6 = 18\right]$

(This section comprises of 6 short answer (SA) type questions of 3 marks each.)

Q.26. Find the remainder when 5^{61} is divided by 7.

Q.27. (a) Two batches of the same product are tested for their mean life. Assuming that, the lives of the product follow a normal distribution with an unknown variance; test the hypothesis that the mean life is the same for both the branches, given the following information:

Batch	**Sample Size**	**Mean life** (in hours)	**Standard Deviation** (in hours)
Batch I	10	750	12
Batch II	8	820	14

$\left[\textbf{Given } \sqrt{4.4444} = 2.1081 \textbf{ and } t_{16}(0.05) = 2.120\right]$

OR

Q.27. (b) The manufacturer of electrical items makes bulbs and claims that these bulbs have a mean life of 25 months. The life in months of a random sample of 6 such bulbs are given to be 24, 26, 30, 20, 20 and 18. Test the validity of the manufacturer's claim at 1% level of significance. [Given $t_5(0.01) = 4.032$]

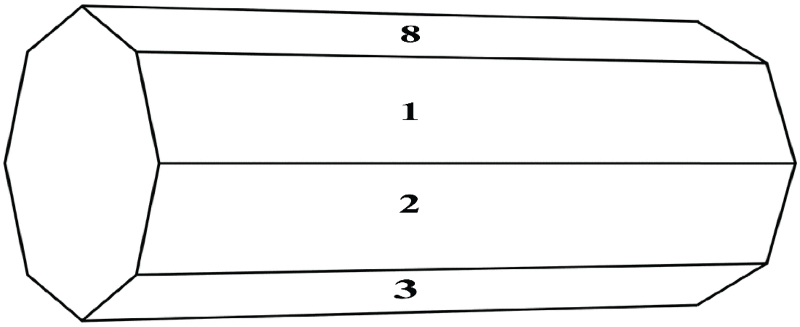
Q.28. A traffic engineer records the number of bicycle riders that use a particular cycle track. He records that an average of 3.2 bicycle riders use the cycle track every hour. Given that the number of bicycles that use the cycle track follow a Poisson distribution, what is the probability that 2 or less bicycle riders will use the cycle track within an hour? Also find the mean expectation and variance for the random variable. (Given $e^{-3.2} = 0.041$)

Q.29. Mr Rohit invested ₹ **5000** in a fund at the beginning of year **2021** and by the end of year **2021** his investment was worth ₹ **9000**. Next year market crashed and he lost ₹ **3000** and ending up with ₹ **6000** at the end of year **2022**. Next year i.e. **2023** he gained ₹ **4500** and ending up with ₹ **10500** at the end of the year. Find **CAGR** (Compounded Annual Growth Rate) of his investment. (Use $(2.1)^{1/3} = 1.2805$)

Q.30. A small firm manufactures necklaces and bracelets. The total number of necklaces and bracelets that it can handle per day is at most **25**. It takes one hour to make a bracelet and half an hour to make a necklace. The maximum number of hours available per day is **14**. If the profit on a necklace is **₹ 100** and that on a bracelet is **₹ 300**, formulate an **L.P.P**. for finding how many of each should be produced daily to maximize the profit? It is being given that at least one of each must be produced.

(Note: No need to find the feasible region and optimal solution)

Q.31.(a) An octagonal prism is a three-dimensional polyhedron bounded by two octagonal bases and eight rectangular side faces. It has $\mathbf{24}$ edges and $\mathbf{16}$ vertices.



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
$P(X)$:	p	$2p$	$2p$	p	$2p$	p^2	$2p^2$	$7p^2+p$

On the above context, answer the following questions.

(i) Find the value of p .

(ii) Find the mean, $E(X)$.

OR

Q.31.(b) If the probability of success in a single trial is $\mathbf{0.01}$, how many minimum number of Bernoulli trials must be performed in order that the probability of at least one success is $\frac{1}{2}$ or more?

$\left(\textbf{Use } \log_{10} 2 = 0.3010 \textbf{ and } \log_{10} 99 = 1.9956\right)$

SECTION D $[5 \times 4 = 20]$

(This section comprises of 4 long answer (LA) type questions of 5 marks each)

Q.32. (a) Fit a straight-line trend by using the method of least squares for the following data and calculate the trend values.

Year	Production (in tonnes)
1962	2
1963	4
1964	3
1965	4
1966	4
1967	2
1968	4
1969	9
1970	7
1971	10
1972	8

OR

Q.32. (b) The quarterly profits of a small-scale industry (₹ in thousands) are as follows.

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

Calculate **4-quarterly** moving averages.

Q.33. (a) An owl was sitting at $(0,k); k>0$. Then it starts flying along the path whose equation is given by $y=ax^2+bx+c,$ where $a\in\mathbb{R}-\{0\}$, $b,c\in\mathbb{R}$. 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

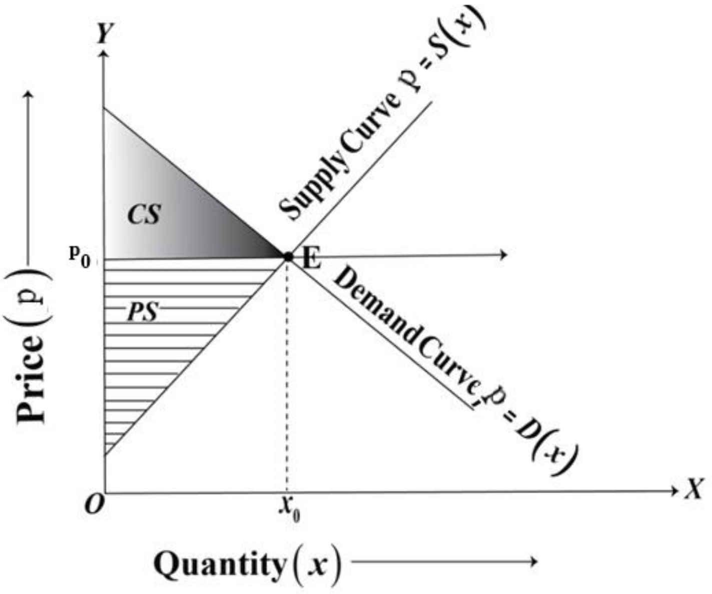
OR

Q.33. (b) A toy rocket is fired, from a platform, vertically into the air, its height above the ground after t seconds is given by $s(t)=at^2+bt+c,$ where $a,b,c\in\mathbb{R}; a\neq 0$ and $s(t)$ is measured in metres. After **10** second, the rocket is **16 m** above the ground; after **20** seconds, **22 m**; after **30** seconds, **25 m**.

(i) Write down a system of three linear equations in terms of a, b and c.

(ii) Hence find the values of a, b and c, using matrix method.

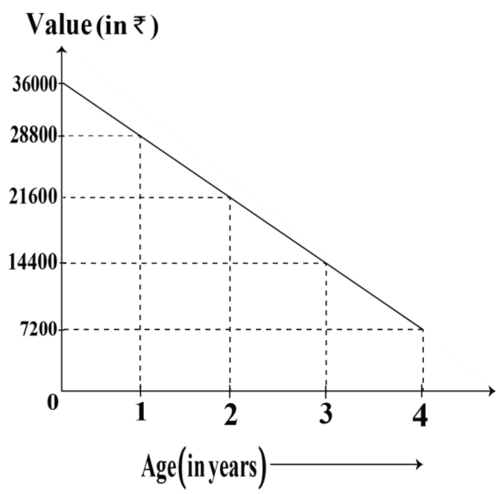
Q.34. Supply and demand curves of a tyre manufacturer company is given below:



The above graph showing the demand and supply curves of a tyre manufacturer company which are linear. 'ABC' tyre manufacturer sold **25** units every month when the price of a tyre was ₹ **20000** per units and 'ABC' tyre manufacturer sold **125** units every month when the price dropped to ₹ **15000** per unit. When the price was ₹ **25000** per unit, **180** tyres were available per month for sale and when the price was only ₹ **15000** per unit, **80** tyres remained. Find the demand function. Also find the consumer surplus if the supply function is given to be $S(x) = 100\,x + 7000$

Q.35. In **4** years, a mobile costing **₹ 36,000** will have a salvage value of ₹ **7200**.

The following graph shows the depreciation of a mobile's value over 4 years.



A new mobile at that time (i.e., after **4 years**) is expected to cost for ₹ **55,200**. In order to provide funds for the difference between the replacement cost and the salvage cost, a sinking fund is set up into which equal payments are placed at the end of each year. If the fund earns interest at the rate 7% compounded annually, how much should each payment be? Also find the amount of Annual Depreciation of the mobile's value over **4** years and find the rate of depreciation (under straight line method). Use $(1.07)^4 = 1.3107$.

SECTION- E $[4 \times 3 = 12]$

(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)

Case Study-1

Q.36. A student Shivam is running on a playground along the curve given by $y = x^2 + 7$. Another student Manita standing at point $(3, 7)$ on playground wants to hit Shivam by paper ball when Shivam is nearest to Manita.

Based on above information, answer the following questions:

(i) Let at any instant while running along the curve $y = x^2 + 7$, Shivam's position be (x, y). Find the expression for the distance (D) between Shivam and Manita in terms of $'x'$. $[1]$

(ii) Find the critical point(s) of the distance function. $[1]$

(iii) (a) What is the distance between Shivam and Manita when they are at least distance from each other. $[2]$

OR

(iii) (b) Find the position of Shivam, when he is closest to Manita. $[2]$

Case Study-2

Q.37. EQUATED MONTHLY INSTALMENTS (EMI): -

Each instalment can be considered as consisting of two parts:

(i) Interest on the outstanding loan (ii) Repayment of part of the loan.

<u>Methods of calculation of EMI or Instalment:</u> -

EMI or Installment can be calculated by two methods:

1. Flat Rate Method
2. Reducing-balance method or Amortization of Loan

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. $\left(\text{Given}\left(1.0075\right)^{-300} = 0.1062\right)$

Based on the above information, answer the following questions:

(i) Find the number of payments and find the rate of interest per month. [1]

(ii) (a) What are the monthly payments of instalments using ***reducing balance method***? [2]

OR

(ii) (b) What are the monthly payments of instalments using ***flat rate method***? [2]

(iii) What is the total interest payment made in the process applied to calculate **EMI** in the above part $(37(ii))$? [1]

Case Study- 3

Q.38. A company has two factories located at **P** and **Q** and has three depots situated at **A, B** and **C**. The weekly requirement of the depots at **A, B** and **C** is respectively **5, 5** and **4** units, while the production capacity of the factories **P** and. **Q** are respectively **8** and **6** units. The cost (in ₹) of transportation per unit is given below.

Cost (in ₹)			
To / From	A	B	C
P	160	100	150
Q	100	120	100

Based on the above information, answer the following questions:

(i) Formulate the objective function and the constraints of the above Linear programming problem. [2]

(ii) How many units should be transported from each factory to each depot in order that the transportation cost is minimum? [2]

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MARKING SCHEME
CLASS XII
APPLIED MATHEMATICS (CODE-241)
SECTION: A (Solution of MCQs of 1 Mark each)

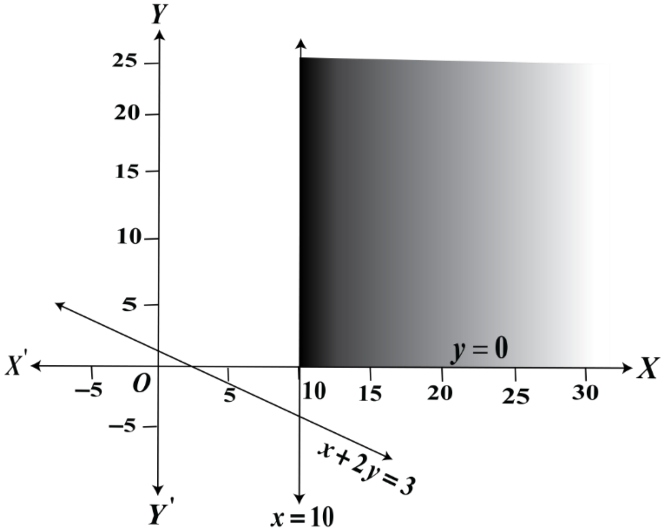
Q no.	ANS	HINTS/SOLUTION
1.	(C)	The required area is given by $\left\|\int_1^4 \left(\sqrt{x}\right) dx\right\| = \left\|\left[\dfrac{x^{\frac{3}{2}}}{\frac{3}{2}}\right]_1^4\right\| = \left\|\dfrac{2}{3}(8-1)\right\| = \dfrac{14}{3}$ **sq units.**
2.	(A)	Systematic Sampling as it is a type of probability sampling while others are types of non-probability sampling. (When selection of objects from the population is random, then objects of the population have an equal probability i.e., has a known non-zero equal chance of selection. In other words, in probability sampling, sample units are selected at random.)
3.	(A)	The cost function for a manufacturer is given by $C(x) = \dfrac{x^3}{3} - x^2 + 2x$ (in rupees). The marginal cost function is given by $MC(x) = \dfrac{dC}{dx} = x^2 - 2x + 2$ $MC'(x) = 2x - 2$ So, the marginal cost decreases from 0 to 1 and then increases onwards
4.	(C)	$f(x) = 4x - \dfrac{1}{2}x^2$ **Being a polynomial function** $f(x)$ **is differentiable** $\forall x \in \left(-2, \dfrac{9}{2}\right)$ $f'(x) = 4 - x$. $f'(x) = 4 - x = 0 \Rightarrow x = 4$. **For the function** $f(x) = 4x - \dfrac{1}{2}x^2$ **in the interval** $\left[-2, \dfrac{9}{2}\right]$**, the end points are** $x = -2$ & $x = \dfrac{9}{2}$ ∴The absolute minimum value of the function $f(x) = 4x - \dfrac{1}{2}x^2$ in the interval $\left[-2, \dfrac{9}{2}\right]$ is $\text{Min}\left\{f(-2), f(4), f\left(\dfrac{9}{2}\right)\right\} = \text{Min}\left\{-10, 8, \dfrac{63}{8}\right\} = -10.$

5. **(D)**

Here $n = 2025$

$\therefore$ Degree of freedom $= 2025 - 1 = 2024.$

6. **(A)**



From the graph, it is clear that $x + 2y \geq 3$ may be removed so that the feasible region remains the same.

7. **(C)**

Number on the die	x_i	p_i	$p_i x_i$
1	1	$\frac{1}{6}$	$\frac{1}{6}$
2	-1	$\frac{1}{6}$	$-\frac{1}{6}$
3	3	$\frac{1}{6}$	$\frac{3}{6}$
4	-2	$\frac{1}{6}$	$-\frac{2}{6}$
5	5	$\frac{1}{6}$	$\frac{5}{6}$
6	-3	$\frac{1}{6}$	$-\frac{3}{6}$

Expected gain $= E(X) = \sum p_i x_i = \frac{3}{6} = \frac{1}{2}$

8. **(C)**

Annual depreciation $= \frac{1200000 - 300000}{3} =$ ₹ 300000

$\therefore$ Book value of the asset at the end of **2 years** $=$ ₹ $(1200000 - 2 \times 300000) =$ ₹ $600000.$

9. **(A)**

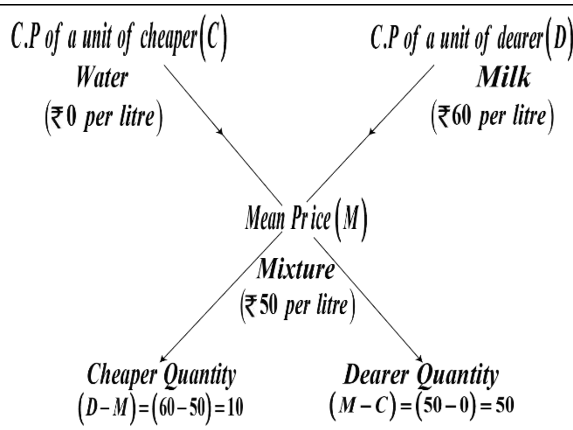
The equation of the parabolic path $y = 6x - x^2 - 8;\ 2 \leq x \leq 4$

		$\frac{dy}{dx}=6-2x$ $\Rightarrow \frac{dy}{dx}_{x=3}=6-2\times 3=0.$
10.	**(B)**	This is a binomial distribution with $n=80, p=5\%=\frac{1}{20}.$ If X is the binomial random variable for the number of defectives then X is $B\left(80,\frac{1}{20}\right).$ So, $\sigma^2=npq=80\times\frac{1}{20}\times\frac{19}{20}=\frac{19}{5}.$
11.	**(C)**	$375\,\text{hours}=(24\times 15+15)\,\text{hours}$ $\therefore 375(\text{mod}\,24)=15$ Therefore, it will be **9 am** after **375 hours.**
12.	**(B)**	$x\in(-1,3)-\{0\}\Rightarrow x\in(-1,0)\cup(0,3)$ When $x\in(-1,0)$ then $\frac{1}{x}\in(-\infty,-1)......(i)$ When $x\in(0,3)$ then $\frac{1}{x}\in\left(\frac{1}{3},\infty\right)......(ii)$ From (i) & (ii) , we have $\frac{1}{x}\in(-\infty,-1)\cup\left(\frac{1}{3},\infty\right).$
13.	**(C)**	Secular trend variations are considered as long-term variation, attributable to factor such as population change, technological progress and large –scale shifts in consumer tastes.
14.	**(B)**	$R=$ ₹ **800**. $i=\frac{4}{200}=0.02$ $P=\frac{R}{i}=\frac{800}{0.02}=$ ₹ **40000.**
15.	**(A)**	The slope of L_1 at any arbitrary point (x,y) is $\frac{dy}{dx}.$ The slope of L_2 that connects the point (x,y) to the origin is $\frac{y-0}{x-0}=\frac{y}{x}$ Now, $\frac{dy}{dx}=\frac{1}{3}\times\frac{y}{x}$ $\therefore \frac{dy}{dx}=\frac{y}{3x}.$

16.	**(A)**	$\text{adj } A = 2A^{-1} \implies A^{-1} = \frac{1}{2}(\text{adj } A)$ $\therefore \|A\| = 2$ Now, $\|3AA^T\| = 3^3 \times \|A\|^2 = 108$
17.	**(B)**	We have, $P = \begin{bmatrix} 3 & 4 \\ -1 & 2 \\ 0 & 1 \end{bmatrix}$ & $Q^T = \begin{bmatrix} -1 & 2 & 1 \\ 1 & 2 & 3 \end{bmatrix} \Rightarrow Q = \begin{bmatrix} -1 & 1 \\ 2 & 2 \\ 1 & 3 \end{bmatrix}$ So, $P - Q = \begin{bmatrix} 3 & 4 \\ -1 & 2 \\ 0 & 1 \end{bmatrix} - \begin{bmatrix} -1 & 1 \\ 2 & 2 \\ 1 & 3 \end{bmatrix} = \begin{bmatrix} 4 & 3 \\ -3 & 0 \\ -1 & -2 \end{bmatrix}$.
18.	**(B)**	order is **2** and degree is **1**.
19.	**(A)**	**Both (A) and (R) are true and (R) is the correct explanation of (A).**
20.	**(C)**	**(A) is true but (R) is false.**

Section –B

[This section comprises of solution of very short answer type questions (VSA) of 2 marks each]

21(a).	 **C.P** of 1 litre of water = ₹ **0** **C.P** of 1 litre of milk = ₹ **60** Mean Price = ₹ **50** Therefore, ratio of water and milk = $\frac{60-50}{50-0} = \frac{10}{50} = \frac{1}{5}$ or $1:5$	1 1
	OR	
21(b).	Time taken to drain full tank $= x$ hours i.e., the time rate of drain the tank $= \frac{1}{x}$ units per hour	

	Time taken to fill the full tank is 2 hours i.e., the time rate of filling the tank $=\frac{1}{2}$ units per hour Again, with the leakage, the pipe takes $2\frac{1}{3}=\frac{7}{3}$ hours to fill the full tank. The rate of filling the tank along with the leakage will be $=\frac{3}{7}$ units per hour. Now, according to question, $\left(\frac{1}{2}\right)-\left(\frac{1}{x}\right)=\left(\frac{3}{7}\right)$ Solving, we get $x=14$ Hence, 14 hours are required to drain the full tank.	½ 1 ½
22.	In a $200m$ race, when A covers $200m$ then B covers $(200-18)=182m$ and C covers $(200-31)=169m$ $\Rightarrow A : C = 200 : 169$ $\frac{B}{C}=\frac{A}{C}\times\frac{B}{A}=\frac{200}{169}\times\frac{182}{200}=\frac{182}{169}$ When B covers $182m$ then C covers $169m$ When B covers $350m$ then C covers $\frac{169}{182}\times 350=325m$ Therefore, B can give a start of $(350-325)=25m$ to C.	½ ½ ½ ½
23.	Let the total distance be d km and the speed of boat in still water be x km/h Speed of stream = 5 km/h Speed upstream $=(x-5)$ km/h Speed downstream $=(x+5)$ km/h According to question, $\frac{d}{x-5}=3\times\frac{d}{x+5}$ Solving, we get $x=10$ Hence, the speed of boat in still water is 10 km/h	½ ½ ½ ½
24(a).	Let X be the random variable denoting the number of workers who catch the disease.	

	Given, $p=\frac{20}{100}=\frac{1}{5}\Rightarrow q=\frac{4}{5}$ and $n=6$ Now, $P(X=x)={}^6C_x\left(\frac{1}{5}\right)^x\left(\frac{4}{5}\right)^{6-x}$, $x=0,1,....,6$ So, the required probability that out of six workers **4** or more will catch the disease is $P(X\geq 4)=P(X=4)+P(X=5)+P(X=6)$ $={}^6C_4\left(\frac{1}{5}\right)^4\left(\frac{4}{5}\right)^2+{}^6C_5\left(\frac{1}{5}\right)^5\left(\frac{4}{5}\right)^1+{}^6C_6\left(\frac{1}{5}\right)^6\left(\frac{4}{5}\right)^0$ $=\frac{265}{5^6}$ **or** 0.017 .	½ 1 ½
	OR	
24(b).	We have, mean $\mu=12$ and standard deviation $\sigma=2$, i.e., $X\sim N(\mu,\sigma^2)$ (i) Let X denote the count of the months for which this machine lasts. The probability of an item produced by this machine will last less than 7 months is $P(X<7)$ **For** $X=7$, $Z=\frac{7-12}{2}=-\frac{5}{2}$ Now, $P(X<7)=P\left(Z<-\frac{5}{2}\right)=P\left(Z>\frac{5}{2}\right)$ $=1-P\left(Z<\frac{5}{2}\right)=1-0.9938=0.0062$ (ii) The probability of an item produced by this machine will last more than 7 months and less than 14 months is $P(7<X<14)$ **For** $X=7$, $Z=\frac{7-12}{2}=-\frac{5}{2}$ **and for** $X=14$, $Z=\frac{14-12}{2}=1$ $P(7<X<14)=P\left(-\frac{5}{2}<Z<1\right)$ $=P(Z<1)-P\left(Z<-\frac{5}{2}\right)$ $=0.8413-0.0062=0.8351$	½ ½ ½ ½
25.	Given, $A^2=B$	

	$\Rightarrow \begin{bmatrix} \alpha & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} \alpha & 0 \\ 1 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 5 & 1 \end{bmatrix}$ $\Rightarrow \begin{bmatrix} \alpha^2 & 0 \\ \alpha+1 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 5 & 1 \end{bmatrix}$	1
	$\Rightarrow \alpha^2 = 1$ and $\alpha + 1 = 5$.	½
	Hence, no real value of α exists.	½
Section –C **[This section comprises of solution short answer type questions (SA) of 3 marks each]**		
26.	$5 \equiv 5 (\mathrm{mod}\ 7)$ $\Rightarrow 5^2 \equiv 25 (\mathrm{mod}\ 7)$ $\Rightarrow 5^2 \equiv 4 (\mathrm{mod}\ 7)$ $\Rightarrow 5^4 \equiv 4^2 (\mathrm{mod}\ 7)$	1
	$\Rightarrow 5^4 \equiv 2 (\mathrm{mod}\ 7)$ $\Rightarrow 5^{20} \equiv 32 (\mathrm{mod}\ 7)$ $\Rightarrow 5^{20} \equiv 4 (\mathrm{mod}\ 7)$	1
	$\Rightarrow 5^{60} \equiv 1 (\mathrm{mod}\ 7)$ $\Rightarrow 5^{61} \equiv 5 (\mathrm{mod}\ 7)$ Hence, the remainder when 5^{61} is divided by 7 is 5	1
27(a).	Given, $n_1 = 10,\ n_2 = 8,\ \overline{x_1} = 750,\ \overline{x_2} = 820,\ s_1 = 12\ \&\ s_2 = 14$ Consider, Null hypothesis $\mathbf{H_0}$: Mean life is same for both the batches i.e., $(\mu_1 = \mu_2)$. Alternate hypothesis $\mathbf{H_\alpha}$: Two batches have different mean lives i.e., $(\mu_1 \neq \mu_2)$. Test Statistics, $t = \dfrac{\overline{x_1} - \overline{x_2}}{S} \times \sqrt{\dfrac{n_1 n_2}{n_1 + n_2}}$, Where $S = \sqrt{\dfrac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1 + n_2 - 2}}$	
	$\Rightarrow \quad S = \sqrt{\dfrac{9 \times 144 + 7 \times 196}{10 + 8 - 2}}$	1

	$= \sqrt{\frac{2668}{16}} = 12.91$ $\therefore\ t = \frac{750-820}{12.91} \times \sqrt{\frac{10 \times 8}{10+8}}$ $= \frac{-70}{12.91} \times 2.1081$ $= -11.430$ Since, calculated value $\lvert t \rvert = 11.430 >$ tabulated value $t_{16}(0.05) = 2.120$ So, rejected the null hypothesis at **5%** level of significance. Hence, the mean life for both the batches is not the same.	½ 1 ½
	OR	
27(b).	Here, population mean $(\mu) = 25$ Sample mean $(\bar{x}) = \frac{\sum x_i}{n} = \frac{138}{6} = 23$ Sample size $(n) = 6$ Consider, Null hypothesis $\mathbf{H_0}$: There is no significant difference between the sample mean and the population mean i.e., $(\mu_1 = \mu_2)$. Alternate hypothesis $\mathbf{H_\alpha}$: There is no significant difference between the sample mean and the population mean i.e., $(\mu_1 \neq \mu_2)$. Values of $(x_i - \bar{x})^2$ are $1, 9, 49, 9, 9$ and 25 $\therefore s = \sqrt{\frac{102}{5}} = 4.52$ Now, $t = \frac{\bar{x}-\mu}{\frac{s}{\sqrt{n}}} = \frac{23-25}{\frac{4.52}{\sqrt{6}}}$ $= -1.09$ $\Longrightarrow\ \lvert t \rvert = 1.09$ Since, calculated value $\lvert t \rvert = 10.763 <$ tabulated value $t_5(0.01) = 4.132$ So, the null hypothesis is accepted. Hence, the manufacturer’s claim is valid at 1% level of significance.	 ½ 1 1 ½
28.	Given, mean $= \lambda = 3.2$ Let X be the number of bicycle riders which use the cycle track.	½

	Required probability $= P(X \leq 2) = P(X=0) + P(X=1) + P(X=2)$ $= \frac{e^{-3.2}(3.2)^0}{0!} + \frac{e^{-3.2}(3.2)^1}{1!} + \frac{e^{-3.2}(3.2)^2}{2!}$ $= e^{-3.2}(1 + 3.2 + 5.12)$ $= 0.041 \times 9.32 = 0.618$ Also, mean expectation = variance of $X = \lambda = 3.2$	**1½** ½ ½
29.	Here, Initial investment value $(IV) = ₹\,5000$ Final investment value $(FV) = ₹\,10500$ No of period $(n) = 3$ (starting from 2021 to 2023) $\Rightarrow r = \left(\frac{FV}{IV}\right)^{\frac{1}{n}} - 1 = \left(\frac{10500}{5000}\right)^{\frac{1}{3}} - 1$ $= 1.2805 - 1 = 0.2805$ $CAGR = 28.05\%$	½ ½ **1** ½ ½
30.	Let the number of necklaces manufactured be x, and the number of bracelets manufactured be y. According to question, $x + y \leq 25$ and $\frac{x}{2} + y \leq 14$ The profit on one necklace is **₹ 100** and the profit on one bracelet is **₹ 300**. Let the profit (the objective function) be Z, which has to be maximized. Therefore, required LPP is Maximize $Z = 100x + 300y$ Subject to the constraints $x + y \leq 25$ $\frac{x}{2} + y \leq 14$ $x, y \geq 0$	**1** ½ **1** ½
31(a).	(i) **We have,** $\sum_{i=1}^{8} P(X = i) = 1$	

	$\Rightarrow p+2p+2p+p+2p+p^2+2p^2+7p^2+p=1$ $\Rightarrow 10p^2+9p-1=0$ $\Rightarrow (10p-1)(p+1)=0$ $\Rightarrow p\neq -1$ $\therefore\ p=\frac{1}{10}$ (ii) **Mean,** $E(X)=\sum_{i=1}^{8} i\,P(X=i)$ $=1\times p+2\times p+3\times 2p+4\times p+5\times 2p+6\times p^2+7\times 2p^2+8\times(7p^2+p)$ $=33p+76p^2$ $=\frac{33}{10}+\frac{76}{100}=\frac{203}{50}$	½ 1 ½ ½ ½
	OR	
31(b).	We have, $p=0.01=\frac{1}{100}\Rightarrow q=\frac{99}{100}$ Let number of Bernoulli trials be n. Now, the binomial distribution formula is for any random variable (X) is given by $P(X=x)={}^{n}C_x\left(\frac{1}{100}\right)^{x}\left(\frac{99}{100}\right)^{n-x}$ So, the probability of at least one success is $P(X\geq 1)=1-P(X=0)=1-{}^{n}C_0\left(\frac{1}{100}\right)^{0}\left(\frac{99}{100}\right)^{n}=1-\left(\frac{99}{100}\right)^{n}$ **According to condition,** $P(X\geq 1)\geq 0.5\Rightarrow 1-\left(\frac{99}{100}\right)^{n}\geq 0.5\Rightarrow\left(\frac{99}{100}\right)^{n}\leq 0.5$ $\Rightarrow n\log_{10}\frac{99}{100}\leq\log_{10}0.5\Rightarrow n\geq\frac{\log_{10}0.5}{\log_{10}0.99}$; $\quad(\text{as }\log_{10}0.99<0)$ $\left[\text{Using }\log_{10}2=0.3010\text{ and }\log_{10}99=1.9956\right]\ \Rightarrow n\geq 68.409\Rightarrow n=69\ [\because n\in\mathbb{N}]$.	½ 1 ½ ½ ½

<u>**Section –D**</u>

[This section comprises of solution of long answer type questions (LA) of 5 marks each]

<table>
<tr><td>32(a).</td><td>

Here, number of observations $n = 11(odd\ number)$

Year (t)	Production (y)	$x = t_i - 1967$	x^2	xy
1962	2	-5	25	-10
1963	4	-4	16	-16
1964	3	-3	9	-9
1965	4	-2	4	-8
1966	4	-1	1	-4
1967	2	0	0	0
1968	4	1	1	4
1969	9	2	4	18
1970	7	3	9	21
1971	10	4	16	40
1972	8	5	25	40
Total	$\sum y = 57$	$\sum x = 0$	$\sum x^2 = 110$	$\sum xy = 76$

Year **1967** is taken as year of origin.

The normal equations are $\sum y = na + b\sum x$ and $\sum xy = a\sum x + b\sum x^2$

Since, $\sum x = 0$ i.e., deviation from actual mean is zero,

we have $a = \frac{\sum y}{n} = \frac{57}{11} = 5.18$,$b = \frac{\sum xy}{\sum x^2} = \frac{76}{110} = 0.69$

Therefore, the required equation of the trend line $y = 5.18 + 0.69x$

The trend values are

1.73, 2.42, 3.11, 3.8, 4.49, 5.18, 5.87, 6.56, 7.25, 7.94, 8.63

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2 marks for correct table

1

2

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<tr><td></td><td>OR</td><td></td></tr>
<tr><td>32(b).</td><td>

Yearly/ Quarterly		Small scale industry	4-quarterly moving total	4-quarterly moving average	4-year centered moving average
	I	**39**			

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	II	**47**	162	40.5	
2020	III	**20**	191	47.75	**44.125**
	IV	**56**	203	50.75	**49.25**
	I	**68**	249	62.25	**56.5**
	II	**59**	265	66.25	**64.25**
2021	III	**66**	285	71.25	**68.75**
	IV	**72**	286	71.5	**71.375**
	I	**88**	280	70.00	**70.75**
	II	**60**	275	68.75	**69.375**
2022	III	**60**			
	IV	**67**			

1½ marks each for 3rd and 4th column

2 marks for last column

33(a).

$y = ax^2 + bx + c$

Owl passes through the points $(1,2), (2,1)$ and $(4,5)$. So, it must satisfy the given equation

Therefore,

$$\left.\begin{aligned} 2 &= a + b + c \\ 1 &= 4a + 2b + c \\ 5 &= 16a + 4b + c \end{aligned}\right\} \qquad \textbf{1}$$

Now, $D = \begin{vmatrix} 1 & 1 & 1 \\ 4 & 2 & 1 \\ 16 & 4 & 1 \end{vmatrix} = 1(2-4) - 1(4-16) + 1(16-32) = -6 \neq 0$ ½

$D_a = \begin{vmatrix} 2 & 1 & 1 \\ 1 & 2 & 1 \\ 5 & 4 & 1 \end{vmatrix} = 2(2-4) - 1(1-5) + 1(4-10) = -6$ ½

$D_b = \begin{vmatrix} 1 & 2 & 1 \\ 4 & 1 & 1 \\ 16 & 5 & 1 \end{vmatrix} = 1(1-5) - 2(4-16) + 1(20-16) = 24$ ½

	and $D_c = \begin{vmatrix} 1 & 1 & 2 \\ 4 & 2 & 1 \\ 16 & 4 & 5 \end{vmatrix} = 1(10-4) - 1(20-16) + 2(16-32) = -30$	½
	$\therefore a = \frac{D_a}{D} = \frac{-6}{-6} = 1$; $,b = \frac{D_b}{D} = \frac{24}{-6} = -4$, $,c = \frac{D_c}{D} = \frac{-30}{-6} = 5$	1½
	Therefore, equation of the curve is $y = x^2 - 4x + 5$	
	When owl is sitting at $(0,k)$ then $x = 0 \Rightarrow k = 5$	½
	OR	
33(b).	(i) $s(t) = at^2 + bt + c ; t \geq 0$	
	Clearly, $(10,16),(20,22),(30,25)$ **lie on the curve of** $s(t)$. **Then,** $\left.\begin{aligned} 100a + 10b + c &= 16 \\ 400a + 20b + c &= 22 \\ 900a + 30b + c &= 25 \end{aligned}\right\}$	1
	(ii) **Let,** $A = \begin{pmatrix} 100 & 10 & 1 \\ 400 & 20 & 1 \\ 900 & 30 & 1 \end{pmatrix}; X = \begin{pmatrix} a \\ b \\ c \end{pmatrix}; B = \begin{pmatrix} 16 \\ 22 \\ 25 \end{pmatrix}$	½
	Then, the system becomes, $AX = B$ $\lvert A \rvert = 100(-10) - 400(-20) + 900(-10) = -1000 + 8000 - 9000 = -2000 \neq 0$	½
	Now, $adjA = \begin{pmatrix} -10 & 500 & -6000 \\ 20 & -800 & 6000 \\ -10 & 300 & -2000 \end{pmatrix}^T = \begin{pmatrix} -10 & 20 & -10 \\ 500 & -800 & 300 \\ -6000 & 6000 & -2000 \end{pmatrix}$	1
	Therefore, $A^{-1} = \frac{1}{\lvert A \rvert}(adjA) = \frac{1}{-2000}\begin{pmatrix} -10 & 20 & -10 \\ 500 & -800 & 300 \\ -6000 & 6000 & -2000 \end{pmatrix}$	½

	Then, $X = A^{-1}B = \dfrac{1}{-2000}\begin{pmatrix} -10 & 20 & -10 \\ 500 & -800 & 300 \\ -6000 & 6000 & -2000 \end{pmatrix}\begin{pmatrix} 16 \\ 22 \\ 25 \end{pmatrix}$ $= \dfrac{1}{-2000}\begin{pmatrix} 30 \\ -2100 \\ -14000 \end{pmatrix}$ $= \begin{pmatrix} -\dfrac{3}{200} \\ \dfrac{21}{20} \\ 7 \end{pmatrix}$ **Therefore,** $a = -\dfrac{3}{200}, b = \dfrac{21}{20}, c = 7.$	1½
34.	Let us consider demand function be $p = D(x) = ax + b........(i)$ When $x = 25$ then $p = 20000$ From equation (i), we have $20000 = 25a + b..........(ii)$ And when $x = 125$ then $p = 15000$ From equation (i), we have $15000 = 125a + b..........(ii)$ On solving equations (i) and (ii), we get $a = -50$ and $b = 21250$ Therefore, demand function, $p = D(x) = -50x + 21250$ For equilibrium point $D(x_0) = S(x_0)$ $\Rightarrow -50x_0 + 21250 = 100x_0 + 7000$ $\Rightarrow -150x_0 = -14250$ $\Rightarrow x_0 = 95$ On putting value of x_0 in demand function and supply function, we get $p_0 = 16500$	½ ½ 1 ½ ½ ½

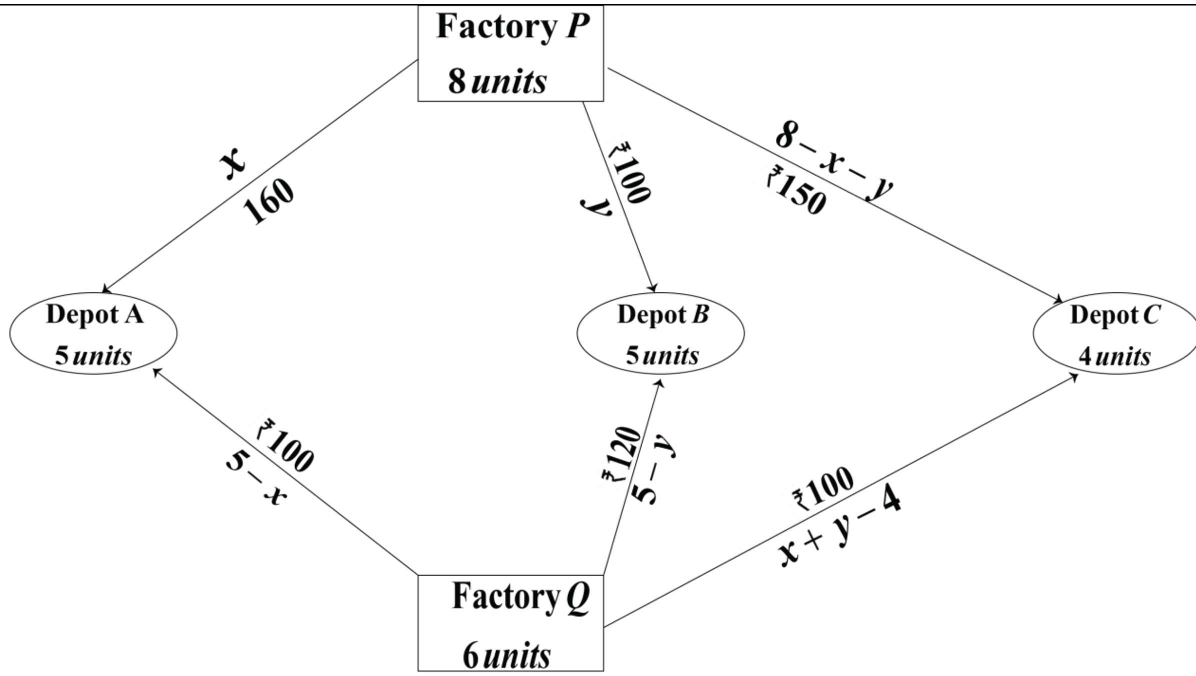
	$\therefore$ Consumer surplus (CS) $=\int_0^{x_0} D(x)dx - p_0x_0$ $=\int_0^{95}(-50x+21250)dx - 16500\times 95$ $=\left(-50\frac{x^2}{2}+2150x\right)_0^{95} - 1567500$ $=1793125-1567500$ $=₹\ 225625$	1 ½
35.	Amount needed after **4** years = Replacement Cost - Salvage Cost = ₹ (**55,200** – 72**00)** = **₹ 48,000** The payments into sinking fund consisting of 10 annual payments at the rate 7% per year is given by $A = RS_{\overline{n}\rceil i} = R\left[\frac{(1+i)^n - 1}{i}\right]$ $\Rightarrow 48000 = R\left[\frac{(1+0.07)^4-1}{0.07}\right] = R\left[\frac{(1.07)^4-1}{0.07}\right]$ $\Rightarrow R = \frac{48000}{4.4385} = ₹10814.5$ **Amount of Annual Depreciation** $= \frac{36000-7200}{4} = \frac{28800}{4} = ₹7200$ and rate of Depreciation $= \frac{7200}{36000-7200}\times 100 = 25\%$	1 2 1 1

Section –E

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

36.	(i) For all values of $x, y = x^2+7$ $\therefore$ Shivam's position at any point of x will be $\left(x,\ x^2+7\right)$ The measure of the distance between Shivam and Manita, i.e., D $D=\sqrt{(x-3)^2+\left(x^2+7-7\right)^2}=\sqrt{(x-3)^2+x^4}$ (ii) We have, $D=\sqrt{(x-3)^2+x^4}$ Let $\Delta = D^2 = (x-3)^2+x^4$ Now, $\frac{d}{dx}(\Delta)=2(x-3)+4x^3=4x^3+2x-6$ $\frac{d}{dx}(\Delta)=0 \Rightarrow x=1$ (iii) (a): $\Delta''(x)=8x^2+2$ Clearly, $\Delta''(x)=8x^2+2>0$ at $x=1$ $\therefore$ Value of x for which D will be minimum is 1. For $x=1, y=8.$ Therefore, required distance = $D=\sqrt{(1-3)^2+(1)^4}=\sqrt{4+1}=\sqrt{5}$ **OR** (iii) (b): $\Delta''(x)=8x^2+2$ Clearly, $\Delta''(x)=8x^2+2>0$ at $x=1$ $\therefore$ Value of x for which D will be minimum is 1. For $x=1, y=8.$ Thus, the required position for Shivam is $(1, 8)$ when he is closest to Manita.	½ + ½ ½ ½ 1 1 1 1
37.	(i) Here, time = 25 years $\therefore$ Total number of payments = $25\times 12=300$ $R=9\%$ per annum. Rate of interest per month $=\frac{9}{1200}=0.0075$ (ii) (a) Cost of house $=₹\,2500000$ Down Payment $=₹\,500000$	½ ½

	$\therefore$ Principal amount $= ₹\left(2500000-500000\right)$ $= ₹\,2000000$	½
	EMI (using ***reducing balance method***) = $\dfrac{P\times i}{1-\left(1+i\right)^{-n}}$ $= \dfrac{2000000\times 0.0075}{1-\left(1+0.0075\right)^{-300}}$	1
	$= \dfrac{15000}{1-\left(1.0075\right)^{-300}}$ $= \dfrac{15000}{1-\left(0.1062\right)}$ $= \dfrac{15000}{0.8938} = 16782.27$	½
	Hence, monthly payment is $₹\,16782.27$ **OR** (ii) (b) Cost of house $= ₹\,2500000$ Down Payment $= ₹\,500000$ $\therefore$ Principal amount $= ₹\left(2500000-500000\right)$ $= ₹\,2000000$	½
	EMI (using ***flat rate method***) = $P\left(i+\dfrac{1}{n}\right)$ $= 2000000\left(0.0075+\dfrac{1}{300}\right) = 2000000\left(0.0108333\right)$	1
	$= ₹\,21666.66$	½
	(iii) **EMI** (using ***reducing balance method***) = $₹\,16782.27$ $\therefore$ $\textbf{Total interest} = n\times \text{EMI} - P$ $= 300\times 16782.27 - 2000000$	½
	$= 3034681$	½
	Hence, total interest is $₹\,3034681$ When **EMI** is calculated by (using ***flat rate method***), then $\textbf{Total interest} = n\times EMI - \text{P} = 300\times 21666.6 - 2000000$	½
	$= ₹\,4499980$	½
38.	(i) Let the factory P supply x units per week to depot **A** and y units to depot **B** so that it supplies $8-x-y$ units to depot **C**. Obviously $0\le x\le 5, 0\le y\le 5, 0\le 8-x-y\le 4.$ The given data can be represented diagrammatically as:	



Thus, total transportation cost (in ₹)

$$= 160x + 100y + 150(8 - x - y) + 100(5 - x) + 120(5 - y) + 100(x + y - 4) = 10(x - 7y + 190).$$

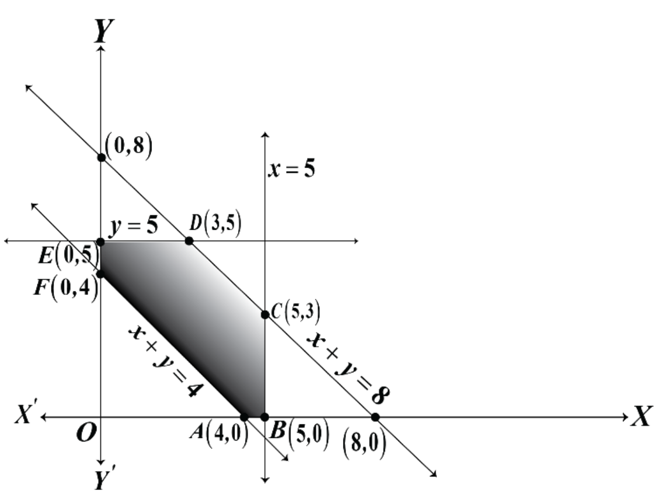
Hence the given problem can be formulated as an L.P.P as: **1**

Minimize $Z = 10(x - 7y + 190)$

subject to the constraints

$$\left.\begin{aligned} &x + y \geq 4, \\ &x + y \leq 8, \\ &x \leq 5, \\ &y \leq 5 \\ &x \geq 0, y \geq 0 \end{aligned}\right\}$$ **1**

(ii) The feasible region corresponding to these in equations is shown shaded in the figure given below.



1

Corner Points	Value of $Z = 10(x - 7y + 190)$
A (4,0)	1940
B (5,0)	1950
C (5,3)	1740
D (3,5)	1580
E (0,5)	**1550 $\rightarrow$ Minimum**
F (0,3)	1690

1

We observe that Z is minimum at point $E(0,\ 5)$ and minimum value is ₹ 1550.

Hence $x = 0,\ y = 5$. Thus for minimum transportation cost, factory P should supply $0,\ 5,\ 3$ units to depots **A, B, C** respectively and factory **Q** should supply $5,\ 0,\ 1$ units respectively to depots **A, B, C**.