MARKING SCHEME

CLASS XII

APPLIED MATHEMATICS (CODE-241)

SECTION: A (Solution of MCQs of 1 Mark each)

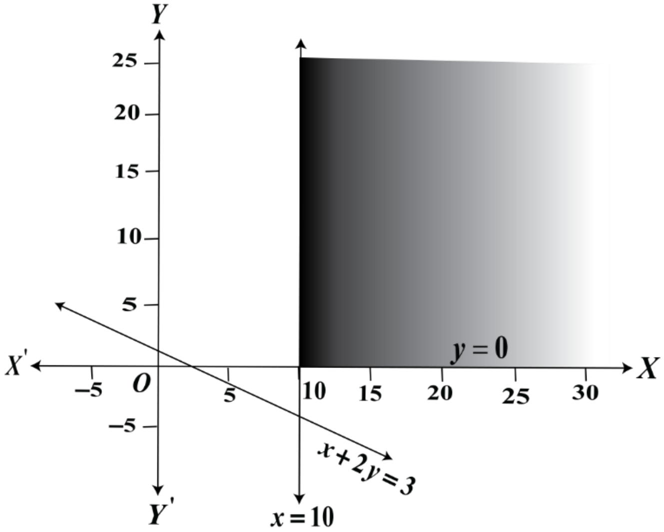
Q no.	ANS	HINTS/SOLUTION
1.	(C)	The required area is given by $\left\|\int_1^4 \left(\sqrt{x}\right) dx\right\| = \left\|\left[\dfrac{x^{\frac{3}{2}}}{\frac{3}{2}}\right]_1^4\right\| = \left\|\dfrac{2}{3}(8-1)\right\| = \dfrac{14}{3}$ sq units.
2.	(A)	Systematic Sampling as it is a type of probability 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 $= \dfrac{1200000 - 300000}{3} =$ ₹ 300000

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

9. **(A)**

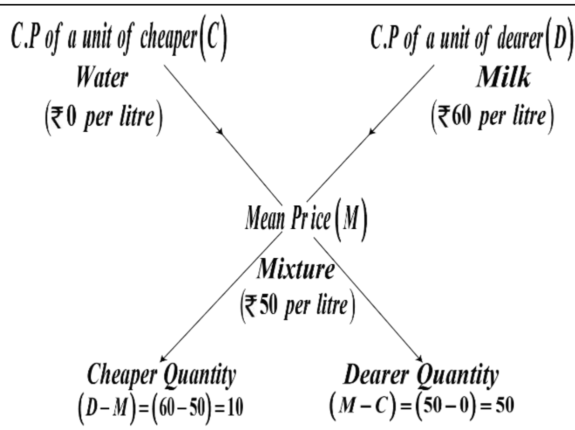
The equation of the parabolic path $y = 6x - x^2 - 8;\ 2 \leq x \leq 4$

		$\frac{dy}{dx}=6-2x$ $\Rightarrow \left.\frac{dy}{dx}\right\|_{x=3}=6-2\times 3=0.$
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, $\boldsymbol{P} = \begin{bmatrix} 3 & 4 \\ -1 & 2 \\ 0 & 1 \end{bmatrix}$ & $\boldsymbol{Q}^T = \begin{bmatrix} -1 & 2 & 1 \\ 1 & 2 & 3 \end{bmatrix} \Rightarrow \boldsymbol{Q} = \begin{bmatrix} -1 & 1 \\ 2 & 2 \\ 1 & 3 \end{bmatrix}$ So, $\boldsymbol{P} - \boldsymbol{Q} = \begin{bmatrix} 3 & 4 \\ -1 & 2 \\ 0 & 1 \end{bmatrix} - \begin{bmatrix} -1 & 1 \\ 2 & 2 \\ 1 & 3 \end{bmatrix} = \begin{bmatrix} 4 & 3 \\ -3 & 0 \\ -1 & -2 \end{bmatrix}$.
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 $P(X\ge 4)=P(X=4)+P(X=5)+P(X=6)$ $={}^6C_4\left(\frac{1}{5}\right)^4\left(\frac{4}{5}\right)^2+{}^6C_5\left(\frac{1}{5}\right)^5\left(\frac{4}{5}\right)^1+{}^6C_6\left(\frac{1}{5}\right)^6\left(\frac{4}{5}\right)^0$ $=\frac{265}{5^6}$ 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.	$5 \equiv 5(\text{mod } 7)$ $\Longrightarrow 5^2 \equiv 25(\text{mod } 7)$ $\Longrightarrow 5^2 \equiv 4(\text{mod } 7)$	1
	$\Longrightarrow 5^4 \equiv 4^2(\text{mod } 7)$ $\Longrightarrow 5^4 \equiv 2(\text{mod } 7)$ $\Longrightarrow 5^{20} \equiv 32(\text{mod } 7)$ $\Longrightarrow 5^{20} \equiv 4(\text{mod } 7)$	1
	$\Longrightarrow 5^{60} \equiv 1(\text{mod } 7)$ $\Longrightarrow 5^{61} \equiv 5(\text{mod } 7)$ 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, $\mathbf{t} = \dfrac{\overline{x_1} - \overline{x_2}}{\mathbf{S}} \times \sqrt{\dfrac{n_1 n_2}{n_1 + n_2}},$ Where $S = \sqrt{\dfrac{(n_1\text{-}1)s_1^2 + (n_2\text{-}1)s_2^2}{n_1 + n_2 - 2}}$	
	$\Rightarrow \quad \mathbf{S} = \sqrt{\dfrac{9 \times 144 + 7 \times 196}{10 + 8 - 2}}$	1

	$= \sqrt{\frac{2668}{16}} = 12.91$	½
	$\therefore\ t = \frac{750-820}{12.91} \times \sqrt{\frac{10\times 8}{10+8}}$ $= \frac{-70}{12.91} \times 2.1081$ $= -11.430$	1
	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
	OR	
27(b).	Here, population mean $(\mu) = 25$	
	Sample mean $(\bar{x}) = \frac{\sum x_i}{n} = \frac{138}{6} = 23$	½
	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	
	$\therefore s = \sqrt{\frac{102}{5}} = 4.52$	1
	Now, $t = \frac{\bar{x}-\mu}{\frac{s}{\sqrt{n}}} = \frac{23-25}{\frac{4.52}{\sqrt{6}}}$	
	$= -1.09$	1
	$\implies \lvert t \rvert = 1.09$	
	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
28.	Given, mean $= \lambda = 3.2$	½
	Let X be the number of bicycle riders which use the cycle track.	

	Required probability $= P(X \le 2) = P(X=0) + P(X=1) + P(X=2)$ $= \frac{e^{-3.2}(3.2)^0}{0!} + \frac{e^{-3.2}(3.2)^1}{1!} + \frac{e^{-3.2}(3.2)^2}{2!}$ $= e^{-3.2}(1 + 3.2 + 5.12)$ $= 0.041 \times 9.32 = 0.618$ 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, $x + y \le 25$ and $\frac{x}{2} + y \le 14$ 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 $x + y \le 25$ $\frac{x}{2} + y \le 14$ $x, y \ge 0$	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) $\textbf{Mean}, E(X)=\sum_{i=1}^{8} i\,P(X=i)$ $=1\times p+2\times p+3\times 2p+4\times p+5\times 2p+6\times p^2+7\times 2p^2+8\times(7p^2+p)$ $=33p+76p^2$ $=\frac{33}{10}+\frac{76}{100}=\frac{203}{50}$	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,** $P(X\geq 1)\geq 0.5\Rightarrow 1-\left(\frac{99}{100}\right)^n\geq 0.5\Rightarrow\left(\frac{99}{100}\right)^n\leq 0.5$ $\Rightarrow n\log_{10}\frac{99}{100}\leq\log_{10}0.5\Rightarrow n\geq\frac{\log_{10}0.5}{\log_{10}0.99};\qquad(\text{as}\log_{10}0.99<0)$ $\left[\text{Using }\log_{10}2=0.3010\text{ and }\log_{10}99=1.9956\right]\Rightarrow n\geq 68.409\Rightarrow n=69\;[\because n\in\mathbb{N}]$.	½ 1 ½ ½ ½

Section –D

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

32(a).	Here, number of observations $\boldsymbol{n = 11(odd\ number)}$	

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	$\sum y = 57$	$\sum x = 0$	$\sum x^2 = 110$	$\sum xy = 76$

2 marks for correct table

Year $\mathbf{1967}$ 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 $y = 5.18 + 0.69x$ **1**

The trend values are

$1.73, 2.42, 3.11, 3.8, 4.49, 5.18, 5.87, 6.56, 7.25, 7.94, 8.63$ **2**

OR

32(b).

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

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

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

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
	$\therefore a = \dfrac{D_a}{D} = \dfrac{-6}{-6} = 1$; ,b $= \dfrac{D_b}{D} = \dfrac{24}{-6} = -4$, ,c $= \dfrac{D_c}{D} = \dfrac{-30}{-6} = 5$	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).	$(\text{i})\ s(t) = at^2 + bt + c\ ; t \geq 0$ **Clearly,** $(10,16),(20,22),(30,25)$ **lie on the curve of** $s(t)$. **Then,** $100a + 10b + c = 16$ $400a + 20b + c = 22$ $900a + 30b + c = 25$	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, $A^{-1} = \dfrac{1}{\lvert A \rvert}(adjA) = \dfrac{1}{-2000}\begin{pmatrix} -10 & 20 & -10 \\ 500 & -800 & 300 \\ -6000 & 6000 & -2000 \end{pmatrix}$	½

	Then, $X = A^{-1}B = \frac{1}{-2000}\begin{pmatrix} -10 & 20 & -10 \\ 500 & -800 & 300 \\ -6000 & 6000 & -2000 \end{pmatrix}\begin{pmatrix} 16 \\ 22 \\ 25 \end{pmatrix}$ $= \frac{1}{-2000}\begin{pmatrix} 30 \\ -2100 \\ -14000 \end{pmatrix}$ $= \begin{pmatrix} -\frac{3}{200} \\ \frac{21}{20} \\ 7 \end{pmatrix}$ Therefore, $a = -\frac{3}{200}, b = \frac{21}{20}, c = 7.$	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

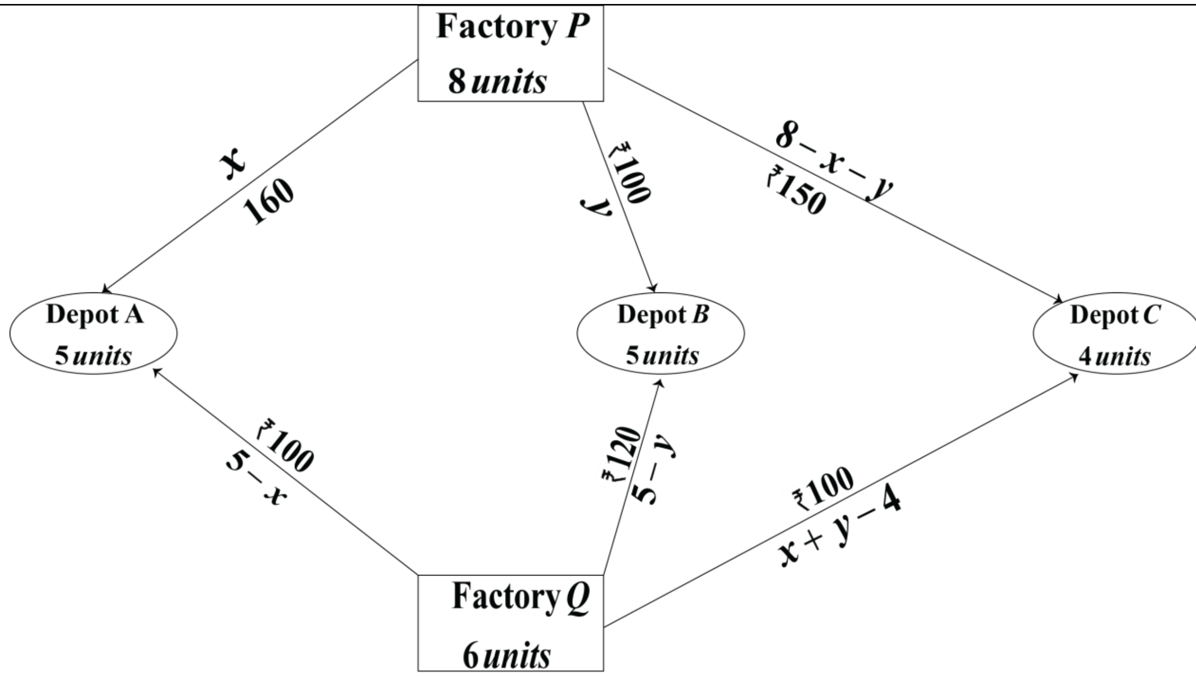
	$\therefore$ Consumer surplus (CS) $= \int_0^{x_0} D(x)dx - p_0 x_0$ $= \int_0^{95} (-50x + 21250)dx - 16500 \times 95$ $= \left(-50\frac{x^2}{2} + 2150x\right)_0^{95} - 1567500$ $= 1793125 - 1567500$ $=$ ₹ 225625	1 ½
35.	Amount needed after **4** years = Replacement Cost - Salvage Cost = ₹ (**55,200** – 72**00)** = **₹ 48,000** The payments into sinking fund consisting of 10 annual payments at the rate 7% per year is given by $A = RS_{\overline{n}\|i} = R\left[\frac{(1+i)^n - 1}{i}\right]$ $\Rightarrow 48000 = R\left[\frac{(1+0.07)^4 - 1}{0.07}\right] = R\left[\frac{(1.07)^4 - 1}{0.07}\right]$ $\Rightarrow R = \frac{48000}{4.4385} =$ ₹10814.5 **Amount of Annual Depreciation** $= \frac{36000-7200}{4} = \frac{28800}{4} =$ **₹7200** $\text{and rate of Depreciation} = \frac{7200}{36000-7200} \times 100 = 25\%$	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 $D = \sqrt{(x-3)^2 + \left(x^2+7-7\right)^2} = \sqrt{(x-3)^2 + x^4}$	½ + ½
	(ii) We have, $D = \sqrt{(x-3)^2 + x^4}$ $\text{Let } \Delta = D^2 = (x-3)^2 + x^4$ Now, $\frac{d}{dx}(\Delta) = 2(x-3) + 4x^3 = 4x^3 + 2x - 6$	½
	$\frac{d}{dx}(\Delta) = 0 \Rightarrow x = 1$	½
	(iii) (a): $\Delta''(x) = 8x^2 + 2$ Clearly, $\Delta''(x) = 8x^2 + 2 > 0$ at $x = 1$	1
	$\therefore$ Value of x for which D will be minimum is 1. For $x = 1, y = 8.$ Therefore, required distance = $D = \sqrt{(1-3)^2 + (1)^4} = \sqrt{4+1} = \sqrt{5}$	1
	OR (iii) (b): $\Delta''(x) = 8x^2 + 2$ Clearly, $\Delta''(x) = 8x^2 + 2 > 0$ at $x = 1$	1
	$\therefore$ Value of x for which D will be minimum is 1. For $x = 1, y = 8.$	1
	Thus, the required position for Shivam is $(1, 8)$ when he is closest to Manita.	
37.	(i) Here, time = 25 years $\therefore$ Total number of payments = $25 \times 12 = 300$	½
	$R = 9\%$ per annum. Rate of interest per month $= \frac{9}{1200} = 0.0075$	½
	(ii) (a) Cost of house $= ₹\, 2500000$ Down Payment $= ₹\, 500000$	

	$\therefore$ 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 ₹)

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

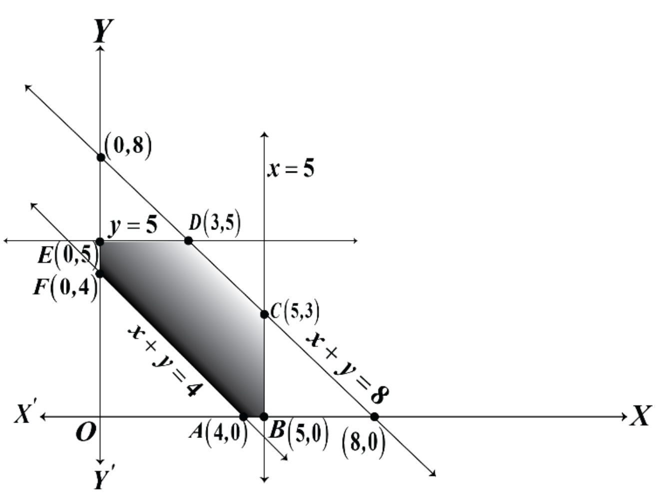
Hence the given problem can be formulated as an L.P.P as: **1**

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**.