Section – A

Each question carries 1-mark weightage

|	
1.	$x \equiv 27(\text{mod } 4)$ $\Rightarrow x - 27 = 4k$, for some integer k $\Rightarrow x = 31$ as $27 < x \leq 36$ **(C) option**
2.	**(D) option**
3.	n = 26 $\Rightarrow |t| = 3.07 > t_{25}(0.05) = 2.06$ **(B) option**
4.	n = 34 $\Rightarrow v = 34 - 1 = 33$ **(B) option**
5.	Speed of boat downstream = u = 10 km/h And, speed of boat upstream = v = 6 km/h $\Rightarrow$ Speed of stream = $\frac{1}{2}$(u − v) = 2 km/h **(B) option**
6.	**(C) option**
7.	Truck A carries water = 100 − $(\frac{20 \times 1500}{1000})$ = 70 l Truck B carries water = 80 − $(\frac{20 \times 1000}{1000})$ = 60 l **(C) option**
8.	Let the face value of the bond = x Then, $\frac{10}{200}x = 1800 \Rightarrow x = 36000$ **(D) option**
9.	**(C) option**
10.	**(D) option**
11.	D = $\frac{C-S}{n}$ = $\frac{480000-25000}{10}$ = 45500 **(B) option**
12.	**(A) option**
13.	$\int \frac{dy}{y\,logy} = \int \frac{dx}{x}$ $\Rightarrow \log(logy) = \log|x| + \log|C|$ $\Rightarrow \log(logy) = \log|Cx|$ $\Rightarrow y = e^{|Cx|}$

	(B) option	
14.	$$\left[\left(\frac{60000}{10000}\right)^{\frac{1}{4}} - 1\right] \times 100 = [\sqrt[4]{6} - 1] \times 100$$ **(C) option**	
15.	⇒ 180 : 300 = 3 : 5 **(C) option**	
16.	**(D) option**	
17.	**(C) option**	
18.	**(B) option**	
19.	P(Win in one game) = P(Lose in one game) = ½ ⇒ P (Beena to win in 3 out of 4 games) = $^4C_3 . \left(\frac{1}{2}\right)^4 = \frac{1}{4} = 25\%$ Assertion is correct and Reason is the correct explanation for it **(A)option**	
20.	Effective rate of interest = Nominal rate – inflation rate = 12.5 − 2 = 10.5% Assertion is correct Reason is true but not supportive of assertion **(B) option**	

	Section – B	
	Each question carries 2-mark weightage	
21.	P = 250000, R = 7500, $i = r/400$ $$\Rightarrow 250000 = \frac{7500 \times 400}{r} \Rightarrow r = 12$$	1
	$\Rightarrow r = 12$	1
22.	a − 8 = 1 ⇒ $a = 9$ 3b = −2 ⇒ $b = -\frac{2}{3}$ −c + 2 = −28 ⇒ $c = 30$	1
	⇒ 2a + 3b − c = − 14	1
	OR Expanding C_1, we get $\Delta = 1(2x^2 + 4) - 2(-4x - 20) = 86$	1
	$$\Rightarrow x^2 + 4x - 21 = 0$$ $$\therefore x = 3, -7$$	1
23.	Let the number of hardcopy and paperback copies be x and y respectively ⇒ Maximum profit Z = (72x + 40y) −(9600 + 56x + 28y) = 16x + 12y− 9600	1

	Subject to constraints: x + y ≤ 960 5x + y ≤ 2400 x, y ≥ 0	1
24.	Speed of boat in still waters = x km/h Speed of stream = y km/h Distance travelled = d km Time taken to travel downstream = $\frac{d}{x+y}$ Time taken to travel upstream = $\frac{d}{x-y}$	1
	Then, $\frac{2d}{x+y} = \frac{d}{x-y} \Rightarrow x:y = 3:1$	1
	OR Param runs 5 m in 3 seconds $\Rightarrow$ time taken to run 200 m $= \frac{3}{5} \times 200 = 120$ seconds	1
	Anuj 's time = 120 − 3 = 117 seconds	1
25.	$V_f = 437500, V_i = 350000$ Nominal rate $= \frac{V_f - V_i}{V_i} \times 100$	1
	$= \frac{437500 - 350000}{350000} \times 100 = 25\%$	1
Section – C Each question carries 3-mark weightage	

26.	$f'(x) = x^3 - 6x^2 + 11x - 6 = (x-1)(x-2)(x-3)$ $\Rightarrow x = 1,2,3$	1
	Strictly increasing in (1,2)∪(3,∞)	1
	Strictly decreasing in (−∞,1)∪(2,3)	1
27.	Daily diet of team A = $\begin{bmatrix} 2 & 3 & 1 \end{bmatrix} \begin{bmatrix} 2500 & 65 \\ 1900 & 50 \\ 2000 & 54 \end{bmatrix} = \begin{bmatrix} 12700 \\ 334 \end{bmatrix}$ Team A consumes 12700 calories and 334 g vitamin	1.5
	Daily diet of team B = $\begin{bmatrix} 1 & 2 & 2 \end{bmatrix} \begin{bmatrix} 2500 & 65 \\ 1900 & 50 \\ 2000 & 54 \end{bmatrix} = \begin{bmatrix} 10300 \\ 273 \end{bmatrix}$ Team B consumes 10300 calories and 273 g vitamin	1.5
28.	$\int \frac{dx}{(1+e^x)(1+e^{-x})}$ $= \int \frac{e^x dx}{(1+e^x)^2}$	3

$= \int \frac{dt}{t^2}$, *where t = e^x + 1 and dt = $e^x dx$*

$= \frac{-1}{t} + C$

$= \frac{-1}{1+e^x} + C$

OR

$\int \underset{II}{x} \log(1+x^2) \underset{I}{dx}$, Integration by parts

$= \log(1+x^2). \int x dx - \int [\frac{d}{dx}\log(1+x^2). \int x \, dx] \, dx$

$= \frac{x^2}{2}\log(1+x^2) - \int [\frac{2x}{1+x^2} . \frac{x^2}{2}] \, dx$

$= \frac{x^2}{2}\log(1+x^2) - \int \frac{x^3}{1+x^2} \, dx$

$= \frac{x^2}{2}\log(1+x^2) - \int [x - \frac{x}{1+x^2}] \, dx$

$= \frac{x^2}{2}\log(1+x^2) - \frac{x^2}{2} + \frac{1}{2}\log(1+x^2) + C$

$= \frac{1}{2}[(1+x^2)\log(1+x^2) - x^2] + C$

29.	Under pure competition, $p_d = p_s$ $\Rightarrow \frac{8}{x+1} - 2 = \frac{x+3}{2}$ $\Rightarrow x^2 + 8x - 9 = 0$ $\Rightarrow x = -9, 1$ $\therefore x = 1$	1.5
	When $x_0 = 1 \Rightarrow p_0 = 2$ $\therefore$ Produce surplus = $2 - \int_0^1 \frac{x+3}{2} dx = 2 - [\frac{x^2}{4} + \frac{3x}{2}]_0^1 = \frac{1}{4}$	1.5
	OR $p = 274 - x^2$ $\Rightarrow R = px = 274x - x^3$ $\frac{dR}{dx} = 274 - 3x^2$ Given MR = $4 + 3x$ In profit monopolist market, MR = $\frac{dR}{dx} \Rightarrow 4 + 3x = 274 - 3x^2$ $\Rightarrow x^2 + x - 90 = 0$	1.5

	$\Rightarrow x = -10, 9$ $\therefore x = 9$	
	When $x_0 = 9 \Rightarrow p_0 = 193$ $\therefore$ Consumer surplus $= \int_0^9 (274 - x^2)dx - 193 \times 9$ $$= \left[274x - \frac{x^3}{3}\right]_0^9$$ $= 486$	1.5
30.	Purchase = ₹ 40,00,000 Down payment = x Balance = 40,00,000 − x $i = \frac{9}{1200} = 0.0075$, n = 25 x 12 = 300 E = ₹ 30,000	1
	$\Rightarrow 30000 = \dfrac{(4000000 - x) \times 0.0075}{1 - (1.0075)^{-300}}$ $\Rightarrow 30000 = \dfrac{(4000000 - x) \times 0.0075}{1 - 0.1062}$ $\Rightarrow x = 424800$ Down payment = ₹ 4,24,800	2
31.	n = 10 x 2 = 20, S = 10,21,760, $i = \frac{5}{200} = 0.025$, R = ? S = R $\left[\frac{(1+i)^n - 1}{i}\right]$	1.5
	$\Rightarrow$ 1021760 = R $\left[\frac{(1+0.025)^{20} - 1}{0.025}\right]$ $\Rightarrow$ 1021760 = R $\left[\frac{1.6386 - 1}{0.025}\right]$ $\Rightarrow$ R = $\left[\frac{1021760 \times 0.025}{0.6386}\right]$ $\Rightarrow$ R = ₹ 40,000 Mr Mehra set aside an amount of ₹ 40,000 at the end of every six months	1.5
	Section – D Each question carries 5-mark weightage	
32.	Probability of defective bucket = 0.03 n = 100 m = np = 100 x 0.03 = 3 Let X = number of defective buckets in a sample of 100 P (X = r) = $\frac{m^r e^{-m}}{r!}, r = 0,1,2,3, \ldots$	1
	(i) P (no defective bucket) = P(r = 0) = $\frac{3^0 e^{-3}}{0!} = 0.049$	2
	(ii) P (at most one defective bucket) = P(r = 0, 1) = $\frac{3^0 e^{-3}}{0!} + \frac{3^1 e^{-3}}{1!}$	2

	$= 0.049 + 0.147$ $= 0.196$	
	OR X = scores of students, $\mu = 45, \sigma = 5$ $$\therefore Z = \frac{X - \mu}{\sigma} = \frac{X - 45}{5}$$	1
	(i) When X = 45, $Z = 0$ P (X > 45) = P (Z > 0) = 0.5 $\Rightarrow$ 50% students scored more than the mean score	2
	(ii) When X = 30, $Z = -3$ and when X = 50, $Z = 1$ P (30< X< 50) = P (-3< Z < 1) = P (-3< Z $\leq$ 1) = P ($- 3 < Z \leq 0$) + P (0 $\leq$ Z <1) = P (0 $\leq Z < 3$) + P (0 $\leq$ Z <1) = 0.4987 + 0.3413 = 0.84 $\Rightarrow$ 84% students scored between 30 and 50 marks	2
33.	Let x be the number of guests for the booking Clearly, $x > 100$ to avail discount $\therefore$ Profit, P = $[4800 - \frac{200}{10}(x - 100)]\, x = 6800x - 20x^2$	2
	$\Rightarrow \frac{dP}{dx} = 6800 - 40\,x \Rightarrow x = 170$	1
	As $\frac{d^2P}{dx^2} = -40 < 0, \forall\, x$	1
	A booking for 170 guests will maximise the profit of the company And, Profit = ₹ 5,78,000	1
	OR P(x) = R(x) − C(x) = 5x − (100 + 0.025x²)	2
	$\Rightarrow$P′(x) = 5 − 0.05 x $\Rightarrow x = 100$	1
	As P′′(x) = −0.05 < 0, $\forall\, x$	1
	$\therefore$ Manufacturing 100 dolls will maximise the profit of the company And, Profit = ₹ 1,50,000	1
34.	Let the number of tables and chairs be x and y respectively (Max profit) Z = 22x + 18y Subject to constraints: $x + y \leq 20$ $3x + 2y \leq 48$ $x, y \geq 0$	1.5
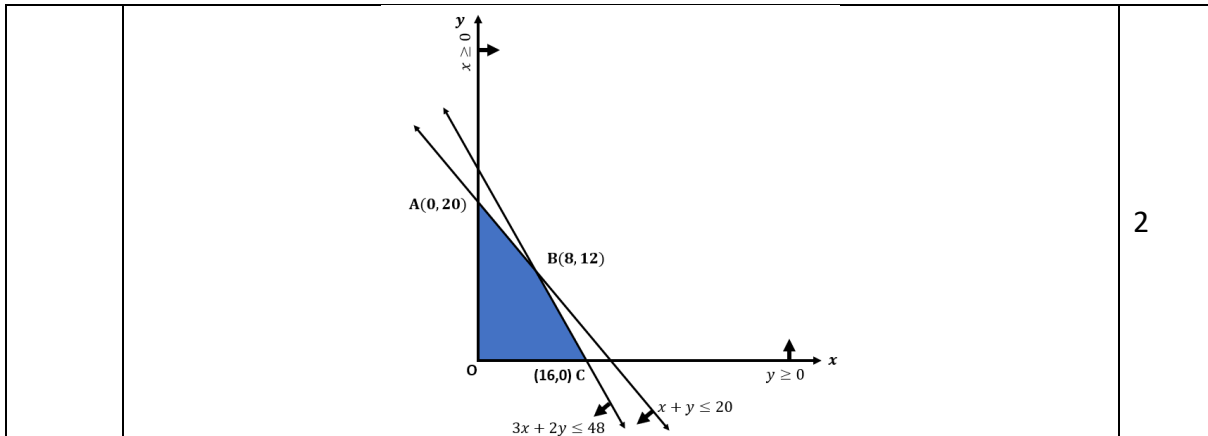
The feasible region OABCA is closed (bounded)

Corner points	Z = 22 x + 18 y
O (0,0)	0
A (0,20)	360
B (8,12)	392
C (16,0)	352

Buying 8 tables and 12 chairs will maximise the profit

35.

$A = \begin{bmatrix} 1 & 2 & 3 \\ 3 & 2 & 2 \\ 2 & 3 & 2 \end{bmatrix}$

$\Rightarrow |A| = 9 \Rightarrow A^{-1}$ exists

And $A^{-1} = \frac{1}{9}\begin{bmatrix} -2 & 5 & -2 \\ -2 & -4 & 7 \\ 5 & 1 & -4 \end{bmatrix}$

AX = B $\Rightarrow X = A^{-1}B$

$\Rightarrow X = \frac{1}{9}\begin{bmatrix} -2 & 5 & -2 \\ -2 & -4 & 7 \\ 5 & 1 & -4 \end{bmatrix}\begin{bmatrix} 85 \\ 105 \\ 110 \end{bmatrix} = \begin{bmatrix} 15 \\ 20 \\ 10 \end{bmatrix}$

$\Rightarrow p_1 = 15, p_2 = 20, p_3 = 10$

Section – E
Each Case study carries 4-mark weightage

36. CASE STUDY - I

a) Pipe C empties 1 tank in 20 h $\Rightarrow$ 2/5 th tank in $\frac{2}{5} \times 20 = 8$ hours

b) Part of tank filled in 1 hour = $\frac{1}{15} + \frac{1}{12} - \frac{1}{20} = \frac{1}{10}$ th

$\Rightarrow$ time taken to fill tank completely = 10 hours

c) At 5 am,

|	Let the tank be completely filled in 't' hours ⇒pipe A is opened for 't' hours pipe B is opened for 't−3' hours And, pipe C is opened for 't−4' hours ⇒ In one hour, part of tank filled by pipe A = $\frac{t}{15}$ th part of tank filled by pipe B = $\frac{t-3}{15}$ th and, part of tank emptied by pipe C = $\frac{t-4}{15}$ th Therefore $\frac{t}{15} + \frac{t-3}{12} - \frac{t-4}{20} = 1$ ⇒ $t = 10.5$ Total time to fill the tank = 10 hours 30 minutes	
	OR 6 am, pipe C is opened to empty ½ filled tank Time to empty = 10 hours Time for cleaning = 1 hour Part of tank filled by pipes A and B in 1 hour= $\frac{1}{15} + \frac{1}{12} = \frac{3}{20}$ th tank ⇒ time taken to fill the tank completely = $\frac{20}{3}$ hours Total time taken in the process = 10 + 1 + $\frac{20}{3}$ = 17 hour 40 minutes	
37.	CASE STUDY - II	
a)	<table><tr><th>Year</th><th>Y</th><th>X</th><th>X²</th><th>XY</th></tr><tr><td>2015</td><td>35</td><td>-2</td><td>4</td><td>-70</td></tr><tr><td>2016</td><td>42</td><td>-1</td><td>1</td><td>-42</td></tr><tr><td>2017</td><td>46</td><td>0</td><td>0</td><td>0</td></tr><tr><td>2018</td><td>41</td><td>1</td><td>1</td><td>41</td></tr><tr><td>2019</td><td>48</td><td>2</td><td>4</td><td>96</td></tr><tr><td></td><td>212</td><td></td><td>10</td><td>25</td></tr></table> a = $\frac{\sum Y}{n} = \frac{212}{5}$ = 42.4 and b = $\frac{\sum XY}{\sum X^2} = \frac{25}{10}$ = 2.5 $$Y_C = 42.4 + 2.5X$$ **OR** <table><tr><th>Year</th><th>Y</th><th>3-year moving average</th></tr><tr><td>2015</td><td>35</td><td>-</td></tr><tr><td>2016</td><td>42</td><td>41</td></tr><tr><td>2017</td><td>46</td><td>43</td></tr><tr><td>2018</td><td>41</td><td>45</td></tr><tr><td>2019</td><td>48</td><td>-</td></tr></table>	2
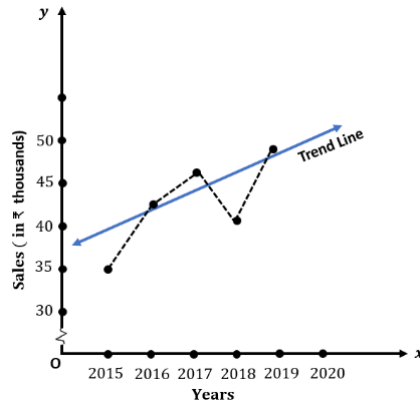
b)	For year 2022, $$Y_{2022} = 42.4 + 2.5(2022 - 2017) = 54.9$$ $\Rightarrow$ the estimated sales for year 2022 = ₹ 54,900	1
c)	$$Y_C = 42.4 + 2.5X$$ $$\Rightarrow 67.4 = 42.4 + 2.5X$$ $$\Rightarrow X = 10$$ Sales will be ₹ 67,400 in year (2017+ 10) = year 2027	1
38.	CASE STUDY - III	
a)	$\frac{k}{6} + \frac{2k}{6} + \frac{3(1-k)}{6} + \frac{4k}{2} = 1 \Rightarrow k = \frac{1}{4}$	1
b)	P (getting admission on applying at least 2 weeks ahead of application deadline) = P (X = 2,3,4) $= \frac{1}{12} + \frac{3}{8} + \frac{1}{2} = \frac{23}{24}$ [alternate method: 1 – P (X = 1) = 1 - $\frac{1}{24}$ = $\frac{23}{24}$]	1

c)					
	X = week applied ahead of application deadline				

X	1	2	3	4
P(X)	$\frac{1}{24}$	$\frac{1}{12}$	$\frac{3}{8}$	$\frac{1}{2}$
XP(X)	$\frac{1}{24}$	$\frac{1}{6}$	$\frac{9}{8}$	2

$\therefore$ E(X) = $\frac{80}{24}$ = $3\frac{1}{3}$ weeks

OR

X = Scholarship money awarded for the week applied in, before the deadline

Week applied in	1	2	3	4
X	9600	12000	20000	50000

(c) score cell: 2

P(X)	$\dfrac{1}{24}$	$\dfrac{1}{12}$	$\dfrac{3}{8}$	$\dfrac{1}{2}$		
XP(X)	$\dfrac{9600}{24}$	$\dfrac{12000}{12}$	$\dfrac{60000}{8}$	$\dfrac{50000}{2}$		

$\therefore$ E(X) = ₹ 33,900