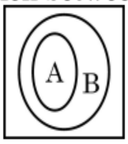
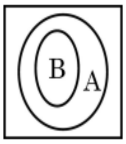
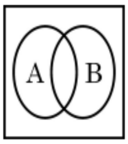
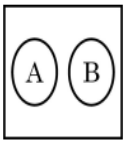
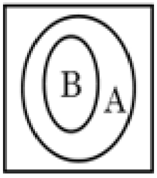
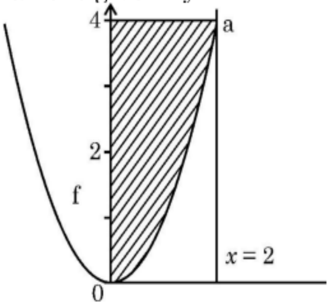
Marking Scheme Strictly Confidential (For Internal and Restricted use only) Senior Secondary Examination, 2025 SUBJECT NAME MATHEMATICS (Q.P. CODE – 65/2/1)	
General Instructions: -	
1	You are aware that evaluation is the most important process in the actual and correct assessment of the candidates. A small mistake in evaluation may lead to serious problems which may affect the future of the candidates, education system and teaching profession. To avoid mistakes, it is requested that before starting evaluation, you must read and understand the spot evaluation guidelines carefully.
2	**"Evaluation policy is a confidential policy as it is related to the confidentiality of the examinations conducted, Evaluation done and several other aspects. Its leakage to the public in any manner could lead to derailment of the examination system and affect the life and future of millions of candidates. Sharing this policy/document to anyone, publishing in any magazine and printing in Newspaper/Website, etc. may invite action under various rules of the Board and IPC."**
3	Evaluation is to be done as per instructions provided in the Marking Scheme. It should not be done according to one's own interpretation or any other consideration. The Marking Scheme should be strictly adhered to and religiously followed. **However, while evaluating, answers which are based on latest information or knowledge and/or are innovative, they may be assessed for their correctness otherwise and due marks be awarded to them. In class-XII, while evaluating the competency-based questions, please try to understand the given answer and even if reply is not from a marking scheme but correct competency is enumerated by the candidate, due marks should be awarded.**
4	The Marking Scheme carries only suggested value points for the answers. These are Guidelines only and do not constitute the complete answer. The students can have their own expression and if the expression is correct, the due marks should be awarded accordingly.
5	The Head-Examiner must go through the first five answer books evaluated by each evaluator on the first day, to ensure that evaluation has been carried out as per the instructions given in the Marking Scheme. If there is any variation, the same should be zero after deliberation and discussion. The remaining answer books meant for evaluation shall be given only after ensuring that there is no significant variation in the marking of individual evaluators.
6	Evaluators will mark (√) wherever answer is correct. For wrong answer CROSS 'X' be marked. Evaluators will not put right (✓) while evaluating which gives the impression that the answer is correct, and no marks are awarded. **This is the most common mistake which evaluators are committing.**
7	If a question has parts, please award marks on the right-hand side for each part. Marks awarded for different parts of the question should then be totaled up and written in the left-hand margin and encircled. This may be followed strictly.
8	If a question does not have any parts, marks must be awarded in the left-hand margin and encircled. This may also be followed strictly.
9	If a student has attempted an extra question, answer to the question deserving more marks should be retained and the other answer scored out with a note **"Extra Question"**.

10	No marks to be deducted for the cumulative effect of an error. It should be penalized only once.
11	A full scale of marks_____________ (example 0 to 80/70/60/50/40/30 marks as given in Question Paper) has to be used. Please do not hesitate to award full marks if the answer deserves it.
12	Every examiner must necessarily do evaluation work for full working hours, i.e., 8 hours every day and evaluate 20 answer books per day in main subjects and 25 answer books per day in other subjects (Details are given in Spot Guidelines). This is in view of the reduced syllabus and number of questions in question paper.
13	Ensure that you do not make the following common types of errors committed by the Examiner in the past: - ● Leaving answer or part thereof unassessed in an answer book. ● Giving more marks for an answer than assigned to it. ● Wrong totaling of marks awarded on an answer. ● Wrong transfer of marks from the inside pages of the answer book to the title page. ● Wrong question wise totaling on the title page. ● Wrong totaling of marks of the two columns on the title page. ● Wrong grand total. ● Marks in words and figures not tallying/not same. ● Wrong transfer of marks from the answer book to online award list. ● Answers marked as correct, but marks not awarded. (Ensure that the right tick mark is correctly and clearly indicated. It should merely be a line. Same is with the X for incorrect answer.) ● Half or a part of the answer marked correct and the rest as wrong, but no marks awarded.
14	While evaluating the answer books if the answer is found to be totally incorrect, it should be marked as cross (X) and awarded zero (0) Marks.
15	Any unassessed portion, non-carrying over of marks to the title page, or total error detected by the candidate shall damage the prestige of all the personnel engaged in the evaluation work as also of the Board. Hence, to uphold the prestige of all concerned, it is again reiterated that the instructions be followed meticulously and judiciously.
16	The Examiners should acquaint themselves with the guidelines given in the “**Guidelines for Spot Evaluation**” before starting the actual evaluation.
17	Every Examiner shall also ensure that all the answers are evaluated, marks carried over to the title page, correctly totaled and written in figures and words.
18	The candidates are entitled to obtain a photocopy of the Answer Book on request on payment of the prescribed processing fee. All Examiners/Additional Head Examiners/Head Examiners are once again reminded that they must ensure that evaluation is carried out strictly as per value points for each answer as given in the Marking Scheme.

Q. No.	EXPECTED ANSWER / VALUE POINTS	Marks
SECTION-A This section comprises multiple choice questions (MCQs) of 1 mark each.		
1.	The projection vector of vector $\vec{a}$ on vector $\vec{b}$ is (A) $\left(\frac{\vec{a}\cdot\vec{b}}{\vert\vec{b}\vert^2}\right)\vec{b}$ (B) $\frac{\vec{a}\cdot\vec{b}}{\vert\vec{b}\vert}$ (C) $\frac{\vec{a}\cdot\vec{b}}{\vert\vec{a}\vert}$ (D) $\left(\frac{\vec{a}\cdot\vec{b}}{\vert\vec{a}\vert^2}\right)\vec{b}$	
Ans	(A) $\left(\frac{\vec{a}.\vec{b}}{\vert\vec{b}\vert^2}\right)\vec{b}$	1
2.	The function $f(x) = x^2 - 4x + 6$ is increasing in the interval (A) $(0, 2)$ (B) $(-\infty, 2]$ (C) $[1, 2]$ (D) $[2, \infty)$	
Ans	(D) $[2, \infty)$	1
3.	If $f(2a - x) = f(x)$, then $\int_0^{2a} f(x)\,dx$ is (A) $\int_0^{2a} f\left(\frac{x}{2}\right) dx$ (B) $\int_0^{a} f(x)\,dx$ (C) $2\int_a^{0} f(x)\,dx$ (D) $2\int_0^{a} f(x)\,dx$	
Ans	(D) $2\int_0^a f(x)dx$	1

4.	If $A = \begin{bmatrix} 1 & 12 & 4y \\ 6x & 5 & 2x \\ 8x & 4 & 6 \end{bmatrix}$ is a symmetric matrix, then $(2x + y)$ is (A) -8 (B) 0 (C) 6 (D) 8	
Ans	(D) 8	1
5.	If $y = \sin^{-1}x, -1 \le x \le 0$, then the range of y is (A) $\left(\frac{-\pi}{2}, 0\right)$ (B) $\left[\frac{-\pi}{2}, 0\right]$ (C) $\left[\frac{-\pi}{2}, 0\right)$ (D) $\left(\frac{-\pi}{2}, 0\right]$	
Ans	(B) $[-\frac{\pi}{2}, 0]$	1
6.	If a line makes angles of $\frac{3\pi}{4}, \frac{\pi}{3}$ and θ with the positive directions of x, y and z-axis respectively, then θ is (A) $\frac{-\pi}{3}$ only (B) $\frac{\pi}{3}$ only (C) $\frac{\pi}{6}$ (D) $\pm\frac{\pi}{3}$	
Ans	No option is correct. Full marks may be awarded for attempting the question.	1
7.	If E and F are two events such that $P(E) > 0$ and $P(F) \neq 1$, then $P(\overline{E}/\overline{F})$ is (A) $\frac{P(\overline{E})}{P(\overline{F})}$ (B) $1 - P(\overline{E}/F)$ (C) $1 - P(E/F)$ (D) $\frac{1 - P(E \cup F)}{P(\overline{F})}$	
Ans	(D) $\frac{1-P(E \cup F)}{P(\bar{F})}$	1
8.	Which of the following can be both a symmetric and skew-symmetric matrix ? (A) Unit Matrix (B) Diagonal Matrix (C) Null Matrix (D) Row Matrix	
Ans	(C) Null Matrix	1

9.	The equation of a line parallel to the vector $3\hat{i} + \hat{j} + 2\hat{k}$ and passing through the point (4, –3, 7) is : (A) $x = 4t + 3, y = -3t + 1, z = 7t + 2$ (B) $x = 3t + 4, y = t + 3, z = 2t + 7$ (C) $x = 3t + 4, y = t - 3, z = 2t + 7$ (D) $x = 3t + 4, y = -t + 3, z = 2t + 7$	
Ans	(C) $x = 3t + 4, y = t - 3, z = 2t + 7$	1
10.	Four friends Abhay, Bina, Chhaya and Devesh were asked to simplify 4 AB + 3(AB + BA) – 4 BA, where A and B are both matrices of order 2 × 2. It is known that $A \neq B \neq I$ and $A^{-1} \neq B$. Their answers are given as : Abhay : 6 AB Bina : 7 AB – BA Chhaya : 8 AB Devesh : 7 BA – AB Who answered it correctly ? (A) Abhay (B) Bina (C) Chhaya (D) Devesh	
Ans	(B) Bina	1
11.	A cylindrical tank of radius 10 cm is being filled with sugar at the rate of 100π cm^3/s. The rate, at which the height of the sugar inside the tank is increasing, is : (A) 0.1 cm/s (B) 0.5 cm/s (C) 1 cm/s (D) 1.1 cm/s	
Ans	(C) 1 cm/s	**1**
12.	Let $\vec{p}$ and $\vec{q}$ be two unit vectors and α be the angle between them. Then $(\vec{p} + \vec{q})$ will be a unit vector for what value of α ? (A) $\frac{\pi}{4}$ (B) $\frac{\pi}{3}$ (C) $\frac{\pi}{2}$ (D) $\frac{2\pi}{3}$	
Ans	(D) $\frac{2\pi}{3}$	1

13.	The line $x = 1 + 5\mu$, $y = -5 + \mu$, $z = -6 - 3\mu$ passes through which of the following point ? (A) (1, −5, 6) (B) (1, 5, 6) (C) (1, −5, −6) (D) (−1, −5, 6)	
Ans	(C) (1, -5, -6)	1
14.	If A denotes the set of continuous functions and B denotes set of differentiable functions, then which of the following depicts the correct relation between set A and B ? (A)  (B)  (C)  (D) 	
Ans	 (B)	1
15.	The area of the shaded region (figure) represented by the curves $y = x^2$, $0 \le x \le 2$ and y-axis is given by  (A) $\int_0^2 x^2\, dx$ (B) $\int_0^2 \sqrt{y}\, dy$ (C) $\int_0^4 x^2\, dx$ (D) $\int_0^4 \sqrt{y}\, dy$	
Ans	(D) $\int_0^4 \sqrt{y}\, dy$	1

16.	A factory produces two products X and Y. The profit earned by selling X and Y is represented by the objective function $Z = 5x + 7y$, where x and y are the number of units of X and Y respectively sold. Which of the following statement is correct ? (A) The objective function maximizes the difference of the profit earned from products X and Y. (B) The objective function measures the total production of products X and Y. (C) The objective function maximizes the combined profit earned from selling X and Y. (D) The objective function ensures the company produces more of product X than product Y.	
Ans	(C) The objective function maximizes the combined profit earned from selling X and Y	1
17.	If A and B are square matrices of order m such that $A^2 - B^2 = (A - B)(A + B)$, then which of the following is always correct ? (A) A = B (B) AB = BA (C) A = 0 or B = 0 (D) A = I or B = I	
Ans	(B) AB = BA	1
18.	If p and q are respectively the order and degree of the differential equation $\frac{d}{dx}\left(\frac{dy}{dx}\right)^3 = 0$, then (p – q) is (A) 0 (B) 1 (C) 2 (D) 3	
Ans	(B) 1	1
	*Questions number **19** and **20** are Assertion and Reason based questions. 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.* (A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A). (B) Both Assertion (A) and Reason (R) are true, but Reason (R) is ***not*** the correct explanation of the Assertion (A). (C) Assertion (A) is true, but Reason (R) is false. (D) Assertion (A) is false, but Reason (R) is true.	

19.	**Assertion (A)** : A = diag [3 5 2] is a scalar matrix of order 3 × 3. **Reason (R)** : If a diagonal matrix has all non-zero elements equal, it is known as a scalar matrix.	
Ans	(D) Assertion (A) is false and Reason (R) is true.	1
20.	**Assertion (A)** : Every point of the feasible region of a Linear Programming Problem is an optimal solution. **Reason (R)** : The optimal solution for a Linear Programming Problem exists only at one or more corner point(s) of the feasible region.	
Ans	(D) Assertion (A) is false and Reason (R) is true.	1
SECTION-B This section comprises 5 Very Short Answer (VSA) type questions of 2 marks each.		
21	(a) A vector $\vec{a}$ makes equal angles with all the three axes. If the magnitude of the vector is $5\sqrt{3}$ units, then find $\vec{a}$. **OR** (b) If $\vec{\alpha}$ and $\vec{\beta}$ are position vectors of two points P and Q respectively, then find the position vector of a point R in QP produced such that $QR = \frac{3}{2}QP$.	
21 (a) Ans	Let α be the angle which the vector $\vec{a}$ makes with all the three axes. Then $3\cos^2\alpha = 1$ $\Rightarrow \cos\alpha = \frac{1}{\sqrt{3}}$ The unit vector along the vector $\vec{a} = \frac{1}{\sqrt{3}}(\hat{\imath} + \hat{\jmath} + \hat{k})$ $\vec{a} = 5(\hat{\imath} + \hat{\jmath} + \hat{k})$ OR	1 ½ ½
21 (b) Ans	 $\frac{QR}{QP} = \frac{3}{2}$	

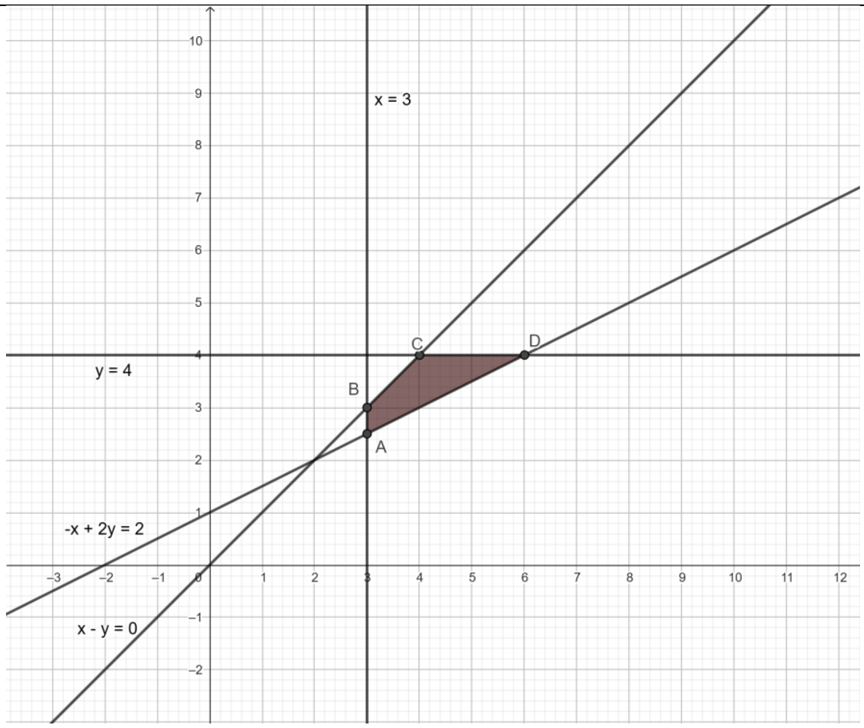
	Hence, R divides PQ, externally, in the ratio 1:3. The Position vector of R = $\vec{x} = \frac{\vec{\beta}-3\vec{\alpha}}{1-3} = \frac{3\vec{\alpha}-\vec{\beta}}{2}$	1 1
22.	Evaluate : $\int_0^{\frac{\pi}{4}} \sqrt{1+\sin 2x}\ dx$	
Ans	Given definite integral = $\int_0^{\frac{\pi}{4}} \sqrt{(sinx + cosx)^2}dx$ $= \int_0^{\frac{\pi}{4}} (sinx + cosx)dx$ $= [-cosx + sinx]_0^{\frac{\pi}{4}}$ = 1	1 1
23.	Find the values of 'a' for which f(x) = sin $x - ax$ + b is increasing on R.	
Ans	$f'(x) = cosx - a$ For f(x) to be increasing, $f'(x) \geq 0$ $i.e., cosx \geq a$ Since, $-1 \leq cosx \leq 1$ $\Rightarrow a \leq -1$ Hence, $a \in (-\infty, -1]$. (Also, accept $a \in (-\infty, -1)$)	1 1
24.	If $\vec{a}$ and $\vec{b}$ are two non-collinear vectors, then find x, such that $\vec{\alpha} = (x - 2)\vec{a} + \vec{b}$ and $\vec{\beta} = (3 + 2x)\vec{a} - 2\vec{b}$ are collinear.	
Ans	$\vec{\alpha}$ and $\vec{\beta}$ are collinear $\Rightarrow \frac{x-2}{3+2x} = \frac{1}{-2}$	1½

	$\Rightarrow x = \frac{1}{4}$	½
25	(a) If $x = e^{\frac{x}{y}}$, then prove that $\frac{dy}{dx} = \frac{x - y}{x \log x}$. **OR** (b) If $f(x) = \begin{cases} 2x - 3 \ , & -3 \le x \le -2 \\ x + 1 \ , & -2 < x \le 0 \end{cases}$ Check the differentiability of f(x) at $x = -2$.	
25 (a) Ans	$x = e^{\frac{x}{y}}$ $\Rightarrow logx = \frac{x}{y}$ $\Rightarrow ylogx = x$ Differentiating both sides w.r.to x, we get $\frac{y}{x} + logx\frac{dy}{dx} = 1$ $\Rightarrow \frac{dy}{dx} = \frac{x - y}{xlogx}$ OR	 ½ 1 ½
25 (b) Ans	$Lf'(-2) = \lim_{h \to 0} \frac{f(-2-h) - f(-2)}{-h} \quad (h > 0)$ $= \lim_{h \to 0} \frac{2(-2 - h) - 3 - (-7)}{-h}$ $= \lim_{h \to 0} 2 = 2$ $Rf'(-2) = \lim_{h \to 0} \frac{f(-2+h) - f(-2)}{h} \quad (h > 0)$ $= \lim_{h \to 0} \frac{-2 + h + 1 - (-7)}{h}$ $= \lim_{h \to 0} \frac{6+h}{h}$, which does not exist, i.e., RHD does not exist.	 1

	Therefore, the function is not differentiable at -2. Note: (1) If a student finds only RHD and concludes the result, full marks may be awarded. (2) If a student proves that the function is discontinuous at -2 and hence not differentiable at -2, full marks may be awarded.	1
SECTION-C This section comprises 6 Short Answer (SA) type questions of 3 marks each.		
26	(a) Solve the differential equation $2(y+3) - xy\frac{dy}{dx} = 0$; given $y(1) = -2$. **OR** (b) Solve the following differential equation : $(1+x^2)\frac{dy}{dx} + 2xy = 4x^2$.	
26(a) Ans	Given differential equation can be written as $\frac{y}{y+3}dy = \frac{2}{x}dx$ $\Rightarrow \int\left(1 - \frac{3}{y+3}\right)dy = 2\int\frac{1}{x}dx$ $\Rightarrow y - 3log\lvert y+3\rvert = 2log\lvert x\rvert + C$ y = -2, when x = 1 $\Rightarrow C = -2$ Hence, the required particular solution is $\Rightarrow y - 3log\lvert y+3\rvert = 2log\lvert x\rvert - 2$ OR	1 1½ ½
26(b) Ans	Given differential equation can be written as $\frac{dy}{dx} + \frac{2x}{1+x^2}y = \frac{4x^2}{1+x^2}$, which is linear in y. I.F. = $e^{\int\frac{2x}{1+x^2}dx} = e^{log(1+x^2)} = 1 + x^2$ The solution is given by $y(1+x^2) = \int 4x^2dx$ $\Rightarrow y(1+x^2) = \frac{4}{3}x^3 + C$ $or\ y = \frac{4x^3}{3(1+x^2)} + C\frac{1}{(1+x^2)}$, which is the required general solution	1 1 1

27.	Let R be a relation defined over N, where N is set of natural numbers, defined as "mRn if and only if m is a multiple of n, m, n $\in$ N." Find whether R is reflexive, symmetric and transitive or not.	
Ans	Let $x \in N$. Then we know that x is a multiple of itself. $\Rightarrow xRx$ Hence, R is reflexive. We have $2, 8 \in N$ such that 8 is a multiple of 2 $\Rightarrow 8R2$ But, 2 is not a multiple of 8. Hence, 2 is not R-related to 8. Therefore, R is not symmetric. Let $x, y, z \in N$ such that xRy, yRz Then $x = my, y = nz$ for some m, $n \in N$ $\Rightarrow x = mnz \Rightarrow x = pz,$ where $p = mn \in N.$ Hence, xRz Therefore, R is transitive.	1 1 1
28.	Solve the following linear programming problem graphically : Minimise Z = $x - 5y$ subject to the constraints : $x - y \geq 0$ $-x + 2y \geq 2$ $x \geq 3, y \leq 4, y \geq 0$	

Ans



Correct graph and shading 1½

Corner point	Value of Z = x – 5y
A (3, 2.5)	-9.5
B (3, 3)	-12
C (4, 4)	-16
D (6, 4)	-14

1

The minimum value of Z is -16, which is attained at x = 4, y = 4. ½

29

(a) If $y = \log\left(\sqrt{x} + \frac{1}{\sqrt{x}}\right)^2$, then show that $x(x+1)^2 y_2 + (x+1)^2 y_1 = 2$.

OR

(b) If $x\sqrt{1+y} + y\sqrt{1+x} = 0, -1 < x < 1, x \neq y$, then prove that $\frac{dy}{dx} = \frac{-1}{(1+x)^2}$.

29(a) Ans

The given function can be written as

$y = 2\,log(x+1) - logx$

$\Rightarrow y_1 = \frac{2}{x+1} - \frac{1}{x} = \frac{x-1}{x(x+1)}$ 1

$\Rightarrow (x+1)y_1 = \frac{x-1}{x} = 1 - \frac{1}{x}$

	$\Rightarrow (x+1)y_2 + y_1 = \frac{1}{x^2}$ $\Rightarrow x(x+1)^2 y_2 + x(x+1)y_1 = 1 + \frac{1}{x}$ $\Rightarrow x(x+1)^2 y_2 + x(x+1)y_1 = 1 + 1 - (x+1)y_1$ $\Rightarrow x(x+1)^2 y_2 + (x+1)^2 y_1 = 2$ OR	1 1
29(b) Ans	$x\sqrt{1+y} + y\sqrt{1+x} = 0$ $\Rightarrow x\sqrt{1+y} = -y\sqrt{1+x}$ $\Rightarrow x^2(1+y) = y^2(1+x)$ $\Rightarrow (x-y)(x+y) + xy(x-y) = 0$ $\Rightarrow (x-y)(x+y+xy) = 0$ $x \neq y \Rightarrow x + y + xy = 0$ $\Rightarrow y = \frac{-x}{1+x}$ $\Rightarrow \frac{dy}{dx} = \frac{-1}{(1+x)^2}$	 ½ 1 ½ 1
30	(a) A die with number 1 to 6 is biased such that $P(2) = \frac{3}{10}$ and probability of other numbers is equal. Find the mean of the number of times number 2 appears on the dice, if the dice is thrown twice. **OR** (b) Two dice are thrown. Defined are the following two events A and B : A = {(x, y) : x + y = 9}, B = {(x, y) : $x \neq 3$}, where (x, y) denote a point in the sample space. Check if events A and B are independent or mutually exclusive.	
30(a) Ans	$P(2) = \frac{3}{10}$, P(any other number) $= 1 - \frac{3}{10} = \frac{7}{10}$ Let X represent the Random Variable "the number of 2's". Then X = 0, 1, 2	½ ½

The probability distribution is

X	P(X)	XP(X)
0	$\frac{7}{10} \times \frac{7}{10} = \frac{49}{100}$	0
1	$\frac{3}{10} \times \frac{7}{10} \times 2 = \frac{42}{100}$	$\frac{42}{100}$
2	$\frac{3}{10} \times \frac{3}{10} = \frac{9}{100}$	$\frac{18}{100}$

1½

Mean = $\sum \mathrm{XP(X)} = \frac{60}{100} = 0.6$

½

OR

30(b)

Ans

$A = \{(3,6), (4,5), (5,4), (6,3)\}$

$P(A) = \frac{4}{36} = \frac{1}{9}, P(B) = \frac{30}{36} = \frac{5}{6}$

1

$\mathrm{P(A \cap B)} = \frac{3}{36} = \frac{1}{12}$

½

$P(A) \times P(B) = \frac{5}{54} \neq P(A \cap B)$

1

Therefore, A and B are not independent.

A and B are not mutually exclusive as $A \cap B \neq \emptyset$

½

31. Find : $\int \frac{1}{x} \sqrt{\frac{x+a}{x-a}}\, dx.$

Ans

$\mathrm{I} = \int \frac{1}{x} \frac{x+a}{\sqrt{x^2-a^2}} dx = \int \frac{1}{\sqrt{x^2-a^2}} dx + a \int \frac{1}{x\sqrt{x^2-a^2}} dx$

1

$= \log\left|\mathrm{x} + \sqrt{\mathrm{x}^2 - \mathrm{a}^2}\right| + \sec^{-1}\left(\frac{\mathrm{x}}{\mathrm{a}}\right) + \mathrm{C}$

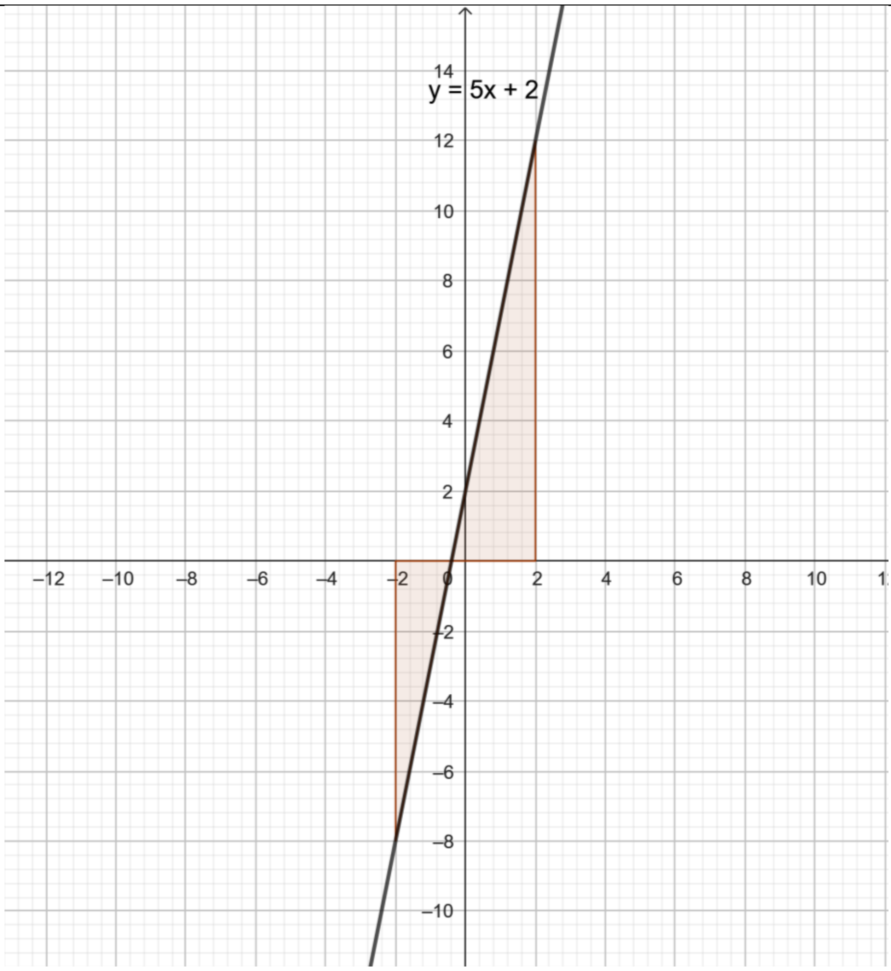
1+1

SECTION-D

This section comprises 4 Long Answer (LA) type questions of 5 marks each.

32. Using integration, find the area of the region bounded by the line $y = 5x + 2$, the $x-$axis and the ordinates $x = -2$ and $x = 2$.

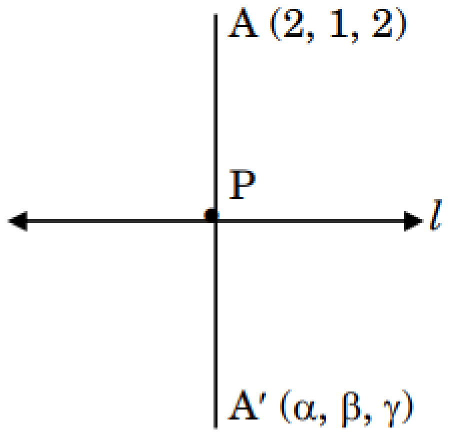
Ans

		Correct sketch and shading 2
	The required area	
	$= \left\|\int_{-2}^{-\frac{2}{5}}(5x+2)dx\right\| + \int_{-\frac{2}{5}}^{2}(5x+2)dx$	1
	$= \left\|\left[\frac{(5x+2)^2}{10}\right]_{-2}^{-\frac{2}{5}}\right\| + \left[\frac{(5x+2)^2}{10}\right]_{-\frac{2}{5}}^{2}$	1
	$= \frac{64}{10} + \frac{144}{10} = \frac{104}{5}$	1
33.	Find : $\int \frac{x^2+x+1}{(x+2)(x^2+1)}\, dx.$	
Ans	$\frac{x^2+x+1}{(x+2)(x^2+1)} = \frac{A}{(x+2)} + \frac{Bx+c}{x^2+1}$	2
	Getting $A = \frac{3}{5}, B = \frac{2}{5}, C = \frac{1}{5}$	1½
	Given integral $= \frac{3}{5}\int \frac{1}{x+2}dx + \frac{1}{5}\int \frac{2x}{x^2+1}dx + \frac{1}{5}\int \frac{1}{x^2+1}dx$	

	$= \frac{3}{5}\log\lvert x+2\rvert + \frac{1}{5}\log(x^2+1) + \frac{1}{5}tan^{-1}x + C$	1½
34	(a) Find the shortest distance between the lines : $\frac{x+1}{2} = \frac{y-1}{1} = \frac{z-9}{-3}$ and $\frac{x-3}{2} = \frac{y+15}{-7} = \frac{z-9}{5}$. **OR** (b) Find the image A′ of the point A(2, 1, 2) in the line $l : \vec{r} = 4\hat{i} + 2\hat{j} + 2\hat{k} + \lambda(\hat{i} - \hat{j} - \hat{k})$. Also, find the equation of line joining AA′. Find the foot of perpendicular from point A on the line l.	
34(a) Ans	The vector equations of the lines are $\vec{r} = -\hat{\imath} + \hat{\jmath} + 9\hat{k} + \lambda(2\hat{\imath} + \hat{\jmath} - 3\hat{k})$ $\vec{r} = 3\hat{\imath} - 15\hat{\jmath} + 9\hat{k} + \mu(2\hat{\imath} - 7\hat{\jmath} + 5\hat{k})$ $\overrightarrow{a_1} = -\hat{\imath} + \hat{\jmath} + 9\hat{k},\ \overrightarrow{a_2} = 3\hat{\imath} - 15\hat{\jmath} + 9\hat{k}$ $\overrightarrow{b_1} = 2\hat{\imath} + \hat{\jmath} - 3\hat{k}\ ,\ \overrightarrow{b_2} = 2\hat{\imath} - 7\hat{\jmath} + 5\hat{k}$ $\overrightarrow{a_2} - \overrightarrow{a_1} = 4\hat{\imath} - 16\hat{\jmath}$ $\overrightarrow{b_1} \times \overrightarrow{b_2} = \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ 2 & 1 & -3 \\ 2 & -7 & 5 \end{vmatrix} = -16\hat{\imath} - 16\hat{\jmath} - 16\hat{k}$ S.D. $= \frac{\lvert(\overrightarrow{a_2} - \overrightarrow{a_1}).(\overrightarrow{b_1} \times \overrightarrow{b_2})\rvert}{\lvert\overrightarrow{b_1} \times \overrightarrow{b_2}\rvert} = \frac{12}{\sqrt{3}} = 4\sqrt{3}$ OR	1 1 2 1

34(b

Ans



Let the image of A in the line be $A'(\alpha, \beta, \gamma)$

The point P, which is the point of intersection of the lines l and AA', will have coordinates $(\lambda + 4, -\lambda + 2, -\lambda + 2)$ for some λ. ½

Drs of AP are $< \lambda + 2, -\lambda + 1, -\lambda >$ ½

$AP \perp l$

$(\lambda + 2) - (-\lambda + 1) - (-\lambda) = 0$

$\Rightarrow \lambda = -\frac{1}{3}$ 1

Therefore, the coordinates of P are $(\frac{11}{3}, \frac{7}{3}, \frac{7}{3})$ ½

P is the mid-point of AA'

$\Rightarrow \frac{2 + \alpha}{2} = \frac{11}{3}, \frac{1 + \beta}{2} = \frac{7}{3}, \frac{2 + \gamma}{2} = \frac{7}{3}$

$\Rightarrow \alpha = \frac{16}{3}, \beta = \frac{11}{3}, \gamma = \frac{8}{3}$ 1½

The coordinates of the image are $(\frac{16}{3}, \frac{11}{3}, \frac{8}{3})$

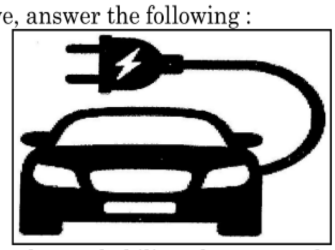
The equation of AA' is

$\frac{x - 2}{\frac{10}{3}} = \frac{y - 1}{\frac{8}{3}} = \frac{z - 2}{\frac{2}{3}}$ 1

or,
$\frac{3(x - 2)}{5} = \frac{3(y - 1)}{4} = \frac{3(z - 2)}{1}$

35	(a) Given $A = \begin{bmatrix} -4 & 4 & 4 \\ -7 & 1 & 3 \\ 5 & -3 & -1 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & -1 & 1 \\ 1 & -2 & -2 \\ 2 & 1 & 3 \end{bmatrix}$, find AB. Hence, solve the system of linear equations : $x - y + z = 4$ $x - 2y - 2z = 9$ $2x + y + 3z = 1$ **OR** (b) If $A = \begin{bmatrix} 1 & 2 & 0 \\ -2 & -1 & -2 \\ 0 & -1 & 1 \end{bmatrix}$, then find A^{-1}. Hence, solve the system of linear equations : $x - 2y = 10$ $2x - y - z = 8$ $-2y + z = 7$	
35(a) Ans	$AB = \begin{bmatrix} 8 & 0 & 0 \\ 0 & 8 & 0 \\ 0 & 0 & 8 \end{bmatrix} = 8I$	2
	The system of equations is equivalent to the matrix equation: $BX = C$, where $C = \begin{bmatrix} 4 \\ 9 \\ 1 \end{bmatrix}, X = \begin{bmatrix} x \\ y \\ z \end{bmatrix}$	½
	$\Rightarrow X = B^{-1}C$ $AB = 8I$ $\Rightarrow B^{-1} = \frac{1}{8}A$	1
	$X = \frac{1}{8}\begin{bmatrix} -4 & 4 & 4 \\ -7 & 1 & 3 \\ 5 & -3 & -1 \end{bmatrix}\begin{bmatrix} 4 \\ 9 \\ 1 \end{bmatrix} = \frac{1}{8}\begin{bmatrix} 24 \\ -16 \\ -8 \end{bmatrix} = \begin{bmatrix} 3 \\ -2 \\ -1 \end{bmatrix}$ $\therefore \mathrm{x} = 3, \mathrm{y} = -2, \mathrm{z} = -1$	1½
	OR	
35(b) Ans	$\lvert A \rvert = 1 \neq 0 \Rightarrow A^{-1}$ exists.	1
	$adjA = \begin{bmatrix} -3 & -2 & -4 \\ 2 & 1 & 2 \\ 2 & 1 & 3 \end{bmatrix}$	1½

	$A^{-1} = \frac{1}{\lvert A \rvert}\text{adj}A = \begin{bmatrix} -3 & -2 & -4 \\ 2 & 1 & 2 \\ 2 & 1 & 3 \end{bmatrix}$	
	The given system of equations is equivalent to the matrix equation	
	$A^T X = B$, where $B = \begin{bmatrix} 10 \\ 8 \\ 7 \end{bmatrix}, X = \begin{bmatrix} x \\ y \\ z \end{bmatrix}$	½
	$\Rightarrow X = (A^T)^{-1} B$	
	$\Rightarrow X = (A^{-1})^T B$	½
	$\Rightarrow X = \begin{bmatrix} -3 & 2 & 2 \\ -2 & 1 & 1 \\ -4 & 2 & 3 \end{bmatrix} \begin{bmatrix} 10 \\ 8 \\ 7 \end{bmatrix} = \begin{bmatrix} 0 \\ -5 \\ -3 \end{bmatrix}$	
	$\therefore x = 0, y = -5, z = -3$	1½
	SECTION-E	
	This section comprises 3 case study based questions of 4 marks each	
36.	A school is organizing a debate competition with participants as speakers $S = \{S_1, S_2, S_3, S_4\}$ and these are judged by judges $J = \{J_1, J_2, J_3\}$. Each speaker can be assigned one judge. Let R be a relation from set S to J defined as $R = \{(x, y) : \text{speaker } x \text{ is judged by judge } y, x \in S, y \in J\}$. 	

	Based on the above, answer the following : (i) How many relations can be there from S to J ? **1** (ii) A student identifies a function from S to J as f = {(S_1, J_1), (S_2, J_2), (S_3, J_2), (S_4, J_3)} Check if it is bijective. **1** (iii) (a) How many one-one functions can be there from set S to set J ? **2** **OR** (iii) (b) Another student considers a relation R_1 = {(S_1, S_2), {S_2, S_4)} in set S. Write minimum ordered pairs to be included in R_1 so that R_1 is reflexive but not symmetric. **2**	
36 Ans (i)	The number of relations = $2^{4\times3} = 2^{12}$	1
36 Ans (ii)	Since, S_2 and S_3 have been assigned the same judge J_2, the function is not one-one. Hence, it is not bijective.	1
36 (iii) (a)	There cannot exist any one-one function from S to J as n(S) > n(J). Hence, the number of one-one functions from S to J is 0. OR	2
36 (iii) (b)	To make R_1 reflexive and not symmetric we need to add the following ordered pairs: $(S_1, S_1), (S_2, S_2), (S_3, S_3), (S_4, S_4)$	2
37.	Three persons viz. Amber, Bonzi and Comet are manufacturing cars which run on petrol and on battery as well. Their production share in the market is 60%, 30% and 10% respectively. Of their respective production capacities, 20%, 10% and 5% cars respectively are electric (or battery operated). Based on the above, answer the following :  (i) (a) What is the probability that a randomly selected car is an electric car ? **2** **OR** (i) (b) What is the probability that a randomly selected car is a petrol car ? **2** (ii) A car is selected at random and is found to be electric. What is the probability that it was manufactured by Comet ? **1** (iii) A car is selected at random and is found to be electric. What is the probability that it was manufactured by Amber or Bonzi ? **1**	

37(i) (a) Ans	Let A = Amber manufactures the car B = Bonzi manufactures the car C = Comet manufactures the car E = The selected car is electric $P(A) = \frac{60}{100}, P(B) = \frac{30}{100}, P(C) = \frac{10}{100}$ $P(E) = P(A) \times P\left(\frac{E}{A}\right) + P(B) \times P\left(\frac{E}{B}\right) + P(C) \times P(\frac{E}{C})$ $= \frac{60}{100} \times \frac{20}{100} + \frac{30}{100} \times \frac{10}{100} + \frac{10}{100} \times \frac{5}{100}$ $= \frac{155}{1000}\ or\ \frac{31}{200}$ OR	½ 1 ½
37(i)(b) Ans	Let A = Amber manufactures the car B = Bonzi manufactures the car C = Comet manufactures the car E = The selected car is a petrol car $P(A) = \frac{60}{100}, P(B) = \frac{30}{100}, P(C) = \frac{10}{100}$ $P(E) = P(A) \times P\left(\frac{E}{A}\right) + P(B) \times P\left(\frac{E}{B}\right) + P(C) \times P(\frac{E}{C})$ $= \frac{60}{100} \times \frac{80}{100} + \frac{30}{100} \times \frac{90}{100} + \frac{10}{100} \times \frac{95}{100}$ $= \frac{845}{1000}\ or\ \frac{169}{200}$	½ 1 ½
37(ii) Ans	$P\left(\frac{C}{E}\right) = \frac{P(C) \times P(\frac{E}{C})}{P(E)}$ $= \frac{\frac{10}{100} \times \frac{5}{100}}{\frac{60}{100} \times \frac{20}{100} + \frac{30}{100} \times \frac{10}{100} + \frac{10}{100} \times \frac{5}{100}}$ $= \frac{\frac{50}{10000}}{\frac{1550}{10000}} = \frac{1}{31}$	1

37(iii) Ans	$P\left(\frac{\text{A or B}}{\text{E}}\right) = 1 - P\left(\frac{\text{C}}{\text{E}}\right) = 1 - \frac{1}{31} = \frac{30}{31}$	1
38.	 A small town is analyzing the pattern of a new street light installation. The lights are set up in such a way that the intensity of light at any point x metres from the start of the street can be modelled by $f(x) = e^x \sin x$, where x is in metres. Based on the above, answer the following : (i) Find the intervals on which the $f(x)$ is increasing or decreasing, $x \in [0, \pi]$. **2** (ii) Verify, whether each critical point when $x \in [0, \pi]$ is a point of local maximum or local minimum or a point of inflexion. **2**	
(i) Ans	$f'(x) = e^x(\cos x + \sin x)$ For critical points, $f'(x) = 0$ $\Rightarrow \cos x + \sin x = 0$ $\Rightarrow \cos x = -\sin x$ For x to be a critical point $x \in (0, \pi)$, hence, $x = \frac{3\pi}{4}$ For all $x \in \left[0, \frac{3\pi}{4}\right], f'(x) \geq 0$ Hence, f is increasing in $[0, \frac{3\pi}{4}]$ Note: If a student concludes the answer in any of the following intervals, full marks may be awarded: $\left(0, \frac{3\pi}{4}\right)$ or $\left[0, \frac{3\pi}{4}\right)$ or $(0, \frac{3\pi}{4}]$ For all $x \in \left[\frac{3\pi}{4}, \pi\right], f'(x) \leq 0$ Hence, f is decreasing in $[\frac{3\pi}{4}, \pi]$ Note: If a student concludes the answer in any of the following intervals, full marks may be awarded: $(\frac{3\pi}{4}, \pi)$ or $(\frac{3\pi}{4}, \pi]$ or $[\frac{3\pi}{4}, \pi)$	½ ½ ½ ½

(ii) Ans	$x = \frac{3\pi}{4}$ is a critical point $f''(x) = e^x(cosx - sinx) + e^x(cosx + sinx)$ $= 2e^x cosx$ $f''\left(\frac{3\pi}{4}\right) = -ve$ Hence, $\frac{3\pi}{4}$ is a point of local maximum.	 1 ½ ½