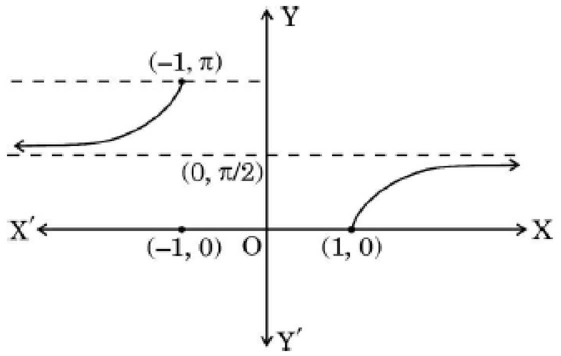
Marking Scheme **Strictly Confidential** **(For Internal and Restricted use only)** **Senior Secondary Examination, 2025** **SUBJECT: MATHEMATICS (Q.P. CODE – 65/7/3)**	
General Instructions: -	
1	You are aware that evaluation is the most important process in the actual and correct assessment of the 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
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.

MARKING SCHEME – 65/7/3

Q.No.	EXPECTED ANSWER / VALUE POINTS	Marks
	SECTION-A ***This section comprises multiple choice questions (MCQs) of 1 mark each.***	
1.	The given graph illustrates :  (A) $y = \sec^{-1} x$ (B) $y = \cot^{-1} x$ (C) $y = \tan^{-1} x$ (D) $y = \text{cosec}^{-1} x$	
Ans	**(A) $\sec^{-1} x$**	**1**
2.	Let A be a square matrix of order 3. If $\|A\| = 5$, then $\|\text{adj } A\|$ is : (A) 5 (B) 125 (C) 25 (D) – 5	
Ans	**(C) 25**	**1**
3	If A and B are two square matrices each of order 3 with $\|A\| = 3$ and $\|B\| = 5$, then $\|2AB\|$ is : (A) 30 (B) 120 (C) 15 (D) 225	
Ans	**(B) 120**	**1**
4.	What is the total number of possible matrices of order 3 × 3 with each entry as $\sqrt{2}$ or $\sqrt{3}$? (A) 9 (B) 512 (C) 615 (D) 64	
Ans	**(B) 512**	**1**
5.	Domain of $f(x) = \cos^{-1} x + \sin x$ is : (A) R (B) (–1, 1) (C) [–1, 1] (D) ϕ	
Ans	**(C) $[-1, 1]$**	**1**

6.	The matrix $A = \begin{bmatrix} \sqrt{3} & 0 & 0 \\ 0 & \sqrt{2} & 0 \\ 0 & 0 & \sqrt{5} \end{bmatrix}$ is a/an : (A) scalar matrix (B) identity matrix (C) null matrix (D) symmetric matrix	
Ans	**(D) symmetric matrix**	**1**
7.	If $f(x) = -2x^8$, then the correct statement is : (A) $f'\left(\frac{1}{2}\right) = f'\left(-\frac{1}{2}\right)$ (B) $f'\left(\frac{1}{2}\right) = -f'\left(-\frac{1}{2}\right)$ (C) $-f'\left(\frac{1}{2}\right) = f\left(-\frac{1}{2}\right)$ (D) $f\left(\frac{1}{2}\right) = -f\left(-\frac{1}{2}\right)$	
Ans	**(B)** $f'\left(\frac{1}{2}\right) = -f'\left(-\frac{1}{2}\right)$	**1**
8.	If $f(x) = \begin{cases} 3ax - b & , x > 1 \\ 11 & , x = 1 \\ -5ax - 2b & , x < 1 \end{cases}$ is continuous at $x = 1$, then the values of a and b are : (A) $a = 3,\ b = 5$ (B) $a = 8,\ b = -1$ (C) $a = 1,\ b = -8$ (D) $a = -3,\ b = 5$	
Ans	**(C)** $a = 1, b = -8$	**1**
9.	If $\begin{bmatrix} 2x - 1 & 3x \\ 0 & y^2 - 1 \end{bmatrix} = \begin{bmatrix} x + 3 & 12 \\ 0 & 35 \end{bmatrix}$, then the value of $(x - y)$ is : (A) 2 or 10 (B) -2 or 10 (C) 2 or -10 (D) -2 or -10	
Ans	**(B)** -2 **or 10**	**1**

10.	Edge of a variable cube increases at the rate of 5 cm/s. The rate at which the surface area of the cube increases when the edge is 2 cm long is : (A) 24 cm^2/s (B) 120 cm^2/s (C) 12 cm^2/s (D) 5 cm^2/s	
Ans	**(B) 120 cm^2/s**	**1**
11.	$\int \frac{e^{9\log x} - e^{8\log x}}{e^{6\log x} - e^{5\log x}}$ dx is equal to : (A) $x + C$ (B) $\frac{x^2}{2} + C$ (C) $\frac{x^4}{4} + C$ (D) $\frac{x^3}{3} + C$	
Ans	**(C) $\frac{x^4}{4} + C$**	**1**
12.	If $f : R \rightarrow R$ is defined as $f(x) = 2x - \sin x$, then f is : (A) a decreasing function (B) an increasing function (C) maximum at $x = \frac{\pi}{2}$ (D) maximum at $x = 0$	
Ans	**(B) an increasing function**	1
13.	A student tries to tie ropes, parallel to each other from one end of the wall to the other. If one rope is along the vector $3\hat{i} + 15\hat{j} + 6\hat{k}$ and the other is along the vector $2\hat{i} + 10\hat{j} + \lambda\hat{k}$, then the value of λ is : (A) 6 (B) 1 (C) $\frac{1}{4}$ (D) 4	
Ans	**(D) 4**	**1**

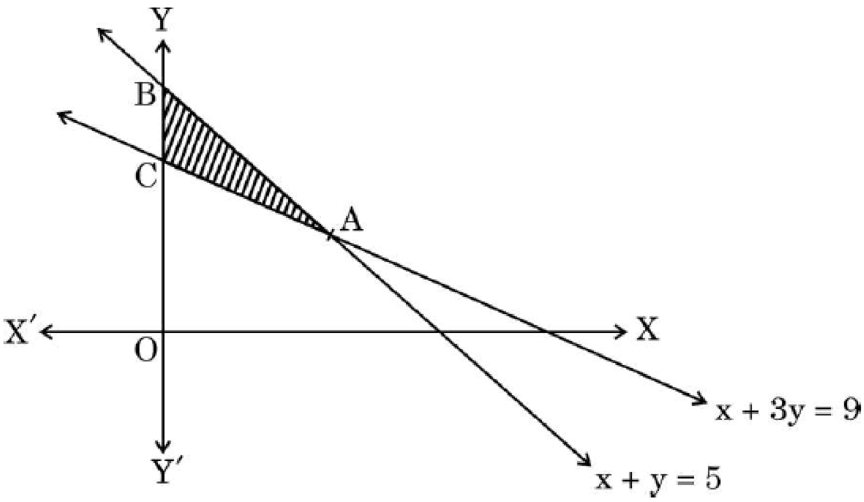
14.	$\int \frac{e^{-x}}{16+9e^{-2x}} dx$ is equal to : (A) $\frac{16}{9}\tan^{-1}(e^{-x})+C$ (B) $-\frac{1}{12}\tan^{-1}\left(\frac{3e^{-x}}{4}\right)+C$ (C) $\tan^{-1}\left(\frac{e^{-x}}{4}\right)+C$ (D) $-\frac{1}{3}\tan^{-1}\left(\frac{e^{-x}}{4}\right)+C$	
Ans	**(B)** $-\frac{1}{12}\tan^{-1}\left(\frac{3e^{-x}}{4}\right)+C$	**1**
15.	If $\lvert\vec{a}+\vec{b}\rvert = \lvert\vec{a}-\vec{b}\rvert$ for any two vectors, then vectors $\vec{a}$ and $\vec{b}$ are : (A) orthogonal vectors (B) parallel to each other (C) unit vectors (D) collinear vectors	
Ans	**(A) orthogonal vectors**	**1**
16.	A coin is tossed and a card is selected at random from a well shuffled pack of 52 playing cards. The probability of getting head on the coin and a face card from the pack is : (A) $\frac{2}{13}$ (B) $\frac{3}{26}$ (C) $\frac{19}{26}$ (D) $\frac{3}{13}$	
Ans	**(B)** $\frac{3}{26}$	**1**
17.	If A and B are two events such that $P(B)=\frac{1}{5}$, $P(A \mid B)=\frac{2}{3}$ and $P(A\cup B)=\frac{3}{5}$, then P(A) is : (A) $\frac{10}{15}$ (B) $\frac{2}{15}$ (C) $\frac{1}{5}$ (D) $\frac{8}{15}$	

Ans	**(D)** $\frac{8}{15}$	**1**
18.	For a function f(x), which of the following holds true ? (A) $\int_a^b f(x)\,dx = \int_a^b f(a+b-x)\,dx$ (B) $\int_{-a}^{a} f(x)\,dx = 0$, if f is an even function (C) $\int_{-a}^{a} f(x)\,dx = 2\int_0^a f(x)\,dx$, if f is an odd function (D) $\int_0^{2a} f(x)\,dx = \int_0^a f(x)\,dx - \int_0^a f(2a+x)\,dx$	
Ans	**(A)** $\int_a^b f(x)\,dx = \int_a^b f(a+b-x)\,dx$	**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) :* $f(x) = \begin{cases} x \sin \dfrac{1}{x}, & x \neq 0 \\ 0, & x = 0 \end{cases}$ is continuous at x = 0. *Reason (R) :* When $x \to 0$, $\sin \dfrac{1}{x}$ is a finite value between – 1 and 1.	
Ans	**(A) Both Assertion (A) and Reason (R) are true, and Reason (R) is the correct explanation of the Assertion (A).**	**1**
20.	*Assertion (A) :* Set of values of $\sec^{-1}\left(\dfrac{\sqrt{3}}{2}\right)$ is a null set. *Reason (R) :* $\sec^{-1} x$ is defined for $x \in R - (-1, 1)$.	
Ans	**(A) Both Assertion (A) and Reason (R) are true, and Reason (R) is the correct explanation of the Assertion (A).**	**1**
SECTION-B ***This section comprises 5 Very Short Answer (VSA) type questions of 2 marks each.***		
21.	(a) Differentiate $\left(\dfrac{5^x}{x^5}\right)$ with respect to x. **OR** (b) If $-2x^2 - 5xy + y^3 = 76$, then find $\dfrac{dy}{dx}$.	
Ans	**(a) Let,** $y = \dfrac{5^x}{x^5} = 5^x \cdot x^{-5} \Rightarrow \dfrac{dy}{dx} = \left(5^x\right)' \cdot x^{-5} + 5^x \cdot \left(x^{-5}\right)'$	**1**

	$= \frac{5^x}{x^5}\log 5 - \frac{5^{x+1}}{x^6}$	1
	Or **(b) Differentiating** $-2x^2 - 5xy + y^3 = 76$**, with respect to 'x'** $-4x - 5y - 5x\frac{dy}{dx} + 3y^2\frac{dy}{dx} = 0$ $\Rightarrow \frac{dy}{dx} = \frac{4x+5y}{3y^2-5x}$	1 1
22.	If $A = \begin{bmatrix} 1 & 0 \\ -1 & 5 \end{bmatrix}$, then find the value of K if $A^2 = 6A + KI_2$, where I_2 is an identity matrix.	
Ans	$A^2 = 6A + KI_2 \Rightarrow \begin{bmatrix} 1 & 0 \\ -6 & 25 \end{bmatrix} = \begin{bmatrix} 6+K & 0 \\ -6 & 30+K \end{bmatrix}$ $\Rightarrow 6+K = 1 \Rightarrow K = -5$ **, also satisfies** $30+K = 25$.	$1\frac{1}{2}$ $\frac{1}{2}$
23.	(a) 10 identical blocks are marked with '0' on two of them, '1' on three of them, '2' on four of them and '3' on one of them and put in a box. If X denotes the number written on the block, then write the probability distribution of X and calculate its mean. **OR** (b) In a village of 8000 people, 3000 go out of the village to work and 4000 are women. It is noted that 30% of women go out of the village to work. What is the probability that a randomly chosen individual is either a woman or a person working outside the village ?	
Ans	**(a) Probability distribution table is:**	

X	0	1	2	3	
P(X)	$\frac{2}{10}$	$\frac{3}{10}$	$\frac{4}{10}$	$\frac{1}{10}$	½ 1

	Mean = E(X) = $\sum p_i x_i = 0\cdot\frac{2}{10}+1\cdot\frac{3}{10}+2\cdot\frac{4}{10}+3\cdot\frac{1}{10}=\frac{14}{10}=\frac{7}{5}$ **(or 1.4)** **OR** **(b) A = A randomly chosen person is a woman** **B = A randomly chosen person works outside village.** $P(A)=\frac{4000}{8000}=\frac{1}{2},\ P(B)=\frac{3000}{8000}=\frac{3}{8},\ P(A\cap B)=\frac{1200}{8000}=\frac{3}{20}$ **Required probability =** $P(A\cup B)=P(A)+P(B)-P(A\cap B)=\frac{1}{2}+\frac{3}{8}-\frac{3}{20}=\frac{29}{40}$	½ 1½ ½
24.	For a Linear Programming Problem, find min Z = 5x + 3y (where Z is the objective function) for the feasible region shaded in the given figure.  (Note : The figure is not to scale)	
Ans	<table><tr><th>Corner Points</th><th>Value of Z = 5x + 3y</th></tr><tr><td>A (3,2)</td><td>21</td></tr><tr><td>B (0,5)</td><td>15</td></tr><tr><td>C (0,3)</td><td>9</td></tr></table> **Min (Z) = 9**	1½ ½
25.	Let f : A → B be defined by $f(x) = \frac{x-2}{x-3}$, where A = R – {3} and B = R – {1}. Discuss the bijectivity of the function.	

Ans	**Let $x_1, x_2 \in A$ such that $f(x_1) = f(x_2) \Rightarrow \frac{x_1 - 2}{x_1 - 3} = \frac{x_2 - 2}{x_2 - 3} \Rightarrow x_1 = x_2$, $\therefore$ 'f' is one-one.**	**1**
	For each $y \in B$, there exists $x = \frac{3y - 2}{y - 1} \in R - \{3\}$, such that $f(x) = y$, $\therefore$ 'f' is onto	**½**
	$\Rightarrow$ 'f' is one-one & onto, or 'f' is a bijective function.	**½**

SECTION-C

This section comprises 6 Short Answer (SA) type questions of 3 marks each.

26. In the Linear Programming Problem for objective function Z = 18x + 10y subject to constraints

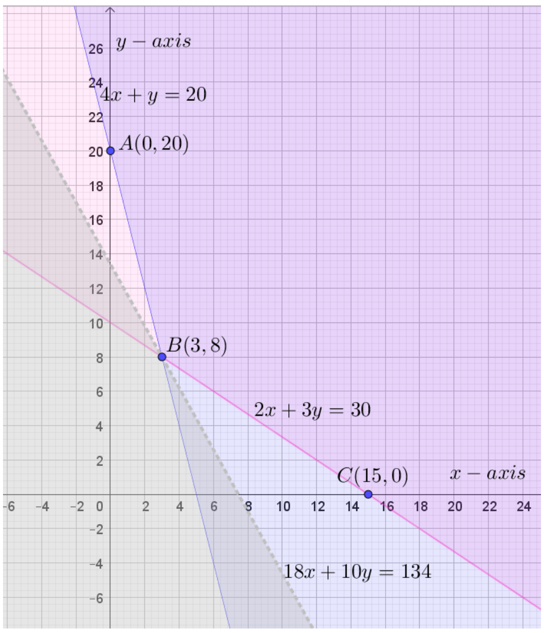
$$4x + y \geq 20$$

$$2x + 3y \geq 30$$

$$x, y \geq 0$$

find the minimum value of Z.

Ans



Correct Fig. — **1½**

Corner points	Value of Z = 18x + 10y
A (0, 20)	200
B (3, 8)	134
C (15, 0)	270

1

Also, $Z < 134$, does not have any common point with the feasible region, $\therefore$ Min$(Z) = 134$ at B (3, 8) — **½**

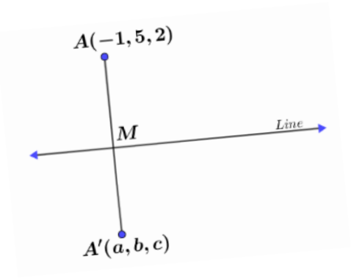
27.	(a) The scalar product of the vector $\vec{a} = \hat{i} - \hat{j} + 2\hat{k}$ with a unit vector along sum of vectors $\vec{b} = 2\hat{i} - 4\hat{j} + 5\hat{k}$ and $\vec{c} = \lambda\hat{i} - 2\hat{j} - 3\hat{k}$ is equal to 1. Find the value of λ. **OR** (b) Find the shortest distance between the lines : $\vec{r} = (2\hat{i} - \hat{j} + 3\hat{k}) + \lambda(\hat{i} - 2\hat{j} + 3\hat{k})$ $\vec{r} = (\hat{i} + 4\hat{k}) + \mu(3\hat{i} - 6\hat{j} + 9\hat{k})$.	
Ans	**(a) Let** $\vec{d} = \vec{b} + \vec{c} = (2+\lambda)\hat{i} - 6\hat{j} + 2\hat{k}$ $\hat{d} = \dfrac{(2+\lambda)\hat{i} - 6\hat{j} + 2\hat{k}}{\sqrt{(2+\lambda)^2 + 40}}$ $\vec{a} \cdot \hat{d} = (\hat{i} - \hat{j} + 2\hat{k}) \cdot \dfrac{(2+\lambda)\hat{i} - 6\hat{j} + 2\hat{k}}{\sqrt{(2+\lambda)^2 + 40}} = 1$ $\Rightarrow (2+\lambda) + 6 + 4 = \sqrt{(2+\lambda)^2 + 40} \Rightarrow \lambda = -5$ **OR** **(b) The two given lines are parallel with,** $\vec{a}_1 = 2\hat{i} - \hat{j} + 3\hat{k},\ \vec{a}_2 = \hat{i} + 4\hat{k}$ **Then** $\vec{a}_2 - \vec{a}_1 = -\hat{i} + \hat{j} + \hat{k}$ **and the parallel vector is** $\vec{b} = \hat{i} - 2\hat{j} + 3\hat{k}$ $\vec{b} \times (\vec{a}_2 - \vec{a}_1) = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & -2 & 3 \\ -1 & 1 & 1 \end{vmatrix} = -5\hat{i} - 4\hat{j} - \hat{k}$ **Shortest Distance =** $\dfrac{\lvert \vec{b} \times (\vec{a}_2 - \vec{a}_1) \rvert}{\lvert \vec{b} \rvert} = \dfrac{\sqrt{42}}{\sqrt{14}} = \sqrt{3}$	1 ½ 1 ½ ½ 1½ 1

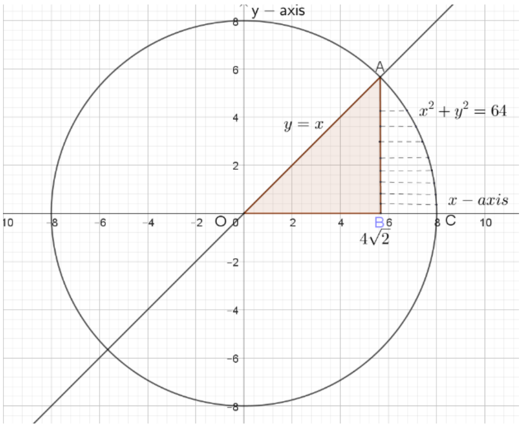
28.	Differentiate $\log(x^x + \operatorname{cosec}^2 x)$ with respect to x.	
Ans	$\frac{d}{dx}\log\left(x^x + \operatorname{cosec}^2 x\right) = \frac{1}{x^x + \operatorname{cosec}^2 x}\frac{d}{dx}\left(e^{x\log x} + \operatorname{cosec}^2 x\right) \quad (\because x^x = e^{x\log x})$ $= \frac{1}{x^x + \operatorname{cosec}^2 x}\left[e^{x\log x}(1+\log x) - 2\operatorname{cosec}^2 x\cot x\right]$ $= \frac{1}{x^x + \operatorname{cosec}^2 x}\left[x^x(1+\log x) - 2\operatorname{cosec}^2 x\cot x\right]$	1 $1\frac{1}{2}$ $\frac{1}{2}$
29.	Show that of all the rectangles with a fixed perimeter, the square has the greatest area.	
Ans	**Let P be the perimeter of the rectangle, which is a constant. Also assume 'x' and 'y' be the length and breadth of the rectangle, then** $2(x+y) = P$ and $A(\text{Area}) = xy = \frac{x}{2}(P-2x) = \frac{1}{2}(Px - 2x^2)$ $A'(x) = \frac{1}{2}(P-4x), \ \therefore \ A'(x) = 0 \Rightarrow x = \frac{P}{4}, y = \frac{P}{4}$ $A''(x) = -2 < 0$ at $x = \frac{P}{4}$, $\therefore$ **Area of the rectangle is max. if it is a square.**	$1\frac{1}{2}$ 1 $\frac{1}{2}$
30.	(a) Show that the function $f: R \to R$ defined by $f(x) = 4x^3 - 5, \forall x \in R$ is one-one and onto. **OR** (b) Let R be a relation defined on a set N of natural numbers such that $R = \{(x, y) : xy$ is a square of a natural number, $x, y \in N\}$. Determine if the relation R is an equivalence relation.	
Ans	**(a) One-One: Let $x_1, x_2 \in R$ such that** $f(x_1) = f(x_2) \Rightarrow 4x_1^3 - 5 = 4x_2^3 - 5 \Rightarrow x_1^3 = x_2^3 \Rightarrow x_1 = x_2$, $\therefore$ **'f' is one-one** **Onto:** $x \in R\ (D_f) \Rightarrow x^3 \in R \Rightarrow 4x^3 - 5 \in R \Rightarrow f(x) \in R$, $\therefore\ R_f = \text{Co-domain}(f)$ $\therefore$ **'f' is an onto function** $\Rightarrow$ **'f' is one-one & onto both** **OR** **(b) Reflexive: For any $x \in N$, $x \cdot x = x^2$, which is square of the natural number 'x'.** $\Rightarrow (x, x) \in R$ $\therefore$ **'R' is a Reflexive relation.**	$1\frac{1}{2}$ $1\frac{1}{2}$ 1

	Symmetric: Let $(x,y)\in R \Rightarrow xy$ is a square of a natural number $\Rightarrow$ **yx is a square of a natural number, $\because xy = yx$.** $\Rightarrow (y,x)\in R$ $\therefore$ **'R' is a Symmetric relation.** **Transitive: Let $(x,y),(y,z)\in R \Rightarrow xy = a^2, yz = b^2$ for some $a,b\in N$,** $\therefore \frac{a^2}{y} = x, \frac{b^2}{y} = z \in N$ $\Rightarrow xz = \frac{a^2}{y}\cdot\frac{b^2}{y} = \left(\frac{ab}{y}\right)^2, \frac{ab}{y}\in N$ $\Rightarrow (x,z)\in R$ $\therefore$ **'R' is a Transitive relation.** **Hence, R is an Equivalence relation**	1 ½ ½
31.	(a) Let 2x + 5y − 1 = 0 and 3x + 2y − 7 = 0 represent the equations of two lines on which the ants are moving on the ground. Using matrix method, find a point common to the paths of the ants. **OR** (b) A shopkeeper sells 50 Chemistry, 60 Physics and 35 Maths books on day I and sells 40 Chemistry, 45 Physics and 50 Maths books on day II. If the selling price for each such subject book is ₹ 150 (Chemistry), ₹ 175 (Physics) and ₹ 180 (Maths), then find his total sale in two days, using matrix method. If cost price of all the books together is ₹ 35,000, what profit did he earn after the sale of two days ?	
Ans	**(a) The system of equations in matrices is:** $AX = B$, **where** $A = \begin{bmatrix} 2 & 5 \\ 3 & 2 \end{bmatrix}, X = \begin{bmatrix} x \\ y \end{bmatrix}, B = \begin{bmatrix} 1 \\ 7 \end{bmatrix}$ **The solution is given by** $X = A^{-1}B \Rightarrow \begin{bmatrix} x \\ y \end{bmatrix} = \frac{-1}{11}\begin{bmatrix} 2 & -5 \\ -3 & 2 \end{bmatrix}\begin{bmatrix} 1 \\ 7 \end{bmatrix} = \begin{bmatrix} 3 \\ -1 \end{bmatrix}$ **Point common to paths of the ants is $(3,-1)$.** **OR**	1 1½ ½

	(a) Let $A = \begin{bmatrix} 50 & 60 & 35 \\ 40 & 45 & 50 \end{bmatrix} \begin{matrix} \text{Day I} \\ \text{Day II} \end{matrix}$, $B = \begin{bmatrix} 150 \\ 175 \\ 180 \end{bmatrix}$ be the day wise sale and the selling price per subject, matrices respectively. Total sales day wise = $\begin{bmatrix} 50 & 60 & 35 \\ 40 & 45 & 50 \end{bmatrix} \begin{bmatrix} 150 \\ 175 \\ 180 \end{bmatrix} = \begin{bmatrix} 24,300 \\ 22,875 \end{bmatrix} \begin{matrix} \text{Day I} \\ \text{Day II} \end{matrix}$ Total sales in two days = ₹ 24,300 + ₹ 22,875 = ₹ 47,175 Profit = ₹ 47,175 – ₹ 35,000 = ₹ 12,175.	1 1 $\frac{1}{2}$ $\frac{1}{2}$
	SECTION-D *This section comprises 4 Long Answer (LA) type questions of 5 marks each.*	
32.	(a) Find : $\int \frac{3x+1}{(x-2)^2 (x+2)} dx$ **OR** (b) Evaluate : $\int_0^{\pi/2} \frac{x}{\cos x + \sin x} dx$	
Ans	**(a) Using Partial fractions,** $\int \frac{3x+1}{(x-2)^2(x+2)} dx = \frac{5}{16}\int \frac{1}{x-2} dx + \frac{7}{4}\int \frac{1}{(x-2)^2} dx - \frac{5}{16}\int \frac{1}{x+2} dx$ $= \frac{5}{16}\log\lvert x-2\rvert - \frac{7}{4(x-2)} - \frac{5}{16}\log\lvert x+2\rvert + C$ or $= \frac{5}{16}\log\left\lvert\frac{x-2}{x+2}\right\rvert - \frac{7}{4(x-2)} + C$ **Or**	$2\frac{1}{2}$ $2\frac{1}{2}$

	(b) Let $I=\int_0^{\pi/2}\frac{x}{\cos x+\sin x}dx \Rightarrow I=\int_0^{\pi/2}\frac{\frac{\pi}{2}-x}{\sin x+\cos x}dx \Rightarrow 2I=\frac{\pi}{2}\int_0^{\pi/2}\frac{1}{\cos x+\sin x}dx$ $\Rightarrow I=\frac{\pi}{4\sqrt{2}}\int_0^{\pi/2}\frac{1}{\cos\left(x-\pi/4\right)}dx=\frac{\pi}{4\sqrt{2}}\int_0^{\pi/2}\sec\left(x-\pi/4\right)dx$ $\Rightarrow I=\frac{\pi}{4\sqrt{2}}\log\left[\sec\left(x-\pi/4\right)+\tan\left(x-\pi/4\right)\right]_0^{\frac{\pi}{2}}=\frac{\pi}{4\sqrt{2}}\left[\log\left(\sqrt{2}+1\right)-\log\left(\sqrt{2}-1\right)\right]$ **Or ,** $I=\frac{\pi}{4\sqrt{2}}\log\left(\frac{\sqrt{2}+1}{\sqrt{2}-1}\right)$	$1\frac{1}{2}$ 2 $1\frac{1}{2}$
33.	(a) Find the point Q on the line $\frac{2x+4}{6}=\frac{y+1}{2}=\frac{-2z+6}{-4}$ at a distance of $3\sqrt{2}$ from the point P(1, 2, 3). **OR** (b) Find the image of the point (–1, 5, 2) in the line $\frac{2x-4}{2}=\frac{y}{2}=\frac{2-z}{3}$. Find the length of the line segment joining the points (given point and the image point).	
Ans	**(a) The general point on the line** $\left(3\lambda-2, 2\lambda-1, 2\lambda+3\right)$ **is Q, from some** $\lambda\in R$ $PQ=3\sqrt{2}\Rightarrow\left(PQ\right)^2=18\Rightarrow\left(3\lambda-3\right)^2+\left(2\lambda-3\right)^2+\left(2\lambda\right)^2=18$ $17\lambda^2-30\lambda=0\Rightarrow\lambda=0 \text{ or } \lambda=\frac{30}{17}$ **Thus, the point is** $Q\left(-2,-1,3\right)$ **or** $Q\left(\frac{56}{17},\frac{43}{17},\frac{111}{17}\right)$ **Or** **(b) Let** $A'\left(a,b,c\right)$ **be the image of the point** $A\left(-1,5,2\right)$ **in the given line, also assume 'M' as the point of intersection of** AA' **with the given line, then 'M' is the mid-point of the line segment** AA'	2 1 1 1

	 **The Line in the standard form is:** $\frac{x-2}{1}=\frac{y}{2}=\frac{z-2}{-3}$, **then** **M is the point** $(\lambda+2, 2\lambda, -3\lambda+2)$, **for some** $\lambda \in R$ **Direction Ratios of AM are** $\lambda+3, 2\lambda-5, -3\lambda$ **AM** $\perp$ **Line,** $\therefore 1(\lambda+3)+2(2\lambda-5)-3(-3\lambda)=0 \Rightarrow \lambda=\frac{1}{2}$ $M\left(\frac{5}{2},1,\frac{1}{2}\right)=M\left(\frac{a-1}{2},\frac{b+5}{2},\frac{c+2}{2}\right) \Rightarrow a=6, b=-3, c=-1$ $\therefore$ **The Image of A in the line is** $A'(6,-3,-1)$ **And,** $AA'=\sqrt{49+64+9}=\sqrt{122}$	1 ½ ½ 1 1 ½ ½
s **34.**	Solve the differential equation $(x-\sin y)\,dy+(\tan y)\,dx=0$, given $y(0)=0$.	
Ans	**The differential equation can be written as:** $\frac{dx}{dy}+\cot y \cdot x=\cos y$, **which is a linear order differential equation** **Here,** $P=\cot y$, $Q=\cos y$, **I.F. (Integrating Factor) =** $e^{\int \cot y\, dy}=e^{\log \sin y}=\sin y$ **The solution is ,** $x(\sin y)=\int \cos y \cdot \sin y\, dy$ $\Rightarrow x(\sin y)=\frac{(\sin y)^2}{2}+C$, **For** $x=0, y=0$, $C=0$. $\therefore$ **The Particular solution is:** $x \sin y=\frac{\sin^2 y}{2}$ **or** $\sin y=2x$ **or** $y=\sin^{-1} 2x$	1 1½ 1 1 ½

<table>
<tr>
<td>35.</td>
<td>A woman discovered a scratch along a straight line on a circular table top of radius 8 cm. She divided the table top into 4 equal quadrants and discovered the scratch passing through the origin inclined at an angle $\frac{\pi}{4}$ anticlockwise along the positive direction of x-axis. Find the area of the region enclosed by the x-axis, the scratch and the circular table top in the first quadrant, using integration.</td>
<td></td>
</tr>
<tr>
<td>Ans</td>
<td>


Correct graph
Equation of the circular tabletop: $x^2+y^2=64$
Equation of line (scratch): $x=y$
The line and circle intersect at $x=4\sqrt{2}$
Area of the shaded region
$$=\int_0^{4\sqrt{2}} x\,dx+\int_{4\sqrt{2}}^{8}\sqrt{64-x^2}\,dx$$
$$=\left.\frac{x^2}{2}\right]_0^{4\sqrt{2}}+\left[\frac{x}{2}\sqrt{64-x^2}+32\sin^{-1}\frac{x}{8}\right]_{4\sqrt{2}}^{8}$$
$$=\frac{32}{2}+32\sin^{-1}1-2\sqrt{2}\cdot4\sqrt{2}-32\sin^{-1}\frac{1}{\sqrt{2}}$$
$$=16+16\pi-16-8\pi=8\pi\ \text{cm}^2$$
</td>
<td>1
½
½
½
1
1
½</td>
</tr>
</table>

36.

Case Study – 1

Camphor is a waxy, colourless solid with strong aroma that evaporates through the process of sublimation, if left in the open at room temperature.

(Cylindrical-shaped Camphor tablets)

A cylindrical camphor tablet whose height is equal to its radius (r) evaporates when exposed to air such that the rate of reduction of its volume is proportional to its total surface area. Thus, $\frac{dV}{dt} = kS$ is the differential equation, where V is the volume, S is the surface area and t is the time in hours.

Based upon the above information, answer the following questions :

(i) Write the order and degree of the given differential equation. *1*

(ii) Substituting $V = \pi r^3$ and $S = 2\pi r^2$, we get the differential equation $\frac{dr}{dt} = \frac{2}{3}k$. Solve it, given that r(0) = 5 mm. *1*

(iii) (a) If it is given that r = 3 mm when t = 1 hour, find the value of k. Hence, find t for r = 0 mm. *2*

OR

(iii) (b) If it is given that r = 1 mm when t = 1 hour, find the value of k. Hence, find t for r = 0 mm. *2*

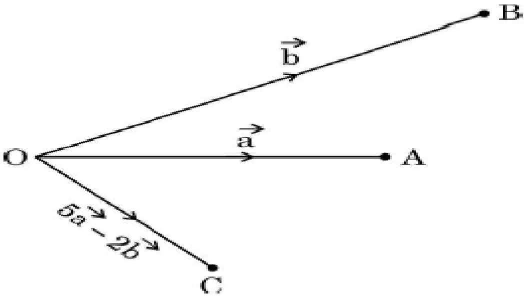
Ans	**(i) Order = 1, Degree = 1**	$\frac{1}{2}+\frac{1}{2}$
	(ii) Separating the variable and integrating, $\int dr = \frac{2k}{3}\int dt \Rightarrow r = \frac{2}{3}kt + C$	$\frac{1}{2}$
	Putting $t = 0, r = 5$, **we get** $C = 5$	
	$r = \frac{2}{3}kt + 5$	$\frac{1}{2}$
	(iii) (a) Putting $r = 3, t = 1$, $3 = \frac{2}{3}k(1) + 5 \Rightarrow k = -3$	1
	$r = -2t + 5$, **For** $r = 0$, $t = \frac{5}{2}$ **hrs or 2.5 hours**	1
	Or	
	(iii) (b) Putting $r = 1, t = 1$, $1 = \frac{2}{3}k + 5 \Rightarrow k = -6$	1
	$\therefore$ $r = -4t + 5$, **For** $r = 0$, $t = \frac{5}{4}$ **hrs or 1.25 hours**	1

37.	**Case Study – 2** Based upon the results of regular medical check-ups in a hospital, it was found that out of 1000 people, 700 were very healthy, 200 maintained average health and 100 had a poor health record. Let A_1 : People with good health, A_2 : People with average health, and A_3 : People with poor health. During a pandemic, the data expressed that the chances of people contracting the disease from category A_1, A_2 and A_3 are 25%, 35% and 50%, respectively. Based upon the above information, answer the following questions : (i) A person was tested randomly. What is the probability that he/she has contracted the disease ? *2* (ii) Given that the person has not contracted the disease, what is the probability that the person is from category A_2 ? *2*	
Ans	**(i) Let A: Person contracted the disease** $\mathbf{P(A)=P(A_1)\cdot P(A\mid A_1)+P(A_2)\cdot P(A\mid A_2)+P(A_3)\cdot P(A\mid A_3)}$ $\mathbf{=\frac{7}{10}\left(\frac{25}{100}\right)+\frac{2}{10}\left(\frac{35}{100}\right)+\frac{1}{10}\left(\frac{50}{100}\right)}$ $\mathbf{=\frac{295}{1000}=0.295 \text{ or} \left(\frac{59}{200}\right)}$	$1\frac{1}{2}$ $\frac{1}{2}$
	(ii) $\mathbf{P(A_2\mid \bar{A})=\frac{P(A_2)\cdot P(\bar{A}/A_2)}{P(A_1)\cdot P(\bar{A}/A_1)+P(A_2)\cdot P(\bar{A}/A_2)}}$ $\mathbf{=\frac{\frac{2}{10}\times\frac{65}{100}}{\frac{7}{10}\times\frac{75}{100}+\frac{2}{10}\times\frac{65}{100}+\frac{1}{10}\times\frac{50}{100}}}$ $\mathbf{=\frac{2\times 13}{7\times 15+2\times 13+1\times 10}=\frac{26}{141}}$	$1\frac{1}{2}$ $\frac{1}{2}$

38.

Case Study – 3

Three friends A, B and C move out from the same location O at the same time in three different directions to reach their destinations. They move out on straight paths and decide that A and B after reaching their destinations will meet up with C at his predecided destination, following straight paths from A to C and B to C in such a way that $\overrightarrow{OA} = \vec{a}$, $\overrightarrow{OB} = \vec{b}$ and $\overrightarrow{OC} = 5\vec{a} - 2\vec{b}$ respectively.



Based upon the above information, answer the following questions :

(i) Complete the given figure to explain their entire movement plan along the respective vectors. *1*

(ii) Find vectors $\overrightarrow{AC}$ and $\overrightarrow{BC}$. *1*

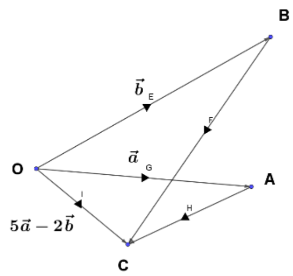
(iii) (a) If $\vec{a}\cdot\vec{b} = 1$, distance of O to A is 1 km and that from O to B is 2 km, then find the angle between $\overrightarrow{OA}$ and $\overrightarrow{OB}$. Also, find $|\vec{a} \times \vec{b}|$. *2*

OR

(iii) (b) If $\vec{a} = 2\hat{i} - \hat{j} + 4\hat{k}$ and $\vec{b} = \hat{j} - \hat{k}$, then find a unit vector perpendicular to $(\vec{a} + \vec{b})$ and $(\vec{a} - \vec{b})$. *2*

Ans

(i) The Complete figure of their entire movement plan is: 1



(ii) $\overrightarrow{AC} = \overrightarrow{OC} - \overrightarrow{OA} = 4\vec{a} - 2\vec{b}$, $\overrightarrow{BC} = \overrightarrow{OC} - \overrightarrow{OB} = 5\vec{a} - 3\vec{b}$ 1

(iii) (a) we are given: $|\vec{a}| = 1, |\vec{b}| = 2$, **assuming '** θ **' as the angle between** $\overrightarrow{OA}$ **and** $\overrightarrow{OB}$.

$$\theta = \cos^{-1}\left(\frac{\vec{a}\cdot\vec{b}}{|\vec{a}||\vec{b}|}\right) = \cos^{-1}\frac{1}{1\times 2} = \cos^{-1}\frac{1}{2} = \frac{\pi}{3}$$ 1

$$|\vec{a}\times\vec{b}| = |\vec{a}||\vec{b}|\sin\theta = 1(2)\frac{\sqrt{3}}{2} = \sqrt{3}$$ 1

	Or	
	(iii) (b) $\vec{a}+\vec{b}=2\hat{i}+3\hat{k}$, $\vec{a}-\vec{b}=2\hat{i}-2\hat{j}+5\hat{k}$, **let** $\vec{c}$ **be** $\perp$ **to both** $(\vec{a}+\vec{b})$ **and** $(\vec{a}-\vec{b})$	½
	Then, $\vec{c}=(\vec{a}+\vec{b})\times(\vec{a}-\vec{b})=\begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ 2 & 0 & 3\\ 2 & -2 & 5\end{vmatrix}=6\hat{i}-4\hat{j}-4k$ **and** $\lvert\vec{c}\rvert=\sqrt{68}$	1
	The required unit vector is, $\hat{c}=\frac{1}{2\sqrt{17}}(6\hat{i}-4\hat{j}-4\hat{k})=\frac{1}{\sqrt{17}}(3\hat{i}-2\hat{j}-2\hat{k})$	½