
Marking Scheme
Strictly Confidential
(For Internal and Restricted use only)
Senior Secondary Supplementary School Examination, 2025
APPLIED MATHEMATICS (241) PAPER CODE – 465/S

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 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 News Paper/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. 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.**
4	The Marking scheme carries only suggested value points for the answers These are in the nature of 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 an impression that answer is correct and no marks are awarded. **This is 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	**In Q1-Q20, if a candidate attempts the question more than once (without canceling the previous attempt), marks shall be awarded for the first attempt only and the other answer scored out with a note "Extra Question".**
10	**In Q21-Q38, if a student has attempted an extra question, answer of the question deserving more marks should be retained and the other answer scored out with a note "Extra Question".**
11	No marks to be deducted for the cumulative effect of an error. It should be penalized only once.
12	A full scale of marks ____80______ (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.
13	Every examiner has to 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.
14	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 answer marked correct and the rest as wrong, but no marks awarded.
15	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.
16	Any unassessed portion, non-carrying over of marks to the title page, or totaling error detected by the candidate shall damage the prestige of all the personnel engaged in the evaluation work as also of the Board. Hence, in order to uphold the prestige of all concerned, it is again reiterated that the instructions be followed meticulously and judiciously.
17	The Examiners should acquaint themselves with the guidelines given in the "**Guidelines for spot Evaluation**" before starting the actual evaluation.
18	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.
19	The candidates are entitled to obtain 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
APPLIED MATHEMATICS (Subject Code–241)
(PAPER CODE: 465/S)

Section A

Q. No.	EXPECTED OUTCOMES/VALUE POINTS	Marks
	SECTION A **Questions no. 1 to 18 are multiple choice questions (MCQs) and questions number 19 and 20 are Assertion-Reason based questions of 1 mark each.**	
1.	The smallest positive integer (mod 11) to which 282 is congruent, is : (A) 3 (B) 7 (C) 9 (D) 17	
Sol.	(B) 7	**1**
2.	A man can row 6 km/h in still water. It takes him twice as long to row up as to row down the river. Then, the speed of the stream is : (A) 2 km/h (B) 4 km/h (C) 6 km/h (D) 8 km/h	
Sol.	(A) 2 km/h	**1**
3.	If $\frac{\|x+1\|}{x+1} > 0, x \in R$, then (A) $x \in [-1, \infty)$ (B) $x \in (-1, \infty)$ (C) $x \in (-\infty, -1)$ (D) $x \in (-\infty, -1]$	
Sol.	(B) $x \in (-1, \infty)$	**1**
4.	If $P = \begin{bmatrix} 1 & 0 \\ 2 & 1 \end{bmatrix}, Q = \begin{bmatrix} x & 0 \\ 1 & 1 \end{bmatrix}$ and $P = Q^2$, then x equals : (A) ± 1 (B) -1 (C) 1 (D) 2	
Sol.	(C) 1	**1**

5.	If A is an invertible matrix, then which of the following is ***not*** true ? (A) $\lvert A^{-1}\rvert = \lvert A\rvert^{-1}$ (B) $(A^2)^{-1} = (A^{-1})^2$ (C) $(A')^{-1} = (A^{-1})'$ (D) $\lvert A\rvert \neq 0$	
Sol.	(B) $(A^2)^{-1} = (A^{-1})^2$	**1**
6.	The system of linear equations $2x + ky = 7$ $3x + 2y = 7$ will be consistent, if : (A) $k = \frac{4}{3}$ (B) $k \neq \frac{4}{3}$ (C) $k \neq \frac{3}{4}$ (D) $k = \frac{3}{4}$	
Sol.	(B) $k \neq \frac{4}{3}$	**1**
7.	If $y = x^y$, then $\frac{dy}{dx}$ is : (A) $x^y (\log x + 1)$ (B) $\frac{y^2}{x(1 + y\log x)}$ (C) $x^y (\log x - 1)$ (D) $\frac{y^2}{x(1 - y\log x)}$	
Sol.	(D) $\frac{y^2}{x(1-y\log x)}$	**1**
8.	The function $f(x) = a^x$ is increasing on R, if : (A) $a > 0$ (B) $a > 1$ (C) $a < 0$ (D) $0 < a < 1$	
Sol.	(B) $a > 1$	**1**

9.	A function $f : R \rightarrow R$ is defined as $f(x) = x^3 + 1$. The function f has : (A) no maximum value (B) no minimum value (C) both maximum and minimum values (D) neither maximum nor minimum value	
Sol.	(D) neither maximum nor minimum value	**1**
10.	The relation between "Marginal Cost (MC)" and "Average Cost (AC)" of producing 'x' units of a product is : (A) $\frac{d}{dx}(AC) = x\,(MC - AC)$ (B) $\frac{d}{dx}(AC) = x\,(AC - MC)$ (C) $\frac{d}{dx}(AC) = \frac{1}{x}(MC - AC)$ (D) $\frac{d}{dx}(AC) = \frac{1}{x}(AC - MC)$	
Sol.	(C) $\frac{d}{dx}(AC) = \frac{1}{x}(MC - AC)$	**1**
11.	For a random variable X, $E(X) = 3$ and $E(X^2) = 11$. The variance of X is : (A) 8 (B) 5 (C) 2 (D) 1	
Sol.	(C) 2	**1**
12.	If the mean and standard deviation of a binomial distribution are 12 and 2 respectively, then the value of the parameter p is : (A) $\frac{5}{6}$ (B) $\frac{1}{6}$ (C) $\frac{1}{3}$ (D) $\frac{2}{3}$	
Sol.	(D) $\frac{2}{3}$	**1**

13.	If the variance of a Poisson distribution is 2, then P(X = 2) is : (A) $4e^2$ (B) $2e^2$ (C) $\frac{2}{e^2}$ (D) $\frac{4}{e^2}$	
Sol.	(C) $\frac{2}{e^2}$	**1**
14.	Normal distribution is symmetric about : (A) Variance (B) Co-variance (C) Mean (D) Standard deviation	
Sol.	(C) Mean	**1**
15.	Using the flat rate method, the EMI to repay a loan of ₹ 20,000 in $2\frac{1}{2}$ years at an interest rate of 8% per annum is : (A) ₹ 100 (B) ₹ 700 (C) ₹ 800 (D) ₹ 1,000	
Sol.	(C) ₹ 800	**1**
16.	The graph of the inequality $3x + 2y > 6$ is the : (A) entire XOY plane (B) whole XOY plane excluding the points on the line $3x + 2y = 6$ (C) half plane that contains the origin (D) half plane that neither contains the origin nor the points on the line $3x + 2y = 6$	
Sol.	(D) half plane that neither contains the origin nor the points on the line $3x + 2y = 6$	**1**
17.	The straight line trend is represented by the equation : (A) $y = a + bx$ (B) $y = a - bx$ (C) $y = na + b\sum x$ (D) $y = na - b\sum x$	
Sol.	(A) $y = a + bx$	**1**

18.	If for the purpose of t-test of significance, a random sample of size (n) 34 is drawn from a normal population, then the degree of freedom (N) is : (A) 32 (B) 33 (C) 35 (D) 36	
Sol.	(B) 33	**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) :* Solution set of inequality $\lvert 3x-2\rvert \le \frac{1}{2}, x \in R$ is $\left[\frac{1}{2}, \frac{5}{6}\right]$. *Reason (R) :* $\lvert x-a\rvert \le r \Leftrightarrow x \le a-r$ or $x \ge a+r$.	
Sol.	(C) Assertion (A) is true, but Reason (R) is false.	**1**
20.	*Assertion (A) :* Matrix $A = \begin{bmatrix} 0 & -6 & 7 \\ 6 & 5 & -1 \\ -7 & 1 & 0 \end{bmatrix}$ is a skew-symmetric matrix. *Reason (R) :* A matrix A is skew-symmetric if $A' = -A$.	
Sol.	(D) Assertion (A) is false, but Reason (R) is true.	**1**
	SECTION B This section comprises very short answer (VSA) type questions of 2 marks each.	
21(a).	Two pipes P and Q together can fill a tank in 10 minutes. If pipe P takes 15 minutes less than Q to fill the tank alone, then find the time taken by pipe Q to fill the tank alone.	
Sol.	Let pipe Q fills the tank in x minutes, then P will fill the tank in $x-15$ minutes.	

	$\frac{1}{x}+\frac{1}{x-15}=\frac{1}{10}$	**1**
	$\Rightarrow\ x^2 - 35x + 150 = 0$	**½**
	$\Rightarrow\ x = 30$	**½**
	(x = 5 rejected)	
	$\therefore$ Q can fill the tank alone in 30 minutes.	
	OR	
21(b).	In a 200 m race, A beats B by 35 m or 7 seconds. Find the time taken by A to complete the race.	
Sol.	B covers a distance of 35 metres in 7 seconds. So, speed of B is 5 m/s So, B completes the race of 200 m in 40 seconds. Hence, A covers the race is (40 – 7) = 33 seconds.	 **½** **1** **½**
22.	Find the probability distribution of a number of successes in two tosses of a die, where a success is defined as getting a number greater than 4.	
Sol.	X can take the values 0, 1 and 2 $p=\frac{2}{6}=\frac{1}{3}, q=\frac{2}{3}$ <table><tr><td>X</td><td>0</td><td>1</td><td>2</td></tr><tr><td>P(X)</td><td>$\frac{4}{9}$</td><td>$\frac{4}{9}$</td><td>$\frac{1}{9}$</td></tr></table>	**½** **1½**
23.	Suppose that a 95% confidence interval states that population mean is greater than 100 and less than 300. How would you interpret this statement ?	
Sol.	95% are confident that true population mean lies in the interval (100, 300).	**2**

24.	Fill in the blanks : (a) t-distribution curve is symmetrical about the line __________. (b) The variable t of t-distribution lies between __________. (c) The mean of the t-distribution is __________. (d) The variance of the t-distribution is __________.	
Sol.	(a) $t = 0$ (b) $-\infty$ to $+\infty$ (c) 0 (d) greater than 1	½ ½ ½ ½
25 (a).	Find the present value of a perpetuity of ₹ 4,200 payable at the beginning of each year, if money is worth 5% compounded annually.	
Sol.	Here, R = ₹4,200 and $i = \frac{5}{100} = 0.05$ $P = R + \frac{R}{i}$ $P = 4200 + \frac{4200}{0.05}$ $= 88,200$ Thus, present value of perpetuity is ₹88,200.	 1 1
	OR	
25 (b).	Find the present value of a perpetuity of ₹ 5,000 payable at the end of each year, if money is worth 5% compounded annually.	
Sol.	$P = \frac{R}{i}$ $P = \frac{5000}{0.05}$ $= 1,00,000$ Thus, present value of perpetuity is ₹1,00,000.	 1 1

	SECTION C This section comprises short answer (SA) type questions of 3 marks each.	
26 (a).	Prove that $\begin{vmatrix} x+y & x & x \\ 5x+4y & 4x & 2x \\ 10x+8y & 8x & 3x \end{vmatrix} = x^3$	
Sol.	$\begin{vmatrix} x+y & x & x \\ 5x+4y & 4x & 2x \\ 10x+8y & 8x & 3x \end{vmatrix} = \begin{vmatrix} x & x & x \\ 5x & 4x & 2x \\ 10x & 8x & 3x \end{vmatrix} + \begin{vmatrix} y & x & x \\ 4y & 4x & 2x \\ 8y & 8x & 3x \end{vmatrix}$ $= x^3 \begin{vmatrix} 1 & 1 & 1 \\ 5 & 4 & 2 \\ 10 & 8 & 3 \end{vmatrix} + x^2y \begin{vmatrix} 1 & 1 & 1 \\ 4 & 4 & 2 \\ 8 & 8 & 3 \end{vmatrix}$ $= x^3 \begin{vmatrix} 1 & 1 & 1 \\ 5 & 4 & 2 \\ 10 & 8 & 3 \end{vmatrix} + x^2y \times 0$ $= x^3 \begin{vmatrix} 1 & 0 & 0 \\ 5 & -1 & -3 \\ 10 & -2 & -7 \end{vmatrix}$ $C_2 \to C_2 - C_1$ and $C_3 \to C_3 - C_1$ $= x^3 [7-6] = x^3$	½ 1 ½ 1
	OR	
26 (b).	Prove that $\begin{vmatrix} y+z & z & y \\ z & z+x & x \\ y & x & x+y \end{vmatrix} = 4xyz$	
Sol.	$\Delta = \begin{vmatrix} y+z & z & y \\ z & z+x & x \\ y & x & x+y \end{vmatrix} = \begin{vmatrix} 0 & z & y \\ -2x & z+x & x \\ -2x & x & x+y \end{vmatrix}$ $C_1 \to C_1 - C_2 - C_3$ $= -2x \begin{vmatrix} 0 & z & y \\ 1 & x+z & x \\ 1 & x & x+y \end{vmatrix}$ $= -2x \begin{vmatrix} 0 & z & y \\ 0 & z & -y \\ 1 & x & x+y \end{vmatrix}$ $R_2 \to R_2 - R_3$ $= -2x(-2zy) = 4xyz$	1 1 ½ ½

27.	Find the inverse (if it exists) of the matrix $A = \begin{bmatrix} 1 & 2 & -2 \\ -1 & 3 & 0 \\ 0 & -2 & 1 \end{bmatrix}$.	
Sol.	$\lvert A \rvert = 1 \neq 0$ $\therefore$ A is invertible and so A^{-1} exists. $\text{adj } A = \begin{bmatrix} 3 & 1 & 2 \\ 2 & 1 & 2 \\ 6 & 2 & 5 \end{bmatrix}' = \begin{bmatrix} 3 & 2 & 6 \\ 1 & 1 & 2 \\ 2 & 2 & 5 \end{bmatrix}$ $\Rightarrow A^{-1} = \begin{bmatrix} 3 & 2 & 6 \\ 1 & 1 & 2 \\ 2 & 2 & 5 \end{bmatrix}$	1 1½ ½
28 (a).	Prove that the function $f(x) = x^2 - x + 1$ is neither strictly increasing nor strictly decreasing on the interval $(-1, 1)$.	
Sol.	$f'(x) = 2x - 1$ $f'(x) = 0 \Rightarrow x = \frac{1}{2}$ $\Rightarrow f'(x) > 0$ when $x > \frac{1}{2}$ and $f(x) < 0$ when $x < \frac{1}{2}$ Since $f'(x)$ changes its sign in the interval $(-1,1)$, hence f(x) is neither strictly increasing nor strictly decreasing on $(-1, 1)$.	½ ½ ½ + ½ 1
	OR	
28 (b).	Find $\frac{dy}{dx}$, if $y^x + x^y + x^x = a^b$.	
Sol.	Let $P = y^x$, $Q = x^y$, $R = x^x$ Then, $\log P = x \log y \Rightarrow \frac{dP}{dx} = y^x \left[\log y + \frac{x}{y}\frac{dy}{dx}\right]$ $\log Q = y \log x \Rightarrow \frac{dQ}{dx} = x^y \left[\frac{y}{x} + \log x \frac{dy}{dx}\right]$ $\log R = x \log x \Rightarrow \frac{dR}{dx} = x^x [1 + \log x]$ $\frac{dP}{dx} + \frac{dQ}{dx} + \frac{dR}{dx} = 0$ $\Rightarrow \frac{dy}{dx} = -\frac{y^x \log y + yx^{y-1} + x^x (1 + \log x)}{x[y^{x-1} + x^{y-1} \log x]}$	½ ½ ½ ½ 1

29 (a).	A person invested ₹ 5,000 in a fund for 5 years. The value of the investment was ₹ 4,800 at the end of the second year, ₹ 6,000 at the end of the third year, ₹ 6,700 at the end of the fourth year and on maturity, the final investment sold at ₹ 8,000. Find the CAGR. [Use $(1\cdot6)^{\frac{1}{5}} = 1\cdot098$]	
Sol.	$i = \left(\dfrac{8000}{5000}\right)^{\frac{1}{5}} - 1$ $= (1.6)^{\frac{1}{5}} - 1$ $= 0.098$ $\therefore$ CAGR = 9.8 %	**1** **1** ½ ½
	OR	
29 (b).	The annual depreciation of an asset is ₹ 50,000 and its scrap value after useful life of 10 years is ₹ 60,000. Find the original cost of the asset, using linear depreciation method.	
Sol.	Let C denotes the original cost of the Asset. Then annual depreciation (D) is given by $D = \dfrac{C - S}{n}$ $\Rightarrow \quad 50000 = \dfrac{C - 60000}{10}$ $\Rightarrow \quad C = 5{,}60{,}000$ So, the original cost of the asset is ₹ 5,60,000	**2** **1**
30 (a).	Find : $\displaystyle\int \frac{dx}{(x+1)^2\,(x^2+1)}$	
Sol.	Let $\dfrac{1}{(x+1)^2\,(x^2+1)} = \dfrac{A}{x+1} + \dfrac{B}{(x+1)^2} + \dfrac{Cx + D}{x^2+1}$ Getting the values, $A = \dfrac{1}{2},\ B = \dfrac{1}{2},\ C = \dfrac{-1}{2}$ and $D = 0$ Thus $I = \displaystyle\int \frac{1}{2(x+1)}\,dx + \frac{1}{2}\int \frac{1}{(x+1)^2}\,dx - \frac{1}{2}\int \frac{x\,dx}{x^2+1}$ $= \dfrac{1}{2}\log(x+1) - \dfrac{1}{2(x+1)} - \dfrac{1}{4}\log\lvert x^2+1\rvert + C$	½ **1** 1½

OR

30 (b). Solve the differential equation : $\frac{dy}{dx} = e^{x-y} + x^2 e^{-y}$

Sol.

$\frac{dy}{dx} = e^{-y}(e^x + x^2)$ — ½

$\Rightarrow \frac{dy}{e^{-y}} = (e^x + x^2)\,dx$ — 1

$\int e^y dy = \int (e^x + x^2)\,dx$

$\Rightarrow \quad e^y = e^x + \frac{x^3}{3} + C$ — 1½

31. Minimise Z = 5x + 10y, subject to the constraints

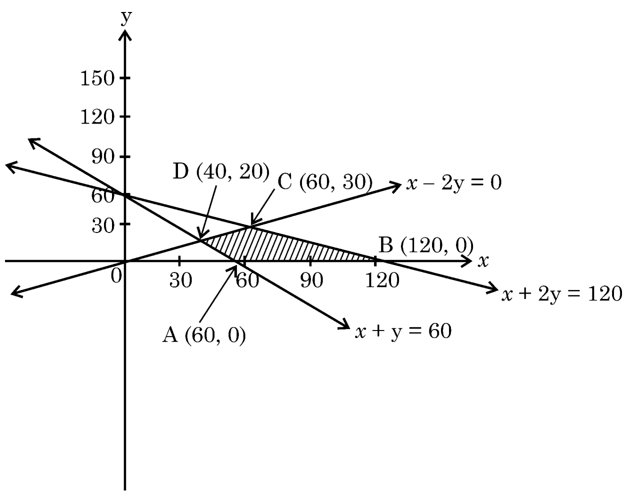
$x + 2y \le 120$

$x + y \ge 60$

$x - 2y \ge 0$

$x, y \ge 0$

Sol.



1½ for correct graph

Corner Points	Z = 5x+10y
A (60, 0)	300
B (120, 0)	600
C (60, 30)	600
D (40, 20)	400

1 for correct table

Z is minimum at A(60, 0) — ½

	SECTION D This section comprises of Long Answer (LA) type questions of 5 marks each.	
32.	Solve for x : $1 \le \lvert x-2 \rvert \le 3$	
Sol.	$\lvert x-2 \rvert \ge 1$ $\Rightarrow x-2 \ge 1$ or $x-2 \le -1$ $\Rightarrow x \ge 3$ or $x \le 1$ $\Rightarrow x \in (-\infty, 1] \cup [3, \infty)$ --- (i) $\lvert x-2 \rvert \le 3$ $\Rightarrow -3 \le x-2 \le 3 \Rightarrow -1 \le x \le 5$ $\Rightarrow x \in [-1,5]$ --- (ii) From (i) and (ii) $x \in [-1,1] \cup [3,5]$	**2** **2** **1**
33 (a).	A given rectangular area is to be fenced off in a field whose length lies along a straight river. If no fencing is needed along the river, show that the least length of fencing will be required when the length of the rectangular area is twice its breadth.	
Sol.	Let the length and breadth of rectangle be x and y units respectively. Let L be the length of fencing required, then $L = x + 2y$ If 'a' denotes the area of the rectangular region. Then $a = xy$ $\Rightarrow L = x + \frac{2a}{x}$ $\Rightarrow \frac{dL}{dx} = 1 - \frac{2a}{x^2}$ $\frac{dL}{dx} = 0 \Rightarrow x = \sqrt{2a}$ $\left(\frac{d^2L}{dx^2}\right)_{x=\sqrt{2a}} = \frac{2}{\sqrt{2a}} > 0$ Thus L is least when $x = \sqrt{2a}$ Length of fence $= x = \sqrt{2a}$	 **1** ½ ½ **1** **1** ½

	Breadth of fence $= y = \frac{a}{x} = \frac{a}{\sqrt{2a}} = \frac{1}{2}\sqrt{2a} = \frac{1}{2}x$ Hence, length $= 2 \times$ breadth	½
	OR	
33 (b).	Solve the differential equation : $x\frac{dy}{dx} + 2y = x^2 \log x$	
Sol.	$\frac{dy}{dx} = \frac{x^2 \log x - 2y}{x}$ Full marks may be awarded to the student who has attempted the question till finding correct value of $\frac{dy}{dx}$ as Linear differential equations is not explicitly mentioned in the curriculum.	
34(a).	Fit a straight line trend by the method of least squares to the following data and find the trend values. Year: 2010, 2012, 2013, 2014, 2015, 2016, 2019 Sales (in lakh ₹): 65, 68, 70, 72, 75, 67, 73	
Sol.	(see table below)	**2½ for the correct table**

Year	2010	2012	2013	2014	2015	2016	2019
Sales (in lakh ₹)	65	68	70	72	75	67	73

Year	Index Number (Y)	$X = x_i - A$ $= x_i - 2014$	X^2	XY	$Y_t = a + bX$
2010	65	-4	16	-260	$69.75 + (-4)0.75 = 66.75$
2012	68	-2	4	-136	68.25
2013	70	-1	1	-70	69
2014	72	0	0	0	69.75
2015	75	1	1	75	70.5
2016	67	2	4	134	71.25
2019	73	5	25	365	73.5
$n = 7$	$\sum Y = 490$	$\sum X = 1$	$\sum X^2 = 51$	$\sum XY = 108$	

Equation of trend line is $Y = a + bX$

$\sum Y = na + b\sum X$ and $\sum XY = a\sum X + b\sum X^2$

	$\Rightarrow 490 = 7a + b$ and $108 = a + 51b$ Solving the two equations, we get $a = 69.75$ and $b = 0.75$ (approx.) Required line is $Y = a + bX = 69.75 + 0.75\ X$	½ ½ **1** ½
	OR	
34(b).	Find the trend values by taking 4-yearly moving averages for the following data.	

Year	2015	2016	2017	2018	2019	2020	2021	2022
Sales (in thousand ₹)	108	112	110	120	140	120	100	135

Sol.

Year	Sales	4 yearly moving total	4 yearly moving Average	Centered moving average
2015	108			
2016	112			
		450	112.5	
2017	110			116.5
		482	120.5	
2018	120			121.5
		490	122.5	
2019	140			121.25
		480	120	
2020	120			121.875
		495	123.75	
2021	100			
2022	135			

4 yearly moving total: **1½ marks**

4 yearly moving average: **1½ marks**

centered moving average: **2 marks**

35. A machine costs a company ₹ 52,000 and its effective life is estimated to be 25 years. A sinking fund is created for replacing the machine by a new model at the end of its life time, when its scrap realizes a sum of ₹ 2,500 only. The price of the new model is estimated to be 25% more than the price of the present one. Find what amount should be set aside at the end of each year out of the profits for the sinking fund, if it accumulates at 3·5% per annum compound. [Given $(1{\cdot}035)^{25} = 2{\cdot}3632$]

Sol.	Let R be the amount set aside each year. Price of new model = 52000 + 25% of 52000 = ₹ 65000 Scrap Value = ₹ 2500 Net amount = ₹ 62500 $R = \frac{Si}{(1+i)^n - 1}$ $= \frac{62500 \times 0.035}{(1+0.035)^{25} - 1} = \frac{62500 \times 0.035}{1.3632}$ = ₹ 1604.68	1 1 2 1
	SECTION E This section comprises of 3 case-study based questions of 4 marks each.	
36.	According to an educational board survey, it was observed that class XII students apply at least one to four weeks ahead of college application deadlines. Let X represent the week when an average student applies ahead of a college's application deadline and the probability of the student to get admission in the college P(X = x) is given as follows : $P(X=x)=\begin{cases} \frac{kx}{6}, \text{ when } x = 0, 1 \text{ or } 2 \\ \frac{(1-k)x}{6}, \text{ when } x = 3 \\ \frac{kx}{2}, \text{ when } x = 4 \\ 0, \text{ when } x > 4 \end{cases}$ where k is a real number. Based on the above information, answer the following questions : (i) Determine the value of k. (ii) What is the probability that Mahesh will get admission in the college, given that he applied at least 3 weeks ahead of application deadline ? (iii) (a) Calculate the mathematical expectation of number of weeks taken by a student to apply ahead of a college's application deadline. **OR** (iii) (b) To promote early admissions, the college is offering scholarships to the students for applying ahead of deadline as follows : ₹ 50,000 for applying 4 weeks ahead ₹ 20,000 for applying 3 weeks ahead ₹ 12,000 for applying 2 weeks ahead and ₹ 9,600 for applying 1 week ahead Determine the expected scholarship offered by the college.	

Sol.	(i) $\frac{k}{6}+\frac{2k}{6}+\frac{3(1-k)}{6}+\frac{4k}{2}=1$ $\Rightarrow 3+12k=6$ $\Rightarrow k=\frac{3}{12}=\frac{1}{4}$	½ ½
	(ii) Required Probability $= P(X=3)+P(X=4)$ $=\frac{3}{8}+\frac{1}{2}$ $=\frac{7}{8}$	 ½ ½
	(iii) (a)	

X	0	1	2	3	4
P(X)	0	$\frac{1}{24}$	$\frac{1}{12}$	$\frac{3}{8}$	$\frac{1}{2}$

1

$E(X)=1\times\frac{1}{24}+2\times\frac{1}{12}+3\times\frac{3}{8}+4\times\frac{1}{2}=\frac{10}{3}$ weeks or $3\frac{1}{3}$ weeks **1**

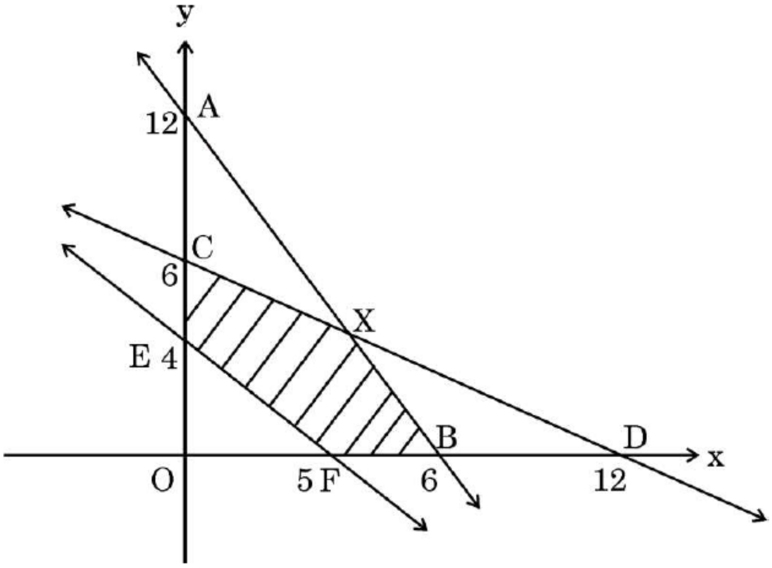
OR

(iii) (b)

X	9600	12000	20000	50000
$P(X)$	$\frac{1}{24}$	$\frac{1}{12}$	$\frac{3}{8}$	$\frac{1}{2}$

1

$E(X)=\ 9600\times\frac{1}{24}+12000\times\frac{1}{12}+20000\times\frac{3}{8}+50000\times\frac{1}{2}=₹\ 33900$ **1**

37.	The feasible region for an LPP is shown in the graph given below :  Based on the above information, answer the following questions : (i) Determine the equation of CD. (ii) Determine the equation EF. (iii) (a) Determine all the constraints for the LPP. **OR** (iii) (b) Find the maximum value of the objective function Z = 600x + 400y.	
Sol.	(i) $x + 2y = 12$ (ii) $4x + 5y = 20$ (iii) (a) $x + 2y \leq 12,\quad 4x + 5y \geq 20,$ $2x + y \leq 12,$ $x \geq 0, y \geq 0$	**1** **1** **½** **1** **½**
	OR	
	(iii) (b)	

Corner Points	Value of Z
B (6,0)	3600
X (4,4)	4000
C (0,6)	2400
E (0,4)	1600
F (5,0)	3000

1½

Maximum value of Z = 4000 **½**

38.	A man took a home loan of ₹ 40,00,000 from a bank at the interest of 6·75% per annum compounded monthly which is to be amortized by equal payments at the end of each month for 10 years. Based on the above information, answer the following questions : (i) Find the monthly instalment. [Use $(1{\cdot}005625)^{-120} = 0{\cdot}510120$] (ii) Find the principal outstanding at the beginning of 61^{st} month. [Use $(1{\cdot}005625)^{60} = 1{\cdot}400115$] (iii) (a) Find the interest amount paid in the 61^{st} instalment. **OR** (iii) (b) Find the principal amount paid in the 61^{st} instalment.	
Sol.	P = ₹ 40,00,000, $i = \frac{6.75}{1200} = 0.005625$, n = 120 months (i) EMI $= \frac{Pi}{1-(1+i)^{-n}}$ $= \frac{4000000 \times 0.005625}{1-(1.005625)^{-120}}$ $= \frac{22500}{1-0.510120} = \frac{22500}{0.48988}$ ≈ ₹ 45,930 (ii) Principal outstanding at beginning of 61^{st} instalment $= \frac{E[(1+i)^{120-61+1}-1]}{i(1+i)^{120-61+1}}$ $= \frac{45930\,[(1.005625)^{60}-1]}{0.005625\,(1.005625)^{60}}$ $= \frac{45930 \times (1.400115-1)}{0.005625 \times 1.400115}$ $= \frac{45930 \times 0.400115}{0.005625 \times 1.400115}$ ≈ ₹ 23,33,431 (iii) (a) Interest paid in 61^{st} instalment $= 2333431 \times 0.005625$ ≈ ₹ 13,126	 ½ ½ ½ ½ 1 1

	OR	
	(iii) (b) Interest paid in 61^{st} instalment $= 2333431 \times 0.005625$ $\approx$ ₹ 13,126	**1**
	Principal amount paid in 61^{st} instalment = EMI – Interest = 45,930 – 13,126 = ₹ 32,804	½ ½