Marking Scheme
Strictly Confidential
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Senior Secondary School Examination, 2026 (XII)
APPLIED MATHEMATICS (241) QUESTION PAPER CODE – 465

General Instructions: -

1	The CBSE has decided to introduce On Screen Marking (OSM) for the evaluation of Class XII answer Book with the 2026 Examination.
2	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.
3	**"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 Newspaper/Website, etc. may invite action under various rules of the Board and IPC."**
4	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. In Class-XII, while evaluating the competency-based questions, please try to understand given answer and even if reply is not from marking scheme but correct competency is enumerated by the candidate, due marks should be awarded.**
5	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.
6	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.
7	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.**
8	If a question has parts, please award marks on the right-hand side for each part in the OSM Portal. Marks awarded for different parts of the question will be totaled up by the OSM System.
9	If a question does not have any parts, marks must be awarded in the left-hand margin in the OSM Portal. This may also be followed strictly.
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 ___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.
12	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.
13	Ensure that you do not make the following common types of errors committed by the Examiner in the past :- ● 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.
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	The Examiners should acquaint themselves with the guidelines given in the "**Guidelines for Spot Evaluation**" before starting the actual evaluation.
16	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.
17	**If a candidate attempts both alternatives/options in a question where only one option/ alternative is required to be attempted, the Evaluator shall award marks in both the options. The system will take the higher of two scores and disregard the other response.**
18	**In a question having two options/alternatives, if a candidate has attempted only one, then the evaluator shall mark "NA" (Not attempted) against the option that has not been attempted by the candidate.**

MARKING SCHEME
APPLIED MATHEMATICS (Subject Code–241)
(PAPER CODE: 465)

Section A

Q. No.	EXPECTED OUTCOMES/VALUE POINTS	Step	Marks
	SECTION A This section comprises 20 Multiple Choice Questions (MCQs) of 1 mark each.		
1.	The real x for which $2(2x + 3) - 10 < 6(x - 2)$ is : (A) $x > 2$ (B) $x > 3$ (C) $x > 4$ (D) $x > -4$		
Sol.	(C) $x > 4$	**I**	**1**
2.	The number of all possible matrices of order 3×2 with each entry 1 or 2 is : (A) 6 (B) 16 (C) 24 (D) 64		
Sol.	(D) 64	**I**	**1**
3.	If AB = A and BA = B, then $(B^2 + B)$ is equal to : (A) 2A (B) O (C) 2I (D) 2B		
Sol.	(D) 2B	**I**	**1**
4.	The value of $\begin{vmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{vmatrix}$ is : (A) 5 (B) -7 (C) 9 (D) 0		
Sol.	(D) 0	**I**	**1**

5.	General solution of differential equation $y \log y\, dx - x\, dy = 0$ is : (A) $y = \log \lvert cx \rvert$ (B) $y = e^{\lvert cx \rvert}$ (C) $y = e^{c+x}$ (D) $\log y = \lvert c + x \rvert$		
Sol.	(B) $y = e^{\lvert cx \rvert}$	**I**	**1**
6.	If $\int_0^{40} \frac{dx}{2x+1} = \log k$, then the value of k is : (A) 3 (B) 9 (C) $\frac{9}{2}$ (D) $\frac{3}{2}$		
Sol.	(B) 9	**I**	**1**
7.	If $x = t^2$ and $y = t^3$, then $\frac{d^2y}{dx^2}$ is equal to : (A) $\frac{3}{2}$ (B) $\frac{3}{4t}$ (C) $\frac{1}{2t^2}$ (D) $\frac{3}{2t}$		
Sol.	(B) $\frac{3}{4t}$	**I**	**1**
8.	The rate of change of the area of a circle with respect to its radius r (in cm^2/s), when r = 6 cm, is : (A) 10π (B) 12π (C) 8π (D) 11π		
Sol.	(B) 12π	**I**	**1**

9.	Let X be a discrete random variable, then the variance of X is : (A) $E(X^2)$ (B) $E(X^2) - [E(X)]^2$ (C) $E(X^2) + [E(X)]^2$ (D) $\sqrt{E(X^2) - [E(X)]^2}$		
Sol.	(B) $E(X^2) - [E(X)]^2$	**I**	**1**
10.	If 'm' is the mean of a Poisson distribution, then its variance is given by : (A) m^2 (B) $\sqrt{m}$ (C) m (D) $\frac{m}{2}$		
Sol.	(C) m	**I**	**1**
11.	The total area under a standard normal curve is : (A) 1 (B) $\sqrt{2}$ (C) 2 (D) $\frac{1}{2}$		
Sol.	(A) 1	**I**	**1**
12.	For the purpose of t-test of significance, if a random sample of size drawn from a normal population, then the degree of freedom (ν) is : (A) 32 (B) 33 (C) 34 (D) 35		
Sol.	(B) 33	**I**	**1**
13.	The range of variable t of the t-distribution is : (A) (0, 1) (B) (1, 2) (C) (– 1, 1) (D) $(-\infty, \infty)$		
Sol.	(D) $(-\infty, \infty)$	**I**	**1**

14.	The present value of a perpetuity of ₹ R payable at the end of each period, when the money is worth i per period is : (A) Ri (B) $R + \frac{R}{i}$ (C) $\frac{R}{i}$ (D) $R - Ri$		
Sol.	(C) $\frac{R}{i}$	**I**	**1**
15.	Using 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) ₹ 700 (B) ₹ 800 (C) ₹ 900 (D) ₹ 100		
Sol.	(B) ₹ 800	**I**	**1**
16.	If an investment of ₹ 10,000 becomes ₹ 60,000 in 4 years, then the Compound Annual Growth Rate (CAGR) is : (A) $\frac{\sqrt[4]{6}-1}{100}$ (B) $\frac{\sqrt[4]{6}+1}{100}$ (C) $(\sqrt[4]{6}-1) \times 100$ (D) $(\sqrt[4]{6}+1) \times 100$		
Sol.	(C) $\left(\sqrt[4]{6}-1\right) \times 100$	**I**	**1**
17.	A machine costs ₹ 45,000 with an estimated useful life of 5 years and a scrap value of ₹ 10,000. The annual depreciation of the machine is : (A) ₹ 8,000 (B) ₹ 7,000 (C) ₹ 6,000 (D) ₹ 5,000		
Sol.	(B) ₹ 7,000	**I**	**1**
18.	The maximum value of the function $z = 7x + 5y$, subject to the constraints $x \leq 3, y \leq 2, x \geq 0, y \geq 0$ is : (A) 10 (B) 21 (C) 31 (D) 29		
Sol.	(C) 31	**I**	**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) :* $\int \frac{1}{\sqrt{9-x^2}}\,dx = \sin^{-1}\frac{x}{3} + C$ *Reason (R) :* $\int \frac{1}{\sqrt{a^2-x^2}}\,dx = \sin^{-1}\frac{x}{a} + C$		
Sol.	(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A). **Note:** Full 1 mark may be awarded to the students who attempted the question.	**I**	**1**
20.	*Assertion (A) :* In sinking fund, a fixed amount at regular intervals is deposited. *Reason (R) :* In Savings Bank Account, any amount, any time can be deposited.		
Sol.	(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is *not* the correct explanation of the Assertion (A).	**I**	**1**
	SECTION B **This section comprises 5 very Short Answer (VSA) type questions of 2 marks each.**		
21.	A man in a boat goes 12 km downstream and comes back to the starting point by rowing non-stop in a total time of 3 hours. If the speed of the stream is 3 km/h, find the speed with which the man can row the boat in still water.		
Sol.	Let x km/h be the speed of the boat in still water. $\therefore$ Speed of the boat downstream $= (x + 3)$ km/h Speed of the boat upstream $= (x - 3)$ km/h According to question, $\frac{12}{x+3} + \frac{12}{x-3} = 3$	**I** **II**	½ ½

	$\Rightarrow 3x^2 - 24x - 27 = 0$ or $x^2 - 8x - 9 = 0$ $\Rightarrow (x-9)(x+1) = 0$ Rejecting the $-$ve value, we get $x = 9$ So, the speed of the boat in still water $= 9$ km/h	III IV	½ ½
22 (a).	Solve the following differential equation : $\frac{dy}{dx} = \frac{2-y}{x+1}$		
Sol.	$\int \frac{dy}{2-y} = \int \frac{dx}{x+1}$ $\Rightarrow -\log\lvert 2-y\rvert = \log\lvert x+1\rvert - \log c$ $\Rightarrow \log\lvert(2-y)(x+1)\rvert = \log c$ or $\lvert(2-y)(x+1)\rvert = c$	I II III	½ 1 ½
	OR		
22 (b).	If $\int_a^b x^3\ dx = 0$ and $\int_a^b x^2\ dx = \frac{2}{3}$, then find the values of 'a' and 'b'.		
Sol.	Here, $\left\lvert\frac{x^4}{4}\right\rvert_a^b = 0$ and $\left\lvert\frac{x^3}{3}\right\rvert_a^b = \frac{2}{3}$ $\Rightarrow \frac{1}{4}(b^4 - a^4) = 0$ and $\frac{1}{3}(b^3 - a^3) = \frac{2}{3}$ Solving the two, we get $a = -1, b = 1$	I II III	½ ½ 1
23 (a).	For a Poisson distribution, if mean (m) = 1, then find P(r = 1).		
Sol.	$P(X = r) = \frac{e^{-m}(m)^r}{r!}$ $P(r = 1) = \frac{e^{-1}(1)^1}{1!}$ $= e^{-1}$ or $\frac{1}{e}$	I II	1 1

	OR		
23 (b).	Find the mean and standard deviation of the Binomial distribution $B\left(4, \frac{1}{3}\right)$.		
Sol.	Mean $= np = 4 \times \frac{1}{3} = \frac{4}{3}$ S.D $= \sqrt{npq} = \sqrt{4 \times \frac{1}{3} \times \frac{2}{3}} = \frac{\sqrt{8}}{3}$ or $\frac{2\sqrt{2}}{3}$	**I** **II**	**1** **1**
24.	Calculate 3-yearly moving averages for the following data :		

Years (t)	2013	2014	2015	2016	2017	2018	2019	2020
Variables (x)	3	5	7	10	12	14	15	16

Sol.

Year (t)	Variable (x)	3-yearly moving total	3-yearly moving average
2013	3	-	-
2014	5	15	5
2015	7	22	7.33
2016	10	29	9.67
2017	12	36	12
2018	14	41	13.67
2019	15	45	15
2020	16	-	-

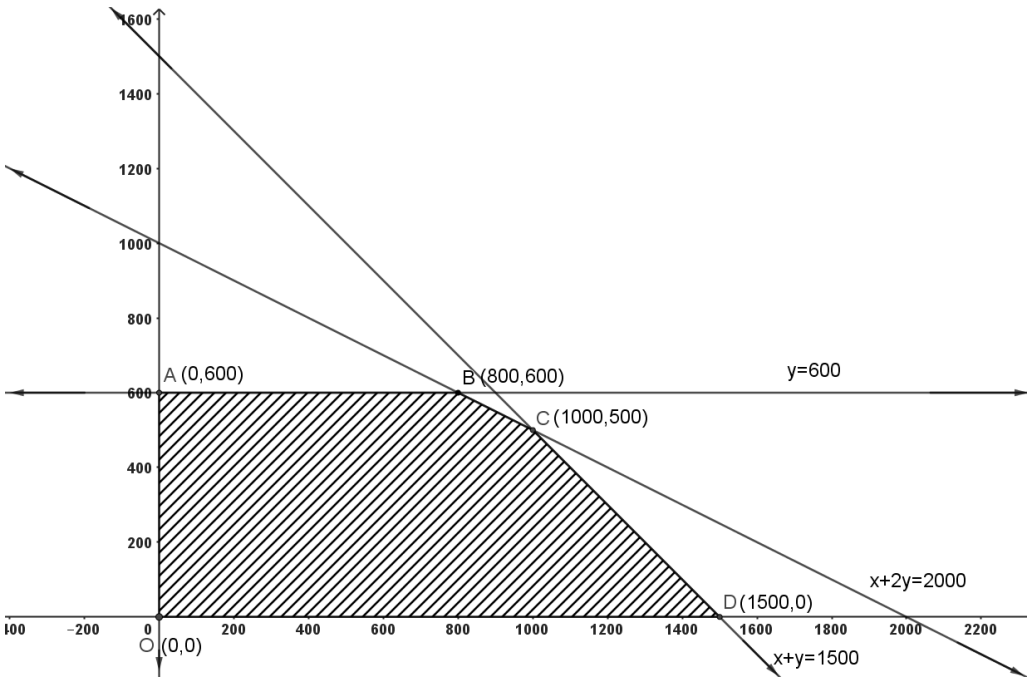
Correct Table — **I** — **2**

(Remark: 1 mark for any 3 correct entries)

25.	A man takes a personal loan of ₹ 2,00,000 at an interest rate of 15% p.a. compounded monthly, to be repaid by equal monthly instalments in 4 years. Calculate the EMI, using reducing balance method. [Given : $(1{\cdot}0125)^{-48} = 0{\cdot}55$]		
Sol.	EMI $= \frac{Pi}{1-(1+i)^{-n}}$ Here, P $= ₹\ 2{,}00{,}000, i = \frac{15}{1200} = 0.0125, n = 4 \times 12 = 48$ EMI $= \frac{200000 \times 0.0125}{1-(1.0125)^{-48}}$ $= \frac{2500}{1-0.55} = ₹\ 5555.56$ (approx.)	**I** **II**	**1½** **½**
	SECTION C **This section comprises 6 short answer (SA) type questions of 3 marks each.**		
26 (a).	(i) Apply addition modulo to positive integers 17 and 13 for modulo 30. (ii) Find subtraction modulo 8 for numbers 11 and 3.		
Sol.	(i) $(17 + 13) \bmod 30 = 30 \bmod 30 = 0$ (ii) $(11 - 3) \bmod 8 = 8 \bmod 8 = 0$	**I** **II**	**1½** **1½**
	OR		
26 (b).	Three pipes A, B and C can together fill a tank in 8 hours. After working at it together for 2 hours, B is closed and A and C fill the remaining part in 9 hours. Determine the time in which pipe B alone can fill the tank.		
Sol.	Part of the tank filled by pipes A, B and C in 1 hour $= \frac{1}{8}$ Part of the tank filled by pipes A, B and C in 2 hours $= \frac{2}{8} = \frac{1}{4}$ Remaining part to be filled $= 1 - \frac{1}{4} = \frac{3}{4}$ Part of unfilled tank filled by pipes A and C in 1 hour $= \frac{3}{4} \times \frac{1}{9} = \frac{1}{12}$ So, part of tank filled by pipe B alone in 1 hour $= \frac{1}{8} - \frac{1}{12} = \frac{1}{24}$	**I** **II** **III** **IV** **V**	**½** **½** **½** **½** **½**

	Hence the time taken by pipe B alone $= 24$ hours	**VI**	**½**
27.	Using Cramer's rule, show that the following system of linear equations is consistent and hence solve it : $2x - 3y + 5z = 11$ $3x + 2y - 4z = -5$ $x + y - 2z = -3$		
Sol.	$D = \begin{vmatrix} 2 & -3 & 5 \\ 3 & 2 & -4 \\ 1 & 1 & -2 \end{vmatrix} = -1$ Since $D \neq 0 \therefore$ the system of equations is consistent.	**I**	**½**
	$D_1 = \begin{vmatrix} 11 & -3 & 5 \\ -5 & 2 & -4 \\ -3 & 1 & -2 \end{vmatrix} = -1$	**II**	**½**
	$D_2 = \begin{vmatrix} 2 & 11 & 5 \\ 3 & -5 & -4 \\ 1 & -3 & -2 \end{vmatrix} = -2$	**III**	**½**
	$D_3 = \begin{vmatrix} 2 & -3 & 11 \\ 3 & 2 & -5 \\ 1 & 1 & -3 \end{vmatrix} = -3$	**IV**	**½**
	$x = \frac{D_1}{D} = 1, y = \frac{D_2}{D} = 2, z = \frac{D_3}{D} = 3$	**V**	**1**
28 (a).	Find the intervals in $\mathbb{R}$ for which the function $f(x) = x^4 - 2x^2$ is increasing or decreasing.		
Sol.	$f'(x) = 4x^3 - 4x = 4x(x-1)(x+1)$	**I**	**1**
	$f'(x) = 0 \Rightarrow x = 0, 1, -1$	**II**	**1**
	Sign of f'(x) − + − + $-\infty$ -1 0 1 ∞ f(x) is decreasing for $x \in (-\infty, -1) \cup (0,1)$ and increasing for $x \in (-1,0) \cup (0, \infty)$.		
	OR f(x) is decreasing for $x \in (-\infty, -1] \cup [0,1]$ and increasing for $x \in [-1,0] \cup [0, \infty)$.	**III**	**1**
	OR		

28 (b).	Find : $\int \frac{2x+1}{18-4x-x^2}\,dx$		
Sol.	$I = -\int \frac{2x+1}{x^2+4x-18}dx$	**I**	**1**
	$= -\int \frac{2x+4}{x^2+4x-18}dx + \int \frac{3}{x^2+4x-18}dx$	**II**	**1**
	$== -\log\lvert x^2+4x-18\rvert + \int \frac{3}{(x+2+2\sqrt{22})(x+2-2\sqrt{22})}dx$	**III**	**1**
	$= -\log\lvert x^2+4x-18\rvert + \frac{3}{2\sqrt{22}}\log\left\lvert\frac{x+2-\sqrt{22}}{x+2+\sqrt{22}}\right\rvert + c$		
29.	A soap manufacturing company was distributing a particular brand of a soap through a large number of retail shops. Before a heavy advertisement campaign, the mean sales per week per shop was 140 dozen. After the campaign, a sample of 26 shops was taken and mean sales was found to be 147 dozen with standard deviation 16. Can you consider the advertisement campaign effective ? [Given t_{25} (0·05) = 2·06]		
Sol.	$\bar{x} = 147,\ \mu = 140$		
	$n = 26, s = 16$		
	H_0: Null hypothesis : If there is no significant difference between $\bar{x}$ and μ	**I**	**½**
	H_1: Alternate hypothesis : If there is a significant difference between $\bar{x}$ and μ		
	$t = \frac{\bar{x}-\mu}{\frac{s}{\sqrt{n-1}}} = \frac{147-140}{\frac{16}{\sqrt{25}}} = 2.187$	**II**	**1½**
	Df $= 25$ and $t_{25}(0.05) = 2.06$		
	Since $\lvert t\rvert = 2.187 > 2.06$	**III**	**½**
	∴ Null hypothesis is rejected		
	Hence the advertisement campaign is effective.	**IV**	**½**
	Note:* $t = \frac{\bar{x}-\mu}{\frac{s}{\sqrt{n}}} = 2.23$ should also be accepted.		

30.	A company XYZ Ltd. has issued a bond having a face value of ₹ 10,000 paying annual dividend at 8·5% p.a. The bond will be redeemed at par at the end of 10 years. Find the purchase value of this bond, if the investor wishes a yield rate of 8%. [Given : $(1{\cdot}08)^{-10} = 0{\cdot}46319349$]		
Sol.	Here, $F = ₹\,10{,}000, n = 10, i = 0.08$ $R = 8.5\%$ of ₹ 10000 $= ₹\,850$, $C = F = ₹\,10{,}000$ Let V be the purchase price of the bond, then $V = R\left[\frac{1-(1+i)^{-n}}{i}\right] + C(1+i)^{-n}$ $= 850\left[\frac{1-(1+0.08)^{-10}}{0.08}\right] + 10000(1+0.08)^{-10}$ $= ₹(5703.57 + 4631.93) = ₹\,10{,}335.50$ (approx.)	**I** **II** **III**	**1** **1** **1**
31.	Solve the following Linnear Programming Problem (LPP) graphically : Maximize z = 3x + 5y subject to the constraints : $x + 2y \le 2000$ $x + y \le 1500$ $y \le 600$ $x \ge 0, y \ge 0$		
Sol.			

Correct graph

Corner Points	Value of Z	
O (0,0)	0	
A (0,600)	3000	
B (800, 600)	5400	
C (1000,500)	5500 →	Maximum Value
D (1500, 0)	4500	

∴ Maximum Z = ₹ 5500 at B (1000, 500)

I 1½

II 1½

SECTION D

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

32. Solve the following inequation :

$$\frac{2x-1}{12} - \frac{x-11}{3} < \frac{3x+1}{4}, x \in R$$

Sol. Given equation can be written as

$(2x-1) - 4(x-11) < 3(3x+1)$ — I 2

$\Rightarrow -2x + 43 < 9x + 3$ — II 2

$\Rightarrow 11x > 40$

$\Rightarrow x > \frac{40}{11}$ — III 1

Hence the solution is $x > \frac{40}{11}$ or $\left(\frac{40}{11}, \infty\right)$

33 (a). Find the consumer's surplus for the demand function $p = 25 - x - x^2$, where the prevailing market price $p_0 = 19$.

Sol. For equilibrium, $p = p_0$ and $x = x_0$

$25 - x_0 - {x_0}^2 = 19$ — I ½

	$\Rightarrow (x_0 + 3)(x_0 - 2) = 0$	**II**	**1**
	Rejecting the $-$ve value		
	$x_0 = 2$	**III**	**½**
	$p_0 x_0 = 38$	**IV**	**½**
	CS $= \int_0^2 (25 - x - x^2)dx - p_0 x_0$	**V**	**1**
	$= 25x - \frac{x^2}{2} - \frac{x^3}{3}\Big]_0^2 - 38$	**VI**	**1**
	$= 50 - 2 - \frac{8}{3} - 38 = \frac{22}{3}$	**VII**	**½**
	OR		
33 (b).	Solve the following initial value differential equation : $(x - 1)\frac{dy}{dx} = 2xy$, when $y(2) = 1$.		
Sol.	The given equation can be written as		
	$\frac{dy}{y} = \frac{2x}{x-1}dx$	**I**	**1**
	$\int \frac{dy}{y} = \int \frac{2x}{x-1}dx$		
	$\Rightarrow \int \frac{dy}{y} = 2\int \left(1 + \frac{1}{x-1}\right)$	**II**	**1½**
	$\Rightarrow \log\lvert y\rvert = 2(x + \log\lvert x - 1\rvert) + c$	**III**	**1**
	$\Rightarrow \log\lvert y\rvert - \log(x-1)^2 = 2x + c$		
	When $x = 2, y = 1$ then $c = -4$	**IV**	**1**
	So, the solution is		
	$\log\lvert y\rvert - \log(x-1)^2 = 2x - 4$	**V**	**½**

34 (a).	Two cards are drawn at random and one by one with replacement from a well-shuffled pack of 52 playing cards. Find the probability distribution of the number of aces. Also, find its mean and variance.		
Sol.	Let a random variable X denote the number of aces. Then X can take the values 0, 1 and 2 Let p be the probability of getting an ace. $p = \frac{4}{52} = \frac{1}{13} \Rightarrow q = \frac{12}{13}$	**I**	**1**
	<table><tr><td>X</td><td>0</td><td>1</td><td>2</td></tr><tr><td>P(X)</td><td>$\frac{12}{13} \times \frac{12}{13} = \frac{144}{169}$</td><td>$2 \times \frac{12}{13} \times \frac{1}{13} = \frac{24}{169}$</td><td>$\frac{1}{13} \times \frac{1}{13} = \frac{1}{169}$</td></tr></table>	**II**	**2**
	$E(X) = np = 2 \times \frac{1}{13} = \frac{2}{13}$	**III**	**1**
	$\text{Var}(X) = npq = 2 \times \frac{1}{13} \times \frac{12}{13} = \frac{24}{169}$	**IV**	**1**
	OR		
34(b).	It is given that 2% of the screws manufactured by a company are defective. Use Poisson distribution to find the probability that a packet of 100 screws contains (i) no defective screw, (ii) one defective screw.		
Sol.	Let X be the random variable and $\boldsymbol{p}$ be the probability of defective screws Then $p = \frac{2}{100} = 0.02, n = 100$	**I**	**1**
	$m = np = 2$	**II**	**1**
	(i) Probability that the packet has no defective screw $= P(X = 0) = e^{-m}\frac{m^0}{0!} = e^{-2}$	**III**	**1½**

	(ii) Probability that the packet has one defective screw $= P(X = 1) = e^{-m}\frac{m^1}{1!} = 2e^{-2}$	**IV**	**1½**
35.	Mr. Arya wants to know the amount he should pay for a gold mine expected to yield an annual return of ₹ 4 lakh for the next 10 years, after which it will be worthless. Find the amount he should pay for the mine, if he wants to yield 18% annual return on his investment and also set up a sinking fund to replace the purchase price. Assume that the sinking fund earns 10% annually. [Use $(1{\cdot}1)^{10} = 2{\cdot}5937$]		
Sol.	Let the purchase price of the goldmine be ₹ x Return on investment $= 18\%$ of $x = 0.18\,x$ Sinking fund is created to replace the purchase price $\therefore$ Amount to be placed in sinking fund $=$ ₹ $(400000 - 0.18x)$ Now, $A = \frac{Sr}{(1+r)^n - 1}$ $\Rightarrow (400000 - 0.18\,x) = \frac{0.1\,x}{(1.1)^{10} - 1}$ $\Rightarrow 400000 = x\left(\frac{0.1}{1.5937} + 0.18\right)$ Solving, we get $x = 1648125.25$ (approx.) Thus, the purchase price of the goldmine is ₹ 1648125.25 **Note:** Full 5 marks may be awarded to the students who attempted the question.	**I**	**5**

SECTION E

This section comprises 3 case-study based questions of 4 marks each.

36. Three schools A, B and C organised a mela for collecting funds for helping the rehabilitation of flood victims. They sold hand-made fans, mats and plates from recycled material at a cost of ₹ 25, ₹ 50 and ₹ 10 each respectively. The number of articles sold are given below :

School / Articles	A	B	C
Hand-made fans	50	30	35
Mats	60	35	40
Plates	40	50	25

Based on the above information, answer the following questions :

(i) What is the price matrix ? *1*

(ii) What is the sales matrix ? *1*

(iii) (a) What is the matrix of funds collected by School B ? *2*

OR

(iii) (b) What is the total amount of funds collected by Schools A and C ? *2*

Sol.

(i) $P = [25 \quad 50 \quad 10]$ — **I** **1**

(ii) $S = \begin{bmatrix} 50 & 30 & 35 \\ 60 & 35 & 40 \\ 40 & 50 & 25 \end{bmatrix}$ — **I** **1**

(iii) (a) Funds collected by School B

$$= [25 \quad 50 \quad 10] \begin{bmatrix} 30 \\ 35 \\ 50 \end{bmatrix}$$ — **I** **1**

$$= [750 + 1750 + 500]$$

$$= [3000]$$ — **II** **1**

OR

(iii) (b) Funds collected by School A

	$= [25 \quad 50 \quad 10]\begin{bmatrix}50\\60\\40\end{bmatrix}$ $= [1250 + 3000 + 400]$ $= ₹\,4650$	**I**	**1**
	Funds collected by School C $= [25 \quad 50 \quad 10]\begin{bmatrix}35\\40\\25\end{bmatrix}$ $= [875 + 2000 + 250]$ $= ₹\,3125$	**II**	**½**
	Total amount of funds collected by School A and C $= 4650 + 3125 = ₹\,7775$	**III**	**½**

37.

When observed over a long period of time, a time series data can predict trends that can forecast increase or decrease or stagnation of a variable under consideration. Such analytical studies can benefit a business for forecasting or prediction of future estimated sales or production.

Mathematically, for finding a line of best-fit to represent a trend, many methods are available. Methods like moving averages and least squares are some of the techniques to predict such trends.

Mr. Nitin runs a soap-making factory and the record of his sales of soaps for the period 2018 – 2024 is as follows :

Year	2018	2019	2020	2021	2022	2023	2024
Sales (in ₹ thousands)	80	90	92	83	94	99	92

Based on the above information, answer the following questions :

(i) Obtain the trend line to the given data. *1*

(ii) Find the average change in the sales. *1*

(iii) (a) Find the sum of the differences between the actual sales and the trend values (for 2018 – 2024). *2*

OR

(iii) (b) What are the expected sales for the year 2025 ? *2*

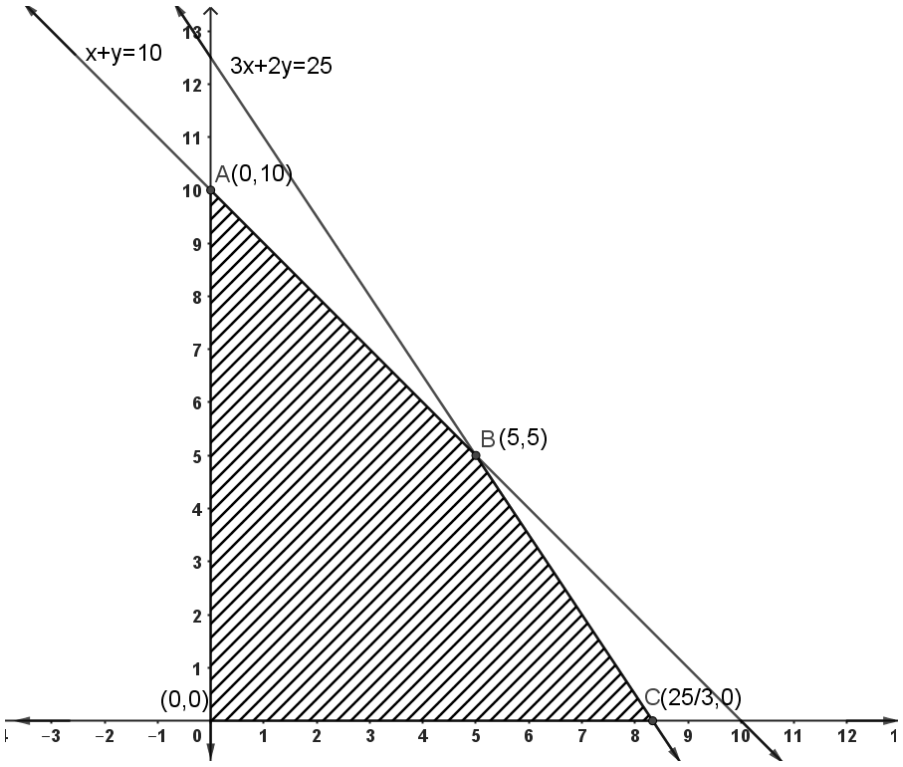
Sol.

Year (x_i)	Sales (in ₹ thousands) Y	A = 2021 $X = x_i - A$	X^2	XY	Trend value $Y_t = a + bX$
2018	80	-3	9	-240	$90 + 2(-3) = 84$
2019	90	-2	4	-180	86
2020	92	-1	1	-92	88
2021	83	0	0	0	90
2022	94	1	1	94	92
2023	99	2	4	198	94
2024	92	3	9	276	96
$n = 7$	$\sum Y = 630$	$\sum X = 0$	$\sum X^2 = 28$	$\sum XY = 56$	

(i)	$a = \frac{\sum Y}{n} = \frac{630}{7} = 90$; $b = \frac{\sum XY}{\sum X^2} = \frac{56}{28} = 2$	I	½
	Trend line = $Y_t = a + b\,X = 90 + 2\,x$	II	½
(ii)	Correct Table	I	1
	Average change in sales = b = 2×1000 = ₹ 2000		
(iii)	(a) $\sum (Y - Y_t) = -4 + 4 + 4 - 7 + 2 + 5 - 4 = 0$	I	2
	OR		
(iii)	(b) Trend value for the year 2025 = $90 + 2 \times 4 = 98$	I	1
	∴ Expected sales for 2025 = ₹ 98,000	II	1

38.	A man has ₹ 15,000 for purchasing rice and wheat. A bag of rice and a bag of wheat cost ₹ 1,800 and ₹ 1,200 respectively. He has a storage capacity of 10 bags. He earns a profit of ₹ 100 and ₹ 90 per bag of rice and wheat respectively. Assuming that he can sell all the items that he can buy, he purchases x bags of rice and y bags of wheat. Based on the above information and by formulation of Linear Programming Problem (LPP), answer the following questions : (i) Write the objective function which represents the total profit from the sale of total bags of both types. *1* (ii) Write the constraints that relate the total cost of both types of bags. *1* (iii) (a) How many bags of each type should the man buy to get maximum profit ? *2* **OR** (iii) (b) Find the profit that the man can earn by selling all the bags. *2*		
Sol.	(i) Objective function $Z = 100x + 90y$ (ii) Constraints are $x + y \leq 10$ $1800\,x + 1200\,y \leq 15000 \;\; i.e \;\; 3x + 2y \leq 25$ $x \geq 0\,, y \geq 0$ (½ marks for writing two correct constraints)	**I** **I**	**1** **1**

(iii) (a)



Correct graph — **I** — **1**

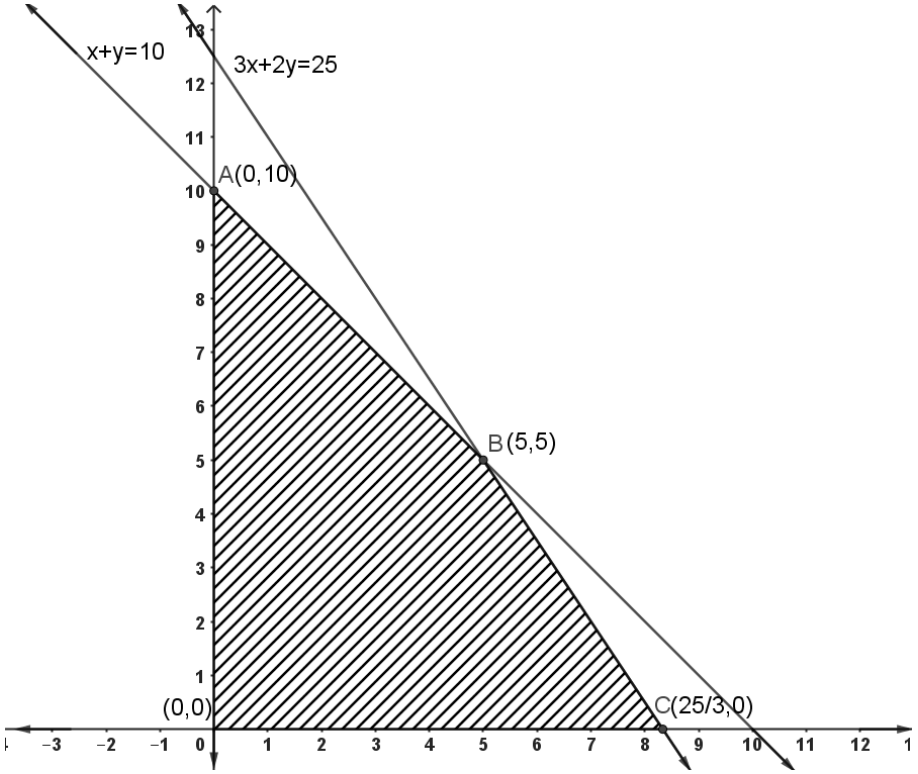
Corner Points	$Z = 100x + 90y$
O (0, 0)	0
A (0, 10)	900
B (5,5)	950 → Maximum Value
$C\left(\frac{25}{3}, 0\right)$	$\frac{2500}{3}$

II — **1**

To get max profit, a man should buy 5 bags of rice and 5 bags of wheat.

OR

(iv) (b)



Correct graph — I — 1

Corner Points	$Z = 100x + 90y$
(0, 0)	0
(0, 10)	900
(5,5)	950 → Maximum Value
$\left(\frac{25}{3}, 0\right)$	$\frac{2500}{3}$

II — 1

Maximum profit = ₹ 950

Note: Alternatively, marks to be given for solving without graph in part (iii)